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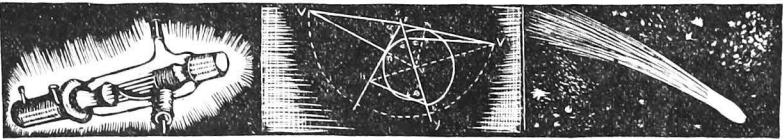
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**AN OUTLINE FOR BOYS & GIRLS
AND THEIR PARENTS**

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AN OUTLINE FOR BOYS & GIRLS AND THEIR PARENTS

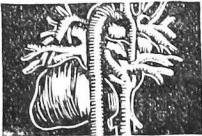
SCIENCE



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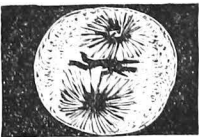
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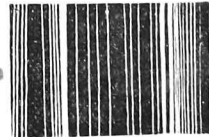
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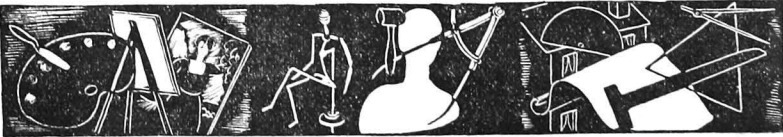
PSYCHOLOGY



BIOLOGY



CHEMISTRY



PAINTING

SCULPTURE

ARCHITECTURE

VICTOR GOLLANCZ LTD
14 HENRIETTA STREET W.C.2

1932

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AN OUTLI BOYS & GIRLS AND THEIR PARENTS

CIVILISATION



PAST

PRESENT

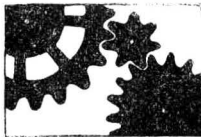
FUTURE



THE FAMILY



THE WORLD



GOVERNMENT



ECONOMICS



DANCING

WRITING

MUSIC

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THE WHOLE UNDER THE DIRECTION OF
DOROTHY HORSMAN



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DEDICATED TO

**DENNY, MURDOCH, LOIS, AVRION, AND VALENTINE
MITCHISON**

and

**LIVIA, DIANA, JULIA, VITA, AND FRANCESCA
GOLLANCZ**

EDITOR'S PREFACE



EDITOR'S PREFACE

APOLOGY

THIS is the editor, telling one of the authors she has had to alter his pet paragraph, and she *so* hopes he doesn't mind. I am the editor. I had never been an editor before, and I thought it would be fun. I thought I had only to make out a scheme for this book, a kind of short cut to Knowledge, and then collect a flock of the Great and Good and drive them along the short cut. I know better now. I collected the Great and Good and tried to shepherd them ; but they all had their own particular idea of where and what Knowledge is ; they all strayed more or less definitely off my short cut on to their own. Of course this really makes the book much more interesting to read, but if you knew what it is like trying to drive the Great and Good one way

when they want to go another—! That is what being an editor is.

If this book had been at least twice as long, it would have been easier to write. It is very difficult to get any subject into the short word limits which were all I could allow anyone. A great deal has had to be left out, where volumes might have been written. But this book doesn't pretend to be an encyclopædia, giving all the information about everything; what it does do, I think, is to give the beginnings of things, the foundations of knowledge, and to show why they are exciting.

One kind of knowledge will be exciting to one sort of person, but not to another. If you are bored by any chapter, go on to the next. The things I would have liked to put in, but hadn't room, are mostly what you can read about in other books; they are apt to be obvious, showy, outside kind of things. For instance, there is hardly anything here about engines, but there is a lot about the fundamental principles by which engines work; there is nothing about X-ray apparatus, but you are told more about what X-rays really are than most people know. Again, there are no descriptions of battles or coronations or even the detail of how people lived, but there is a great deal about how and why people had the kinds of ideas and organisations that they have had, and have now; and you can fit the trimmings on for yourselves. Or, again, there isn't any list of great literature, because that is the kind of thing which you can find out for yourself (and, if you are told you ought to read certain books, you will probably hate reading them!), but you are told why people want to write books. You see the sort of thing? But, all the same, there is a lot I would have liked to put in, and even more that the authors would have liked to put in—and here I make my apologies to all of them for having been such a brute with the blue pencil and cutting their favourite bits!

HOW TO READ THIS BOOK

There is nothing here which you ought to find too difficult, though some of it is very closely written, and you

will have to follow the argument as if it was a detective story (for instance, *Chemistry* and *The History of Ideas*). All the chapters are divided up into short parts, so that you needn't read for very long at a time, and can, anyway, stop and take breath. If you are eleven or twelve, you will probably only want to read bits of some chapters; you mayn't be interested in the whole of them. A few rather difficult bits which yet seemed too interesting to leave out have been put inside square brackets, and there are references to other chapters, so that you can look things up easily; there is an Index at the end.

I expect some of the chapters will leave you wanting to ask questions; that means that your fathers and mothers and teachers will have to think hard and do some more learning! For no one knows everything or can know everything—there is too much to know—but most of us know much too little; we ought to be ashamed of ourselves, but we usually aren't. Most of us think we are capable of governing the country (that is what being a democracy is), but very few of us are—including the ones who do! Government doesn't mean ordering about (anyone can do that), but planning, and planning means knowledge.

Intelligent grown-up people are very apt to know a lot about one kind of thing, but very little about all the other things; that is to say, they are experts. This is bound to make for muddles and misunderstandings. *The Outline for Boys and Girls* is an attempt to clear up these muddles, to make the people who will be running things in another twenty years aware of all the different kinds of knowledge and values.

THE SCHEME OF THIS BOOK

Though you mightn't think it, this book is planned on a definite scheme. It is all working outward, from Me or You (the one thing of whose existence one is fairly certain) to the Universe. From Now (the present) to all time, past and future.

The first part is about the getting, the measuring and the

putting together of scientific knowledge. The first thing about science is asking questions ; the next—and this includes the bulk of what is called scientific work—is measuring the knowledge and finding new standards of measurement ; and the final thing is putting all this knowledge together. That is perhaps partly what used to be called Philosophy, but now every scientist whose job it is to put things together ought to be a philosopher, and have some idea of the shape which his accumulation of knowledge is taking.

So in the first part, after the chapter on *What Science can do* (which I particularly advise you to read if you think, as many grown-ups, a lot of boys, and even some girls, do, that science can do everything !) and the chapter on *The History of Science*, which shows how scientific knowledge has been built up, you start with *Physiology*, which answers the question: What am I ? by saying that I am a living organism, and explaining what that is. Physiology tells you about your body and how it works, and also to some extent about your mind—your mind which is perceiving the whole of this book—because body and mind can't be separated. After that, *Psychology* tells you more about your mind, and especially the parts of your mind which you don't easily and immediately know about. Of course, this isn't the whole of what the "I" is—to understand that, one has to consider values as well as knowledge, and the question has never been completely satisfactorily answered, and probably can't ever be ; but that makes every sort of answer all the more interesting.

Then, spreading out from the "I," the body-mind, you come to *Biology*, the whole science of life—life of plants and animals, the next step outwards, but including you, because you are part of the animal kingdom, in very many ways the same as your dog or cat, in some ways the same as a jelly-fish or even an oak-tree. *Applied Biology* shows you how this knowledge about living things can be used for planning a better, happier, and more sensible world, and clearing up the muddles, and how it will be still more used in the future.

Spreading out farther still, you come to the question: What am I, ultimately, made of? And that, you will see, is the same question as, What is everything made of? You will get this very exciting question argued out in *Chemistry*.

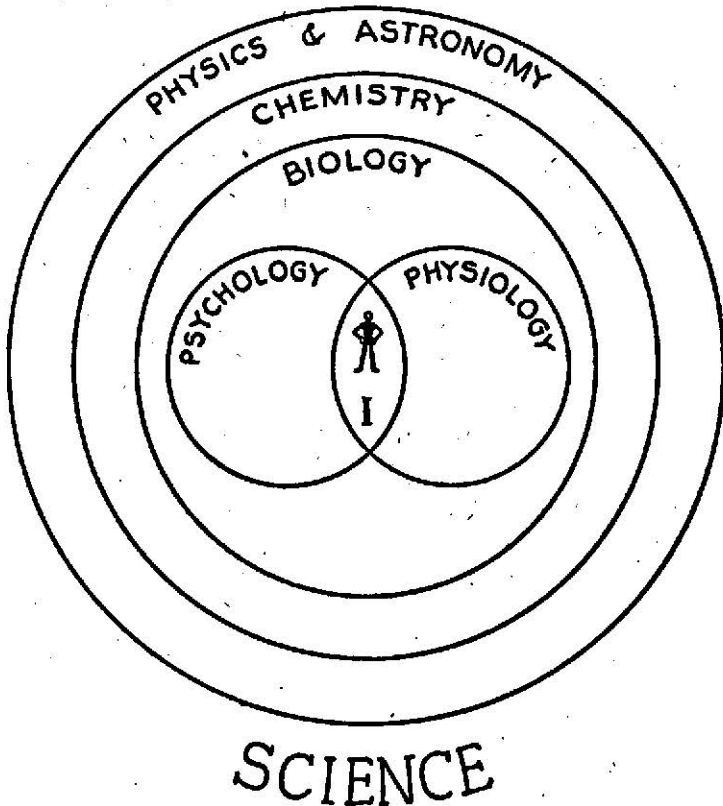


Fig. 1. HERE AM "I" IN THE UNIVERSE

You will find that you yourself, with everything else that lives, is made of the same kind of stuff—the same chemical elements—as trains or stones, air or rivers or stars. The chemistry of living things is called bio-chemistry, and is rather more complicated and difficult to work out than the chemistry of non-living things, but it is not really different.

After that, and apparently a long way from the "I" which lives and thinks, comes *Physics and Mathematics*, which is about the symbolic language which describes how everything works. Sometimes this carries us far beyond the realm of ordinary common-sense. It seems that physics cannot describe life at all; but yet the same general principles hold for us and for the whole of the universe; we are not separate.

Finally, you come to *The Structure of the Earth*, this earth on which we live, that we tread under our feet; this tiny earth broken off very long ago from the sun and still circling round it; this earth perhaps the only one of its kind in the universe, perhaps the only place where this movement, this feeling which we call life, can happen. You see how incredibly tiny you and your earth are in the pattern of the universe, something barely existent, and yet, if you can think of the universe at all, there it all is perceived in your brain, the whole universe a thought which has not even altered a cell in your body.

So everything fits inside everything else. The farther out you go the closer you come back in the end. That is the fun about knowledge. It is exciting to ask the scientific questions—questions which perhaps no one has ever asked before—and exciting to work out the careful and elaborate and delicate machinery for answering them, and exciting to begin to get your answers and to look at and re-interpret your facts, separating out those which are really important, and most exciting of all to see them fit in and light up the whole of the rest of knowledge. And, after the first part of this book, you see how this knowledge can be arranged and organised for the good of the world.

History is partly the story of the development and organisation of knowledge. Sometimes it seems as if the knowledge was developing mostly inside people's minds, making them different sorts of persons (more sensitive and aware—more civilised). And sometimes it seems rather to be developing outside them, altering their environment and the way they live. There is an immense body of knowledge now, but very little of it is really used as it might be. Most

people vaguely think they want the good of humanity, but they don't really help much to get it, nor can they until they can organise their knowledge.

And history is also partly scientific. One oughtn't really to separate the history and science parts nearly so definitely, but it made the scheme of the book simpler. When I say that history is scientific, I mean that, like the scientist, the historian is asking questions and finding things out. He gets hold of a lot of facts (for instance, the way people govern themselves, or the kind of houses they build, or the prices of bread at different times and in different countries), and he measures these facts against one another, just as the scientist measures his facts. But the historian's way of measuring is how people behave (for instance, how people think and what they do under a democracy in Athens and under a democracy in England or France: how people act when the price of bread rises in ancient Egypt, in the Middle Ages, or after the Napoleonic Wars). Here, again, everything fits together, though there are gaps in historical knowledge as there are gaps in scientific knowledge, and it is as exciting to be a good historian as it is to be a good scientist.

In the history part you will find the same plan of working out from the "I." First of all, you will find a kind of historical skeleton, an *Outline of World History*, to fit the rest of the articles on to. It is rather important to remember the sequence of historical events (how they follow one another), though the exact dates don't matter much. After this you come to the history not of men, but of man (if you like, not of women, but of woman), the history of the individual, how he became an individual, what went on in his mind, and how his mind dealt with the knowledge it gradually acquired; this is *The History of Ideas*. You will see that people always wanted to be happy, just as you or I want to be happy, and how they muddled it, and how they came to be the separate, lonely little individuals that they are.

After that you will see the kind of groups that these separate, lonely individuals tried to make, working

outwards from the "I." You will see the history of the first and smallest group, *The Family*, how it affected half the grown-ups, the women, and all the children. Then you will see the next kind of group, in *The Organisation of Society*, how people tried to get into a bigger and more satisfactory group than the family, and how they tried to

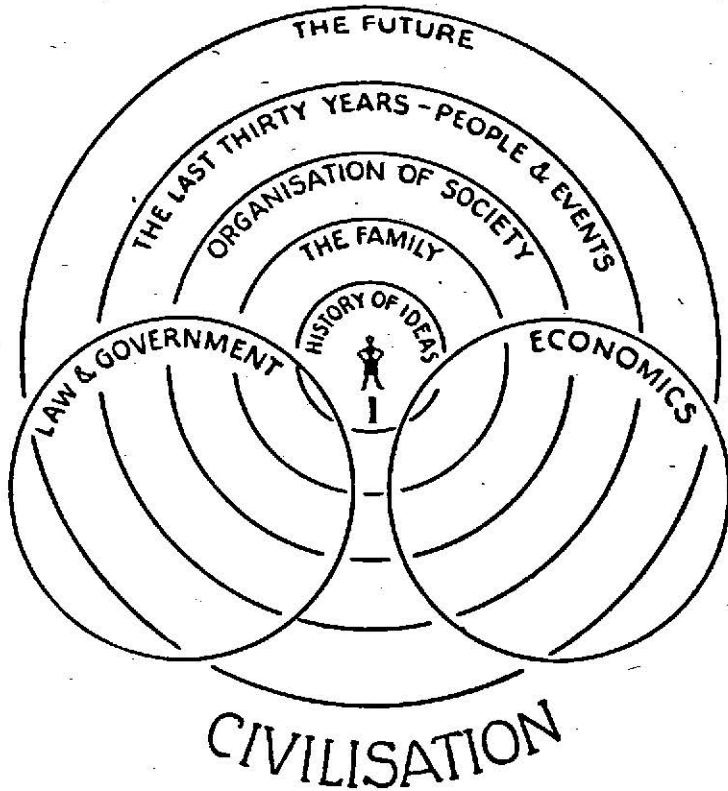


Fig. 2. HERE AM "I" IN THE PAST AND THE FUTURE

organise knowledge so as to make people safer and happier, and how, on the whole, they failed, mainly because they thought of things unscientifically (not in terms of knowledge, but in terms of values, and they got the values wrong). You will see how people dealt with knowledge as it came, and what a muddle they made of it, and you may come to the conclusion that this was because they would

still stick to the idea that they were all separate individuals, and that all the good, all the usefulness and profit that came from this new knowledge of theirs must go to separate individuals instead of to the group or to the whole of humanity. This goes on up to *The Last Thirty Years*, and even now. One of the worst muddles that was made by the misuse of knowledge was what is called the Industrial Revolution, which has made the kind of civilisation in which we live, and in which most people are very uncomfortable, and rather unhappy, and another of the worst muddles was the War.

Now you get on to the *Peoples of the World*, which shows you the group carried another stage out from the individual. It shows the peoples of the world grouped as nations, and then it shows that the time has come to change these divisions and to organise modern knowledge throughout the world as a whole.

Then there are two chapters showing in detail how the organisation of society works, especially in this country, but with reference to others. First of all there is a chapter about *Law and Government*, and then there is a chapter about *Economics*. If you are going to live intelligently in a society and be a good citizen, either of your country or of the world, you have to understand how power and knowledge and order are organised, and how the organisation can be altered.

Last, there is a chapter on the future—on the *Problems* of the world now, and some possible *Solutions* for them. This will show you how it is possible to be the best kind of individual, the best kind of "I," and at the same time to fit in with a group—to be what is called social. It shows how it is possible to be happy and adventurous and at the same time reasonably secure, and how best to use all this great body of knowledge which is there waiting to be used, and which is being added to every minute.

Then comes the last section of the book, which is not about knowledge or organisation, but yet about something without which people can't live good lives. It is about the arts, and how they give value to everything we do, how they make it worth while to be people. Again I have tried to plan them so that they start with the art which is nearest

to the "I," with *Dancing*, which is the art which the higher animals seem to practise and which was the first art for primitive men—dancing, which gives value to a baby's first rhythmical movements. Then comes *Visual Art*, painting and design and so on, the next thing which

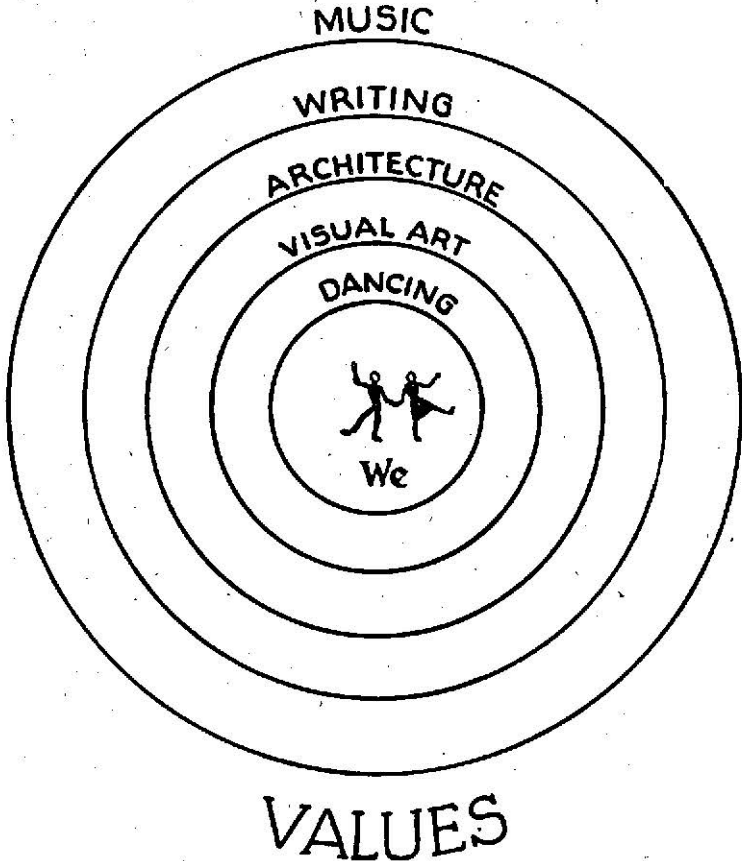


Fig. 3. HERE ARE "WE" IN THE WORLD OF VALUES

savages do and which the first men did, which children do from the time they are old enough to hold a pencil. Then comes *Architecture*, the next thing to be done—the thing which a child does when it is old enough to put one brick on top of another. Then comes *Writing*, which is later still in civilisation and later still for a child. And last comes

Music, the latest art to be developed, both among mankind and in our individual selves. You will see how each of these arts fits in, first of all with the "I," and next with the group, and you will see why these things, which are neither science nor organisation, are yet essential to any outline of life, which is what an outline of knowledge has really got to be.

THE AUTHORS

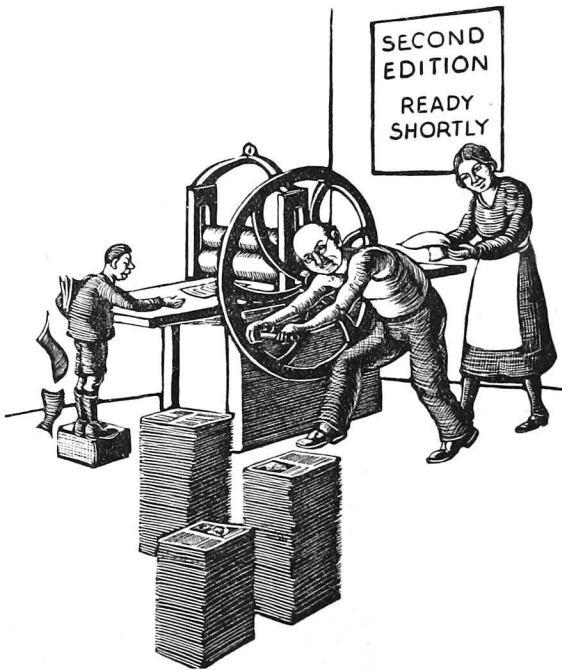
Some of my authors are eminent and some are not eminent yet. I have written biographies of most of them, but some of them would not let me do that, and others made me cut out what I thought were the best and funniest bits. Still, you can tell quite a lot about most of them; I have not put in a biography of William Kermode and Ista Brouncker who drew their pictures, because I thought if I did they might retaliate in their drawing of me. (He is an Australian, and the sort of person who makes one feel gay even on a very gloomy day when one is in the middle of editing. She is English, and very cheerful too.)

HOW TO GO ON READING

If you are really interested in a chapter, you can follow it up, partly by thinking things further out for yourself, and partly by reading the various books which the authors have suggested at the ends of their chapters. Some of them have suggested a lot of books, quite often grown-up books which you will probably not want to read the whole of. There is no virtue in ploughing steadily through the whole of a book after it has stopped saying anything to you, but equally don't turn a book down because the first chapter is dull; they often brighten up! Several people have suggested Wells's three big books, *The Outline of History*, *The Science of Life*, and *The Work, Wealth, and Happiness of Mankind*; don't try to read them straight through unless you feel like

it, but you are absolutely certain to find something you want to read in all of them. The National Book Council publishes lists of books on all kinds of subjects, drawn up by the people who know most about them, and you would certainly find them a help.

Some authors have only suggested one or two books, and others haven't put any, either because nothing has been written on their subject which would interest you, or else because if there has been they don't know about them, and I don't either. Please don't think that the books we have suggested for you to read are *all* the books which have been written interestingly about these subjects; there are lots of others, and if you find any particularly interesting ones which we haven't mentioned, perhaps you'll write and tell me about them. Then we can have a second edition (which we should like to do, anyhow!), and put them all in.



PART I
SCIENCE

**WHAT SCIENCE CAN DO (AND
WHAT IT CANNOT)**

by

JOHN PILLEY

WHAT SCIENCE CAN DO (AND WHAT IT CANNOT)

HOW WE STARTED KNOWING

WE CAN none of us remember what the world looked like when first we opened our eyes upon it, but we can be sure that it must have seemed very confusing and perplexing. Even now we are always coming across something that we have never met before, so imagine how bewildering it must have been when we began at the beginning, and everything in the world was strange and new.

Of course, we began at once finding out things about it. Almost the first thing we must have noticed as we were learning to use our eyes, must have been that some things remained still, and that others moved. We found, too, that some things in moving gave us a sensation quite different from seeing : this we came to recognise as their touching us. Then we discovered that we could move some of the things we saw, and recognised these as parts of our own body and the things they acted upon. And so our knowledge grew.

All this was at the very beginning, so long ago that we have forgotten about it. But it is easy to see that we had to *learn* to understand the difference between what was our own body and what was not, between things near to us, such as our toys, which we could touch, and far-off things, such as the other side of the street, or the moon, which were out of reach. And from this we went on ; the world opening to us rather like a field covered in mist seems to open out and grow bigger as the mist lifts. Before long we began to understand that there were two chief kinds of things in the world. First there were the living things. These included other people like ourselves, with whom we could talk and do things, and animals which, though they did not talk, often made very good friends. Then there were the things that weren't alive, such as the furniture, or houses, or the moon.

But we can only have come to see the difference between these two kinds of things rather gradually. At first we must almost certainly have thought that the fire in the grate, the clouds we saw moving in the sky, or a ball that we saw roll off the table, were living things. At the same time it wasn't easy to think of plants as being alive.

Our parents must have played a big part in helping us to distinguish between living and non-living things. If our parents, instead of being civilised people, had belonged to a primitive tribe, they could never have taught us to make any clear distinction between them. This is because primitive people haven't yet learnt to recognise the distinction. Even if we had been born amongst the people living in England only two thousand years ago, we should probably have looked upon any moving thing, such as a flame or a running stream, as being alive, or at least as being controlled by a kind of spirit (see *History of Ideas*, p. 446).

At first it was quite natural for us to look upon every kind of thing as being alive; it made us feel that we could understand it better. Most of us can remember looking upon our toys, and moving things like motor-cars, as being really alive, and in looking upon our pets as being actually a kind of people; it would not have surprised us at all if they had suddenly started a conversation with us. All this was great fun.

But as we grew up we gradually had to give up these ways of thinking, and had to learn to say that it was only fancy that made us do it. That was rather sad, as it made the world seem cold and indifferent to us. Instead of being full of things which we could talk to, and which we could sometimes love, it began to appear quite inhuman, and full of things the most we could do with was to understand and try to control.

ANIMISM

But as a matter of fact people never do altogether give up the belief that things in the world are really alive. This

we can see from the way they talk. In almost all foreign languages every noun has a gender ; this shows that people talk of things as though they were a kind of man or woman or thing. We ourselves in England often talk of the moon as she, or of the sun as he. And then we are inclined to talk of the crops as *wanting* rain, or of rivers *finding* their way to the sea, and even the most unimaginative can sometimes be caught swearing when they bark their shins against something, or when they can't get the number they want on the telephone. But of course they wouldn't admit that they really thought the thing they were swearing at was able to understand what they said.

But it isn't only in this that people give a hint that they still half believe in things being alive. Whenever you hear anyone ask *why* anything happens—*why*, for example, the water in the kettle boils when you put it on the fire, or *why* a stone falls when you let it go—they are really suggesting that the water and the stone might actually do quite different things, but that they do what you actually see them do because they want to, or because there is something in them which makes them do it.

This belief, which supposes that things are controlled by a kind of will or spirit, is called animism, from a Latin word, *anima*, which means spirit. The word turns up in another form when we talk of things being animated.

Sometimes when a controlling spirit is thought of as actually having a human form, or as acting in a definitely human way, belief in it is called anthropomorphism from two Greek words meaning human shape. You will find both Richard Hughes and Gerald Heard discussing this later on.

SCIENCE

One of the things which makes the world so interesting to-day is that people are rapidly giving up the animistic beliefs which guided most of their actions in the past. The reason for this is that definite orderliness has been recognised in the world.

If, instead of being mystified by what you see happening in the world, you set about observing it very carefully, and start making experiments, you find that things that resemble one another also behave in similar ways under similar conditions. Different pieces of iron, for example, at different times and at different places always rust when exposed to air and to damp at the same time. Again, different people show similar symptoms of illness when they are infected by the same germ. As soon as you have found out enough about the conditions under which any particular thing happens you can start foretelling when it will happen again, and can even make it happen, or prevent its happening, by controlling the conditions.

This gives us great power over nature, and, as we are coming to realise it more and more clearly, the belief that the world is mysteriously and erratically controlled by spirits is rapidly being given up. Instead of praying to these spirits for what we want, we are learning more and more to have confidence in setting about studying the conditions necessary to bring about what we want.

The study of the conditions under which things happen is the task of science.

Science, besides showing how happenings that obviously resemble one another, like the rusting of different pieces of iron or like two people having the same illness, depend upon similar conditions, has also discovered important resemblances between happenings which at first sight do not seem to resemble one another at all. The rusting of iron, for example, seems to have very little resemblance to the burning of fire. And yet science has discovered that the two happenings are alike in that they both depend upon the substance combining with a gas called oxygen in the air. So too there is a definite resemblance between the motion of bodies that are let fall and the motion of planets round the sun. This resemblance isn't at all easy to see, and it was the great achievement of Newton that he did see it. He showed that both these kinds of motion happen in the same way, and can be described as being due to a force of attraction called gravitation.

LAWS OF NATURE

When scientists discover the exact relation between certain kinds of happenings and the conditions under which they always take place, they say that they have discovered a "law of nature." When scientists first adopted this phrase, they were inclined to think that things that happened did so in obedience to laws, in much the same sort of way that people behave in obedience to the laws made by Parliament. This shows that they were still clinging to an animistic outlook, which, as scientists, they had to learn to give up. Nowadays scientists don't really think of things as being *obedient* to laws any longer, though they still often use the phrase. What they mean is that it is possible to *describe* things that happen by means of laws in a way which makes it possible to make predictions.

As a matter of fact, our whole language, because it has been built up as a means of conversing and co-operating with other people in pre-scientific ages, is highly charged with animistic meanings. It is almost impossible to say anything about non-living things that does not suggest that they act upon one another in the same way as we ourselves, or other people, act upon things—that is, by wanting and deciding to. This is a great disadvantage in science, where it is necessary to get away from animistic beliefs. To escape from them, scientists are taking more and more to putting their results in the special language of mathematical equations. This describes how things happen, without at all suggesting that they have any likeness to human action.

All the same, scientists in their use of ordinary speech are very much given to using words with very animistic meanings. They talk of the "life" of radium, of chemical substances being "active" and of atoms being "excited" almost as freely as a poet might talk of flames being "hungry." When you come to read the scientific parts of this book you will recognise lots of words being used animistically. You will find that these words as a rule make what you read about seem much more vivid

and exciting. This is because they suggest all sorts of things that you are familiar and on good terms with. But though the use of these words may make you feel that you are understanding particularly clearly something that the scientist is telling you, you must remember that they all carry with them animistic meanings that science is really busy contradicting. If you were to ask a scientist to write about his subject purposely leaving out all the words that were at all strongly animistic, what he wrote would necessarily seem dull and heavy. You mightn't like it so much, but it would be more scientific. For it to be completely scientific most of what the scientists had to say would have to be written as mathematics. That you almost certainly wouldn't like, but it would be still more scientific!

HOW LAWS ARE DISCOVERED

We are so used to hearing of the laws of science that we seldom stop to think how they are discovered. A scientist certainly does not discover new laws by going up a mountain like Moses and bringing them back inscribed on tablets of stone. It is a much longer and more difficult process. The scientist first notices that there is a resemblance between a number of things which he has observed and between the conditions under which they take place. He then says to himself, If this kind of thing always takes place under these conditions, it must follow that certain other things besides the things I have observed will also happen. He then sets out to find out whether these other things which he has prophesied do really happen or not. If they do, it will make him think his "law" more and more likely to be true. If none of the things he prophesied do happen, of course, he knows that he was altogether wrong, and must start again. But suppose that a law seems fairly well established, a lot of the prophecies have come true, and then something happens which is not exactly according to the rule. This can mean two things—the law

may be right, but the observations insufficient, or the observations may be right and the law wrong. A very good example of this is found in the motion of the planets.

It was discovered first that there were irregularities in the orbit of Uranus, which, if the planetary system consisted of only the planets already discovered, could not be accounted for by Newton's laws. If, on the other hand, there was another planet outside Uranus, so faint that no one had noticed it, the attraction between it and Uranus might account for the variations in the orbit which were giving trouble. It was even found possible to work out on paper that it should be found at a certain time in a certain part of the sky. When the telescopes were turned on that part of the sky, there it was; a new planet—Neptune—had been discovered.

So far the law was proved right; it was the observation which had been insufficient.

But then it was observed that Mercury, the nearest planet to the sun, also seemed to show irregularities in its orbit. Astronomers, encouraged by their former success, concluded that there must be another planet even nearer to the sun than Mercury, although no such planet had ever been seen. They went so far as to give it a name, Vulcan; they calculated where it should be, they turned their telescopes on the spot—but Vulcan wasn't there. The astronomers had now to admit that the laws of Newton—which they thought established beyond question—might be wrong. It remained for Einstein, with his theory of relativity, to suggest a law which would account, not only for the motion of the planet Mercury, but also for everything that was accounted for by the laws of Newton. It was this apparently unimportant irregularity in the movement of an unimportant little planet—things which an ordinary newspaper wouldn't think worth mentioning in its news columns—which caused one of the most important revolutions in the history of science, and altered all our ideas about the nature of the universe.

The important thing about scientific laws is that they enable the scientist to predict what will happen under

particular conditions. They are, therefore, an important guide in making practical use of material things. For example, it is through a knowledge of the laws of chemistry that chemists can make such things as medicines, dyes, or metals with particularly useful properties. It is through a knowledge of the laws of heredity that biologists are able to breed plants and animals which have qualities of particular importance (see *Applied Biology*, p. 215). And we could go on giving other examples indefinitely. In fact, all the things that make our age so materially different from all that have preceded it, such as our improved health, our power to fly in aeroplanes, to talk across oceans, and to make machines of every kind, are a result of the careful application of our knowledge of the laws of nature.

THE DIFFERENT SCIENCES

Scientists have found it possible to describe the behaviour of things of every kind according to laws. But as a matter of convenience they have found it best to study different kinds of things separately as special sciences. To these they give special names. The science which studies living things is called biology. The branch of this which deals with plants is called botany ; the branch which deals with animals is called zoology ; the branch which deals especially with our own bodies is called physiology. Then there are the sciences which study non-living things. Of these, the most important are astronomy, which studies the composition and structure of the universe ; geology, which studies the composition and structure of the earth ; chemistry, which studies the composition and structure of different substances found on the earth and how they change into one another ; physics, which takes on the problem of what substances are made of at the point where chemistry leaves off ; and finally mathematics, which studies and develops the ways of thinking that are especially valuable in science.

These sciences are not, of course, really separate and distinct, but all overlap with one another. All living things,

for example, are composed of the same kind of matter as is studied by physics and chemistry. A knowledge of these sciences is therefore important in helping the biologist to understand the changes that he has seen happening in living things.

But the method of discovery is the same in all sciences ; it depends upon observing things closely and discovering " laws " by which they can be described.

SCIENCE AND LIVING THINGS

In studying living things, the biologist has to avoid animistic explanations and look for laws to describe what he sees happen, just as much as the physicist has to in studying non-living things. The physicist does not say that a stone falls because it wants to, or because it likes the earth ; he shows that its falling is like that of other things that have weight, and that its motion can be foretold according to the law of gravitation. In the same way the biologist must not say that a plant grows towards the light because it wants to, or because it likes the light ; he must show that the plant grows according to biological laws. He must show how the light acts upon the leaves of the plant, and must trace the effect of this through a number of chemical and physical changes on the direction in which the plant grows. He must show that what happens at each stage is in accordance with accepted laws of biology.

Exactly the same applies to the scientific study of people. If a scientist sees a man reach out for a glass of water, he must not say that he does it because he wants to, or even because he is thirsty. He must start with the action of the light reflected from the water on the man's eyes, and must trace the consequences of this through a number of nervous and physical changes which result in the man reaching out for the water. What happens at every stage must be in accord with well-recognised laws.

But this may seem to you to be showing that science leads to the very unsatisfactory conclusion that people, you and I included, go about our lives in accordance with

natural laws, and are therefore nothing but a kind of complicated machine.

But if you think it over you will see that science must come to this conclusion because of the very way it looks at things.

It does not look at things as a whole and as you experience them. It concentrates on the resemblance between things that actually are different, and builds up laws on these resemblances. From the very beginning it leaves out everything that doesn't fit in with a law. This being so, it isn't surprising that science leads to the conclusion that everything happens according to laws. In the same way, it wouldn't be surprising that a man who went about his life not noticing anything that wasn't blue should come to the conclusion that everything *was* blue.

Actually no two things can ever resemble one another completely; even two pins or two drops of water differ slightly, and in so far as they differ science can have nothing to say about them. With non-living things like drops of water it doesn't matter very much if you concentrate only on the resemblances, and leave out everything else, as the differences aren't usually important. But with other things, particularly living things, it is just the differences that are interesting and exciting. If people were as alike as drops of water, they would behave in ways that were as alike under the same conditions. This would make them terribly dull to live with, but it would also make it possible to discover laws about them which would enable you to say what any person was going to do under any given conditions. And so you could build up a science of people as easily as you now can a science of chemistry. But actually people are so different that it is only possible to foretell to a very small extent what they are ever going to do.

Some scientists say that it is only a question of knowing enough about things or about people to be able to foretell exactly how they will behave under any given condition. But this is a mistake. Scientists can only foretell how a thing is going to behave when it resembles other things closely and can be expected to behave in the same way.

Prediction says that what is going to happen will be like something that has happened before. But in some respects every new happening is different from everything that has ever happened before, and in these respects it is impossible to make any prediction about it. In other words you can never know enough *before-hand* to be able to say exactly what will happen. You may find after something new has happened that it resembles other happenings, and so can be described by a law, but you can only discover the law *after* the thing has happened, and so could never have used it as a means of predicting.

WHAT SCIENCE LEAVES OUT

One of the dangers that scientific people run is that they become so interested in the resemblances between things, and the words that stand for them, that they lose sight of the things themselves. Of course, we all recognise resemblances between things, and use words for them, whether we are scientists or not. We may call a large number of different people clever, or ugly, or good cricketers, because of some kind of resemblance between them. But we never look upon cleverness as anything that exists apart from clever people. What is more, in calling anybody clever we usually bear in mind that this is never more than an incomplete description of what we feel about them. The better we know a person the more incompletely will any word or words seem to describe them.

But scientists often forget that the same is true of their special words. They talk as though weight, density, pressure, temperature were things that existed of themselves. This is because they are seeking scientific knowledge for its own sake; their interest in building up a pattern of scientific ideas makes them forget the things which they are really talking about. As a result, their picture of the world contains nothing but "things" which seem very shadowy and unreal to anyone else.

To discover resemblances on which to build laws the

scientist has usually to take the things he is studying to pieces; the result of this is that something is inevitably left out. If you parse a poem and break it up into its separate parts of speech, you may find out a good deal about its construction, and how this resembles the construction of other poems. But so long as you fix your attention only on the grammar you must miss all that is really important about the poem. The same is true of all analysis. If you were to be handed over to the chemist for him to work on, he would analyse your body into its chemical constituents and could find out exactly what substances it was made of. He might even present your executors with a row of little bottles, all neatly labelled, containing the separate substances of which you were made. But still there would remain a good deal about you of which he could say nothing, for all his analysis. A physiologist would analyse you in a different way. He would dissect your body, and show how each part of your body resembled the parts of other people's bodies, and the bodies of other mammals, but still he could say nothing about all that made you yourself. The same applies to the psychologist. He would study what you said and what you did, and would show how this corresponded with what other people said and did. But he too would have to leave out all that made you different from other people.

What it comes to is that no scientist can ever say anything about you as an individual person differing from everyone else. All he can say is that in some respects you resemble one group of other persons and in other respects another group; but these are the respects in which you are not different from other persons. The people who are interested in you *as yourself* are the people who love you; perhaps too the people who hate you. If they wanted to tell other people about you, they would have to write a book about you. They would not set out to show that you were made up of this and that constituent, but would show you acting in a variety of circumstances so chosen that you would be most typically yourself. In this they could only really succeed if they were artists.

THE ARTIST

Those whose desire is to feel and to express all that they experience as fully and as vividly as possible must always be on their guard against having their vision restricted in the way that is necessary to science. In telling us about what they experience they must never let themselves be tied by words. They must realise that words are but an unsatisfactory means of expressing to others what they feel.

And yet words in the hands of the artist can carry the expression of feeling a very long way. By weaving words into patterns, rare people—poets we call them—can breathe magic into words and give to them meanings which they never had before.

But words are not the only means whereby human feelings can be expressed. Feelings may also be expressed without words at all, as in the arts of music, or of design, or of the movement of the body. Of these you will read in the last section of this book.

Science progresses from age to age ; as it learns to analyse things more and more and more completely, so does it build itself up. But art does not progress in this way. As an expression of the fullness of men's feelings in any age it has its periods of richness and of poverty which come and go with the fullness of the feeling of the age.

What the artists of any age have to express is the feeling of their age, and this is always different from the feeling of any other age. And so art is always appearing in new forms. But, though its forms change, it is always about the same thing—the feeling of man in his ever-changing world.

THE HISTORY OF SCIENCE

by

DR. CHARLES SINGER

AND

DOROTHEA WALEY SINGER



CHARLES SINGER is a Professor in London and California, President of all kinds of things, with lots of letters after his name. He and his wife, Dorothea Waley Singer, do a great deal of writing and other work together, on the sound principle that two heads are better than one. They have a son and a daughter and a great many friends. He has written a lot of books, mostly about the history of science, and how science fits on to the rest of thought and life, and now he and Mrs. Singer are putting some of this knowledge in front of you, in their chapter. You have seen already what the attitude of the modern scientist is, on his own subject. Now you will see how people in the past have thought about science, and how they collected and put together their knowledge. You will see what a fascinating history it is, how it runs on into the present, and fore-shadows what will yet be done.

THE HISTORY OF SCIENCE

INTRODUCTION: WHAT IS SCIENCE?

WHAT is science? We begin to think at once of such school subjects as physics and chemistry and botany. Or perhaps we may think of the conveniences of life—engines and cars, telephones and wireless. We know that all these have meant centuries of study by many generations of men, each adding something to the knowledge of those who went before. But as we come to study the history of science we shall see that, while men have always been eager for the useful results of knowledge, they have not always been interested in the knowledge itself.

In trying to decide what is science, we have already found ourselves using the word KNOWLEDGE. So SCIENCE means some kind of KNOWLEDGE. The word science comes from a Latin word meaning knowledge, or knowing. But is science every sort of knowing? Suppose we look at a beautiful sunset; we *know* that it gives us pleasure, we *know* that it presents colours to our eye, we *know* that the sunset effect is *caused* by the effect of the atmosphere on the sun's rays and by the gradual looming up of the bulging curve of the earth between the sun and ourselves. Yet not all of these kinds of knowledge are science. In the chapter on *Physics* you will learn something of what sort of light it is that gives our eye the sensation of red. It is that sort of light that gives the sunset effect to an evening sky. It is, as we may say, the *cause* of the redness. We shall come to decide that science has to do with *knowing the causes* of things.

But what sort of things? Well, when we try to study systematically what causes produce what effects in almost any subject, we are giving scientific study to that subject. Thus, if we make a systematic study of how cricket is best played, we may say that we study cricket scientifically. So we may

decide that to be *scientific* is *systematically to study causes*, or, more generally still, systematically to study how different happenings are related to one another.

When we speak of science in the English language, we usually mean the systematic study of causes in nature, and by nature we mean the whole world around us as it exists apart from what we try to do in it. In fact, we mean *the nature of things*. So let us decide that by SCIENCE we mean the systematic study of the nature of things.

When did man first make a systematic study of the nature of things? Well, if we leave out that one important word, *systematic*, we must answer, "From the beginning," and by "beginning" we mean beginning both of the human race and of the human being. If we watch a tiny baby we shall see it moving its limbs, trying to touch its cradle, its own body, perhaps the faces of those who tend it. It is making its first and feeble efforts to understand, to get at home in the world. Very soon it becomes conscious of a certain order in the world around it. If it is a well-ordered baby, it will lead a rhythmic existence, with definite periods for sleep, for exercise, for food, even for laughing. This order in its own life will build up faith in order outside itself.

So too must early men have made efforts to understand the world into which they had been born, and come to see ever through the ages more and more of order. Mankind's first observations, like those of the baby, must have been vague and unsystematic. Presently, however, the desire for order led him to observe a certain order in the world (see *History of Ideas*, p. 443). He came to notice the habits of animals, and to observe how regular they are. He came to mark the recurring seasons, in which there came up the herbs and fruits which he could gather and eat. Man, while still a hunter, learned his two first crafts, the making of fire and the making of instruments. The first fire was perhaps made by striking two flints sharply against one another and kindling dry tinder from the sparks. More difficult was the craft of flaking flints to make sharp pieces for use as arrowheads or knives or scrapers. Gradually man learned the properties of other substances. He found that the skins of animals could be

tanned and the hides used for warmth. He learned the principle of the needle. Presently, too, he was weaving baskets from reeds and even cloth from vegetable fibre, sometimes strengthened by the quills of birds. The purgative and other medical properties of certain herbs came gradually to his notice. He developed, too, a simple surgery for treating accidents. A great discovery was that wet clay could be moulded into pots, and that fire could be used to harden these pots without destroying them.

Man was thus making the first steps to understand the world around him and so to control his surroundings for his own comfort. Was he also thinking about the nature of things? Surely he was (see *History of Ideas*, p. 417). From the first, men may have had an idea that the general run of things depended somehow on their essential nature. And, the more strongly they have believed this, the more work they have put into trying to understand that essential nature. And what is this but the search for an orderly system of cause and effect that we have agreed to call science?

The ancient civilisations of which we know most are those that arose around the eastern half of the Mediterranean, in Egypt, in Babylonia, in Crete, in Palestine, in Persia, in Asia Minor and the neighbouring islands, in Greece, and in Rome. All these different civilisations had an effect upon each other, just as, to-day, books and works of art from one country influence other distant countries. We know that in our own day some peoples are far more ignorant than other and more civilised peoples. So it has always been. Therefore we cannot study the history of scientific knowledge as though it were a continuous story of steady gain all over the world. For, on the one hand, we often cannot separate from each other the ideas of different peoples; and, on the other hand, subjects that we regard as quite distinct were not always so regarded. Our modern scientific knowledge has, in fact, been built up very slowly and laboriously on the work of very many peoples. For sometimes one people and sometimes another seems to be able to help most in this advance of science. And, even when travel was not so easy as it is to-day,

there were those who made it their special business to bring the knowledge of one country to another. Thus Arabs brought to Europe the methods of arithmetic that they had learned from India and that we use to-day. From Babylonia we learned some of our first astronomy. Egypt taught us the chemical properties that enable us to make glass. The Greeks were the first great geometricians, and they tell us in their writings that they learned the beginning of this art from the ancient Egyptians.

One of the strangest things that mark an early stage of civilisation is the way in which several ideas that seem to us contradictory are accepted at the same time. Thus it might be thought that a god had caused the destruction of a crop, and this belief would still be expressed in elaborate ritual, though it had been discovered that for successful cultivation the ground should be watered in the cool of the evening instead of in the noonday sun. We shall find many examples of these mixed beliefs as we trace the history of ideas about science. In fact, what marks the advance of civilisation is clear thinking, and what marks the backwardness or decay of civilisation is confused thinking. Of all the early peoples, the first to develop a consistent habit of clear thinking were the Greeks. And in that sense, and in that sense alone, science began with the Greeks.

EARLIER GREEK SCIENCE

In the seventh century B.C. there was born at Miletus, in Asia Minor, a man of mixed Greek and Phoenician origin named Thales. He is often described as the first philosopher. He had theories about how the world was made, but he was also keenly observant of the details of nature. He much impressed his contemporaries by correctly predicting an eclipse of the sun for November 585 B.C. We can imagine how all were in terror at the sudden darkness, giving wild explanations of why the gods were angry, while Thales calmly watched the gradual disappearance of the sun's disc and waited quietly for the great light to emerge. The power of

Thales to predict an eclipse came, in fact, from a rule concerning eclipses that he had learned from the Babylonian astronomers. The people of Babylonia devoted much attention to the study of the heavenly bodies. They kept records of observations of the stars and planets, and these formed the beginnings of the science of astronomy. Astronomy depends on the piecing together of observations spread over very long periods, often hundreds of years. It is startling to realise that those who observe the stars, and keep records of what they observe, have been at all times only a handful

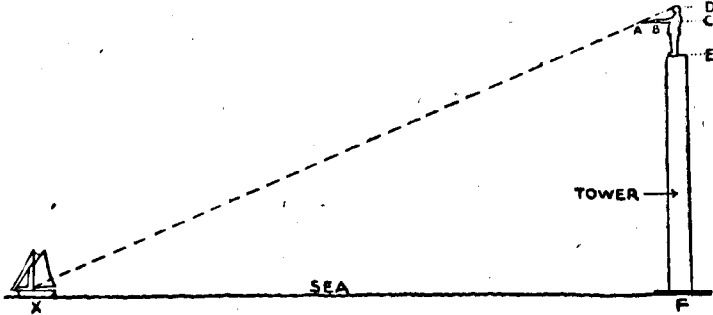


Fig 4. Observer D E, D being the level of his eyes. He holds rod A B extended horizontally by his hand B C to a position such that D A is in alignment with the boat X. The similar triangles are D C A and D F X. The distance of boat from shore is given by the relationship:

Distance of boat X from tower (X F)

Distance of rod end A from Observer (A C)

Height of Observer's Eye D above the arm level (D C)

in number. Yet their work goes on through unnumbered generations, and on their work the knowledge, and to a large extent the civilisation, of our day has been built, and still depends. For on this branch of knowledge depends our calendar, the very framework of our daily life. But Thales had also visited Egypt, and had there learned something of geometry and improved on his originals. In Egypt the land is flooded by the Nile every year. When, therefore, the waters subside, the land has to be surveyed again. Thus some rough rules of geometry (the word means literally "earth measurement") were developed. These Thales adopted, and applied to his own special problems. Thus, for instance, by the law of similar triangles, he was able, by standing at the

top of a tower by the seashore with a rod held horizontally in his hand, to measure how far a ship was from the shore (Fig. 4).

No people have been keener than were the Greeks to investigate and find order in the world around them. To-day, when we want to study science, we know that we must begin by considering one set of things at a time. But ancient peoples were always seeking a complete explanation of the whole world and how it works. Thales probably thought less of what we should call his *scientific* results than of his general theories about the world and its ways, which we should call his *philosophy*. Many ideas in our modern science came to us from Greek philosophy. Thus students of science to-day think that everything on the earth and in the stars is made up of little centres of electricity, or "electrons," as they are called (see *Chemistry*, p. 275). This idea had been suggested by the thoughts of some of the successors of Thales. They had an "atomic" theory, which passed into modern times and gave place gradually to the "electron" theory and to many other mathematical and physical theories.

Many Greeks who lived after Thales hoped to find that the whole world and all its workings could be explained by some reduction to simple terms, such as "atoms." In spite of repeated failure, this hope of a final explanation lived on. One of the most famous of those that clung to this faith or hope was Heraclitus (540-475 B.C.). He was overwhelmed by the thought that *change* is the essential principle of nature. He expressed his philosophy in the phrase, "All things are in a state of flux," which is echoed by the phrase, "There's nothing is and nothing was, but everything's becoming."

The idea that all things in heaven and earth are made up of "atoms" too tiny to be perceived was elaborated by Democritus in the fifth century B.C. The word atom means indivisible. Democritus believed that these indivisible atoms are all of exactly the same substance, but of different shapes and sizes, and that they are separated from one another by "space" or "emptiness," which to him

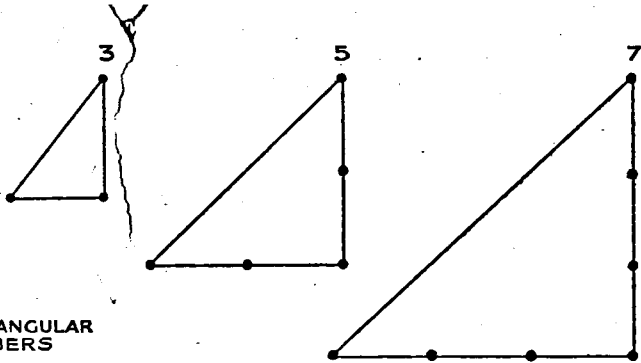
were just as real and important as the atoms themselves. The atoms, he believed, are all constantly moving about, sometimes jostling one another and sometimes fitting against one another. Some 500 years later, the Latin poet Lucretius wrote a very beautiful epic *On the Nature of Things*, in which he expounds the theory. He is contemptuous of the old myths of the Greeks and Latins that explained things as happening at the will of gods and goddesses. Storms at sea, he says, for example, are caused not by the anger of Poseidon, the sea god, but by the rapid movement of the little atoms that make up the water.

But while philosophers were making *theories* about the way Nature might work, others were making and recording observations which helped to show how in fact it does work. These men were specially successful in what we now call mathematics and medicine.

Mathematics stands perhaps midway between philosophy and science. It is in one sense a game, as we may call it, that may be played entirely by argument, according to rules. Yet, unlike other arguments, we can test mathematics *at every stage* by seeing if its conclusions correspond to what we find in the actual world around us. Sometimes we find that they do not correspond, and then an alteration has to be made in the rules, as was done by Newton, and again in recent times by Einstein.

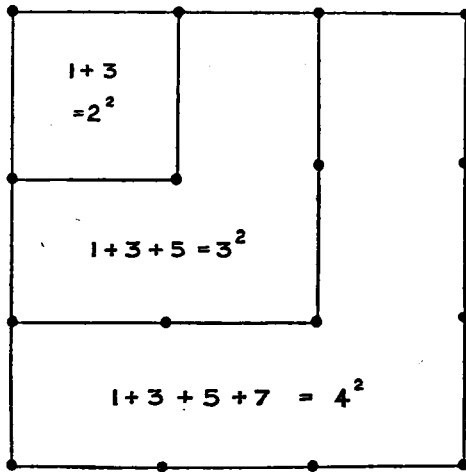
John Pilley has explained, on p. 25, how something was discovered which Newton's laws would not account for, and how Einstein had to think it all out afresh. Richard Hughes has told you more about it on p. 318. And we can be sure there is more to come.

Pythagoras is the first great Greek mathematician of whom we hear, and he lived soon after Thales. Pythagoras founded a queer sort of sect, whose work was done in secret and only their results known. They were greatly interested in numbers (see *History of Ideas*, p. 440), and perceived all sorts of relations in numbers that had not been noticed before. Thus they noticed that if dots are placed in a series, thus :



THE TRIANGULAR
NUMBERS

and if consecutive numbers be added up, thus :



then the first can be arranged in triangles and the second in squares. Hence they spoke of them respectively as triangular and square numbers, and we still have an expression of this in our term "square roots." But the Pythagorean terms *triangular* and *square* numbers remind us how they did many processes by geometry for which we should use arithmetic or algebra. In fact, they could not do otherwise, for they had no system of numbering in which, as in ours, the digits depend for their value on their position. It is wonderful how far they advanced in mathematics despite this disadvantage.

The Pythagoreans regarded the circle and the sphere as

the most "perfect" figures, and this perhaps led them to suggest that the earth and all the heavenly bodies are of spherical shape (see *History of Ideas*, p. 443). It was a Pythagorean who first suggested that the earth is not, as men had believed, in the centre of the universe, but that earth and the planets and sun and moon are all revolving round one great central fire. The Pythagorean Empedocles (about 450 B.C.) supposed that all matter was made up of the four essential elements, earth, air, fire, and water. These were in opposition or alliance to one another. Thus water was opposed to fire but allied to earth. Each of the elements was, moreover, in its turn compounded of a pair of the four "primary qualities," heat and cold, moisture and dryness. These qualities exhibit affinity and opposition, as do the elements. The theory has left its mark on our language, for we still speak of a storm as "the raging of the elements," and we wear coats "to protect ourselves from the elements," and we think of "elemental forces." Nor have we difficulty in understanding references to a "fiery nature" or to an "aerial spirit." These things come to us from Empedocles, and later through Aristotle (p. 46).

Another follower of Pythagoras was Alcmaeon, who dissected animals and discovered the nerve of sight and the tubes that extend from the mouth to the ear. If you pinch your nose and puff out your mouth you will feel something move inside your ear. This means that air is driven into the ear-drums through passages connecting them with the mouth. This discovery was forgotten until it was made again in Italy 2,000 years later!

THE GOLDEN AGE OF GREEK SCIENCE

The greatest of the Greek physicians was Hippocrates, who was born in the small island of Cos, in the Ægean Sea, about 460 B.C. The special gift of Hippocrates to mankind was not so much any discovery, or even any particular sort of treatment, but rather what we must call his personality and his conception of how a doctor should go

about his work. Learned, observant, humane, anxious both to help his patients and that his experience should benefit other physicians, orderly and calm, thoughtful, reticent, pure of mind and master of his passions—such was the Father of Medicine as he appeared to his contemporaries and successors.

The first complete Greek scientific works that have come down to us bear the name of this Hippocrates. Of course, our methods of medicine have changed since his time, and will doubtless often change again, but the Hippocratic ideal will always remain. It is interesting, too, that Hippocrates was a pioneer in seeking an orderly relation of cause and effect. There is a disease called epilepsy which is very difficult to treat. In the time of Hippocrates it was called the "Sacred Disease," and attributed to the special action of the gods. In a very fine passage, Hippocrates declares that "this disease is neither more nor less sacred than other diseases, for, like them, it must have a cause which can be discovered if we seek it diligently enough." This is the doctrine of causes which makes science possible.

About the same time there lived another Hippocrates who came from the island of Chios, also in the Ægean. Hippocrates of Chios became a great geometer. He is the first person of whom we know as having compiled a work on the *Elements of Geometry*. It formed the basis of the work of Euclid of Alexandria 100 years later (p. 50).

The fourth century before the birth of Christ was the period of the famous Greek writers and thinkers whose home was Athens. Greatest of them all were Plato and his pupil Aristotle. Plato was specially interested in the realm of the mind. He sought for order there rather than in the physical universe. He was always thinking about the perfect life for the individual human being, and for the community composed of noble individuals. For mathematics he had the profoundest respect as an expression of the perfect order of nature, but he could see less order in nature itself, and so he made little progress as a naturalist. Like the Pythagoreans, Plato felt a poetry in mathematics, and

like them he was interested in the relation of music and mathematics. To Plato we owe the entry of mathematics into general education.

Aristotle, the pupil of Plato, not only wrote on such subjects as ethics and politics, but was equally interested in the details of natural knowledge which did not appeal to his master. An important incident in Aristotle's life was his time as tutor to a young prince who afterward became the Emperor Alexander the Great. Alexander did much to encourage science, and his old tutor, Aristotle, afterwards founded at Athens the first true scientific school, known as the *Lyceum*.

Aristotle's search for order extended into the material world, and included every department of physical and biological knowledge. In astronomy and meteorology, even more obviously than in other sciences, each generation must build on the work of its predecessors. Aristotle's astronomy was built, not only on the observations, but also on the explanations of those who had worked before him, and in our modern view these went far astray. For example, he believed in the four elements (p. 45). He believed that the earth is set in the centre of the universe, which he thought was arranged in a series of concentric spheres around it. It is unfortunate that, while his works on such subjects as these were studied for more than 2,000 years, and to some extent hampered progress, yet his marvellous writings recording his observations on living things were lost or misunderstood. Had this not happened, knowledge would surely have advanced far more rapidly, for Aristotle was not only a first-rate biological observer, but also an extraordinarily acute interpreter of what he saw. He must have employed a number of pupils to watch the habits of animals, and he must have had an amazingly sure instinct in sifting and considering the reports they brought to him. When the biological works of Aristotle began to be read, many of his observations were for centuries believed to be mistakes or fables, until they were verified by modern men of science.

Aristotle regarded all living things as arrangeable in a

sort of ladder, or scale (Fig. 5), from the lowliest plants up through animals to man himself. He did not, like Darwin in the nineteenth century, suggest that the higher stages of life had developed *out of* the lower forms, but his conception of the *close relationship* of each stage of living things

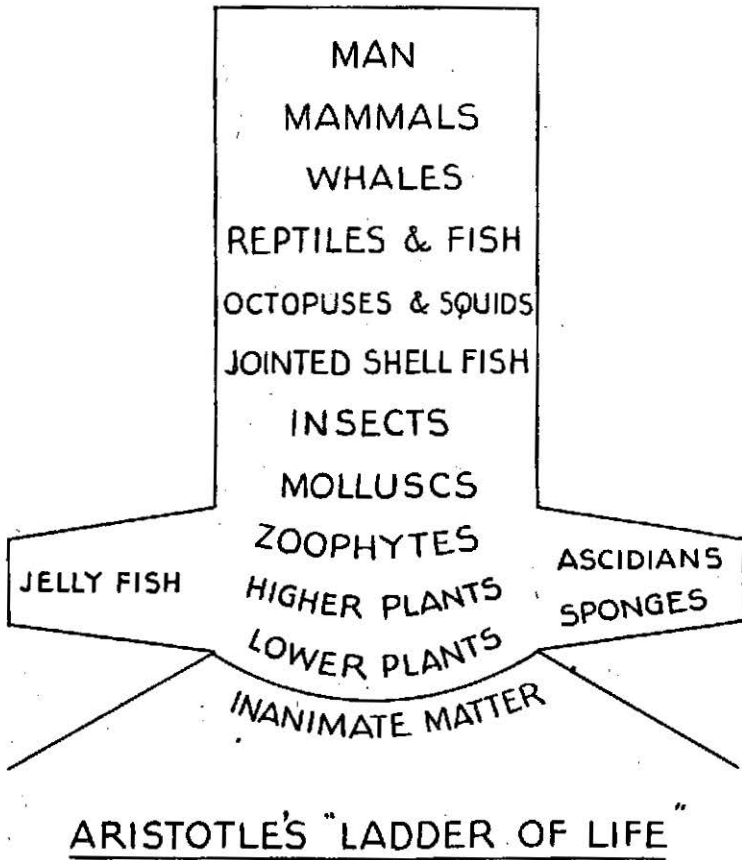


Fig. 5

to that immediately below and to that immediately above makes his biological views most interesting to us.

Aristotle realised that methods of producing the new generation of living things are extremely important for our way of thinking of them. He was, moreover, greatly

interested in the problem, still unsolved, of the nature of life. This he associated with the existence of something that he called *psyche*, which we may translate *soul*, or *the living principle*. He distinguished three orders of soul, corresponding roughly to (1) the plant's faculty of self-nourishment and reproduction—*the vegetative soul*; (2) the animal faculty of sensation and movement—*the sensitive soul*; (3) the human faculty of reasoning—*the rational soul*. He believed, moreover, as do many modern men of science, that life itself implies a certain interrelationship of every part of the living thing. Aristotle's biological works are indeed still studied for his thoughts as to the nature of the order which he discerned in the world of living things.

A pupil of Aristotle, one Theophrastus, was specially interested in plants. He, like ourselves, emphasised the distinction between monocotyledons (like tulips) and dicotyledons (like cress). Nevertheless, the inspiration of Aristotle failed in the men of the generations which followed. They were mainly occupied on commentaries and extensions of the work of their great master rather than on original contributions.

After the death of Alexander, his empire broke up into a number of kingdoms. One of the most stable was that of Egypt, which was governed for 300 years by the descendants of Alexander's general, Ptolemy. The Ptolemaic rulers were an enlightened body of men and women, greatly interested in science and learning. They founded a great museum and library in Alexandria, the capital city, which rapidly replaced Athens as the centre of scientific work, as well as a political centre.

ALEXANDRIAN SCIENCE

We have noticed that the more ancient Greek thinkers were always seeking to fit their ideas of the *nature of things* into a whole scheme of an ordered universe. In Alexandria this philosophic point of view declined. Men were rather

inclined to divide knowledge into special "subjects," and to be content to study some restricted topic. By this method some progress was made in the knowledge of how our bodies work. Public dissections of the human body were introduced, and human anatomy compared with that of animals. It came to be recognised that thought is somehow related to the brain. The arteries and veins were distinguished, and the pulsation of the arteries noticed, though this was not yet recognised as due to the movement of the heart.

Really great and constructive scientific work in Alexandria was done by mathematicians and astronomers. Among them was Euclid, who is familiar to us all from his *Elements of Geometry*. This has very largely determined all mathematical teaching since his time. Euclid was an unpretending man of gentle temper, but entirely devoted to science and to teaching. Asked by King Ptolemy whether there were no easier way of learning geometry than by ploughing through his *Elements*, the mathematician answered: "Sire, to geometry there is no royal road." When a stupid student inquired, "What shall I gain by learning these things?" Euclid said to a servant, "Hand this fellow a penny, since he must needs make profit from his studies."

Another great mathematician who worked at Alexandria was Apollonius. He was a pioneer in the study of *conic sections*. It is an extraordinary fact that Apollonius did his researches from pure abstract interest in the curves arising from cutting variously shaped sections from a cone. Some 1,800 years later, the discovery was made by Kepler that the movements of the heavenly bodies actually conform to these curves!

The greatest of all the mathematicians of antiquity, and perhaps of all time, was Archimedes of Syracuse, in Sicily (287-212 B.C.). He also had spent some years of study in Alexandria. The mere list of his mathematical discoveries is overwhelming, and though by far the greater part of his time was given to such work, he made also many remarkable mechanical inventions. We owe to Archimedes the

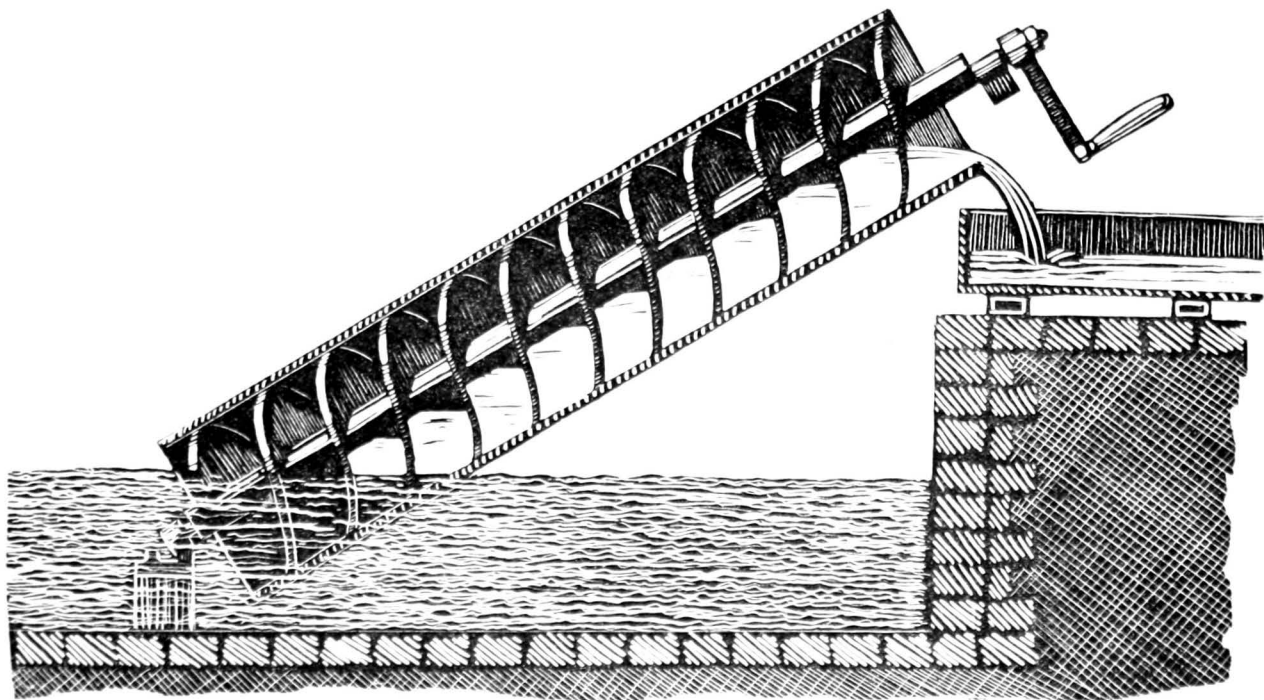


Fig. 6. ARCHIMEDES' SCREW

principle of the screw. The machine known as the "screw of Archimedes" is a device for raising water (Fig. 6). By the discovery also of the principle of the balance, Archimedes laid the foundations of mechanics. A development of this is his doctrine of levers (Fig. 7). He showed the theoretical possibility of moving a weight, however large, by a force, however small. "Give me but a place to stand," said Archimedes, "and I can move the world." He proceeded to demonstrate this by holding the end of a compound lever by which, with only the slightest effort, he was able to move a heavily-laden ship.

The best-known instance of the application of the knowledge of Archimedes to practical affairs is the story of Hiero's crown. Hiero, King of Syracuse, wished to test whether a certain crown was made of pure gold. He put the problem to Archimedes. Soon after, Archimedes, getting into his bath, observed that as more of his body was immersed so more water ran over the top. This suggested the solution. Transported with joy, he leapt from the bath and rushed home naked, crying as he went, "*Eureka! Eureka!*" ("I have found it!"). He had, in fact, found the idea of what we call *specific gravity*. By immersing equal weights of different metals in turn in a vessel brimful of water, and then measuring the bulk of overflowing water in each case, he could tell the bulk of each piece of metal. Since gold has a different specific gravity to any other metal, he could tell whether a given weight of gold had been diluted or no.

A very important and interesting work of Archimedes describes the method that he sometimes employed in his mathematical investigations on the area of curved figures. Suppose he had to find the area of an ellipse. He would cut out an ellipse of paper and weigh this against a rectangle of paper. This would give him the approximately correct result. From this he could work mathematically to test whether his result was likely to be true or no. Archimedes also found a very accurate value for the important ratio between the circumference and the diameter of a circle, the element known to modern mathematicians as π (see p. 352).

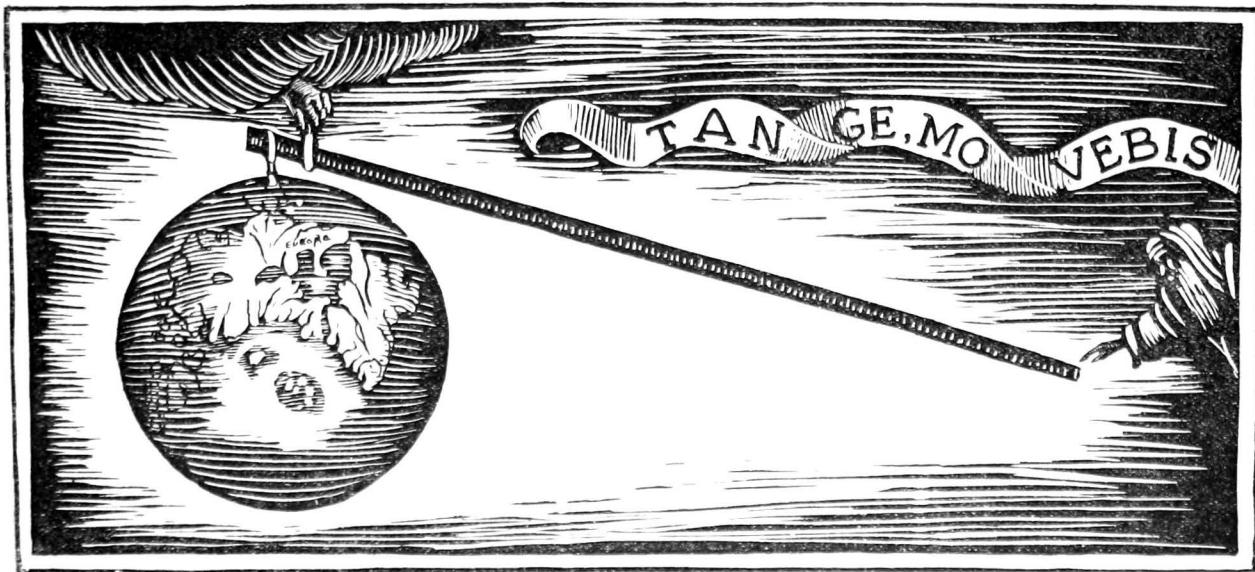


Fig. 7. Archimedes' theory of the centre of gravity (centroid) and of the lever. He said, "Give me a fulcrum on which to rest, and I will move the world." From a picture published in Paris in 1687.

Finally, we may mention the remarkable system used by Archimedes for expressing very large numbers, such as, in our notation, would require eighty thousand million million ciphers. He tells us that this system of his was adequate to express the number of grains of sand that it would take to fill the universe ! He therefore calls this work *The Sand Reckoner*.

The works of Archimedes show a generous appreciation of the achievements of others. His character, as well as his lofty intellect and his compelling lucidity, made a great impression on his fellow-mathematicians. His death was one of the many tragedies of war. During the siege of his native Syracuse by the Romans in 212 B.C. he continued to work on mathematical problems. The besiegers broke in, but his mind remained fixed on his investigation. A soldier came to him and bade him follow him to the general. Archimedes refused to do so until he had worked out his problem, whereat the soldier, enraged, drew his sword and slew him.

Sciences that depend much on mathematics are astronomy and geography. Both were actively pursued in Alexandria. Aristarchus (third century B.C.) taught that the sun itself is at rest, and that the earth, together with the other planets, moves round it. Aristarchus was also the first to attempt to measure the relative distances of the sun and moon from the earth, and their sizes relative to each other. Other astronomers in Alexandria at this time were successful in devising methods of setting forth exactly and conveniently the position of many fixed stars. He was thus able to record the movements of planets in regard to them. The Alexandrian scholar Eratosthenes was the first to measure the size of our earth. His method was beautifully simple (Fig. 8). He also did fine work by giving an exact interpretation to geographical observations. Yet another practical science developed from mathematics in Alexandria was optics, which treats of the relations of light and of vision.

Another Alexandrian worker was Hero of Alexandria (100 B.C.), who made a collection of what we may call scientific conjuring tricks. He understood the principle of

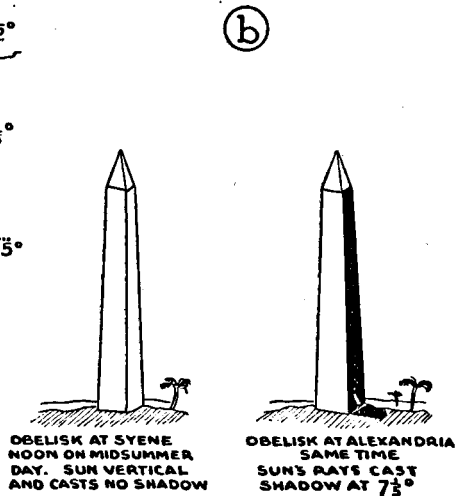
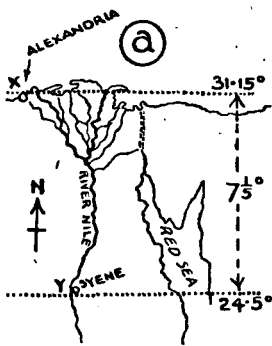
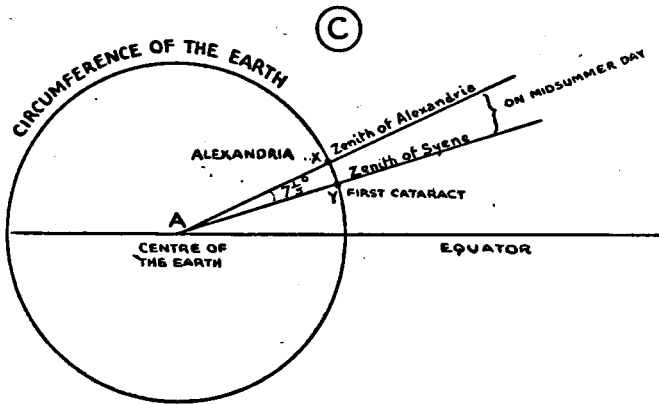


Fig. 8. ERATOSTHENES' DETERMINATION OF THE SIZE OF THE WORLD

Note : Syene is approximately due south of Alexandria (fig. a) and the distance between them XY was known.

The angle subtended by XY at the centre of the earth A was known from the fact that on midsummer's day at noon no shadow is cast at Syene, but a shadow subtended by $7\frac{1}{2}^\circ$ of inclination of the rays was cast at Alexandria (fig. b).

Hence by simple proportion, XY (the distance between Alexandria and Syene) is to the earth's circumference as $7\frac{1}{2}^\circ$ is to 360° .

the siphon, and he made a toy that was the first steam engine. It was a sphere that spins by the force of steam (Fig. 9). He also devoted much attention to surveying, and to the devising of instruments for the purpose.

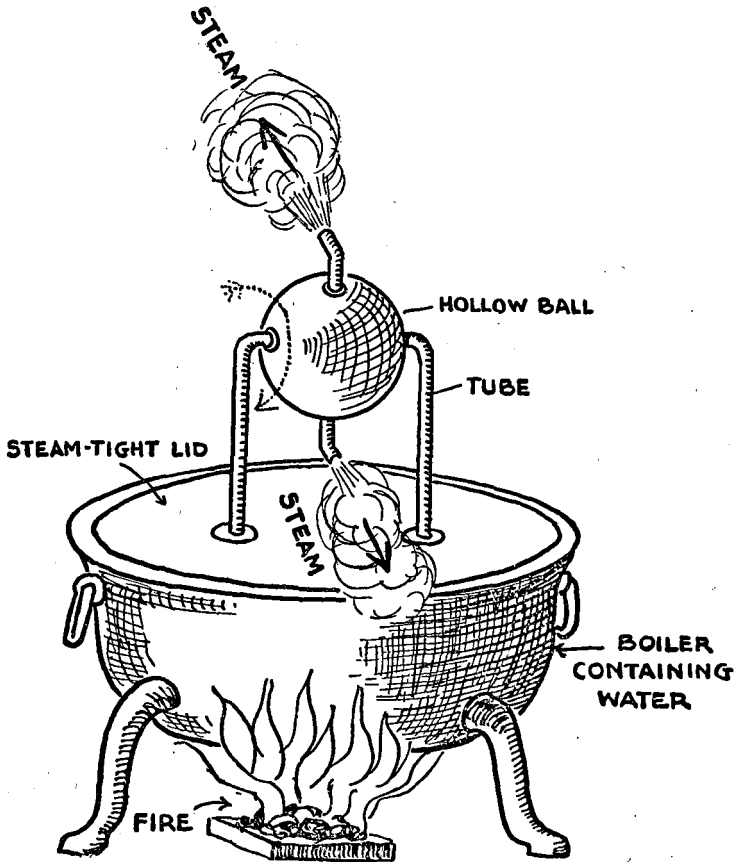


Fig. 9. HERO'S AEOLIPILE

At that time the apparently irregular movements of the planets were a great puzzle. An Alexandrian called Ptolemy invoked the idea of "epicycles," that is of circular movements which themselves take place along the circumferences of other circular movements (Fig. 10). He supposed that the planets moved on such epicycles. By invoking sufficient

numbers of epicycles moving on each other he explained all the movements of the planets as then known.

As important as Ptolemy's astronomy was his work on geography. Acting on the information brought him by Roman travellers, he made maps of all parts of the known world. From the measurements that he gave, the outlines of

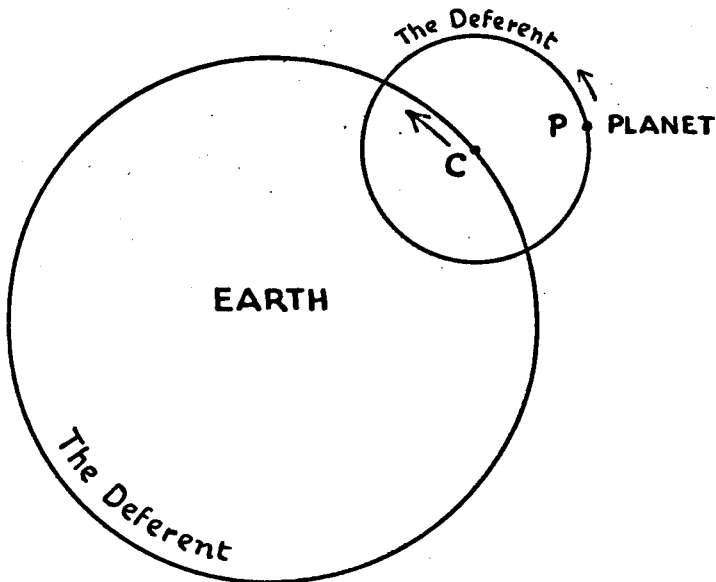


Fig. 10. PTOLEMY'S PLANETARY THEORY OF EPICYCLES

The Earth was the centre of the Universe. The planet P moved in a circle (known as the deferent) round a point C which in its turn moved in a circular orbit (the deferent) round the earth. Thus the irregular movements of the planets in the skies were explained without sacrificing the Aristotelian idea of circular motion.

various European countries can be reconstructed. These roughly resemble the outlines that we now know from our atlases.

SCIENCE UNDER THE ROMAN EMPIRE

In 50 B.C. Egypt became a part of the Roman Empire. The enterprising Greek spirit now turned to Rome for its

field of work. The Greek language was still used for scientific purposes, though the audience addressed was Roman. The Romans were proud to become the pupils of their vanquished foes. Yet science, like every other activity of the Greek mind, changed under Roman auspices.

The systematic search for order in the natural world had no interest for the Roman. His energies were absorbed in the endeavour to establish a human order, the *pax romana*. To this practical end all his efforts were bent. Thus we hear no more of great astronomers or mathematicians or great surveys of the world's surface. Indeed, the fate of geographical study may be taken as typical of what we may call the "Roman fallacy," which is the fallacy of the so-called "practical man." That great genius, Julius Cæsar, did indeed plan a world survey, but after his death it was only thought worth while to map the actual roads to be traversed by the Roman armies. Had the rulers of Rome been less "practical" in their aims, had they extended their investigations more widely, they would surely have discovered that the military frontiers of the empire were in fact most "unpractical," and impossible of permanent defence. A more "scientific" Roman frontier would have meant an empire impregnable to the barbarians. How different would have been the whole course of our European history had that been achieved. The man who neglects theory does not thereby become as practical as he often thinks!

Knowing what we do of the outlook of the Roman, it is not surprising to find his chief scientific activity in the more obvious applications of science to daily life, and especially in hygiene and public health. Few modern cities have such ample supplies of water as were brought to Rome on her magnificent aqueducts (see *Architecture*, Fig. 119). Of her drainage system Rome was justly proud, and parts of it are in use to this day. Her gymnasia and her private houses were furnished with heating apparatus that have only been equalled in quite modern times. Moreover, under the early empire there was a public medical service which was better than anything in Europe until the

nineteenth century. The Romans used a species of crane, and also devised a form of taxicab with a series of cogwheels !

One great Greek medical writer settled in Rome in the second century. This was Galen of Pergamum (A.D. 131-201). He was a successful physician and the personal attendant of three successive emperors. He studied the anatomy and physiology of many animals, notably the Barbary ape, the structure of which is not far removed from that of man. He failed to realise some of the differences between human and monkey anatomy, but his works remained in current use till the seventeenth century. After Galen there is a thousand years of darkness, during which science almost ceases to have a history.

SCIENCE IN THE MIDDLE AGES

Rome was invaded by the barbarian, and her civilisation crumbled. Ever more ignorant and wilder tribes destroyed successively the great capital cities of the empire (see *Outline of World History*, p. 407). Many centuries went by before the invading barbarian could absorb such measure of Roman culture as survived, and still longer before he could begin to build up on it any attempt at a new civilisation.

It was fortunate that at this juncture another people arose to take up the ancient Greek tradition. These were the Arabs, who had been pursuing conquests east and west until by the ninth century they held sway over Mesopotamia and large tracts of Western Asia, over Egypt and Northern Africa, parts of Greece, Southern Italy and Sicily, Spain, and Southern France. Both in Mesopotamia and in Spain, Moslem empires were established whose rulers greatly encouraged the arts and the sciences. They welcomed to their Courts all men of culture, irrespective of race or religion. Thus they came to absorb some elements of the Greek tradition, and notably Greek science, though sadly changed in the transit (see *Outline of World History*, p. 410 and also Fig. 11).

In the meantime, the legend of the great Islamic empires had penetrated to the war-ridden regions of more Northern Europe. Certain of these European scholars were anxious to attain the stores of learning from the Arabic-speaking countries. It is curious that at this period, from the ninth to the fourteenth centuries, the attitude to one another of those whom we call the Westerns and Easterns was almost exactly the reverse of that which holds to-day. At that time

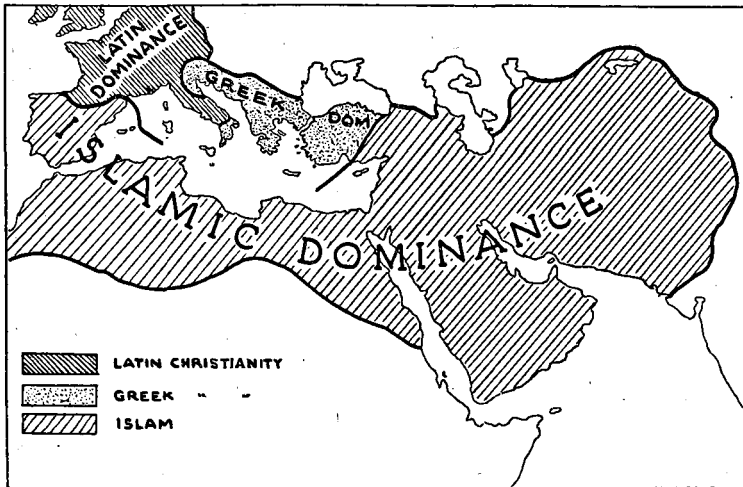


Fig. 11. SPHERES OF RELIGIOUS INFLUENCE ABOUT A.D. 750

the Western (or Northern European) knew that the practical arts were with the Eastern of the Arabic-speaking countries. This is well illustrated by a large number of Arabic words that have entered all European languages. Such, for example, are *admiral*, *horizon*, *arsenal*, *zither*, *zero*, *azure*. The Arabic-speaking people, in fact, had skill and learning, organisation and science, and generally made things work. They had naval and military power. Their religion was regarded by the West with a blend of fear and contempt; yet their useful knowledge was obviously desirable. It was a dangerous enterprise actually to travel to the lands of these people to learn from them. But a few bold spirits managed it. The Jews in Mohammedan lands sometimes had some knowledge of a Western tongue, and

were thus able to act as interpreters. Many texts, indeed, have had a history of translation from Greek, through Syriac, Arabic, and Hebrew, before reaching the Latin form in which they at last became available to Latin-speaking Europe!

Among the European pioneers who sought Arabic learning in the study, the most famous Englishman was Roger Bacon (1214–1294). By his passionate search for order in the realm of scholarship and science, he was one of the very first builders of the new Europe. Educated at Oxford, he worked chiefly at Paris. Aware of an enormous literature hidden from his contemporaries by the barrier of language, Roger was the first to attempt a grammar both of Greek and of Hebrew, and to suggest one of Arabic. He also conducted experiments in optics and chemistry, both being subjects especially developed by Arabic and Hebrew workers.

Roger was invited by one Pope to set forth his ideas on the new studies. Unfortunately, that Pope died, and the next one was not so encouraging. Thus Roger was soon in difficulties with his ecclesiastical superiors. He suffered a long imprisonment, and finally returned to Oxford, where for the remaining few years of his life he was allowed to teach, though under severe restrictions. Nevertheless, there can be no doubt that he was a very great influence.

Through the work of Roger Bacon and the men like him, the scientific treasures of antiquity began again gradually to be studied in translations from the Arabic.

With the fourteenth century began a period of travel. Information concerning rare and strange creatures came in from overseas. Trade, especially with the East, was increasing, and drugs were brought from foreign countries. Along with commerce came also travellers' tales, both true, like Marco Polo's, and false, like Sir John Mandeville's. Later, regular expeditions went forth to explore the unknown world. The most famous are the great journeys of Vasco da Gama to the East Indies and of Christopher Columbus to America (see *Outline of World History*, p. 414).

Curiosity was being aroused in other matters besides that

of the greater and more distant world. Men were looking more keenly at the things immediately around them. In the thirteenth century people began to try to copy plants and animals (Fig. 12). By the fifteenth century they were much more successful. One cause of this was the "re-discovery of antiquity." The great literary masterpieces of Greece and Rome which now began to be studied aroused curiosity as to the material remains of ancient civilisation. By studying the masterpieces of Greek and Roman sculpture the great Italian artists learned to represent nature more accurately. Printing was invented about the middle of the fifteenth century (see *Writing*, p. 860). By the middle of the sixteenth century the art of book illustration was perfected. The world, moreover, was in a ferment on religious and political grounds. The time was ripe for a change in the attitude to nature.

THE RISE OF MODERN SCIENCE

Astronomy and medicine were the battle-grounds of the great struggle for free scientific study. The year 1543 was crucial in both departments. Aristotle had thought of the earth as occupying the centre of the universe, and in this he was followed by Ptolemy, with his doctrine of epicycles (p. 56). In 1543 a Polish mathematician, Nicholas Copernicus (1473-1543), published a book on which he had been working for thirty years and more. Observations of his own, and other observations by Arabic astronomers, he found difficult to fit into the system of Ptolemy. He found it easier to explain them by supposing that the earth, with all the planets, moved round the sun rather than the sun round the earth. This was certainly a great change, but nevertheless the form in which he expressed his ideas was less novel than might at first be thought. Though he set forth the conception that the planets moved round the sun, he still clung to their circular and uniform movement—which we know to be wrong—still clung to a spherical system of fixed stars, and still supposed a complicated system of several circular movements for each planet.

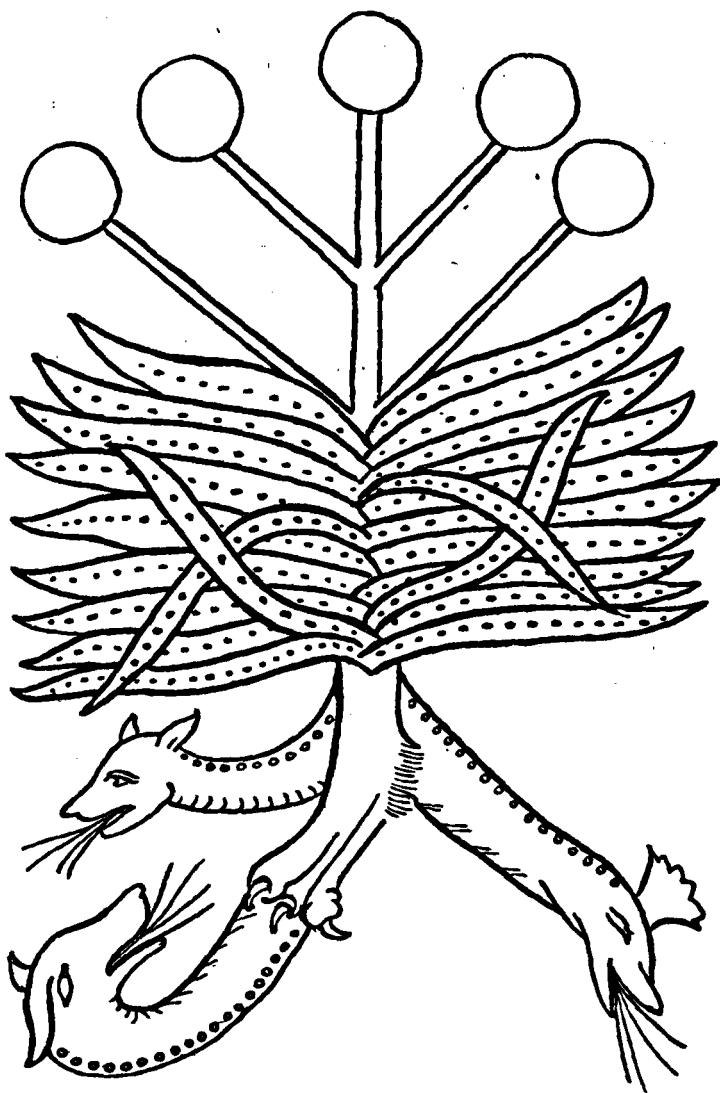


Fig. 12. "BASILISCA," PERHAPS THE BASIL, REPRESENTING THE EXTREME FORMAL DEGRADATION OF PLANT PAINTING (From an Anglo-Norman herbal written about A.D. 1200)

A younger contemporary of Copernicus was the Belgian Andreas Vesalius. This Vesalius became Professor of Anatomy at Padua, which throughout the sixteenth and seventeenth centuries was the leading scientific centre of the world. While there he published, also in 1543, a magnificent volume on anatomy and physiology, which forms the foundation of the modern exact studies of these subjects. No work of such accuracy, detail, and independence had yet appeared on these subjects.

The work of the Pole Copernicus and the Belgian Vesalius may be said to have started the modern physical and biological sciences on their way. It was, however, the Italian Galileo and the Englishman William Harvey who gave them the direction that they have since taken.

Galileo (1564–1642) lived a life of mental activity unparalleled since the days of Aristotle. His education had been in the old Aristotelian science, and his first remarkable achievement was a correction of certain views of that ancient thinker on the subject of falling bodies. Aristotle had stated that the rate of fall of bodies depends on their weight. In a famous experiment, Galileo proved this to be an error. Dropping a ten-pound weight and a one-pound weight from the top of the “leaning tower” at Pisa, he proved that the two came to earth at the same moment. We now know, and Galileo proved, that the rate of fall of a body is accelerated during its fall, and that its rate of fall depends on the time that it has been falling. That rate has nothing to do with its weight (except that to very light bodies, such as feathers, the air offers an effective resistance, and so slows them down). Developing this subject, Galileo created the whole sciences of mechanics and hydrostatics in all their essentials. He soon, too, turned his attention to astronomy, and also observed the appearance of new stars. The possibility of this had hardly been suspected, and was, in fact, contrary to the teaching of Aristotle.

In 1609 Galileo made accessible two instruments that were to have a deep influence on the subsequent development of science, the telescope and microscope. It is with the

former instrument that his name is most frequently associated. His first discoveries made by means of the telescope were issued in 1610. That year was crowded with important observations, especially on the planets, and notably on Venus. It had been rightly claimed, in criticising the Copernican hypothesis, that if the planets resemble the earth in revolving round the sun, only such parts of them should be luminous as are exposed to the sun's rays. In other words, they should exhibit phases like the moon. Such phases in Venus were now actually observed by Galileo. In the following year he described sunspots, and traced them round the sun's disc, and saw the moons of Jupiter and the rings of Saturn.

We cannot follow the further astronomical observations and arguments of Galileo here. It is sufficient to remind ourselves that the appearance of a new star, the behaviour of the moons of Jupiter and of the rings of Saturn, the observations of the phases of Venus and of the sun's spots, struck blows at the Aristotelian astronomy comparable to that delivered against the Aristotelian physics by the falling weights from the leaning tower of Pisa. Aristotelian astronomy demanded heavens eternally changeless. Here were changes and new appearances in the heavens, clearly visible to all who would see.

Galileo's method of scientific investigation demanded exact measurement. He even doubted the reality—apart from the observer—of anything that cannot be exactly measured. Since his day science has come to be regarded more and more widely as an exact process, and the phrase *science is measurement* (see Preface, p. 6) has often been repeated.

One of the most ardent supporters of Galileo was the German Johann Kepler (1571–1630). Kepler was essentially a follower of Plato, and was convinced that somehow or other the arrangement of the world and of its parts must reflect abstract ideas in the human mind. This faith sustained him in the vast and almost incredible labours of calculation that he undertook. He adopted the Copernican view when he was about twenty years old, and spent the

next thirty years of his life seeking mathematical rules that should link together the members of the solar system. At last he reached his end in the three great planetary laws which are still known by his name. These are so important that you should remember them :

1. Planets move round the sun, not in circles but in the figures of the form of conic sections known as *ellipses*.

2. Planets move, not at a uniform speed, but in such a way as to sweep out equal areas about their centres in equal times.

3. The square of the periods of revolution of the planets round the sun is proportional to the cubes of their mean distances from the sun.

This was the first completely satisfactory mathematical theory of the solar system since antiquity.

While Galileo and Kepler were laying the foundations of modern physics and astronomy, biology was also making great advances. William Harvey (1578-1657) (see *Physiology*, p. 106) had studied at Padua both under Galileo and under a pupil's pupil of Vesalius. He determined to apply the Galilean method of research to physiology, and the result was his discovery that the blood circulates in the body. Until his time it had been thought that the blood ebbed and flowed in the arteries and veins. He showed that blood expelled from the heart to the arteries found its way back through the veins and then started on its course again. It was the first satisfactory proof of the mechanical workings of a part of the body.

The knowledge of the circulation has become the basis of the whole of modern medicine. The blood, it was seen, is a carrier always going round and round on the same beat. What it carries and why, how and where it takes up its loads, and how, where, and why it parts with them—these are the questions the answering of which has been the main task of the science of physiology in the centuries that have since followed.

Of all the great divisions of science, chemistry in the seventeenth century remained longest in a backward state. Many advances, it is true, had been made in technical

processes, such as dyeing, glass-making, blending of metals, pigments, etc. But investigations designed to throw light on theory were mostly prosecuted by the band of dupes and charlatans who, since the Middle Ages, had been seeking the philosopher's stone. The old theory of the four elements formed a bad basis for experiment, for it contained no conception of the nature of a *chemically pure* substance. Metals, for instance, were regarded as a mixture, like other substances, in certain proportions of the four elements. Thus the transmutation of one metal or one substance into another did not seem an absurdity.

The main agent in changing the chemical outlook was the Englishman Robert Boyle (1627-1691). His great achievement was his introduction of a new spirit into chemistry. That study under him was no longer prosecuted for purely practical ends. It was freed from the mystery that had pervaded the study called "alchemy" until his time. He loosed it, too, from its direct connection with medicine, a connection which is still recalled by our word "chemist" for a shop where drugs are sold. Under Boyle, chemistry became an independent science the principles of which were to be ascertained for their own sake, and reached through the medium of experiment.

Boyle greatly improved the air pump, and made many researches with it. By its means he proved that the air has weight and that there is in it a part—which we now call oxygen—which alone is necessary for respiration and combustion. The law of the compressibility of gases is still known by Boyle's name. Most important of all Boyle's contributions to chemical theory is his attempt to set forth his conception of the nature of a chemical element in the modern sense, a very different thing from the "four elements" of the ancients.

Boyle and many others were, during the seventeenth century, working out the details of many natural laws. It would be impossible to discuss even a small proportion of their results. It was towards the end of the century, however, that the generalisation was reached which made it possible for the centuries to come to look upon the whole

universe as one vast mechanism. It is this achievement that has given to the study of nature the special intellectual prestige that it has acquired in our time. The achievement is in essence the work of Sir Isaac Newton (1642–1727). Before Newton, no man had shown or seen that the physical system that is demonstrated by the science of mechanics is the same as that by which the heavenly bodies follow their particular movements. To see and prove this, to see and prove that the force that causes the stone to fall is that which keeps the planets in their paths—this was Newton's unique achievement. It was Newton who first set out physical laws that were equally valid in the heavens and on the earth.

Newton knew that if a stone be let drop, its weight, which is another name for earth's attraction, will cause it to fall a certain measurable distance in the first second of its fall. He came early to suspect that the force which keeps the moon in her orbit is none other than this power of attraction by the earth. The period of the moon's rotation around the earth, and the dimensions of her orbit, could be measured by him. Thus he was able to calculate the rate at which the moon is moving. Now the moon, like any body pursuing a curved course, is moving at any particular moment in a direction tangential to her course. But the moon, as we know, does not continue to move along the tangent, but is forced to follow her regular elliptical course round the earth, in accord with Kepler's laws. At the end of the second, she, like the stone, has "fallen" a certain distance towards earth. Earth has drawn her to herself, as we say, "by the power of gravitation." Now, from Kepler's laws Newton had reason to suspect that the power of the earth to attract any body decreases as the square of the distance from the earth's centre. If this conjecture were correct, he was in possession of the equation :

Moon's fall in a second		The square of the stone's distance	
	is to	from the earth's centre	as
Stone's fall in a second		is to	
		The square of the moon's distance	
		from earth's centre	

After years of waiting, trying, experimenting, and pondering, he proved at last that this equation did indeed hold good. The gravity of the earth and the heavens were now seen to be one, and the outline of the whole mechanism of the universe seemed now laid bare. The great work in which this view is set forth is the *Philosophiæ Naturalis Principia Mathematica* ("Mathematical Basis of Natural Science"), which was published in London in 1687.

Two centuries and a half have since elapsed, and science has developed prodigiously along the lines that Newton laid down. He traced the laws of mechanics throughout the universe. In reliance on these laws, the stars have since his time been measured, weighed, analysed (see *Physics, Astronomy, and Structure of the Earth*, pp. 333 and 368). The same scientific process, directed to our own planet, has traced its history, determined its composition, demonstrated its relation to other bodies. The researches of the physicist and chemist have suggested that the nature of the matter of our earth is similar to that of the distant stars. Living things, too, have been examined with greater and ever greater powers of analysis and magnification (see *Biology*, p. 181). Among them, too, law has been found to rule. The wild creature is a subject of law. The migration of the bird that is "as free as air" can be predicted as well as the seasons, as well as the process of digestion, of development, of chemical action.

And so we close our history of science, for the science of the last two and a half centuries has been along the lines that Newton set. During this time there has been a vast amount of experimental activity. Wherever men have looked for scientific laws they have found scientific laws. It has always been a question of looking skilfully enough and patiently enough and long enough for law to emerge. And yet it is not right to end this account by giving the impression that the world has been reduced to a series of scientific laws. Despite efforts to link the living with the not living, the nature of life remains still essentially incomprehensible, or at least explicable only in terms of itself. And there are whole realms of experience, too, where the laws of science

are quite inapplicable. There is no evidence that that part of the world where Art is King and Love is Queen can ever be made the subject of rule. " Thus far shalt thou go and no farther, and there shall thy proud waves be stayed ! "

BOOKS TO READ

CHARLES SINGER : *History of Biology.*

CHARLES SINGER : *Short History of Medicine.*

W. C. D. and M. G. WHETHAM : *Cambridge Readings in the Literature of Science.*

IVOR B. HART : *Makers of Science.*

AMABEL WILLIAMS ELLIS : *Men Who Found Out.*

SCHUSTER and SHIPLEY : *Britain's Heritage of Science.*

PHYSIOLOGY
OR
WHAT AM I? THE FIRST ANSWER
by
PROFESSOR WINIFRED CULLIS
AND
DR. EVELYN E. HEWER



WINIFRED CULLIS is Professor of Physiology at the London School of Medicine for Women. She lives in a flat looking over Trafalgar Square, with books and flowers and papers and pictures and all sorts of things all over the chairs and tables and floor. When she was a girl it was not so easy to get a good education and become a doctor ; she got scholarships at Cambridge, and insisted on being a physiologist and teaching other people ; nowadays, though, girls can get the education they need if they want to be scientists or doctors. She broadcasts a great deal, and is one of the people who run *Time and Tide*. Dr. Evelyn Hewer is a friend and colleague of hers, and they like working together.

PHYSIOLOGY

SECTION I

US AND THE WORLD AROUND US

WE ARE alive ; the things outside ourselves mean something to us. When light falls on our eyes we see, when sounds fall on our ears we hear, when smells reach our noses we smell, when things touch our skin we feel. In this way the eyes, the ears, the nose, and the skin are like windows by which we obtain information from outside. A message that enters like this is called a stimulus, and it is carried at once by nerves to the brain, which is thus like a central receiving station.

In the brain the message is interpreted so that we know what the stimulus was like, and where it came from, and what it meant. When the message has been received in the brain we may do something as a result, perhaps because we cannot help it, as when we pull the hand away from something very hot, or perhaps because we want to, as when we pick up something we see. But in any case a message is sent back again by more nerves to the parts of us that carry out the response needed : many of the responses are movements, and these are carried out by our muscles.

HOW WE SEE

If a beautiful picture is shown to a doll, there can be no result : if it is shown to a blind person, or one with his eyes shut, still no result ; but if it is shown to any ordinary person it means a great deal to him, and this is brought about in the following way. The light rays pass into the eye through the small black-looking hole in the centre (the pupil) and are focused by a lens inside the eye on to the

retina, the sensitive surface at the back (see Fig. 13). The inside of the eye seen through the pupil looks black because the retina is backed by a layer of black pigment.

The iris, which is the coloured part that can be seen in the eye, is like a circular curtain with the pupil as a hole in the middle, and it can alter the size of the pupil like the

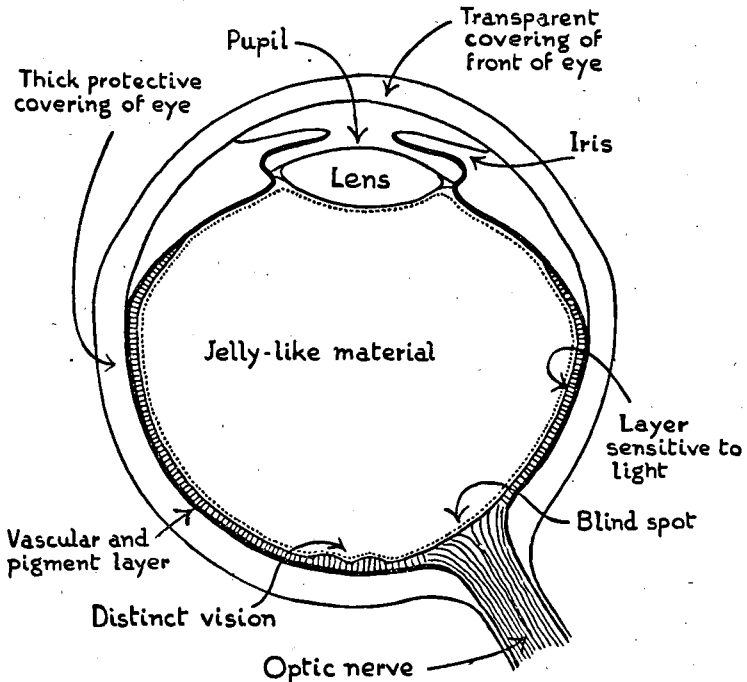


Fig. 13. DIAGRAM OF THE EYE

“stop” on a camera. If we looked at a house a long way off, seeing it quite clearly, and then looked at a tree quite close at hand, we should not see the tree clearly unless we could alter the focusing mechanism inside the eye: actually the lens alters in shape, so that whatever is looked at is clearly seen. This is called “accommodation.” If the light is very strong, the pupil is made smaller to protect the delicate structures within the eye, but in the dark the pupil becomes larger, to collect as many light rays as possible:

these changes can be seen very well in a cat's eye. Sometimes the lens is not able to focus the light rays properly, and then spectacles are worn in front of the eye to correct the focus. In old people the lens sometimes becomes opaque: this is called "cataract," and the remedy is to remove the eye lens very carefully, and then to wear a very strong glass lens in front of the eye. When the light rays are focused on to the retina, the nerve-endings there are stimulated, and the message is sent along the optic nerve, or stalk of the eye, to the part of the brain that is concerned with seeing. Now all the previous messages from the eyes have passed up to this same part of the brain, and have been stored there as memories; every fresh message coming to this same part is then compared with these memories of things seen before, and the brain is able to interpret the meaning of the new message. In other words, we understand what we are looking at.

Some people are not able to distinguish certain colours: red and green may look alike to them. If such a person dropped a scarlet cap on the green grass he would only recognise it by its shape and texture—he is "colour blind."

In some animals the eyes are on stalks, and can be protruded and moved round to look things straight in the face without moving the head: a crab is like that. In other animals, such as horses, the eyes are set quite at the sides of the head, so that they see things usually with only one eye at a time. Our eyes are in the front, so that we see nearly everything with both our eyes at once. This is sometimes called stereoscopic vision, because the images that are formed in the two retinae are not absolutely identical, and we are thus able to appreciate the relative positions and solidity of the objects seen (see *Physics*, p. 335). We can move our eyes a little bit with special muscles: if these muscles are not well balanced, the individual squints.

The eye is protected from damage by the bony socket in which it lies, and also by the movable eyelids. The exposed part is kept moist by a secretion from the little lachrymal gland: this fluid is continually being poured out, and then

drained away through a tiny hole into the nose. If too much moisture is secreted, it cannot drain away quickly enough, and tears run down the cheeks.

HOW WE HEAR

The sense of hearing is more highly developed in many animals than it is in us : some of them can hear sounds of

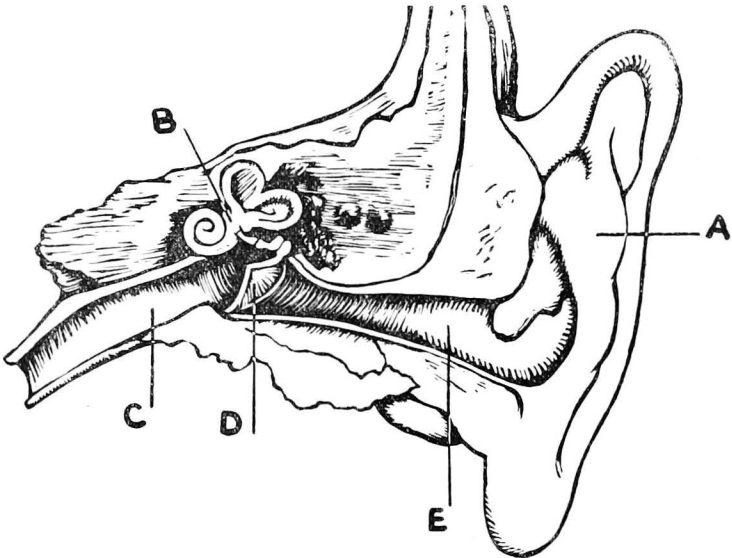


Fig. 14. DIAGRAM OF THE EAR
 A—External ear B—Internal ear
 C—Tube connecting middle ear with throat
 D—Drum E—Auditory canal

a pitch so low or so high that we cannot hear them at all. Many animals have big outer flaps to their ears to collect sounds ; they can move these about and sometimes open them up : we have only small flaps, and most of us cannot move them. The sound impressions enter at the outside hole of the ear : this is the opening of a narrow passage that is ended by the tympanic membrane (or drum) that is stretched right across it (see Fig. 14). The sound impressions, which are really waves in the air, make this membrane

vibrate: if the outer ear has wax in it, the membrane cannot vibrate properly, and we are deaf. The vibrations are carried on by a chain of tiny little bones hinged together, and reach the real inner ear.

This part of the ear is extremely delicate, and for protection is entirely enclosed in the bone of the skull. The inner ear contains fluid, and the vibrations of the little bones set this fluid vibrating. One part of the inner ear is shaped like a snail, and is consequently called the cochlea: it contains special sensitive hair-cells that are stimulated by the vibrations of the fluid, with the result that a nerve impulse is set up which travels along the auditory nerve fibres to that part of the brain concerned with hearing. The brain interprets the message by comparing it with the memories of other messages that have come to this same part before and been stored there, and in this way the sound comes to mean something.

If a person has to hear very loud noises for any length of time he becomes deaf, because the sensitive inner ear gets tired out: gunners are often deaf.

Another part of the inner ear, including the semicircular canals, is concerned with balance. These canals are also filled with fluid, and when the head is moved this fluid moves, and so stimulates the sensitive cells in the canals. The nervous impulses that are set up by this stimulation pass to the brain; we are not usually conscious of these, but they give rise to other messages sent out in response, which enable us to maintain our balance and equilibrium. If we turn round and round very quickly, the stimulation produced by the moving fluid persists after we stop, and then we feel giddy.

Both light and sound travel in the air in waves, but light is the quicker traveller of the two (see *Physics*, p. 338, etc.). We see the flash of a gun before we hear the sound of its firing. If a man can be seen hammering at something a long way off, the sound of the blows comes quite a long time after the movement of his arm has ceased.

HOW WE FEEL

The skin is most useful for collecting messages from outside. We can feel something touching us, even with our eyes shut, and at once we know where it is touching, how hard it is pressing, whether it is something hard or soft : probably by feeling we can even say what it is. We know if it is something hot or cold, and if it hurts or not. This ability to feel is not developed to the same degree in all parts of the skin, but those regions that are most used for this purpose are the most sensitive. The tip of the finger and the tip of the tongue are far more sensitive to stimuli than the skin of the back. Actually we only feel in minute " spots," but as the stimulus is nearly always applied over a relatively large area we are not conscious of this arrangement. (Try this experiment for yourself. Take a lead pencil, hold it vertically, and bring it just to touch the under surface of your wrist or forearm ; in some places it just feels like a touch, in others it feels quite cold : these are " cold spots.") Each sensitive spot is supplied with a nerve-ending, and the nerve fibre carries the message up to that part of the brain concerned with feeling. The " cold spots " are more numerous than the " hot spots " ; consequently a tepid bath feels cold. The sensitive skin is a great protection : if a stimulus is hurtful, immediately we move away from it. If pressure is applied to one of the nerves, as by sitting on the edge of a hard chair, the part of the skin supplied by the nerve becomes " dead," or devoid of feeling : if the foot is in this state and the skin is pricked, nothing is felt at all, and the foot might easily be damaged. When the pressure on the nerve is removed, sensation comes back slowly, and when it is coming back there is a feeling of " pins and needles."

The messages from the skin are first of all carried by nerves into the spinal cord, which is the tract of nervous tissue that is encased for protection inside the backbone : they are then carried up the cord to the brain, which is the enlarged end of the spinal cord and occupies the skull. The messages are interpreted by comparison with memories

of previous messages, and a suitable response is made by sending out new nerve impulses down the spinal cord and then along other nerve fibres to the various muscles.

HOW WE SMELL AND TASTE

We smell with the nose and taste with the tongue. These two organs work together very closely : if the eyes are shut and the nose held it is impossible to distinguish the taste of an onion from that of an apple. Again, with a bad cold in the nose we cannot smell, and in consequence cannot "taste" well : at any time we can only taste substances that are dissolved in the liquid in the mouth. We taste with the minute projections that can be seen with a lens on the surface of the tongue : these projections carry sensitive cells that are in connection with nerve fibres. Four tastes can be distinguished—salt, sweet, sour, and bitter : sweet things are best appreciated at the tip of the tongue, and bitter things at the back.

We smell with special hair cells at the back of the nose, and these also are connected with nerve fibres. The sense of smell is not very important to us, but most animals rely on this sense to catch their food and evade their enemies. In us the special olfactory (or smelling) cells cover an area of about one square inch : but a dog has more than 10 square inches of these cells, and a shark 24 square inches. We smell when the air reaching these cells is moved : sniffing moves the air over the special cells very rapidly.

The messages are taken by the nerves from the tongue and the nose to the brain for interpretation.

THE BRAIN AND WHAT IT DOES

All the receiving surfaces of the body are connected with the brain by nerves, which look like fine white threads. The nerves from the greater part of the skin and muscles and

organs inside us are collected into the spinal cord, which runs up the back, inside and protected by the bony backbone, and ends in the brain : the nerves from the eyes, ears, mouth, and nose and some of the internal organs pass straight to the brain. One of these nerves, going to the brain direct, comes from the alimentary canal, the lungs, and the heart, carrying messages in both directions : because it wanders about the body like this, it is called the vagus.

The brain itself is a soft, whitish, crinkly mass that fills up the skull. It consists of three chief parts : the great brain, or cerebrum; the lesser brain, or cerebellum; and the bulb, or medulla oblongata (see Fig. 15). The cerebrum is concerned with carrying out the highest functions of all, such as memory, reasoning, voluntary acts, and conscious sensation. The cerebellum is mostly concerned with maintaining the proper working together or co-ordination of the various muscles; while the medulla controls many of the unconscious but vital processes, such as respiration, circulation, and digestion.

The brain sorts out all the messages coming to it, puts a meaning into the message, and sends out a suitable response. Messages of one kind pass chiefly to the same part of the brain, so that the memories of impulses of that kind are stored conveniently close, ready for comparison with a new message. This "localisation" is very precise in some respects : thus one part of the brain is concerned with movement, another with seeing, another with hearing, and so forth : and, further, so precise is the localisation that in the movement area one small part is set aside for controlling the movements of the thumb, another the movements of the little toe, another the winking of the eye, and so on (see Fig. 16). The greater the numbers and kinds of memories that must be stored, the larger must the brain surface be. This increase is helped by folding in the surface : there is much more material in a Highland kilt than in a plain skirt, and in the same way much more brain substance, or grey matter, can be packed into a given space by this device. In addition, the brain itself becomes

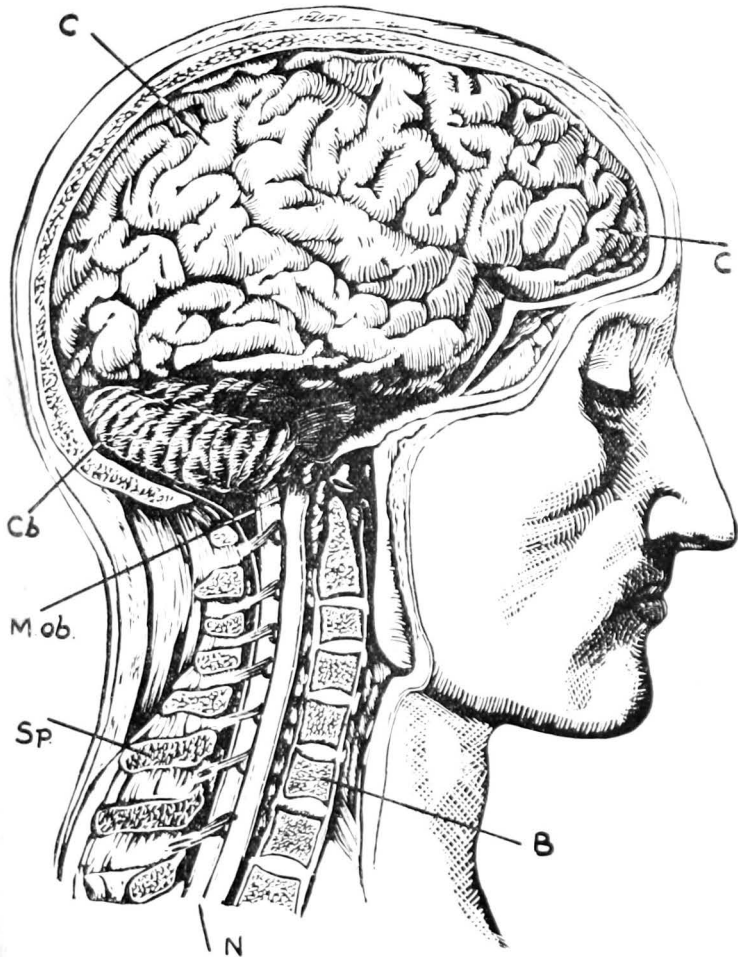


Fig. 15. SIDE VIEW OF BRAIN AND UPPER PART OF SPINAL CORD

- C—The convoluted surface of the right cerebral hemisphere.
 Cb—Cerebellum. M. ob—Medulla oblongata.
 N—Spinal cord with spinal nerves.
 B—The body } of a vertebra
 Sp—The spine }

proportionately larger as the animal scale is ascended, corresponding with the degree of intelligence developed: a man's brain is much larger in proportion than that of a chicken.

The best interpretations are obtained when several messages reach the brain simultaneously from the various sensory surfaces. If you hear a dog bark, you know it is a dog, and probably whether it is large or small: if at the same time you see the dog, and feel its coat, and see what

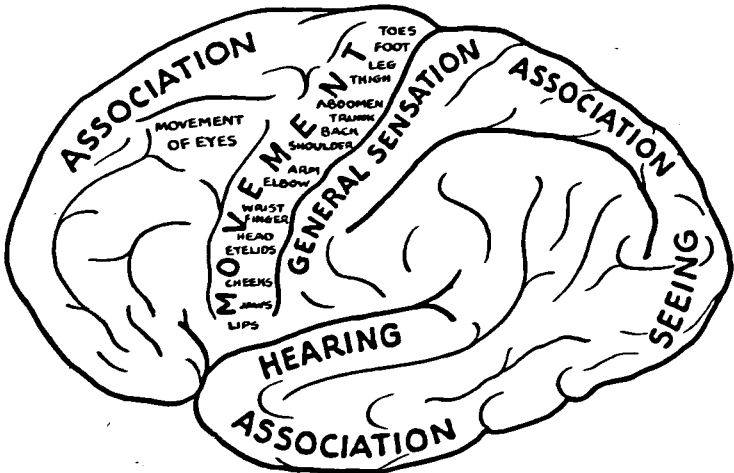


Fig. 16. SIDE VIEW OF CEREBRAL CORTEX SHOWING AREAS OF LOCALISATION OF FUNCTION

it is barking at, you get a much more accurate interpretation of what is happening: you "reason" about it in your mind.

Memories can only be built up gradually: the older we are the more we have, and the more they become linked in complicated patterns in the cerebrum. Just a word can then call up a whole train of memories of things, and people, and sights, and sounds, and smells, and feelings. The greater our power of interpreting the incoming messages, and understanding them, the more intelligent we are, and the better are we able to send out suitable responses (see the chapter on *Psychology*, p. 141).

THE RESPONSE TO A STIMULUS

If a wax doll is pricked, nothing happens ; if it is put too near the fire, it just melts. If you prick your finger you involuntarily pull your hand away, because you cannot help it : if you are too near a fire you voluntarily get up and walk away ; you do it of your own accord, but the heat might have hurt you if you had stayed.

Thus there are two kinds of responses—an involuntary one, called a reflex or an instinct, and a voluntary one that depends on the will of the individual.

Reflex responses are generally protective : all animals can react in this way, but non-living things cannot. It is very necessary that every animal should be able to make protective reflex responses to any harmful stimulus, otherwise it would never survive. If a speck of dust enters the eye, the eye at once waters and blinks to wash it away : if the foot is put into a bath of water that is too hot, it is immediately withdrawn. These reflexes are quite involuntary, but occasionally, by a great effort of will, we can prevent ourselves from giving the reflex response. Suppose a plate is picked up that turns out to be very hot : the instinct is to drop it, but with a strong effort of will it can be carried to a safe place and put down—in other words, the reflex response is “ inhibited ” by a voluntary message. If the stimulus is seriously harmful, it is almost impossible to prevent the reflex protective response.

An important point about reflexes is that the response has always a direct connection with the stimulus, and is always the same for the same stimulus : if the finger is pricked, the response is to pull the finger away, not to kick the leg. As the response is a protective one, the whole process is very rapid, and the message is often short-circuited in the spinal cord without going up to the brain at all.

In the diagram (see Fig. 17) the plain line path is the short reflex one through the spinal cord, the response being quite involuntary. The dotted path is the longer one through the cerebrum, and the response sent out is then modified

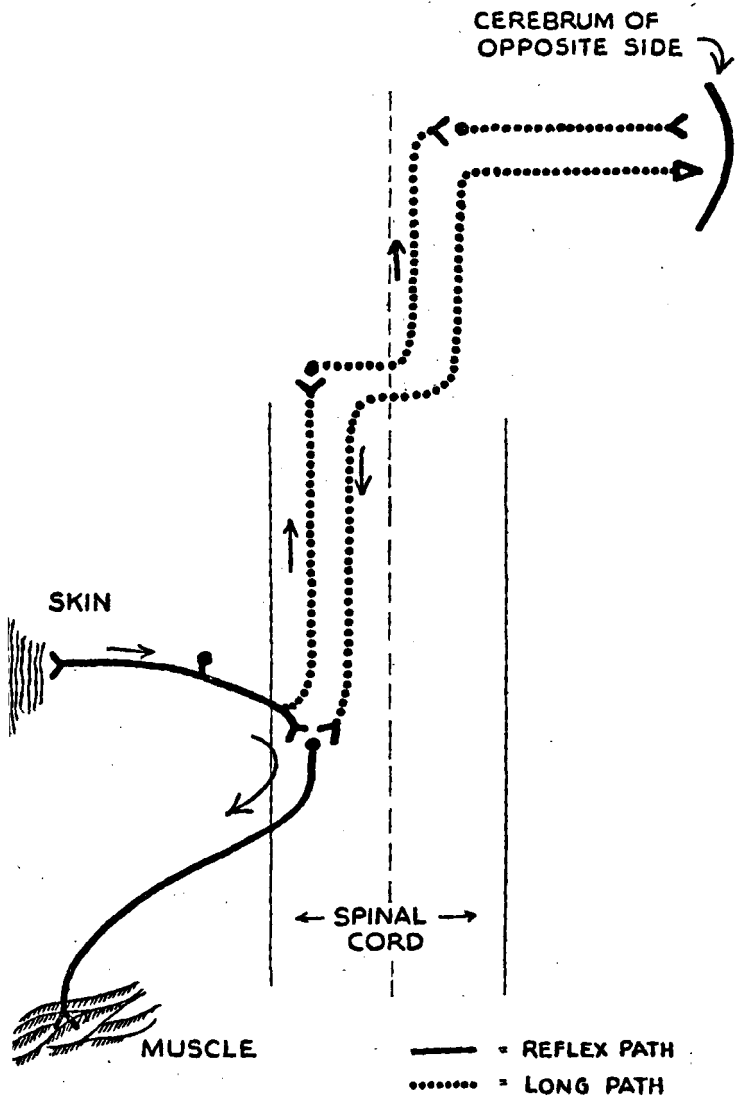


Fig. 17. DIAGRAM OF PATH OF RESPONSE TO A STIMULUS

by the memories of similar messages that passed that way before. If the back has been broken, there is no connection between the brain and the spinal cord, and then the only responses will be the reflex ones.

A curious thing about some reflexes is that they can be "trained" if the brain is working properly. When a dog is given food, his mouth waters: if a bell is always rung at the same time that he receives the food, after a time his mouth will water when the bell is rung, even if no food is given. Many "conditioned reflexes" can be built up in this way, in humans as well as in animals.

HOW THE RESPONSE IS CARRIED OUT

Most of the responses are movements: these are carried out by muscles, which are bundles of fine stringy fibres that make up the "flesh" of the body. Some muscles are attached to the skin; for example, the expression of the face can be altered by muscular contraction: laughing and crying are brought about by the same muscles, but the face does not look the same. But most muscles are attached to bones, and the way they work can be shown as follows. Stretch the right arm straight out in front, and keep the left hand on the right upper arm to feel the muscle: now clench the right hand and slowly raise it to touch the right shoulder. The left hand can feel the muscle bulging and getting tense as it contracts: actually it becomes shorter and fatter, and so brings the two ends closer together: as the muscle ends are attached one to the forearm bone and one to the shoulder, a movement of the arm bringing the hand up to the shoulder results.

Now muscles can only contract if they receive a nerve message: this, therefore, is the way that the response to a stimulus is brought about.

If the muscles are to be of use for moving the parts of the body they require a rigid framework: this is supplied by the bony skeleton, which is partly for protection, and partly for the attachment of the muscles (see Fig. 18).

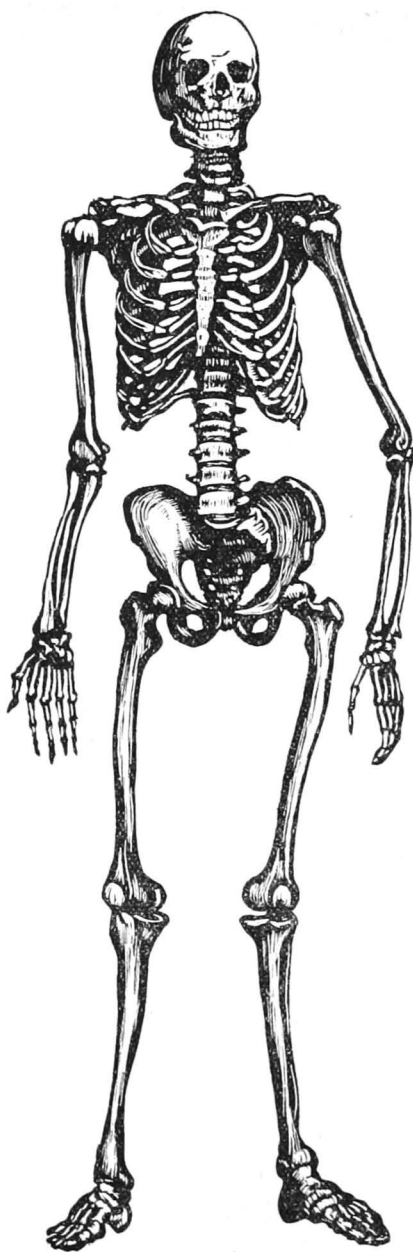


Fig. 18. THE HUMAN SKELETON

The skeleton is not rigid in the same way as a steel bridge, and if the muscles are consistently used in a wrong way the shape of the skeleton will alter. There is no need to be round-shouldered.

Why is it that the effect of gravity does not make a person collapse into a flat heap on the floor? It is because muscles are always at work to keep us upright. All the time there are nerve messages coming up to the brain, mostly to the cerebellum, from the surface of the skin of the feet, from that part of the ears concerned with balance, and from the various stretched and relaxed muscles all over the body: these messages are sorted out and interpreted, and appropriate nerve impulses are sent back again to the muscles, making them contract more or relax more or remain the same, so that the required posture is maintained. We are not usually conscious of all these nerve messages, but in sleep or in a faint the impulses no longer pass to and fro, and the muscles consequently become flabby and toneless, and the body lies limply.

If the same movement is carried out often, it becomes easier to do it. When a baby is learning to walk, at first he has to think very hard; and even then he does it badly, as the muscles are not working together properly: later, the movements go on quite smoothly and easily, and he really never thinks at all about it. The special nerve paths have been used so often that the messages pass along much more quickly and easily than before. This is how we develop a habit.

If the muscles are made to work for too long or too hard they get tired and have to stop. This is because they are poisoned by the waste substances they have produced in contraction: during a rest the blood washes away these substances and then the muscles can begin to work again. Also, if the nerve paths are used too hard or for too long at a time, the system gets tired, and we begin to make mistakes and to do silly things that we did not mean to do.

There is another very important point about muscles: they are generally arranged in pairs that have opposite actions. When you stretch out your arm and bring your

hand up to your shoulder, one group of muscles is contracting; when you bring your hand down again the "antagonist" group of muscles is working. Clearly the opposed muscles must not contract together: if they did there could be no movement. The nerves supplying opposite groups of muscles are so arranged that whenever a nerve message is sent to stimulate one group a nerve message is also sent at the same time exactly to "inhibit" the other group: it is because of this arrangement that we can carry out such wonderfully well-balanced and well-controlled movements.

AN EXAMPLE

All the parts of the brain have to work together to produce a good result. Suppose you see the time is 9 p.m., and you think you will have a hot bath. What is going to happen? First your eyes saw the clock, and a message went to the part of the brain you see with: there it was interpreted, and you knew that it was nine in the evening. That stirs up memories in your brain that 9 p.m. means going to bed and having a bath. So messages are sent out down the spinal cord to your legs to make you walk up to the bathroom. The nerve messages arising in your leg muscles and the balance part of your ear make you walk up properly without overbalancing. When you reach the bathroom, your eyes see the bath and the towel, and your nose smells the soap, and when your brain gets those messages together and understands them it sends another message out by the spinal cord to your hand and arm to turn on the water. Now we will suppose you have undressed. You see and hear that the bath has enough water in it, so the brain sends out more messages down the cord to your legs and arms to make them work together so that you get in. You put a foot in—the water on the skin of the foot is hot—a message is sent hurrying up by the spinal cord to the brain to say it is too hot, so the brain sends an urgent message back again to the leg muscles, and they pull the foot out. Memory tells you that the last time that happened

you put some cold water in too, so a message is sent to your arm and hand again and you turn on the cold water. Then you get in again, but memory reminds you that it was too hot before, so this time messages are sent to your leg so that you put it in very slowly. The stimulation of the water on your skin gives rise to a message that passes up to the brain to say it is all right this time, and so the message comes back and you get right in and sit down and the messages stop coming down to make your muscles move, and you just sit still—and wash.

SECTION II

KEEPING OURSELVES GOING

The human body must do work and keep itself warm ; it must grow and it must repair itself. For these reasons we take food : if we did not, the body would have to live on itself, and it would very soon die. If an engine is provided with fuel it also can do work and make heat, but it can never grow or repair itself : this is possible only to living organisms.

The food that we eat is of many different kinds, and not at all the same as the material of our bodies. This food is therefore changed by the digestive juices as it passes along the food tube (or alimentary tract). When it has been altered into very simple substances which are in solution, it is absorbed ; that is, it passes through the cells lining the tube into the blood or the lymph : the lymph is carried away by a lymph vessel, which opens into one of the big blood-vessels near the heart, and so in the end all the absorbed food materials are found in the blood, and the blood carries them all over the body to nourish the different parts. The lymph is the clear fluid in the spaces between the cells and the smallest blood-vessels ; it acts as a " middleman " between the blood and the cells.

The various food materials are used for different purposes in the body, and always some unwanted waste materials are produced, which are got rid of chiefly by the kidneys.

THE NATURE OF FOOD

The substances taken into the mouth can be divided into six classes—proteins, fats, carbohydrates, salts, water, and vitamins.

Proteins are the only body-building foods; in addition they provide us with energy (see *Chemistry*, p. 291). They are complex substances containing carbon, hydrogen, oxygen, nitrogen, and sulphur, and sometimes phosphorus, linked together in groups called amino-acids, and are found in lean meat, white of egg, milk, and seeds. Amino-acids are not found in any foodstuffs other than proteins, and are necessary for building up the living tissues of the body: it follows, therefore, that we must eat some proteins.

Fats are the best heat-producing foods. They contain carbon, hydrogen, and oxygen, and are found in milk, butter, oil, and meat fat.

Carbohydrates are also energy-producing foods, and are used in muscular work. They contain carbon, hydrogen, and oxygen; the commonest ones are starch and sugar, which are present in large quantities in such food as bread, potatoes, rice, jam, and milk.

Salts are present in all the fluids of the body, the one present in largest amount being ordinary "salt," or sodium chloride. Some parts of the body contain appreciable quantities of salts: thus bones consist chiefly of calcium salts, and the red colouring-matter of blood (hæmoglobin) contains some iron; the thyroid gland in the neck contains iodine. All animals like salt, and it is essential for them: a horse or dog enjoys licking the palm of a man's hand because of the salt left there from the dried-up sweat. Salt is often found in deposits in certain areas, and

wild animals will travel hundreds of miles to these "salt licks." These various salts are found in the diet in milk and in vegetables, and some also in ordinary table salt.

Water, composed of hydrogen and oxygen, makes up 60 per cent. of the weight of the body, and therefore plenty of water is necessary in the diet.

Vitamins are substances present in minute quantities in fresh untreated foods; they are to a great extent destroyed by cooking. They are essential for the health of the individual, and are dependent on the sun for their production. Fresh milk, and fresh vegetables and fruits, will provide these substances, and, if they are omitted from the diet, serious nutritional diseases will occur (see *Applied Biology*, p. 234). The vitamins are not given proper names, because when first discovered their nature was not known, and therefore they were called A, B, C, D, and so on.

Vitamin A is found in milk, animal fats, green vegetables, and cod liver oil: lack of this substance prevents growth and increases susceptibility to infectious diseases.

Vitamin B is present in milk, yeast, and the germ layer of seeds: there is hardly any in white milled flour, but plenty in wholemeal: absence of vitamin B causes a disease known as beri-beri and disturbance of nervous processes, particularly those belonging to the alimentary tract.

Vitamin C, present in lemons, oranges, fresh fruits, and vegetables, is necessary to prevent scurvy.

Vitamin D is formed only under the influence of sunlight, and is found in cod liver oil, eggs, summer milk, and summer butter. If vitamin D is lacking in the diet, rickets develops.

THE DIGESTION AND ABSORPTION OF FOOD

The alimentary tract is a long tube passing right through the body, beginning at the mouth (see Fig. 19).

- The food is put into the mouth, bitten up by the teeth—sharp cutters in front, and flat grinders at the back—mixed up with the spittle or saliva, which changes a little of the starch into sugar, rolled into a ball with the tongue,

and swallowed down the oesophagus into the stomach. Here it stays for three or four hours and is digested by the gastric juice : this juice contains hydrochloric acid and two ferments ; one called pepsin digests the proteins, and the other, which curdles milk, is known as rennet. When the

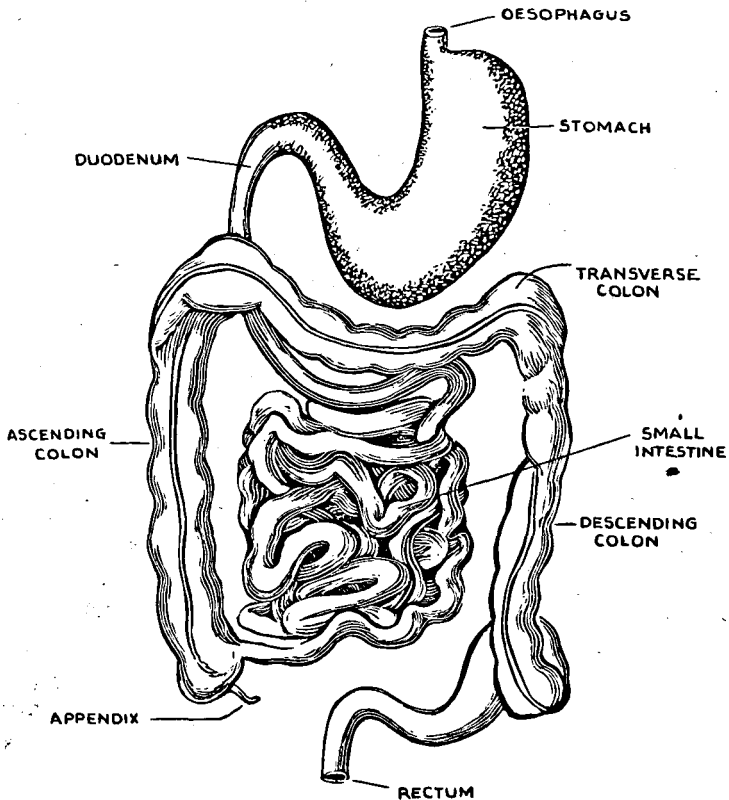


Fig. 19. DIAGRAM OF THE ALIMENTARY CANAL

food is ready to leave the stomach, it is a liquid mass like thin porridge. The ring of muscle that kept the stomach shut off from the intestine while the food was being digested now relaxes, and the food is squirted through a little at a time into the intestine. Here it meets more digestive juices, including the bile from the liver and the pancreatic juice from a gland known as the pancreas, or sweetbread. These

juices contain ferments that complete the digestion in about four hours, and the simple substances now made from the original food eaten are absorbed. The small intestine is lined by minute projections, called villi, like the pile of velvet; these villi increase the surface enormously, and it is the cells covering them that absorb the dissolved materials. Most of the water is absorbed in the large intestine, so that the remains of indigestible material are nearly solid: these are then passed along the large intestine and got rid of from the body. If the indigestible remains are allowed to accumulate, the muscle walls become greatly stretched, and then, when the tube is emptied, the walls contract more feebly than they should do, because their tone has been lost by continual over-stretching, in the same way that a stretched piece of elastic loses its elasticity. This leads to a loss of tone in the muscle, and it becomes less able to carry out its work properly, and constipation results. It is therefore most important that the bowel should be emptied regularly.

It will be seen that the two most important factors in digestion are, first, that the digestive juices should be poured out to mix with the food at the right moment and in correct amount, and, second, that the food mass should be moved along and mixed up or allowed to remain in one place according to the stage of digestion it has reached.

Let us consider the juices first. Whenever food is eaten, or smelt, or seen, or the person hears the preparations for a meal, the saliva is poured out by the salivary glands (one of which—the parotid—swells up in mumps). This is a reflex action, and consequently if food is taken into the mouth there is always some saliva to begin the digestion. The same stimulus of eating, or smelling food, etc., also produces a nervous reflex stimulation in the stomach glands, and some gastric juice is poured out too, but only a little, in case it is not wanted. If food has been eaten and swallowed, then this gastric juice is waiting to begin its digestion. As the food is digested, some of the simpler substances made from it act on the cells at the far end of the stomach: in these cells is present a “chemical messenger,” and the simple food substances set it free into the blood stream,

which then carries it round the body to come back to the other end of the stomach, where it then stimulates the glands to pour out more gastric juice : this goes on as long as any food is awaiting digestion in the stomach. Long ago a great deal about these processes was found out by the simple method of swallowing a sponge tied to a string : the sponge absorbed any fluids it came into contact with, and then, when it was pulled up again, it was possible to find out something about the gastric juice. A better way which is used in these days is to make the patient swallow a rubber tube, and then through the open end, by means of a syringe, the contents of the stomach or intestine can be sucked up and the fluid investigated.

The digestive juices in the small intestine are poured out also as a response to a chemical messenger ; here the acid of the gastric juice coming through with the digested food from the stomach causes the liberation of the hormone, the "chemical messenger," into the blood. These digestive juices are thus only poured out just when they are wanted for digestion. So each stage depends on the one before, and if the first stages of "nervously" secreted juice are not working properly, then all digestion will be upset. In great excitement, or anger, or fear, these nervous reflexes are interfered with ; that is why excitement so often "upsets" people in their digestion.

The movement of the food along the canal can be studied by mixing some bismuth salt with the food and then watching the canal by means of X-rays : these rays pass through all the soft structures of the body, but are stopped by bones, and also by bismuth salts, so that the food mass appears as a black shadow. The food is moved along in the same way that an orange can be squeezed down a stocking—that is, the muscular coat of the tube contracts behind the mass and relaxes in front of it. The food stays in the stomach until it is digested enough to pass on : during this time the wall of the stomach contracts and relaxes and mixes up the food very thoroughly : in some animals there are even small stones in the stomach to help in this mixing. In the intestine we can see by X-rays that the mass of food is

moved along for a foot or so, and then stops still : at once it is broken up into what looks like a string of sausages, by rings of contraction of the muscle coat : then each sausage is squeezed in half by fresh rings of contraction, and the halves join up with new neighbours. This goes on for a short time, mixing the food and digestive juices very thoroughly, and then another wave of contraction carries the mass along for a couple of feet, and the same thing happens again. In this way there is plenty of time for the digestion and absorption of the food. These muscular contractions are under nervous control, and the movements get greatly disorganised in conditions of fear, worry, excitement, and anger.

If something very irritating is taken into the stomach, the muscles contract violently and move the food the other way, and the irritating material is vomited out.

AFTER-HISTORY OF ABSORBED FOOD—METABOLISM

The liver is a most important organ (see Figs. 20 and 21): it deals with the absorbed food materials, and changes some of them further, and stores others, so that the blood passing on from the liver carries to the various parts of the body the correct quantities and kinds of food material for their use.

All the carbohydrate food is changed to sugar during digestion, and when this reaches the liver the excess is picked out of the blood and stored there as glycogen (or animal starch), and the blood passing on contains only a little sugar. When muscles contract, they use sugar to obtain energy, and so they use up the sugar out of the blood : at once the liver turns some of its stored glycogen back to sugar, and thus the muscles are kept supplied with fuel, even if a meal is not being eaten at the time. This power of the liver is regulated by a hormone called insulin, that is made in the pancreas and sent to the liver in the blood : if insulin is deficient, the liver can no longer control the sugar content of the blood, and the individual

Eg

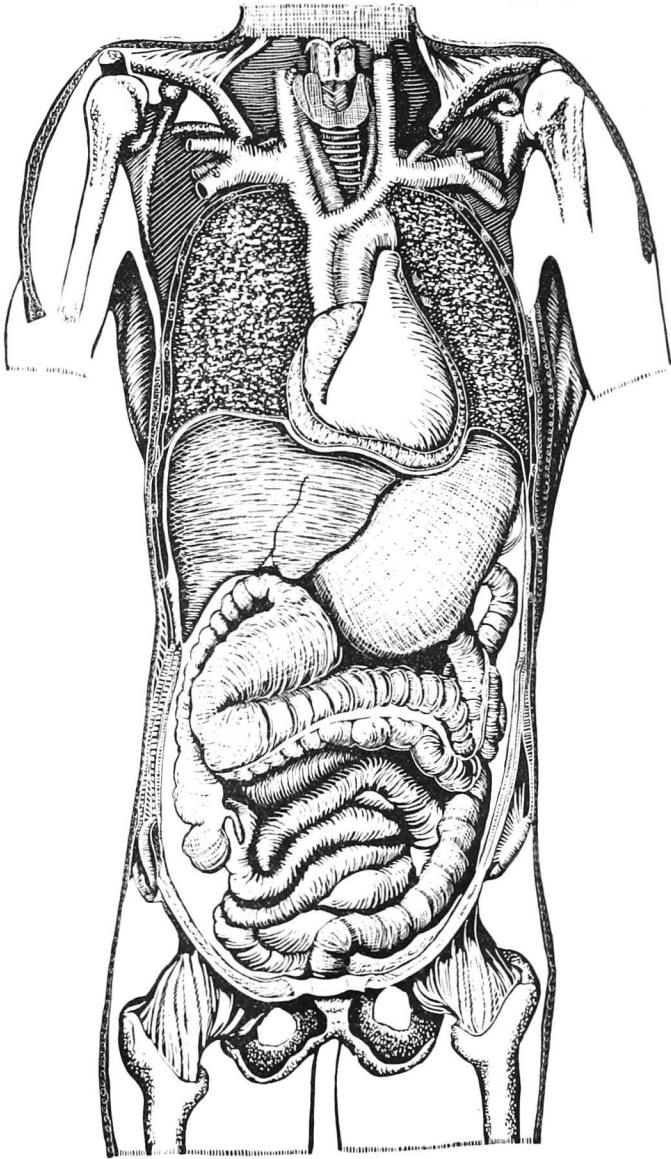


Fig. 20. DIAGRAM SHOWING RELATIVE POSITIONS OF SOME OF THE ORGANS OF THE BODY

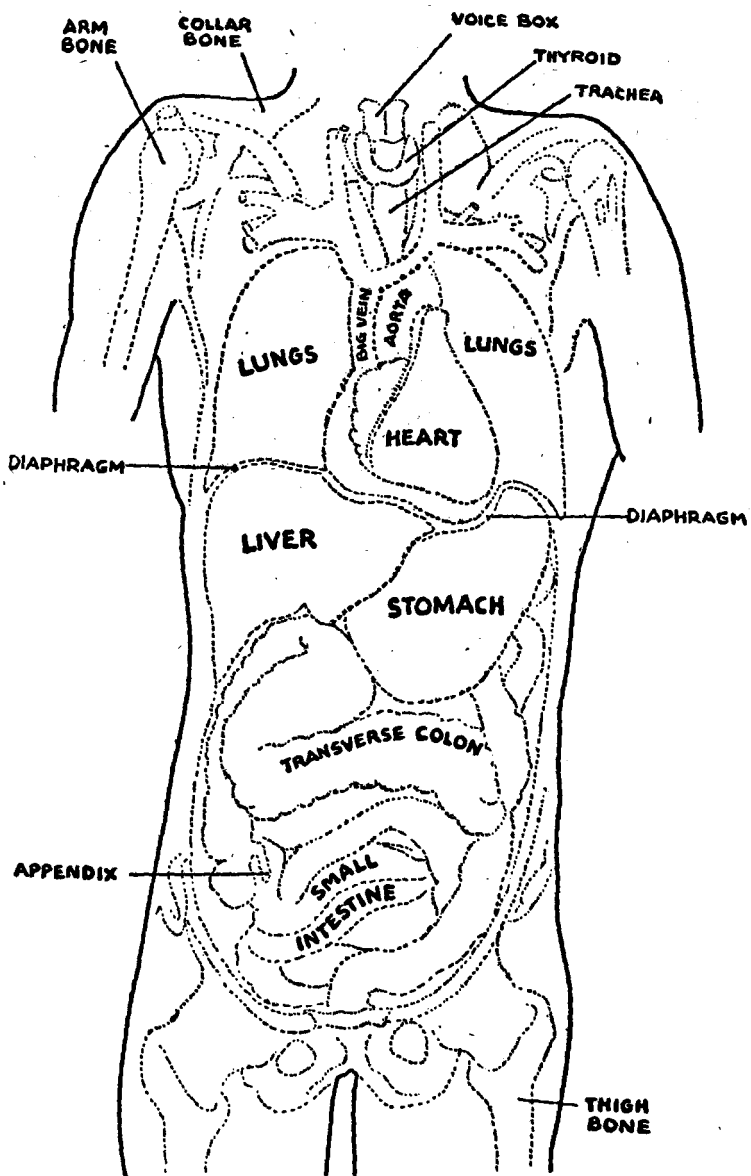


Fig. 21. DIAGRAM SHOWING RELATIVE POSITIONS OF SOME OF THE ORGANS OF THE BODY

suffers from diabetes : insulin can then be given as a medicine (see *Applied Biology*, p. 235).

All the proteins are changed to amino-acids in digestion. When these reach the liver, some are sent on to the tissues to repair any substance that has been broken down by use, and the others are used to provide energy for work. In this latter process a waste substance called urea is produced by the liver : the urea is then carried in the blood to the kidneys and got rid of from the body.

The fats are not greatly changed during digestion : after absorption, they are used for building up cell membranes and nervous tissues, both of which contain a large proportion of fats : the excess fat is then stored up as reserve fuel under the skin, and serves also as padding for the abdominal organs. In starvation, the body then uses up its stored fat to obtain energy, and the person gets thin.

WHAT TO EAT

A proper diet should contain the right kind of foods in the right amounts. The amount could be found out by feeding the person on the chosen diet, and seeing whether he got heavier or lost weight : if he is grown up, the weight should remain the same, but if he is a growing child, he should increase in weight steadily. But a shorter and easier way is to calculate the amount of food required as expressed in units of heat. The body produces energy both as heat and as work, and the total amount can be expressed as units of heat or calories. [A large calorie is the amount of heat required to raise the temperature of 1,000 cc. of water by 1° C.] But to produce energy we have seen that the body must have food, and the food can also be described in terms of calories, the units of heat that it can give rise to in the body. We can measure the calories produced by the body under various conditions, and, if the body is not to be the loser in these activities, then clearly it must be provided with food that will supply this same number of calories.

Now, 1 gramme of protein or 1 gramme of carbohydrate

can supply about 4 large calories, while 1 gramme of fat gives more than 9 large calories. A man doing an average amount of muscular work requires about 3,300 calories a day. These calories could be distributed among the foodstuffs in many ways, but a good proportion would be :

Protein	100 grammes	giving	400 large calories		
Fat	100	"	900	"	"
Carbohydrate	500	"	2,000	"	"
			<hr/>		
			3,300		

Proteins are the body-builders, and can be chosen from fresh meat, fish, cheese, eggs, and milk; carbohydrate provides energy for muscular work, and can be selected from bread, potatoes, rice puddings, sago, jam, sugar, flour; fats provide much heat, and are usually taken as butter, milk, or cheese. If the individual is doing a great amount of muscular work, like a navy, he will need more carbohydrate than a clerk; men living in the tropics need much less food altogether than the Eskimos, who must keep themselves warm and therefore consume large quantities of fat. Growing boys or girls, building up new tissues and taking much exercise, need almost more food, as a rule, than their parents do. The cost of the various foods also influences the selection: proteins, especially animal proteins, are comparatively expensive, and the diet often contains too much of the cheap carbohydrates to maintain a correct balance. Again, unpalatable foods are not digested well, because the nervous mechanism of secretion is inhibited, and then they are not absorbed, but wasted.

The diet should always contain some fresh food, such as milk and fruit and green vegetables, to supply the vitamins and salts. Vegetables and fruits with coarse fibres are of value in preventing constipation, as the undigested remains stimulate the muscular contractions of the alimentary canal. It would be possible to obtain the necessary calories, vitamins, and salts in tablets, but digestion, and consequently absorption, would be very inadequate, as their bulk would be insufficient to provide a stimulus for these processes.

GETTING RID OF UNWANTED MATERIAL

The body is always at work in some way or another, and this means that waste substances are being made, in the same way that a big factory always has unwanted materials to get rid of. In addition to the true waste materials the body also gets rid of water, largely in the process of regulating its temperature. Water is continually being lost through the skin as perspiration; the waste gases that the body makes are lost by the air breathed out; the waste in the alimentary canal from the food is passed out regularly by the large intestine. But the other materials to be eliminated from the body, like urea, and excess of water and salts, are got rid of by means of the kidneys. The two kidneys are bean-shaped, about the size of a large potato. They consist of masses of small coiled tubes that open into a central space in the kidney. The coiled tubes have blind ends that are pushed in by a tuft of blood-vessels, in the way that you can push in a soft rubber ball. As the blood passes through these tufts and other capillaries the unwanted materials are passed out from the blood into the tubes, together with a great deal of water. This fluid is called urine, and it passes down the tubes to collect in the central space of the kidney: this space opens into a long tube that runs down to a muscular bag called the bladder, and the urine brought from the two kidneys by these tubes collects here. There is a ring of muscle round the bladder opening, which is kept shut. When the organ becomes full, a message is sent by its nerves to the spinal cord and the reflex response is that the ring of muscle relaxes, the bladder contracts, and so empties itself to the exterior through the urethra. This is one of the reflexes that can be voluntarily inhibited by the cerebrum; the bladder is not emptied every time the message comes up to the cord, but only when the message comes down from the cerebrum to say that it is a suitable moment for the reflex to occur; but, just as with the large intestine, the bladder should not be allowed to become overstretched, because this leads to weakness of the muscles.

SECTION III

TEMPERATURE

Food provides the body with energy for living and for doing work. Much of this energy is developed in the muscles, which burn sugar when they contract as a motor burns petrol or a steam-engine burns coal. Some of the energy is converted into work and the rest into heat. The efficiency of an engine is the ratio of the energy converted into work to the total energy produced, and in an ordinary engine the heat produced is regarded as waste energy and all sorts of devices have to be used to keep the engine cool. Even in ourselves it will not do to go on piling up the heat as in a furnace, but neither will the body work if it is too cold. So we use the heat to keep the body at the temperature at which it works best (98.4° F. or 36.7° C.). Human beings belong to the warm-blooded group of animals, which maintain a constant temperature whether they are making much heat, as in muscular exercise, or little, as when resting, and whether they live in a hot or in a cold climate. Cold-blooded animals (snakes, frogs, etc.) change their temperatures with that of their surroundings, and so become very lethargic in the winter, a time when we usually become more active.

We manage to keep this steady temperature by balancing heat production and heat loss. We can draw up a kind of income and expenditure account. On the income side we have the heat produced by burning our food or by taking into the body warm food and drink. On the expenditure side is the heat lost from the skin by radiation, and by the evaporation of sweat, as well as that lost from the breath and from the various excreted matters, which all leave the body at body temperature. In the body, happiness and health depend upon maintaining a perfect balance; excess of income over expenditure would mean a fever.

The skin is the great regulator of heat loss. If extra heat is being made by hard muscular work, or in running or playing, or if it is hot outside, then the skin has to get rid of more heat. The skin is red because more blood is brought

to the surface to be cooled down, and the sweat glands also come into action (see Fig. 22). They turn out water, which gets the heat necessary for its evaporation from the body and so helps to cool it down. In hot weather the clothes worn should be light in colour and in texture and fit loosely,

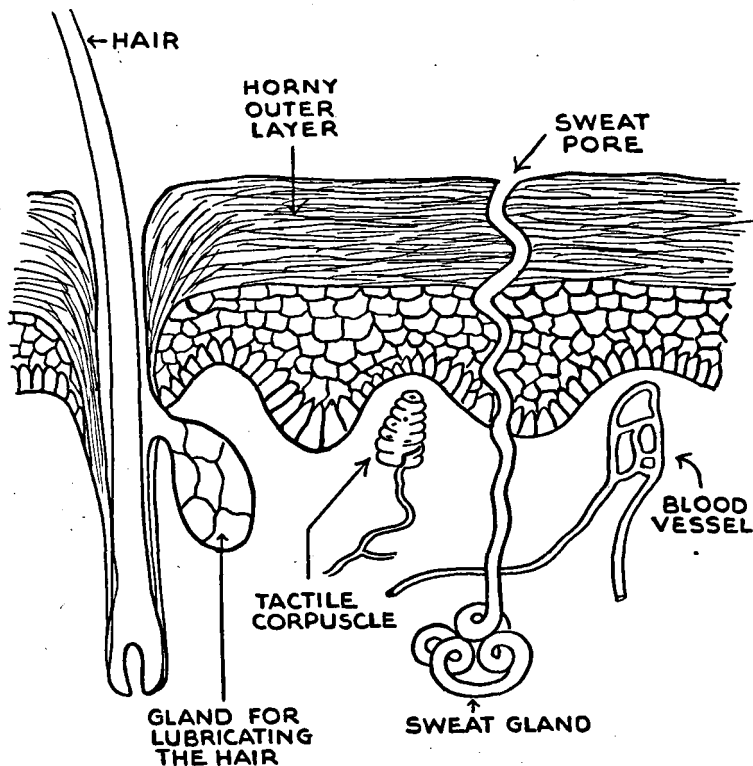


Fig. 22. DIAGRAM OF THE SKIN

so that the hot air can get away and the moisture reach the surface for evaporation.

When it is cold outside, the skin becomes pale, because the blood is now being kept in the deeper parts of the body, where it will not lose heat so rapidly. We use all sorts of other devices to keep up the temperature: houses and fires, and thick clothes of wool or of fur, which are bad conductors of heat. Generally, too, we eat more, particularly fatty

foods, which make the most heat. Best of all, we make heat by taking exercise—shivering is a form of exercise.

Thus it is clear that it is important to have a healthy skin, and that it is worth keeping it in good order. Not only does the skin tell us whether things are hot or cold, rough or smooth, pleasant or painful, but through its glands and blood-vessels it helps us to regulate body temperature. This regulation is controlled by nerves, and has to be developed. A new-born baby cannot regulate its temperature and balance heat production with heat loss, and so has to be protected against losing too much heat by being warmly wrapped up or by contact with its mother's body.

The skin through its sweating mechanism greatly influences the water content of the body. As this has to be kept steady, and as water is lost from the skin according to the need for sweating and not according to the water needs of the body, there must be another system working together with the skin; this is found in the kidneys. In this way we have another balance kept in the body—that of its water content; Income—the water taken in with the food and in drinking, Expenditure—that lost from the sweat glands, from the lungs in the air breathed out and from the kidneys. By breathing on to a cold glass you can show that you are always losing water from the lungs. In the summer a great deal of water is lost by the skin, and then either less is lost from the kidneys in the urine, or more water is taken in. In the winter, when less is lost from the skin, then more is sent out by the kidneys and we are not as a rule so thirsty. Animals with thick coats, such as dogs and cats, cannot lose much heat through the skin, as they only have sweat glands in the pads of the feet. Dogs lose a lot of heat by panting and letting the saliva pour out of the mouth.

The regulation of temperature is another example of the way in which the different parts of the body work together in the interests of the body as a whole. Think how many different systems are involved: the central nervous system, the skin, the digestive organs, the kidneys, the muscles, the respiratory and the circulatory systems, and the ductless

glands which help to control the metabolism. All are involved in this delicate adjustment between heat production and heat loss.

The way of producing heat is, as we have seen, the burning or combustion of the food. The liver is usually the "hottest" of the organs, as it is carrying out so many chemical processes, but when muscular work is being done, much heat is developed in the muscles. But burning is a form of oxidation (see *Chemistry*, p. 247), so if we are to give the body the energy whereby it can live, it must be continuously supplied with oxygen. We can, to a certain extent, store some of the other substances necessary for life. It is possible, for example, to go without food or vitamins or inorganic salts for three or four weeks, and even without water for two or three days, but we can go without oxygen only for a very short time. A nerve cell deprived of oxygen is irretrievably damaged. So it is a matter of life and death for the body to receive an adequate oxygen supply, and this is brought about by two great systems, the respiratory and the circulatory.

All animals need oxygen, which they get ultimately from the air. This they do in various ways. In some the cells get it direct from the air with which they come in contact. But in ourselves the cells of which our bodies are made must stay in their proper places, and cannot be shifted about so that each in turn comes to the surface to pick up its oxygen straight from the air. As we cannot bring the tissues to the oxygen, we must bring the oxygen to the tissues. This is provided for by the circulation of the blood, which carries hæmoglobin, an iron-containing pigment which has the power to take up oxygen if this comes anywhere near it and to give it out again where it is needed. The blood also carries to the cells everything else they need for their feeding and activities, and carries away from them waste materials and manufactured goods, so that it has become a universal provider. But to fulfil this purpose it must be kept going round the body, or circulating all the time.

It was an English scientist—William Harvey (see *History of Science*, p. 66)—who quite conclusively proved the

circulation of the blood. In 1615 he was appointed Lumleian Lecturer, and had "to dissect openly in the reading place all the body of man, particularly the inward parts, for five days together, as well before as after dinner if the bodies may last so long without annoy." In doing this he made observations which convinced him that the general explanations of the work of the heart held at that time could not be correct. He noticed that one of the cavities of the heart would hold about four tablespoonfuls of blood, and by counting the pulse he observed that the heart empties itself about seventy-two times a minute. In one hour the heart would pump 8,640 tablespoonfuls, weighing 540 pounds, or nearly three times the weight of an ordinary person. It was impossible to believe, as people did before, that this blood could be made directly from the food as it was taken in, since if a man were to eat and drink all day he could not take in enough to do this. He suggested that the only way to account for the heart being able to send out this enormous quantity was by pumping the same blood round and round. He also discovered that substances injected into the vein of one side of the body shortly afterwards appeared in the veins of the other side, that the valves were placed in the heart in such a way that blood could flow only in one direction. From these and many other observations he was able to show that the blood was pumped by the heart round the body through a system of closed tubes.

The reason Harvey was able to make this great discovery, one of the most important ever made in the understanding of the working of the body, was that he tested all his theories by experiments, the only way to make sure.

The heart is an organ about the size of the closed fist, contained in a bag, the pericardium, and lies obliquely in the chest, point downwards to the left (see Fig. 23). It has four chambers—two above, called the right and left auricles, whose work it is to squeeze the blood into the two chambers below, known as the right and left ventricles. There is no connection between the chambers on the right and left sides of the heart. This diagram shows the structure of the heart

and the next shows the course of the circulation of the blood round the body, which we can follow beginning at any point we like. Let us start where the blood comes from the lungs into the heart by the pulmonary veins. (Vessels which bring the blood to the heart are always known as veins, and those which carry it away as arteries.) It enters, and for a fraction of a second flows steadily into the left auricle, which then contracts and squeezes its blood on

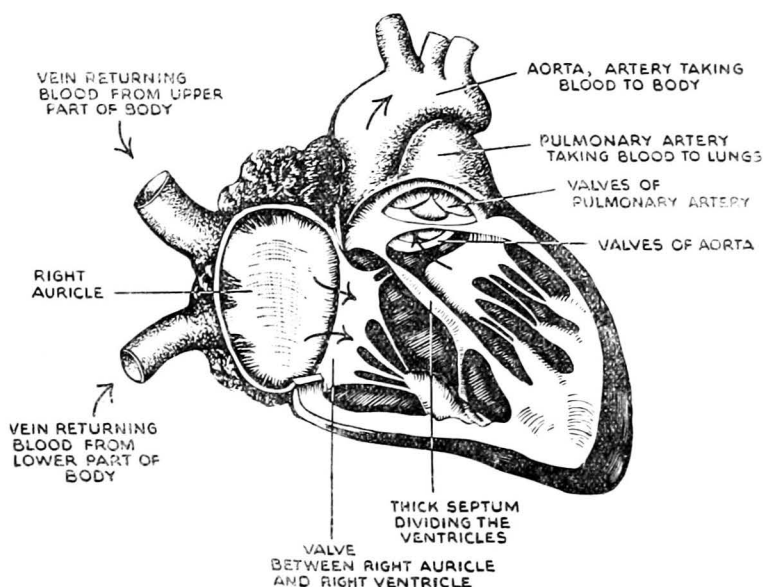


Fig. 23. DIAGRAM OF HEART OPENED TO SHOW THE CHAMBERS, VALVES AND GREAT VESSELS

into the left ventricle. Between the auricle and ventricle are some valves, which, like the lock gates on a river or canal, will open for a flow in one direction only—in this case from auricle to ventricle. When the blood has been passed on in this way, the left ventricle in its turn contracts and presses on the blood, the parachute-like valves between the auricle and ventricle are floated up and opened, and prevent the blood from going back; there is only one way out, through a big artery called the aorta. But this opening

also is guarded by valves, which can only be opened when the pressure inside the ventricle becomes greater than that in the aorta. Directly these valves are opened the blood rushes out with a jerk, and, as the walls of the aorta are elastic, they suddenly stretch, and the bulge made in this way travels along the arteries, making the "pulse." That is why the heart-beat rate can be counted by feeling the pulse. When the blood has been pushed on into the aorta, the ventricle stops contracting, and if it were not for the little cup-shaped valves guarding the opening the blood would run back into the heart (see Fig. 23). As it cannot go in that direction, it is squeezed upon and forced on by the recoil of the elastic walls of the artery away from the heart, and travels on and passes into an artery supplying some particular organ, such as an arm, a leg, the brain or stomach. The artery, after entering the organ, begins to divide up, and, as it penetrates farther in, the branches get smaller and smaller, and finally form tiny vessels, called capillaries (from *capilla*—a hair), which are actually so small that several of them could be packed into a hair. The capillaries have such very thin walls, and come into such close contact with the individual cells of the organs, that exchange of oxygen and carbon dioxide and other materials can easily take place. The capillaries then join together to form small veins, which in turn unite to form finally one or two big veins, which carry all the blood away from the organ. These veins from the different organs then join to form the great veins, the superior and inferior vena cava, which return the blood to the heart, this time to the right side into the right auricle. This contracts at the same time as its neighbour, the left auricle, and squeezes the blood past the guardian valves into the right ventricle, which by its contraction sends the blood into the pulmonary artery, which carries the blood to the lungs. Here also the arteries break up and finally form the capillaries, which bring the blood as near as possible to the surface of the lung alveoli, which are filled with air. In the lungs, carbon dioxide is given out and oxygen taken up by the blood, and this oxygenated blood is passed on into vessels which

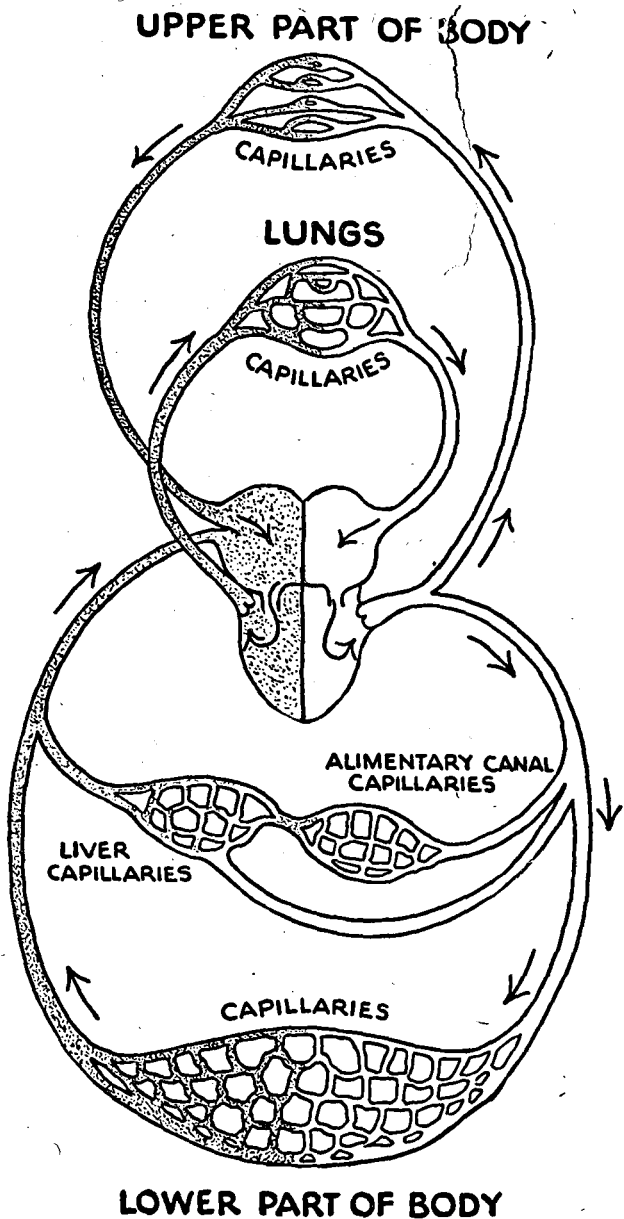


Fig. 24. DIAGRAM SHOWING THE GENERAL COURSE OF THE CIRCULATION OF THE BLOOD

finally join to form the pulmonary veins, which return the blood to the left auricle, from which we started out—the blood has made a complete circulation.

About 8 per cent. of the body weight is blood, so that in a grown-up there are about 8–10 pints of blood. When the body is at rest, or fairly quiet, all this is sent round the body about once a minute, which means that the heart pumps blood weighing about three times the weight of the body round every hour. Probably a drop of blood goes on the average about a mile a day, or 365 miles a year, or 25,000 miles in a life-time of seventy years. It will not be the same drop, naturally, since the blood is changing all the time, but these figures give some idea of the work that has to be done by the heart.

The heart is provided with two sets of nerves which help it to adapt to different circumstances. One set supplied by the vagus is usually in operation, holding it in check, and can, if necessary, slow it very much or momentarily stop it. The other set, which comes into play when it has to work very hard, makes it beat more quickly and more powerfully. This happens if we are frightened and the body has to be prepared to protect itself. In very strenuous exercise, such as the Oxford and Cambridge Boat-race or in a 100-yard race, the heart may have to pump five or six times its ordinary amount to give the muscles all the oxygen they need. It is necessary then to give some help to the heart in getting the blood round. In the veins, particularly those in the muscles, there are valves like those at the exit of the arteries from the heart, placed so that the blood is prevented from running backwards or downhill and is, in fact, actually lifted up by muscle pressure to the heart (from the greater part of the body the blood has to be lifted to get back to the heart). This action against gravity occurs especially when the veins are squeezed by contracting muscles, so exercise is one of the best ways of helping the circulation. The extra breathing we do then, which enlarges the chest and reduces the pressure there, whilst increasing it in the abdominal cavity, also helps to draw the blood up into the chest.

But there is another very important way of helping the heart to get the blood round which also directs the blood to those parts of the body which specially need it. This depends upon the way the blood-vessels divide, and the fact that the smallest arteries and the capillaries are supplied by nerves, which can make them close down or open up, and are therefore called the vaso-motor nerves. Every time a blood-vessel divides, each of its branches is smaller than the parent vessel, but together they make a bigger pathway for the blood. The capillaries altogether would make a path which is about 700 times as wide as the aorta. If all of them were to open at the same time, the blood would be collected in them and the heart would not be able to push it on. The vaso-motor nerves prevent this. They are controlled by a centre in the brain which gets information from all over the body as to what is happening to the blood-vessels of the different organs. If one organ needs lots of blood, its capillaries have to be opened up, but this is balanced by the capillaries of another organ being closed down. If the muscles are working very hard, they get an extra amount of blood, and the stomach and intestines get very little; that is why it is not very good to begin a strenuous game after a meal, as the blood cannot be in two places at once. When food is being digested, then perhaps the skin vessels are the ones to be shut up, and it is very common for a person to feel "shivery" after a full meal.

When we lie down, the heart does not have to work so hard, because it only has to drive the blood round on the flat, so to speak, and does not have to lift it. And because the blood will not tend, under the influence of gravity, to collect in any particular part of the body, the walls of the smaller blood-vessels are also rested by being relaxed. But if we then jump up very quickly, when all these vessels are wide open, the blood at once has a great tendency to collect in those vessels below the level of the heart, and not enough is returned to the heart to pass on up to the brain, and the person may feel very faint, or actually become unconscious. If this happens, he falls and the blood circulates "on the flat" once more, and the brain again gets

its share, and when the person comes round the vaso-motor centre is not caught napping a second time, but sends out warning messages shutting up a lot of vessels below the heart. Feeling faint is generally a sign that the blood is collecting so much in the lower parts of the body, particularly in the abdominal or "splanchnic" area, that the brain is not getting enough. The best thing to do in these circumstances is to bend down and put the head between the knees, so that the blood supply to the brain is helped by gravity, and, if that is not enough, to lie flat. The brain controls so many important functions that it must be kept well supplied with blood to keep its cell centres working properly.

THE BLOOD

Now what about this important fluid which is being circulated? What is it like, and what are its properties? The most obvious thing is perhaps its colour. When shed, it is a purplish red if it comes from a vein, but quickly becomes red on exposure to air, as it is taking up oxygen. If the vessel cut is an artery, the blood is bright red in colour, and comes out in spurts. To stop bleeding, a cut vessel must be pressed on the heart side of the cut if it is an artery, and on the side away from the heart if it is a vein. If the blood is shed into a basin or dish, in a short time it clots or sets into a jelly. The power of clotting is very important, because the clot closes or plugs up any hole that may be made in the blood-vessels. It would be very convenient if, after a frost, when a pipe had burst, the water flowing out mended the pipe by making a sort of solder to fill up the hole! That is just what the blood does to cut vessels when it clots.

If the blood is examined under a microscope before it clots, it is seen to consist of a fluid part called the plasma, in which are floating a very large number of small bodies—the red and white corpuscles. The red corpuscles in human blood are bi-concave discs and have no nuclei; seen

singly, each one is yellow, but when piled, as they often are, like pennies, they appear red, because they contain hæmoglobin, the colouring-matter of the blood. They are very small; 4,000 of them laid flat and placed side by side would measure an inch, but if placed on their edges it would take 12,000 to make an inch. There are enormous numbers of them—5,000,000 in a cubic millimetre, a volume about the size of a small pin's head. The function of these corpuscles is to take up oxygen when the blood circulates through the lungs and to give up as much as the cells want when it goes to the tissues. They live about five or six weeks; they are then destroyed in the liver, and new ones are continually being made in the marrow of the bones.

The white corpuscles, or leucocytes, are a little larger than the red, and not nearly so numerous—about 1 white to 500 red. They are complete cells, each having a nucleus; they can move independently, receive stimuli, and swallow up particles. Their work is to protect the body, particularly against disease germs. This they do in many ways. If germs get into the tissues, as in a cut, for example, they come crowding up to the spot and tackle the invaders. They try first of all to poison them and keep them from moving, and from dividing and reproducing themselves. Some germs can do this very quickly; if they double their number every twenty minutes, as some of them can, it is easy to see there would be hundreds of thousands in a few hours. If the leucocytes succeed in this first attack, they then close in upon them and devour them. It is a fight to the death on both sides, and sometimes the leucocytes do not at once get the best of the fight. *They* may be killed instead of the enemy, and their dead bodies make up part of the pus or matter which is formed when a cut or wound does not heal at once, but fresh leucocytes keep on coming up, and in the vast number of cases sooner or later they win. Sometimes the leucocytes make "anti-toxins," as they are called, which neutralise the poisons or toxins produced by the disease germs, and in this way protect the body from their harmful effects. People infected with diphtheria can be saved from a serious illness by being given an injection of

the fluid part of some of the blood from an animal which has defeated the diphtheria germs, and so developed in its blood a great deal of anti-toxin (see *Applied Biology*, p. 233). At other times the leucocytes make substances called "opsonins," which act like sauces or spices and make the invaders particularly appetising to the leucocytes, so that they are swallowed up quickly before they have time to do any harm.

In the plasma, although we cannot see them, there are also many other valuable substances—everything, in fact, that is wanted by every cell for its proper health and activity; the salts, the proteins, the sugars, the fats, the vitamins. The blood is for every cell the perfect food; it is the oxygen conveyer, the communication and transport agent from organ to organ, the protector against disease, the remover from the cell of waste substances. It has taken on very many functions besides its first and fundamental one of carrying oxygen, and it is easy to see how terribly important it is that it should be kept circulating.

SECTION IV

RESPIRATION

One of the most important results of the circulation of the blood round the body is that every cell gets its chance to take up oxygen and to get rid of carbon dioxide. This exchange of gas involves many factors, and all these together constitute the process of respiration, which takes place in two stages, known as external and internal respiration. In external respiration the blood in the lungs takes up oxygen from the contained air and gives out carbon dioxide, and in internal respiration the blood in the tissues gives up oxygen to the cells and takes from them carbon dioxide.

The lungs are the essential and specialised organs of respiration, evolved to offer the very best conditions for

the body to obtain all the oxygen it needs from the outside air, and to obtain it quickly and continuously.

When it is a question of rapid exchange between a gas and a liquid, the all-important feature is to expose the fluid to the gas in very thin films over as large a surface as possible. A study of the structure of the lungs shows how marvellously this has been accomplished in them. They are made up of a number of minute little sacs, which are the final dilatations of very small airpassages (see Fig. 25). Each sac is rather like the blown-out finger of a glove, and is covered by elastic connective tissue. This is pushed up as very thin partitions into the sac, dividing it into a number of still smaller compartments, known as alveoli, and looking something like a bunch of grapes.

Between the outer connective tissue and the flattened and thin lung cells lining the alveoli run the capillary blood-vessels. Each alveolus is a tiny microscopic structure, but contains a network of capillary blood-vessels. Through these capillaries, often so small that there is only room for one corpuscle to pass at a time, runs the blood, with its millions of red blood corpuscles. Some figures will show how these arrangements fulfil the necessary conditions for exchange between a liquid and a gas. If the surfaces of all the alveoli could be spread out in a single sheet, the sheet would cover nearly half a tennis-court (the calculated area is about 30 by 32 square feet and half a tennis-court is 39 by 42 square feet). The capillaries of the lungs, if placed end to end, would reach right across the Atlantic. The hæmoglobin, which takes out the oxygen from the air, is spread out in the red blood corpuscles, and the single sheet which could be made by putting all *their* surfaces together would be large enough to cover ten tennis-courts. And all this is managed within the comparatively small space of the chest.

For the exchanges to take place the air must be brought in and out of the air sacs and alveoli by channels which connect them with the outside air. For this purpose the tiny air passages from which the air sacs open out join together to make larger passages—bronchial tubes. These in turn join to form larger tubes, ending finally in a single

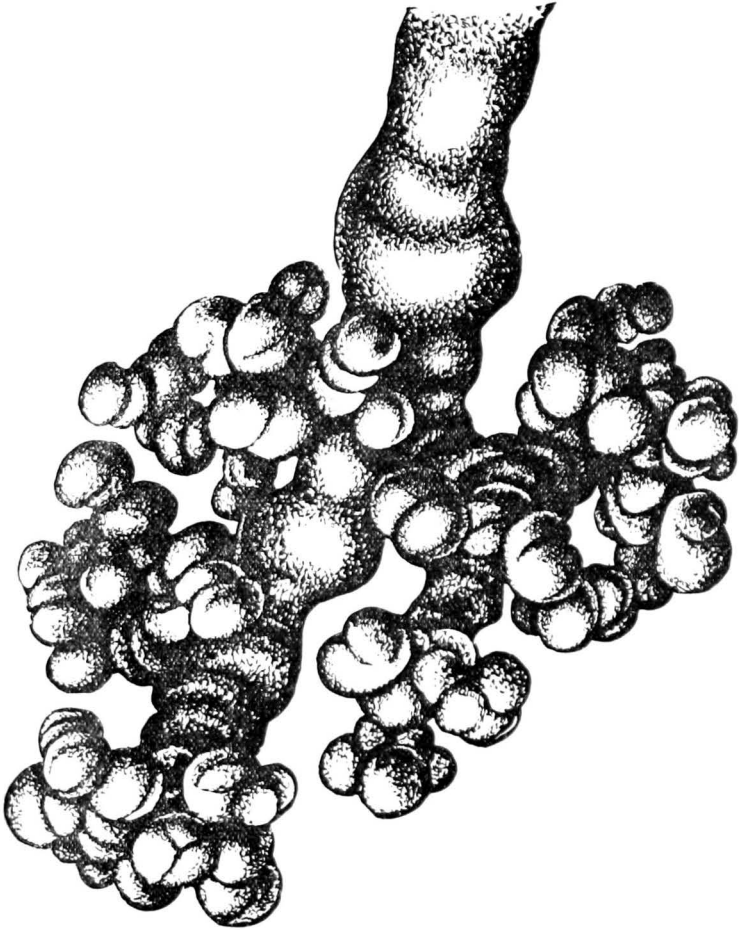


Fig. 25. PHOTOGRAPH OF METAL CAST OF PART OF LUNG,
ENLARGED 36 TIMES

large tube, or bronchus, from each lung. These two unite to make the trachea, or windpipe. This is stiffened and kept open by cartilage arranged, not as a continuous sheet, which would make us literally stiff-necked, but in incomplete rings, which give support with flexibility and allow

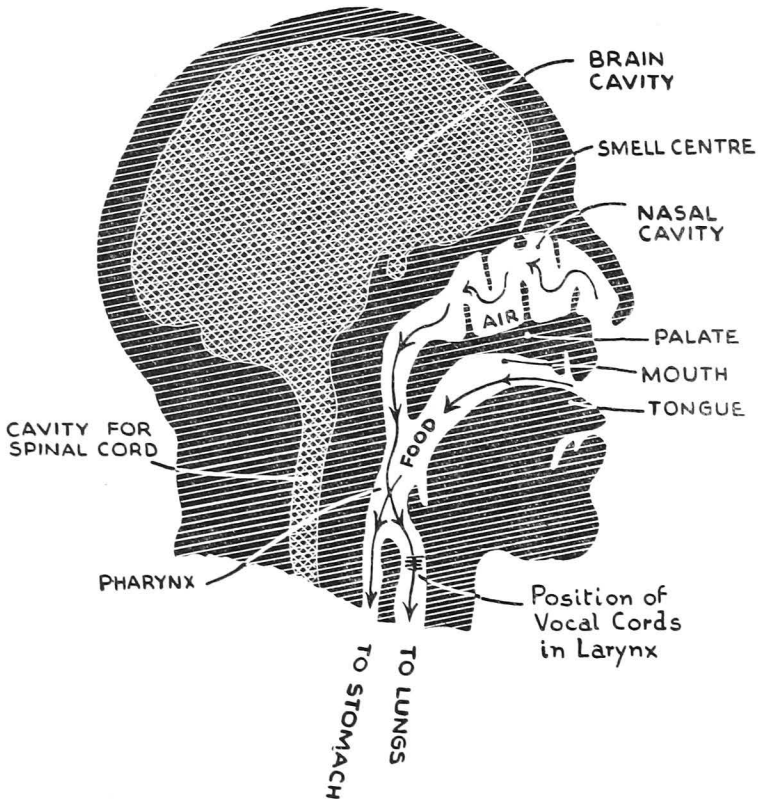


Fig. 26. DIAGRAM OF HEAD SHOWING FOOD AND AIR PASSAGES

plenty of play of movement to the neck. The trachea open through the larynx, or voice-box (Adam's apple), into the pharynx, or throat, and is perfectly free to the passage of the air which is breathed in and out, except when it is momentarily closed by the act of swallowing (see Fig 26).

Air can get into the pharynx either by the nose or by the

mouth, but the proper way in is by the nose. Air entering this way is warmed, moistened, and freed from dust and other particles by passing over little scroll-like bones, covered with a mucous membrane which has a great many blood-vessels in it. It also has glands which pour on to the surface a sticky secretion, which catches the dust rather like a fly-paper catches flies. The cells lining the passages have at their outer borders cilia, or minute hairs, which create a current of fluid down the nose and so help to get rid of the dirt and dust. If the air goes in by the mouth, chilled, dry, dusty air gets into the lungs, and this will interfere with their proper work of exchange.

Where the nasal passages open into the pharynx there are two lymph bodies, the adenoids; farther down the throat, more lymph tissue forms the tonsils. Both pairs of bodies are generally larger in children than in grown-ups. If the adenoids become too large, they may block up the nose passages, so that the child breathes only through the mouth. This has a bad effect on the health, and also on the appearance, as mouth-breathers generally look, and may become, stupid. Such people, too, are very subject to colds, and, as this means an inflammation and thickening of the mucous membrane lining the passage, the air-way is made smaller and it is still harder to breathe through the nose. These glands seldom become too large in people who normally breathe correctly. To do this it is of course necessary to keep the nose clear, hence the necessity for a proper use of the handkerchief. Children who have been encouraged from babyhood to breathe properly will rarely have "tonsils and adenoids" (which, of course, means *enlarged* tonsils and adenoids) which have to be removed.

Each lung is attached to the body only by its bronchus, which opens into the trachea; elsewhere it is perfectly free to move inside the chest cavity. This cavity is bounded at the back and sides by the backbone and ribs and their muscles, in front by the sternum or breast-bone, and below by the diaphragm, a sheet of muscle separating the chest from the abdomen. The lungs are covered with a double layer of thin membrane, the pleuræ (inflammation of these

occurs in pleurisy), so arranged that the space between them and the chest wall is air-tight. If the chest expands, as in inspiration, the elastic lungs must follow suit and air will be drawn in ; in expiration the reverse effect will follow.

The chest is made larger from front to back and from side to side by the raising of the ribs and by their " bucket handle " movement, and from above downwards by the contraction of the diaphragm. Expiration is usually a letting-go of the inspiratory muscles, but there are special muscles which are brought into play in forcible expirations. All these complicated movements, in which dozens of muscles are made to work together, are controlled from a centre in the medulla of the brain, which gets its information as to what the body wants in the way of respiration either by messages brought to it by nerves, especially from the lungs themselves, or by the quality of the blood circulating in the brain and supplying the centre.

Respiration can be affected in many ways ; even thinking about it will alter it. Excitement may make a person hold his breath or breathe very deeply, and getting into a cold bath will certainly produce a deep inspiration. A tickling in the nose or throat will produce a sneeze or a cough, which are both special forms of expiration, as also are laughing and crying. When food passes from the back of the tongue to the pharynx on its way to the gullet, a very important reflex is set up which momentarily stops, or " inhibits," breathing, at whatever stage it may be in, and so prevents us from " swallowing the wrong way," which would be into the trachea instead of into the gullet. We can also change our breathing to some extent voluntarily. It is possible to hold the breath for about half a minute with ordinary respirations, or one and a half to two minutes after several very deep breaths (after forced breathing with oxygen the breath has been held for ten minutes !), but it is impossible by any effort of the will to stop respiration. There comes a time when breathing has to begin again. This is due to a very important control of the breathing

centre, a chemical one which depends upon the composition of the blood particularly as regards the amount of oxygen and carbon dioxide it holds.

The hæmoglobin, which takes the oxygen up from the air (and in doing so is made into oxy-hæmoglobin), has the immensely convenient property of being able to take up nearly its full load of oxygen at pressures much less than that of ordinary air. If the oxygen in the lungs fell to half, the oxygen taken up would only be reduced to four-fifths the usual amount, but, where the pressure of oxygen is very low, as it is in the cells of the body which always seem to have a hunger for it, then the hæmoglobin gives up some of its oxygen with the greatest rapidity. For this reason changes in the oxygen in the lungs, and so in the blood, have to be quite considerable before they will affect the respiratory centre. But it is very different with carbon dioxide. A very average sample of the air in the alveoli (where it is to be remembered the exchanges really take place) would contain 15 per cent. of oxygen and 5.5 per cent. of carbon dioxide, and the rest nitrogen. The oxygen could change from 15 to 10 per cent. without any very obvious effects on respiration, but if the carbon dioxide rose to 5.7 per cent. the air breathed in and out in a minute would be doubled in an attempt to wash out the extra carbon dioxide. In fact, the amount of carbon dioxide in the lung alveoli is the great regulating factor of respiration. The respiratory centre is exquisitely sensitive to the most minute changes of the carbon dioxide in the blood, and works so as to keep it constant in the alveoli. But increasing respiration to get rid of carbon dioxide necessarily increases the supply of oxygen, and in this way a wonderfully ingenious control has been established which balances the oxygen supply with the oxygen needs, without running the person into any risk of a shortage of oxygen.

The energy for muscular exercise, for example, is supplied by the burning of sugar, and for this oxygen is needed. The carbon dioxide so produced immediately stimulates the centre and causes deeper breathing, which, while washing out the carbon dioxide, at the same time increases the

amount of oxygen breathed in. But the oxygen has to be carried to the muscles before it can be used by them, and so it comes about that the ultimate factor which settles how much oxygen the tissues can get is the amount of blood which can be pumped to them by the heart. The difference between the Marathon runner and the ordinary man is a difference of "heart," and "second wind" comes when the heart is adjusted to pumping to the muscles the extra amount of blood which they need.

DIFFICULTIES IN BREATHING

Any interference with an adequate supply of oxygen to the tissues must create difficulties. Certain of these occur in disease—in asthma, for example, there is a spasmodic narrowing of the bronchioles which makes it difficult for the air to pass in and out of the lungs as easily as usual; in congestion of the lungs there is a thickening of the surfaces which prevents a proper exchange of gases. In anæmia there is too little hæmoglobin—this is a condition unlikely to occur in people who have plenty of fresh air and exercise out of doors, and good plain food, with milk and fresh fruit and green vegetables.

In everyday life there are sometimes difficulties in getting enough oxygen. Unsuitable clothing, such as tight collars and belts, will prevent free movement of the respiratory muscles, and so of the air in and out of the lungs. Shallow, lazy breathing moves the air in and out of only some of the alveoli; the cure for this is exercise, which will cause deep breathing and will bring all the alveoli into use.

At high altitudes, such as may be reached by balloons or aeroplanes or climbing, the supply of oxygen will be cut down. At the height of Mount Everest the oxygen pressure is not much more than one-third of its normal value. In an account of one of the attempts to climb this mountain one of the climbers tells how, at 27,000 feet, to get enough oxygen he had to take seven or eight breaths for each step. There must be wonderful powers of acclimatisation and

adaptation in the body, which make it possible for men to live, and much more to climb, when the oxygen pressure is not much more than one-third of what it normally is.

Pilots of aeroplanes going to very high altitudes, which they reach very quickly, take cylinders of oxygen up with them, from which they can breathe in extra oxygen, because in such ascents there is no time for acclimatisation.

Too little oxygen has marked effects on the body, particularly on the mental capacities. Memory and reasoning-power are poor; quite simple arithmetical sums, for instance, cannot be done correctly. Sensations are less vivid, and there is often loss of appetite and great irritability. Too much carbon dioxide also has bad effects. It will make a person stupid, with a flushed face, and will cause him much discomfort. Finally, with either too little oxygen or too much carbon dioxide we become unconscious.

Divers who go down to look for wrecks, or men who have to work under water in bridge-building or cable-laying, are placed under exactly opposite conditions from climbers. They have to breathe air at high pressures to balance the pressure of the water on their bodies. Much more gas goes into solution in the blood under these conditions, and if they are brought too quickly to the surface it is given off just like the bubbles of carbon dioxide which come off when a soda-water bottle is opened. Bubbles of nitrogen given off in this way may block up capillaries in important organs of the body, and this may give rise to great pain, and possibly lead to death. For this reason divers are not allowed to work under pressure for long periods, and they are brought to the surface slowly, or, if they are working in steel chambers, they come out through a series of air locks, so that the gases will not be given off so quickly that they accumulate in the blood.

Another kind of difficulty arises when there is plenty of hæmoglobin in the blood, but it becomes joined up with another gas which will not let it go to the oxygen. This occurs in carbon monoxide poisoning. Carbon monoxide is present in coal gas and in the exhaust from motor-cars, so people should be very careful to see that there are no

leaks in their gas-pipes or taps, to keep windows open in rooms in which gas is laid on, and never to shut themselves up in a garage with a car whose engine is running. Hæmoglobin "likes" carbon monoxide about 300 times as much as it does oxygen, and so if there were only 0.06 per cent. of carbon monoxide in ordinary air, then half of the hæmoglobin would be combined with the carbon monoxide, and only half the usual amount of oxygen could be absorbed.

VENTILATION

If a person were shut up in a hermetically sealed room he would of course gradually, but only after a long time, use up all the oxygen, with fatal effects. Fortunately, in ordinary rooms this is impossible, with windows and chimneys all capable of opening to the outside air and doors opening into other spaces. But, though it takes time to use up all the oxygen, it does not take long to become uncomfortable in a closed or confined space such as a room, or railway carriage, or car, without proper ventilation. This is hardly ever because the oxygen has fallen, or the carbon dioxide risen, to levels which would seriously effect respiration. It is nearly always due to stagnation of air, which has become warmed and saturated with moisture. A rightly adjusted current of air such as can be obtained between two open windows, or between doorways and windows and chimney, will prevent the discomfort. Stuffy rooms often cause a thickening of the mucous membrane of the nose and blocking of the air passages of the nose, with increased susceptibility to colds. Another reason for having windows open is that the air and the health-giving ultra-violet radiations can pass in. These rays are present in sunlight and in the clear, bright light from the skies, and they are essential for the proper growth of children and for the health of everyone. They are stopped by ordinary window-glass, and, though glass is now made which will allow them to pass through, it is simpler to have windows open than to change the glass. In temperate climates and

in smoky cities, to get enough of these rays it is generally necessary to be out of doors a good deal. Certain food substances, such as cod liver oil, can to some extent replace exposure to sunlight, and so cod liver oil is a great help in the darker days of winter, as will be the newly prepared "Calciferol," which seems to be the active substance which makes cod liver oil valuable (see *Applied Biology*, p. 235).

Evidently, then, it is important to keep rooms well supplied with fresh air. This will prevent the accumulation of harmful materials, and will provide the skin with the tonic effects of movement of the air, and of the ultra-violet rays.

SECTION V

GROWTH

A newly born bird does not perhaps look very much like its parents, but it resembles them sufficiently for us to have no doubt as to what it will grow up to be later on. A newly born baby in the same way is quite clearly the offspring of human beings: his shape is the same, the form of his little hands and feet, and arms and legs, are the same as those of his parents, and his face is of the same kind: all the various parts are there, but their sizes and proportions are different. As the baby grows he becomes heavier and larger, but some parts of him grow more quickly in proportion than do others. A baby's head always looks large, and actually at birth the face represents a quarter of the total height, while at twenty-five years old it is only one-eighth, and the brain at birth is one-seventh of the total body weight, and in the adult only one-fiftieth of the whole weight. The skeleton represents about one-seventh of the total weight throughout life, but the muscles are twice as heavy in proportion in the grown-up person as they are in the baby.

Clearly, then, the growth of all parts of the body does not

go on at the same rate, but, given warmth, food, sunlight and exercise, the baby should normally develop into the properly proportioned adult. The regulation of the growth is carried out by certain very important little glands in the body. These glands have no ducts, and so pour their secretions straight into the lymph or the blood, which carry them all round the body. The glands are called ductless glands, and their secretions are known as hormones, or "chemical messengers," because they are carried by the blood from the gland that makes them to other parts of the body, where they control the activities that may be taking place. The pancreas, as you remember (p. 97), makes one of these messengers, known as "insulin." Another gland, the pituitary, is right underneath the brain in the skull. If this gland is over-active, the child grows much too fast, and in the end becomes a real giant, perhaps 8 feet tall; if the gland is not sufficiently active, then growth is much slower, and the result is a very fat dwarf, perhaps only 4 feet tall or even less. Normally the secretion of the pituitary is of just the right amount to maintain the rate of growth correctly.

Yet another ductless gland is the thyroid, in the front of the neck. If a baby has too little of the secretion of this gland he does not grow properly, either mentally or physically; such a child develops into the stupid and stunted cretin. Fortunately this condition can be recognised early, and, if the child is then given some thyroid extract, development will proceed in the usual way: the treatment must, however, be continued all through life, as the thyroid controls the rate of our bodily oxidations at all times, and not only during growth. Sometimes the thyroid is enlarged, giving rise to a swelling in the neck, or a goitre. If it is over-active, then the bodily processes go on too quickly, and the person becomes thin and nervous and excitable: this hardly ever happens in children (see *Applied Biology*, p. 236).

There are other glands also that help in this regulation of bodily processes, but those mentioned are the most important ones.

There is another factor that is of great importance for correct growth, namely, the right kind of food. There must

be sufficient food to keep the weight increasing steadily during the period of growth, or to keep it at a constant level when grown up, and there must also be enough of the right kind of proteins to give all the amino-acids required for building up the new tissues : in addition, plenty of foods are required that contain calcium and phosphorus compounds such as are found in milk. As the bones appear at first they are quite soft, so that a baby's bones bend rather easily. If they break the fracture is called a "green-stick" fracture because it is like the splitting of a green stick. But gradually the soft framework is replaced by the hard, dense bone, that is composed chiefly of calcium phosphate, and is designed to support the weight of the body. If there are insufficient calcium or phosphorus compounds in the diet, or if their relative proportions are incorrect, or if there is not enough vitamin D, the bones do not harden properly, and then the weight of the body and the contractions of the attached muscles make the bones assume wrong shapes.

The teeth require the same substances as bone for their proper formation : if they are too soft, they decay very quickly. A baby's milk teeth begin to come through at about six months ; they should have a hard outer covering of enamel which protects them from decay, but if the calcium salts of the food are deficient the teeth are abnormally soft. The thirty-two permanent teeth begin to be formed in the jaw before birth, and they are waiting to push through the gum in place of the milk teeth when these fall out : the first permanent teeth come through at about six years old. If the diet of the child is not well balanced, the permanent teeth will not be properly hardened either, and when they erupt they will quickly decay.

REPAIR

The body can not only grow, but it can also repair itself in a wonderful way. If a crab loses a leg, he grows another one in its place quite easily : if a lizard is picked up by the tail, he will wriggle about a little and then break away,

leaving his tail behind, and very soon he grows another tail. A human being cannot grow a new arm or a new leg like this, but nevertheless he can repair damage in a wonderful way. If one of a pair of organs such as the kidney has to be removed because of its diseased condition, the one left behind grows larger, until nearly twice its original size, in order to do double work.

The skin is continually being removed : it may get scratched or torn, or even just worn off by rubbing, but it consists of many layers of cells, and the deep ones are continually increasing in numbers and pushing up to the outside to replace the damaged ones. It is very necessary that this should be so, as the skin protects the body from cold, wet, and injury.

Then the hairs are often renewed : when a hair falls out, its place is taken by a new one that grows up from below, otherwise we should quickly become bald. Another example of renewal is found among the blood cells : the red blood cells only live about five weeks, and then they are destroyed by the spleen and the liver and most of the remains are got rid of : but the iron that they contained is kept back and built up into new hæmoglobin for the new red blood cells that are being made continually by the marrow in our bones. Another good example of repair is seen in a broken bone : if it is "set," and kept at rest, the broken ends are soon joined together again by the activity of the bone-forming cells.

REPRODUCTION

There is another difference between a young animal and a grown-up one besides the differences in weight, size, and proportions : an adult can reproduce its own kind. All living organisms have this power of reproduction, otherwise in the struggle for existence they would soon become extinct.

Many of the simplest organisms, consisting of only one cell, merely divide into two offspring ; but except in these very lowly forms of life two different cells are necessary. The

two cells fuse together into one, which then divides repeatedly, and in the end grows into a new organism like the original: this process of fusion is called fertilisation.

Sometimes both the cells needed are produced by one animal, but much more often they are produced by two different animals, which are then called male and female. Usually the male cell is deposited inside the body of the female, and here it meets the female reproductive cell, and the two fuse: this new cell, the "fertilised ovum," then ultimately gives rise to a new animal like its parents (see *Biology*, p. 187). The fertilised ovum is sometimes deposited as an egg: in this case it has a protecting covering within which it divides and increases until it has become an organism capable of taking care of itself; then it breaks the shell and comes out. This happens in fish, amphibia (like frogs), reptiles (like snakes), and birds. While the egg is developing it is usually carefully protected, and in warm-blooded animals kept warm: this is why most birds prepare a nest for the eggs and then sit on the eggs until they are hatched.

But in the mammals the fertilised ovum develops actually within the body of the mother until the baby animal reaches a stage when it can live by itself if looked after, and then it is passed out of the mother's body—i.e. it is born. Some baby animals, such as guinea-pigs, can run about and feed themselves almost at once; others, like kittens and puppies, need their mother's care for some time after birth; human babies are like this. A kangaroo mother has a neat way of tucking all the family into a pouch in the front of her body, where they are quite safe and warm and can be carried about easily.

In the human the fertilised ovum grows into a little baby within the womb (or uterus) of the mother. Only mature organisms can produce the sex cells, and this development into maturity is what we call growing-up, or puberty. Until this time the differences between girls and boys are not very strongly marked, but at puberty all the changes occur that ultimately distinguish a man from a woman, and these bodily changes are controlled by special hormones.

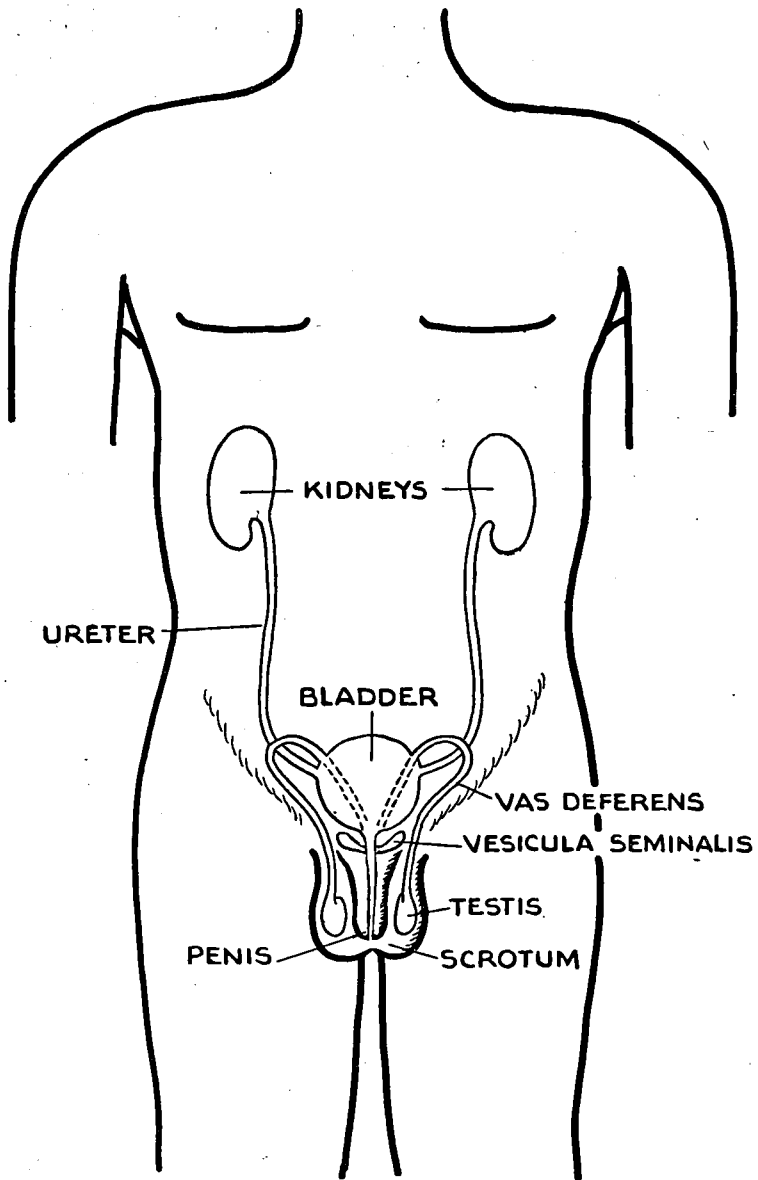


Fig. 27. DIAGRAM OF MALE REPRODUCTIVE SYSTEM

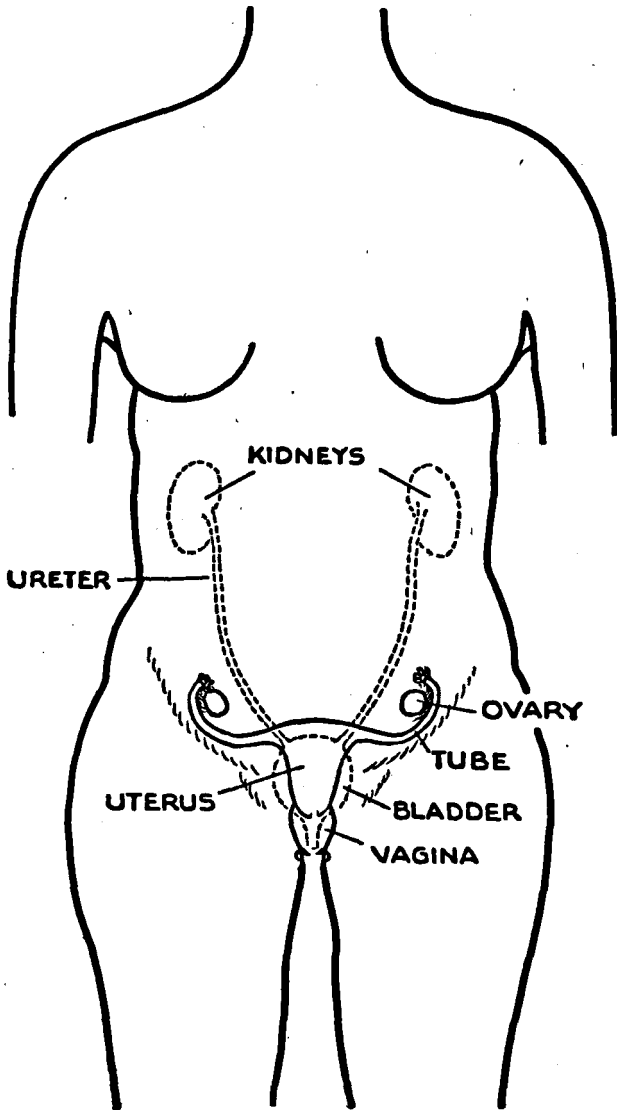


Fig. 28. DIAGRAM OF FEMALE REPRODUCTIVE SYSTEM

Note : The kidneys, ureters, bladder and its passage to the exterior are in dotted outline. The reproductive organs are seen in continuous line. The bladder and its passage lie in front of the uterus and vagina.

At puberty special activity of the nervous system usually occurs, and the sense of "sex" is developed in the girl or boy with the growth of the reproductive organs. All the changes that take place are really designed in a most wonderful way for the production of the germ cells, for their meeting within the body of the mother, and for the development of the new baby within her body, and all these processes are intimately bound up with pleasure-giving emotions (see *Biology*, p. 188, and *Problems and Solutions*, p. 699).

In the male at puberty there are certain obvious changes in the growth of the skeleton and of the hair, and also the "break" of the voice: but more important still is the development of the special sex organs, of which the most important are the two testes (see Fig 27). At this time the testis becomes much larger: it is an olive-shaped little body in the scrotum that at this time becomes capable of making and setting free the special sex cells. These cells, which are called spermatozoa, are very minute; each has a small head containing the nucleus and a long vibratile tail which enables it to move rapidly in a fluid medium. The spermatozoa are continually formed and set free in large numbers: they leave the testis by its duct, the vas deferens, and are temporarily stored: then periodically they are involuntarily passed down the remaining part of the duct or urethra (which also receives the urine from the bladder), through the penis, to the exterior. This sometimes happens in the night, giving rise to "wet dreams," and is simply nature's method of getting rid of the collected cells. The spermatozoa are mixed with secretions from the vesiculæ seminales and from the prostate gland, which are poured into the urethra. The penis is usually quite limp, but when the spermatozoa are to be implanted within the mother's body it becomes engorged with blood (by a reflex mechanism), and this makes it stiff, so that it may be introduced without injury into the female tube. The change in the penis is known as erection, and the coming together of the male and female for the purpose of introducing the spermatozoa into the female is called coitus.

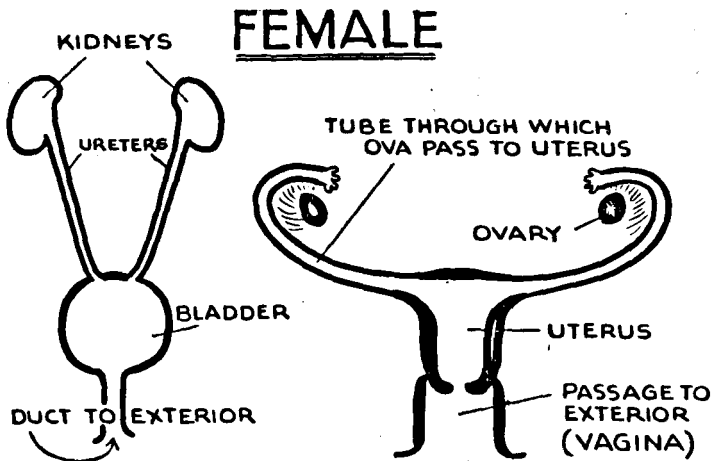
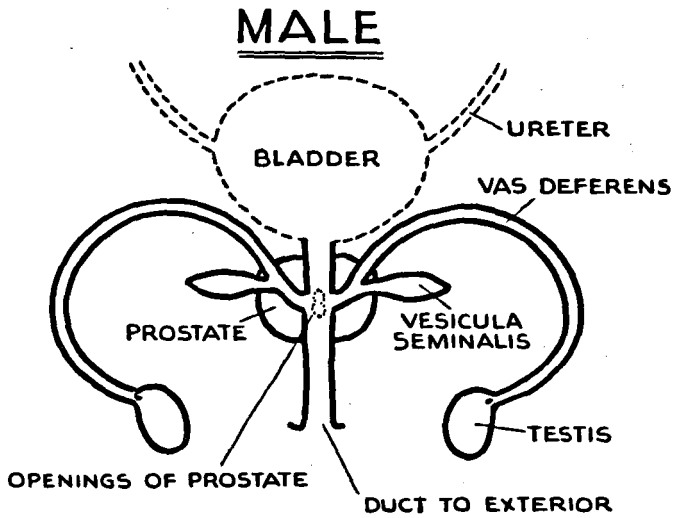


Fig. 29. MALE AND FEMALE REPRODUCTIVE SYSTEMS:
EXPLANATORY DIAGRAM

In the female there are also changes at puberty in the form of the skeleton which adapt her for child-bearing later on ; in addition there is the development of the breasts (or mammary glands) to provide food for the baby after birth, and there is the special development of the uterus.

The uterus is like a nest in which the fertilised ovum will grow into a little baby, and a wonderful provision is made whereby the nest is newly prepared every time there is a possibility of an ovum requiring it (see Figs. 28 and 29). Every four weeks a female reproductive cell is set free from the ovary and passed down the female tubes, ready to be fertilised if it should meet a male cell. Every four weeks, also, there is an increased growth of the lining wall of the uterus, and an increase in the blood-vessels : then this extra tissue breaks down into the cavity of the uterus and the debris of cells and blood are passed out from the body as the menstrual flow : at once the lining is renewed, and at this stage it offers a newly prepared bed for the fertilised ovum. If such an ovum is present, it settles into the nest and is firmly fixed there by the healing growth of the uterus lining, and is thus provided with nourishment while it is developing into a little baby : during this period of development it is known as a foetus.

So it comes about that menstruation usually occurs every four weeks, the changes involved being controlled by hormones, and represents nature's preparation for a developing ovum. If a fertilised ovum does become implanted, then menstruation ceases for a time, and the developing ovum is nourished by the mother's blood. The close connection between the foetus and the mother is maintained by the development of a special arrangement of blood-vessels belonging partly to the foetus and partly to the mother's uterus : this structure is called the placenta, and is attached to the foetus by a cord carrying blood-vessels, and called the umbilical cord. The foetus continues to grow within the mother's uterus, and in forty weeks' time it has developed into a little baby. Then it is born, i.e. it is expelled from the mother's body by strong contractions of the muscle of the uterus, and the umbilical cord is then cut,

and the baby begins to breathe for itself. At the same time hormones are liberated into the blood stream that stimulate the mammary glands, and milk is secreted as food for the new-born child. After the birth of the baby the placenta is expelled as the "afterbirth," the process of menstruation gradually begins again, and possibly another little baby begins to develop.

It is very important that while the baby is growing within the mother's uterus the mother should have plenty of rest and plenty of good and suitable food, as her blood has to provide food for the baby as well as for herself.

SECTION VI

LIFE AND DEATH

The previous sections have dealt with the functions of the living human being rather than with those of a simpler type of organism for various reasons. In the human the different functions have been highly specialised, and this makes them easier to investigate ; further, the human body is one whose activities we can observe, and even to some extent regulate, in accordance with our understanding of them, which is a most important matter. But although man, through the great development of his central nervous system, has been able to control and to adapt himself to his environment more than any other living organism, yet it must be realised that he is not something quite apart from others, but that he forms part of a great whole, and is dependent on its various parts. Like all other animals, he depends for his very existence upon the activities of the plant world (see *Applied Biology*, p. 220).

Although he has learnt to control many conditions, he cannot prevent the gradual wearing out and death of his material self. All living organisms are subject to destruction by what may be called violent death, but the duration of what is sometimes called natural life varies greatly. The

customary span of human life is "threescore years and ten," but birds are often centenarians : some fish, such as carp, if kept in artificial and protected surroundings, have been known to live for more than 200 years, as can be told from their scales, and trees, like some of the sequoias, may live for thousands of years. It is quite true that with better care and sanitation the years of life are lived in better health, and also that to many middle-aged persons some years of life are actually added. But the greatest ages to which people live do not increase appreciably. It is better so, better to think of the wearing out of the body as the natural result of its good and proper use, and to accept death coming gradually and peacefully, as it does to old people, as the fitting and happy end of a body that has served its purpose in the great scheme of things. Life goes on although the individual passes.

PSYCHOLOGY
OR
THE BODY-MIND
by
DR. ERIC STRAUSS



ERIC STRAUSS thought he wanted to learn about mediæval and modern languages, but then he found out he was one of the kind of men who can heal people and especially heal them in ways to do with the mind. If one can't sleep, he tells one to sleep, and then one does sleep. This is very like magic, but it just isn't. In this article he will explain the kind of way in which one can begin to understand people's minds and feelings, and how one can help them. It is a good thing that people who do that should be doctors and understand physiology and medicine, for one can't separate body and mind. So Eric Strauss decided to drop the languages and became a real doctor. That is what he is now, but, because he is particularly a mind-doctor he is called a psychiatrist. He was an infantry captain during the war. He is rather younger than I am, and he wears an eye-glass, so as to impress patients (or perhaps it really helps him to see them too).

PSYCHOLOGY

WHAT IS psychology?—and with what does it deal?

In the previous chapter you have read something about the science of physiology, a science whose boundaries are nicely mapped out and therefore capable of exact definition. It is true that there are many branches of physiology, but all the students of all the branches would accept a single definition for the science as a whole, and would not be at loggerheads amongst themselves. But there is not *one* "psychology"; there are almost as many psychologies—or *schools* of psychology, as they are called—as there are philosophies or religions; and the various members of the various schools work together and agree about as well as mediæval Mohammedans and Christians. So there is no definition of the science and the things with which it is supposed to deal which they will all like. The derivation of the word doesn't help. The Greek scholars amongst you will squabble as to whether psychology should mean the science of breath (the original meaning of the Greek word $\psi\upsilon\chi\eta$) or the science of the soul (a special meaning later attaching to the same word). There *is* a science of breath studied in India and called "Yoga"; and the various schools of theology and philosophy deal with the idea of the soul. Neither of these sciences is psychology.

What is psychology, then, and with what does it deal? Before giving you the definition that appeals to me most, I will give you a few of the other answers. (1) Psychology is the science of the mind. Yes! But what is the mind as apart from the body? No one can provide a satisfactory answer to this question; so that definition is no use. (2) Psychology is the scientific study of behaviour, and nothing more. It is the "nothing more" on which the "behaviourists" (as the disciples of this doctrine call themselves) insist, to which I object. (3) Psychology is the scientific study of conscious experience as revealed by *introspection*, i.e. looking into oneself and reporting what one finds there at any

given moment. This method of approaching psychology has produced some very valuable results, but is rejected by the behaviourists as being inexact and unscientific. My objection is that the study of consciousness by introspection is only one method amongst many. (4) Psychology is concerned with the classification and orderly study of mental "faculties"—trying (*conation*), willing (*volition*), and the like. This approach has only succeeded in producing innumerable dry-as-dust text-books, and has scarcely contributed to human knowledge. (5) Psychology is the study of the primitive urges, called "instincts," governing behaviour, and the various conscious mental states associated with them. But there is good case for denying the existence of instincts in humans (in the sense in which they can be observed in animals); and no two "instinctual" psychologists manage to agree about them at all. So that won't do. (6) Psychology concerns itself with the unconscious "mechanisms" (orderly processes) behind human conduct and feeling. At first it seemed absurd that there could be a mental life which goes on under the surface where we aren't aware of it, but now we can be quite certain that this is what happens. The various psychologies of the unconscious have become very popular of late, largely because they can explain and provide a successful way of treating mental illness. But though this unconscious mental life is very important, it isn't everything. Psychology is something more.

There are still other answers as to what psychology is, but these are most important. The people who believe in them have done valuable work, especially those who do exact laboratory experiments; but, to my mind, no one school of them can give a complete account of psychology.

So now it is about time that I should suggest some sort of definition myself. The widest definition of psychology, and the one that will offend the least number of students is: "Psychology is the scientific study of the activities of the individual." The individual can be either a human or animal organism. The activities can be either external, as in behaviour one can watch, or internal, which include all

the activities commonly called "mental." Our rough test of an activity must be whether the noun expressing it can also be expressed as a verb. Thus, vision can be described as an activity because we can equally well call it "seeing"; memory is an activity because we can substitute "remembering" for it.

MAN IS A BODY-MIND UNIT

What is the individual whose activities psychology purposes to study? Centuries ago the philosopher, St. Thomas Aquinas, said, "I am body-soul." If I say, "I have a body and I have a soul," I am immediately faced with the difficulty: who or what is the "I" who has the body and the soul? Wise psychologists start with a similar formula: "I am body-mind." Now, if psychology wants to find out about all the activities of the individual (i.e. the body-mind organism), you can see what an enormous field of study there is, and how closely it has to link up with the other sciences of life. You can see how nearly related the sciences of psychology and physiology are, since both are about living individuals. Again, people almost always live in some kind of group with other people, so psychology links on to "social" sciences (see *History of Ideas, The Family, and Organisation of Society*, pp. 417, 461 and 493). Again, people have parents and ancestors, and often they do things and think things because their parents and ancestors did. So psychology links on to the science of genetics or inheritance (see *Biology*, p. 196). Finally, the individual may perhaps be ill in mind and body, and, of course, the sick organism acts very differently to the healthy one. The study of mental illness is called "*psychiatry*" or "psychological medicine"; the science of bodily illness is called "medicine." The good doctor should study his patient as a body-mind unit, and should be something of a psychologist.

If the editor had allowed me enough space, I could have given you an outline of psychology! As she has imposed a strict word-limit, I can only talk to you *about* psychology and the kinds of problems with which it tries to deal. If

what you have read here has interested you, I should advise you to read as a start a book by Professor Woodworth called "*Psychology, a Study of Mental Life*," which is written in simple, and therefore sensible, language. In writing parts of this chapter I have made good use of that book.

THE PSYCHOLOGICAL INVESTIGATION OF A SIMPLE SITUATION: THE SNAKE

Let us consider the following simple situation : I am out for a walk and I notice a large snake. I feel disgusted and terribly alarmed and run away. I feel ashamed of my cowardice and tell myself that the snake is probably harmless. I come back to the snake and find it a curious and beautiful creature.

Let us try and tackle this situation from the standpoint of the psychologist. Here are some of the puzzles arising out of the situation and something about a few of them :

(1) Certain qualities or attributes of the "I" who has this experience are interesting and important—how intelligent he (or she) is, what sort of a person, where he lives and with whom, what his parents and ancestors were like, how well he is in body and mind, what he was doing and thinking when it all happened.

(2) "I am going for a walk." Why did I consciously want to? What keeps me on the road instead of wandering off into a neighbouring field? How have I *learned* to walk?

PERCEPTION, CONCEPTION, SYMBOLISM, ATTENTION

(3) "I notice a snake." This involves vision. Vision or seeing is a physiological activity, a function of a special sense-organ (see *Physiology*, p. 75). Seeing, as you know, is the result of certain rays of light striking the sensitive back-curtain of the eye, which carries a record of the changes which have for the moment taken place in it to a part of the brain. This is something very different from

seeing the snake. We want another word for that sort of seeing, and psychology supplies it. We can say, "I *perceive* a snake." Something has gone on in my brain which has translated the mass of light-sensations which first reached the brain into something definite—a snake. In psychological language we say that a sensation has become converted into a perception.

But, even if I perceive a long, mottled object lying curled up on the road, how do I know it is a snake? Because I already have in my mind an *idea* or *concept* of a snake. I may have seen a snake or several snakes in the Zoo or seen pictures of them. But my conception of snakes is more than visual. It includes at one and the same time everything that I know about snakes—the fact that they are scaly, dry, cold-blooded, lay eggs, and so on; that some are poisonous, others not. You will see, then, that conception is a very complicated mental process involving, amongst many other things, *memory*.

I say that I see a *snake*. A German would say that he perceives a *Schlange*; and yet the German would perceive the same object and have a very similar conception. This shows that words are not the things themselves, but only stand for them; they are only *symbols* of things—speech-symbols (see *History of Ideas*, p. 439). And here is yet another branch of psychology—the psychology of speech, language, and *symbolism*, in general. As a simple example of a symbol of another kind, let me mention the figure of Britannia. This figure of a woman with a shield and trident calls up or *stimulates* our concept of Great Britain. She is obviously not the same as Great Britain, but *symbolises* our whole conception of that country.

In our story I say that I "notice" a snake. Going along a road I obviously perceive a hundred and one things—the dust on the road, the sky, the trees, the heat, the roughness of the road, the smell of the bracken; further, there are numberless simple sensations, some conscious, some unconscious (e.g. the pressure of my clothes, the state of my muscles). All these are, as one calls it, *competing for my attention*. What are the laws which govern my selection

of *stimuli to which to respond*? (If you have read *Physiology*, p. 85, you will understand the words "stimulus" and "response." Later I shall try and show how enormous a part of our body-mind activities can, when reduced to their simplest terms, be regarded as responses to stimuli.) That branch of psychology which is concerned with the problems of *attention* and *observation* in general discovers and studies these laws.

EMOTIONS, SENTIMENTS, THE ASSOCIATION OF IDEAS

(4) "I feel disgusted and terribly alarmed." This part of the situation too presents a great number of difficult and interesting psychological problems. Disgust and fear are examples of what are known as *emotions*. What is the nature of these peculiar mental states? What use are they (if any), and how many primary emotions are there? What are the laws governing them, and are they best studied from the bodily or the mental point of view? (I am going to show that there are certainly bodily changes accompanying at least some of the emotions.) My mental attitude to snakes (when I say "my," I am of course referring to the "I" of the story) is a combination of two simple emotions, viz. fear and disgust. Such emotional combinations are known as *sentiments*. One's sentiments with regard to anything are largely the result of personal experience and therefore individual. For example, my sentiments towards my country are of the complicated character which can be summed up in the word "patriotic"; if I had attended a Communist Sunday school my sentiments would be very different.

Now, if my fear and disgust were strong enough, I would notice, or anyone watching me would notice, certain bodily sensations and changes accompanying them. Disgust may be accompanied by a sensation of sickness. The bodily accompaniments of fear are well known—trembling, giving-way at the knees, sweating, raising of the hair on

the scalp, changes in the heart-rate, widening of the pupils of the eyes, and, in extreme cases, the involuntary passage of urine. Two well-known psychologists, one an American and one a Dane, both put forward the interesting idea at the same time that what we really experience in a state of emotion is a perception of these combined bodily sensations. In other words, I feel afraid because I tremble, etc.; not that I tremble, etc., because I feel afraid. This theory, called the James-Lange theory of the emotions (after the two psychologists), has more to recommend it than appears at first sight. But perhaps it doesn't really matter which comes first; it is better to think of sensation and emotion as a single experience.

We have not done with setting puzzles with regard to the emotions and sentiments. We have got to ask ourselves why "I" should respond with fear and disgust to the sight of a snake, when my brother, let us suppose, keeps snakes as pets and allows them to twine round his neck. On the face of it, snakes are neither disgusting nor frightening. It is true that my concept of snakes includes a knowledge that some snakes are poisonous, but my emotions were aroused before I had had time to consider what kind of snake it was. To explain my unreasonable attitude, we may say that snakes awaken unpleasant *associations* in my mind. The problem of the association of ideas forms an important chapter in the psychology of *thinking*. Association can be either *free* or *controlled*. As a simple example of an experiment in controlled association: I may be given a succession of words as *stimuli* to which to *respond* as quickly as possible with their opposites, e.g. black—white; hard—soft; good—evil. Here the associations are *controlled* by the terms of the task set.

The ordinary day-dream provides us with a good example of *free association*. In day-dreaming—or fantasy-making, as it may be called—the mind just wanders on from idea to idea, one thing suggesting the next, without any conscious thought-aim in view. We say that the ideas are linked in an *associated* chain. But free association is not such a haphazard affair as might be thought at first

sight. There are definite laws governing the process, because the ideas are really picked out and selected somehow. The chief factors that decide which idea shall be associated with which in the course of free association are : how often the ideas have been linked before ; how lately they had been linked ; how intensely (violently) they were last linked. Thus, if I had several times been bitten by a flea, the last time only lately, and in the course of free association the idea of a flea (or even possibly the word "flee") cropped up, the three *factors of advantage* mentioned above would almost inevitably determine my next association—flea-bites, irritation, or some such ideas.

Sometimes in the course of free association our minds go blank, and if we try and reach the next link of the association-chain, the next idea becomes conscious against a feeling of uncomfortable emotional resistance. We have to make a disagreeable effort to arrive at the next idea, as though one part of our minds were trying to prevent us from going on with the experiment. Nearly always we find that the idea which comes up in spite of the resistance is of an unpleasant or painful kind which had apparently completely slipped our memory. It is often possible to explain apparently quite unreasonable sentiments by coming across disagreeable associations of that kind.

Thus, let us suppose that after the snake incident I start freely associating on the idea of snakes and come across a disagreeable memory by overcoming a big emotional resistance, and that it was a memory I had completely forgotten ; then my sentiments towards snakes are satisfactorily explained and may even change completely. Let us suppose that the following buried memory was the one to be recaptured in that way : When I was a very small boy, as a joke I put one of my brother's pet snakes into his bed. My brother told my father, who was a very strict man, and I was literally sick with fear of possible punishment. As a matter of fact, my father did thrash me unmercifully (and, to my mind, rather unjustly) for what I thought was just a harmless practical joke. This whole incident, then, was associated in my mind with very

disagreeable and intense emotions, which attached themselves to the *concept*—"snakes." The incident itself was forgotten just because of its painful nature. This kind of purposeful forgetting is called *repression*. I call it purposeful because it protects our conscious minds from being filled up with painful ideas.

But what had happened to this memory in between the time that it was repressed and the time of its recall in the course of free association? It remained *unconscious*. This brings us up against the vast question of the *psychology of the unconscious*.

THE UNCONSCIOUS MIND

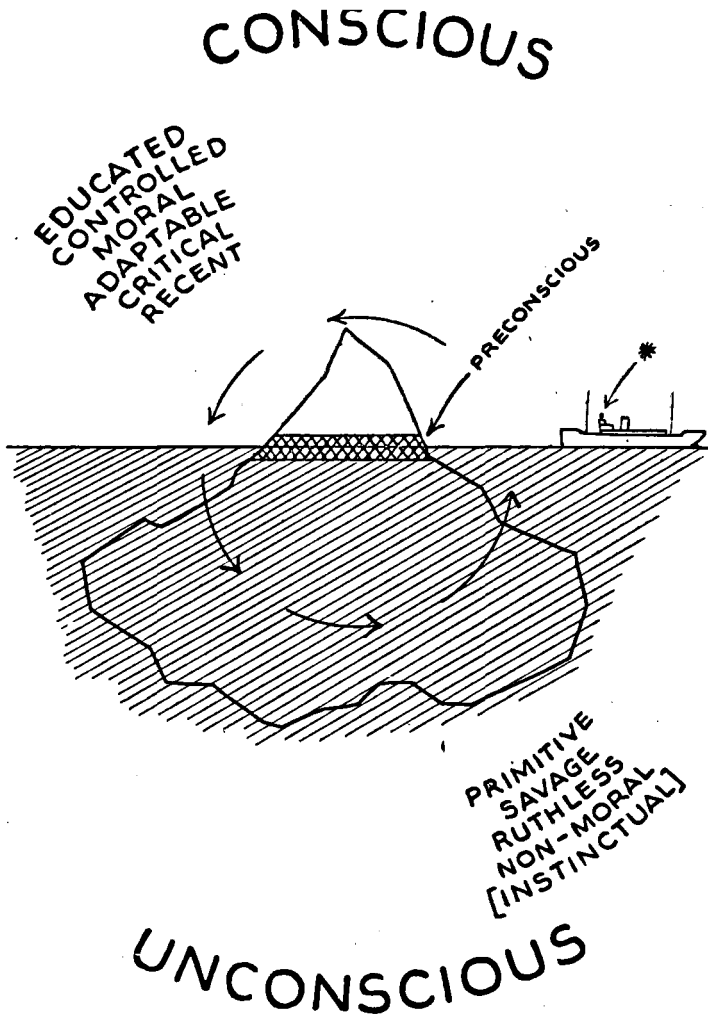
We must start by thinking of the unconscious mind, not as part of the ordinary mind asleep or resting, but as something charged with force and living a life of its own behind the scenes. Thus we can talk about unconscious *activities*.

It is helpful to liken the mind to an iceberg, of which, as you know, only a small fraction appears above the surface of the sea. We will call the visible part of the iceberg the conscious mind, and the invisible part, the unconscious. With the help of our conscious faculties and acquired experience we are able to live satisfactorily in the world outside us. In learned language we might define consciousness as *the instrument by which the individual adapts himself to reality*. In the diagram you will see that I have pointed out a few of the characteristics of the conscious mind. I have described it as educated (by which I mean it has been modified by learning—I shall have more to say about learning towards the end of the chapter), controlled, moral (this means that by learning it has acquired concepts of *good* and *bad*, and has been influenced by this new knowledge), adaptable, critical, and recent. By the word *recent* I mean here that consciousness is always being formed and altered through experience; therefore our conscious minds are as modern as the environment in which we live.

The unconscious mind, on the other hand, is primitive (some psychologists claim that it contains elements inherited from our prehistoric and even sub-human ancestors—see *Dancing*, p. 762), savage, ruthless, non-moral (by which I mean that the concepts *good* and *bad* simply don't belong to this level of the mind). If man does have instincts—and I for one certainly believe in the existence of at least four “dependable motives” which can be called instincts, which I shall mention later—we can say that the unconscious mind acts in an *instinctive* way, as opposed to the conscious mind, which acts in a learned way. The unconscious mind acts as though its sole object were to get pleasure and to avoid pain. (The psychologist would say that the unconscious mind acts according to the *pleasure-pain principle*, while the conscious mind acts according to the *reality principle*.)

Now, if two parts of the mind are, as it were, under two different governments representing opposing interests, it is easy to see that there will often be conflict. In early life, when the conscious conflict is too intense to be comfortable, we have a habit of banishing, below the surface, memories of the situation which caused the conflict, together with the emotions arising out of it. This is the process called *repression* (p. 149). It is represented in the diagram by arrows pointing downwards. You will notice that there are also arrows pointing upwards. These show that repressed material is always trying to reach the surface again; but it meets with a resistance represented by the surface of the sea.

Now forget this picture and imagine repressed material as a number of prisoners trying to cross a frontier which is guarded by a line of sentries. If you were a prisoner in these circumstances, you would immediately think that night-time was the best time to escape, and that you could fool the sentries by disguising yourself. The sentries represent the emotional resistances already referred to (p. 148). As a matter of fact, repressed material does succeed in crossing the frontier from unconsciousness to consciousness, at night and in disguise. This is what psychologists of the



* = THE MAN (not seen) ON THE BRIDGE IS OBSERVING THE ICEBERG & TAKING SOUNDINGS. (i.e. The Psychologist)

Fig. 30. THE MIND AS AN ICEBERG

unconscious mean by saying that *dreams* represent unconscious tendencies. Sometimes the prisoners also manage to get through the line of outposts in the daytime by the clever use of disguise, and this is how we can explain the *meaning* of various apparently unreasonable sentiments (in the way that "my" hatred of snakes might have been determined), various "slips of the tongue," and symptoms in mental disorder.

As the iceberg bobs up and down in the water, part of it will at times be on the surface and at other times below the waves. In the diagram this part has been marked off and called the *pre-conscious*. The pre-conscious part of the mind contains all the mental material, memories, images, wishes, and so on, which are not all the time being thought of by the conscious mind, but which can reach the surface—become conscious—without meeting any emotional resistance. This part of the iceberg diagram should really be shown *much* larger, for, if you come to think of it, *all* our knowledge which we are not immediately thinking about is pre-conscious. In trying to get an idea of the pre-conscious mind, it may help you to see it as an easily "get-at-able" card-index cabinet stocked with information to which we can refer at a moment's notice. Carrying on with the picture, we might see the unconscious mind as a filing-cabinet in the basement, which is protected with a "combination" lock. We once knew the word which works the combination, but have temporarily forgotten it.

We must now detect some further problems arising out of the snake story. As a matter of fact, "my" brother is rather unusual in his liking for snakes; most people have an unreasoning horror of them. It would be too much of a coincidence to account for everyone's dislike of snakes in the same way that we accounted for mine—as a repressed association. You may say that this snake-*phobia* (a phobia is an unreasoning dislike combined with fear) is a natural response to danger. But that explanation does not go far enough, because in temperate climates, such as England's, there is very little danger from snakes, and yet some people who have never come across snakes in the open

feel a sense of disgust when they see snakes behind glass at the Zoo.

According to some psychologists, the unconscious mind is not only a storehouse of personal experience, but also contains memory-patterns common to the race. If that be true, the almost universal snake-phobia represents a response to a danger to which our tree-dwelling, sub-human ancestors were particularly open. That level of the unconscious mind which is supposed to contain inherited concepts has been called the *racial co-conscious* mind. The psychologists who believe this, use it to explain why myths and fairy-tales are alike all over the world, and also why our dreams are very often just like fairy-tales in essential details, and why sometimes things happen in dreams which suggest very ancient magic and ritual.

INSTINCTS

(5) “. . . and run away.” An instinct may be defined as an unlearned activity (remember how wide a meaning we have given to that word) which can be depended upon to repeat itself in like situations. I do not believe that any human activities can be described as instinctive in the sense in which those of the lower animals are instinctive. There is nothing in human beings like the nest-building instincts of certain birds or the honey-storing instinct of bees. That is why I prefer Professor Woodworth’s term “dependable motives” in referring to apparently unlearned activities in man.

I myself can only be convinced of the existence in man of three, or possibly four, of such primary dependable motives: Activities tending to preserve the life of the individual are universal; so we are entitled to regard *self-preservation* as a dependable motive (or instinct, if you prefer to use a more familiar term). Again, activities whose primary end is designed to preserve the continued existence of the *race* are equally universal; so we can regard *reproduction* as another dependable motive (the so-called

sex-instinct). The third dependable motive in whose existence I am inclined to believe is that which impels individuals to associate in groups—the *community* or *herd-instinct* (see *History of Ideas*, p. 417).

The fourth dependable motive which seems to be innate (unlearned) is that of self-assertion. Some of our activities seem to be designed *merely* to gratify the “instinctual” urge to “make ourselves felt.” Certain psychologists and philosophers call the self-assertive instinct the “*will-to-power*.” [It is possible to interpret a man’s conduct or mental state at a given moment in terms of “tension” between the will-to-power and the *will-to-community* (as the herd-instinct may be called in contrast to the will-to-power).]

Some psychologists think there are a lot more instinctive reactions, each with its own emotional response. They explain most of everyone’s behaviour, individual or in groups, that way. For instance, these psychologists believe in a “flight-instinct,” corresponding to which there is the emotion of fear; and they would explain “my” running away from the snake in terms of “instinctive response.”

Those of you who read carefully the preceding chapter will be struck by the resemblance between unlearned behaviour and the reactions called “reflexes” by physiologists (p. 85). After all, the twitch of the extensor muscles (response) when its tendon is sharply struck (the stimulus)—the so-called knee-jerk—is in a sense an unlearned activity. In point of fact, some people define instincts as *systems of linked reflexes*. Think it out for yourselves!

If unlearned activities can be reduced to simpler component parts (reflexes), in much the same way that, in chemistry, molecules can be reduced to combinations of atoms, can the same sort of scheme be made to apply to learned activities? The answer is “yes.” We have the formula: unlearned behaviour equals a chain of unlearned reflexes. We can make up a similar formula: learned behaviour (anyhow, in part) equals chains of learned

reflexes. What are learned reflexes?—and how are they learned? Learned reflexes are what Professor Cullis described in the previous chapter as “conditioned reflexes” (p. 87). You see how nearly related are the two sciences of psychology and physiology. When you come to think of it, the connection is inevitable the moment we begin regarding man as a body-mind unit. Certainly it looks as though a great deal of our learning, expressed in its simplest forms, is just the acquisition of positive and negative conditioned reflexes. The psychology of learning is one of the most fascinating aspects of our science. Most of our knowledge concerning it comes from studying animals under laboratory conditions and also from watching children of all ages in the nursery and classroom.

(6) “I feel ashamed of my cowardice, and return.” This part of the situation introduces another series of problems for the psychologist. Here again I must annoy you by merely mentioning the kind of problem without telling you much about it! First of all, what is the feeling of shame? Shame may be regarded as an emotion or as a sentiment, both of which terms you now know. But here another complicating factor is introduced—*ethics* or *morality*. When I was discussing the conscious mind I brought in the word “moral,” which I defined as “having by learning acquired the concepts of good and bad, and having been modified by this new knowledge.” Now, the science which deals with the problems of good and evil is known as *ethics*, which is itself a branch of the larger science of moral philosophy. Nevertheless, in so far as we can say that our activities are clearly ethical problems, they can and must also be studied from the standpoint of psychology. I say that my sense of shame involves ethics, because it depends on the thought that my conduct was bad, not good. Now, I could not feel ashamed unless I felt at the same time that I could choose between the good and the bad activity. This brings us up against another philosophical problem—*freedom of the will*. No philosopher has ever yet succeeded in proving or disproving the freedom of the will. The psychologist (whose only real concern is

the observation of activities and the deduction of the laws governing them) certainly can't, though there are some who try to.

At most, the psychologist can say that we can account for animal behaviour without having to suppose that it is being consciously done on purpose. Now, by introspection, *we* can detect the purpose behind many of our activities, and it seems to us that the goal has been set by ourselves. Everything we do on purpose is really something we have selected. We mentally envisage two or more possible lines of action and choose one. Whether our selection is itself determined—in other words, whether free will is only a *delusion*—is not for the psychologist to say.

“My” return to the snake, then, was a *volitional* (or *willed*) activity, and resulted from an act of *reasoning*. Reasoning consists in relating two or more concepts and arriving at a third concept as a result. This part of reasoning is called *inference*. [Thus, I can reason that, if both A and B are equal to C, A and B are equal to each other. The two concepts $A = C$ and $B = C$ have been related to each other, and a third concept, $A = B$, has been inferred.] The body-mind processes involved in reasoning, and *thinking* in general, belong to the province of psychology. The forms or the patterns arising out of reasoning activities are the basis of another science—*logic*. A lot of our reasoning is not of a very high order; it is more like the process of *trial and error*. If a hungry cat is imprisoned in a box in sight of food, but can escape from the box by raising a simple latch with its paw, it will eventually hit upon that device after trying out all other possible means of exit. In the same way, if I have mislaid my book, I go over in my mind all the possible places where I might have left it until I hit upon the right one.

“SET” OR ADJUSTMENT

This looks rather a difficult section, because of the use of letters. Don't be afraid of them. They are really a scientific way of making things simple.

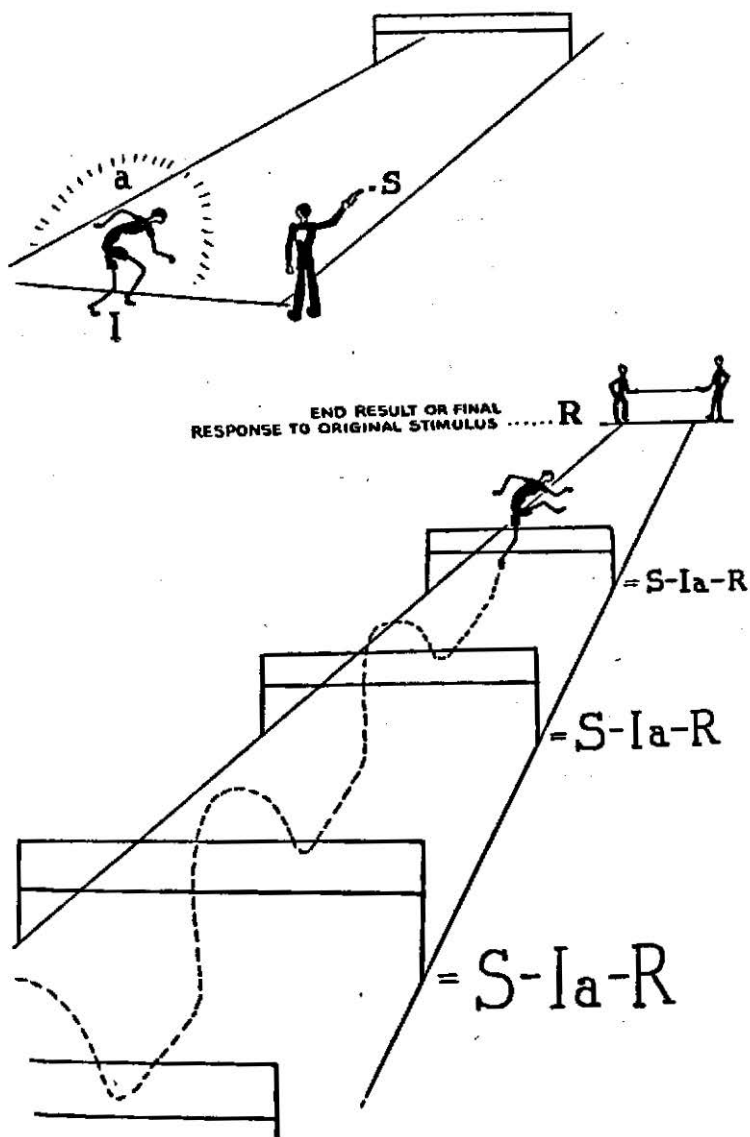


Fig. 81. THE HURDLE RACE

I hinted earlier that a great part of the activities of the individual could be reduced to the stimulus(S)-response(R) formula : S-R. But what about things done on purpose? How does purpose fit into the picture? A simple reflex such as the knee-jerk cannot logically be regarded as purposive, however useful it may be ; it is simply an S-R reaction. It can only be regarded as purposive by introducing the individual(I)—i.e. a complete body-mind unit—into the formula which we now write as S-I-R. That formula applied to the knee-jerk means that the stimulus (the tap on the tendon), although local, affects the whole individual, and that the response (the twitch of the muscle), although local, is an activity of the whole individual. Now, what has this to do with purpose ?

Consider the runner in a hurdle race (you can see him in the picture on preceding page) waiting for the pistol-shot—the stimulus(S)—for his getting off the mark—the response(R). He is not just standing idly there, but his muscles and mind are in a special state of readiness for taking the best advantage of the situation. We can say that he is “*set*” or “*adjusted*” for a special activity. We can represent this special state of the individual by the letter “*a*.” Our formula then is S-Ia-R. Let us suppose that, taking the race as a whole, with the pistol shot as a stimulus and the arrival at the winning-post as the end-result or response, the formula S-Ia-R still holds good ; but in reality we are faced with a series of reactions, because the jump over each hurdle is a separate activity in itself. Let us represent the race by a series of formulæ : S-Ia-R ; S-Ia-R ; and so on. This means that the stimulus for taking the first hurdle finds the individual in a state of readiness for the action, and the response is the jumping of the first hurdle ; the same holds good for the second, third, and subsequent hurdles. What has become of the purpose—namely, to reach the winning-post—during this series of reactions? I will answer that question in Professor Woodworth’s words :

“ Purpose, according to all that has been said, need not be thought of as something lying outside of the general

scheme of stimulus and response that we have been following. Conscious purpose is an adjustment still in the making or just being tuned up, and specially an adjustment that is broad and still precise. Purpose is not something foreign to an activity and directing it from outside, or from above. Purpose is the activity itself, started but not completed. It is an activity in progress. No doubt you can think of doing a thing without really starting to do it ; but, if you fully decide to do a thing, you immediately start preparatory reactions or at least establish a preparatory set for the whole activity."

(7) "And find it a beautiful and curious creature." We are at once brought up against at least two vast problems. The idea of the "beautiful" presents great difficulties to the psychologist. A thing can be beautiful without being useful; beauty arouses certain emotions, ugliness different ones. What is beauty? Why do some people find one thing beautiful whilst others don't? All these and similar questions can be studied from the standpoint of psychology, and form a branch of our science called the *psychology of æsthetics*. Curiosity is another interesting activity (following our old rule, I call it an activity, since it can be expressed as: "being curious"). Is curiosity a primary "dependable motive" (p. 153) which we forgot to mention when dealing with instincts? Probably, curiosity is only a secondary instinct arising originally out of the self-preservation instinct. Animals (as did our sub-human forebears) show curiosity, one supposes, in trying to find out all about any stimulus before they respond to it. We have got to inspect any *new* object so as to discover whether it is likely to be harmful or harmless.

I have tried to introduce the science of psychology to you by analysing a simple situation and mentioning some of the psychological problems arising out of it. Sometimes I have only been able to point out a problem in a single word. I could go on for pages and pages, each page consisting entirely of single words, each word suggesting material for the psychologist to work on! That being so, you will

understand why this chapter has been such a haphazard and scrappy presentation. How far you will forgive the unhappy author will depend upon your *psychological* make-up.

BIOLOGY
OR
FINDING OUT ABOUT LIFE
by
DR. JOHN R. BAKER



JOHN BAKER is a zoologist. He teaches at Oxford, and also does a lot of experiments. But he doesn't always stay at Oxford. He has twice gone to the New Hebrides, in the Pacific Ocean, to explore, and especially to explore the life of the animals and the life of the natives, with whom he made friends. There were some particularly odd sorts of pigs there, which nobody had understood about before, and a steaming hill, and several new kinds of animals, some of which are now called after him. So when he is back in Oxford his mind is not only in that safe and pleasant and sometimes rather dull place, but in far and strange places. All the same, he is an exact scientist ; he thinks about his work, not only as fitting on to biology, the science of life, but also as a very detailed, elaborate, and accurate piece of technique which has to be completely understood and worked out by itself. His chapter shows some of the kind of experiments which he is doing, and which other zoologists and botanists are doing. He likes rowing and plays the flute, and he has two children, called Venice and Gilbert.

BIOLOGY

LIVING AND NON-LIVING THINGS

DIG FOR a few minutes with a spade. You are sure to find a worm. Here is a machine more complicated by far than any ever made by the hand of man. It moves to obtain the food required to give it energy for its movements. It grows. It reproduces, which no man-made machine can do. No one made it ; no one designed it ; it lives for no one but itself. It may incidentally be useful to mankind. Other kinds of animals are incidentally harmful to mankind. Thousands of other kinds again are neither useful nor harmful. All of them, whether useful or harmful to us, or neither, live solely for themselves, or at any rate for the benefit of their own kind only. If they help another kind in any way, they do so because they get some advantage out of it, or because they help themselves by doing so.

Snails are helpful to birds, because birds feed upon them ; but they avoid birds if they can by hiding in vegetation. When making burrows, worms come to the surface to eject the excavated earth. They drag leaves into their burrows to line them. They do these things for their own benefit. There is not the slightest evidence that they make a single unnecessary movement of any sort for the benefit of any other kind of animal or plant. Yet their actions serve to aerate and enrich the soil, and, as a result, more plants can live on it than would otherwise have been possible ; and herbivorous animals may come and browse upon these plants, and flesh-eating animals may feed on the herbivorous animals. Many animals, including man, are affected by the earthworm ; but the earthworm's actions are simply directed towards its own survival and the reproduction of its kind. This applies to all organisms. You may object that plants produce nectar for the benefit of the bees, but it is not so. The plants produce nectar so

that bees will visit them, because, if bees did not visit them, their pollen would not be carried from flower to flower, and this is necessary for the production of seed. The bee helps the plant by carrying the pollen, but only because she is anxious to obtain the nectar for food, and in obtaining it she cannot avoid getting some pollen on her hairy covering, which gets partly rubbed off in the next flower and takes a part in the production of seed.

Plants and animals are made of the same stuff as the rest of the world, chiefly of carbon, which is the same thing as pure charcoal, and nitrogen, which is the gas that makes most of the air, and oxygen and hydrogen, which are the two gases of which water is composed. Is it, then, always easy to distinguish living things from non-living things? The most obvious thing we notice about animals and plants is that they are organisms; that is, that their bodies are organised for a purpose. It is not easy to define their differences from machines, except by saying that they are organised simply for keeping themselves alive and reproducing themselves, and that no one ever made them or designed them. Obviously non-living things, like mud or rocks or rain or thunderstorms, are not organised: there is no system of organs in them acting together to serve an intelligible purpose in guaranteeing their survival. There are very few objects about which we can ever have any doubt as to whether they are organisms or not.

A river is rather an interesting exception. It has certain characteristics of organisms. If a new piece of land is pushed above the surface of the sea by volcanic action, at first the rainwater runs off irregularly and inefficiently. But soon the running water cuts channels for itself, and the channels join up with one another in the mountainous regions till they form one single river running down the valley. In the lowlands the river tends at first to be straight, but any slight unevenness in the ground may throw it into a curve, and natural causes will make a curving river gradually assume a more and more serpentine course. When the river reaches the sea, it may begin to deposit the sand particles which it carries down, and thus form a

delta ; that is, it may finally break up into several smaller streams which open separately to the sea. The whole river, with its collecting streams in the mountains, its winding course along the low ground, and its termination in a delta, has some of the characteristics of an organism ; for it gradually tends to assume a definite form, and no action of man is involved in its construction or design. As it gradually cuts its bed in the solid rock, it tends ever to make itself more permanent. It differs, however, from all animals and plants in having no capacity of reproducing itself. All true organisms have this capacity. One could imagine a living thing with no capacity of reproduction, but it does not exist. Another difference is that a river is an obvious result of the properties of matter, whereas animals and plants are very far from being obvious results. If a huge tract of land were to arise in the middle of the Atlantic, we should predict the formation of rivers with certainty. But if a belt of poison gas were to hang all round the shores of the new continent, so that no animals or plants could get to the continent from outside, then we could not predict that the substances of which the new continent was formed would ever form themselves into plants and animals.

Living things only arise from other living things which already exist, and this does not apply to any non-living things such as rivers. In very early stages of our earth's history, when it was still very hot, there can have been no living things, so living things must have arisen from non-living matter at some remote time ; but there is no evidence that living things are originating from non-living matter at the present day, and we really know nothing of the causes that made it happen in the remote past. We only know that warmth is, on the whole, a help towards the formation of complicated chemical compounds, and that living things consist of enormously complicated chemical compounds, and that the earth was warmer than it is now at the time when the first living things originated. It is quite possible that in the future we may find out how to create new organisms from non-living matter in the laboratory. A little over a hundred years ago it was thought

that it was quite impossible, and always would be, even to make any of the compounds of which living bodies are composed. That was a complete mistake, for a very large number of these "organic" compounds can now be made in the laboratory. In fact it does not seem likely now that any organic compound is impossible to make in the laboratory; that seems to be a matter of time. Of course, we should not have made life even if we had made every organic compound that exists in nature. We should need to arrange the various substances in a definite way. Perhaps it will be hundreds or thousands of years before that is achieved. I only want to point out the production of life in the laboratory from non-living matter is not an unthinkable achievement.

PLANTS AND ANIMALS

If you think of an oak-tree and then of a dog, the differences seem so enormous and so obvious that you might overlook the fact that it is not very easy to define the differences between plants and animals. An oak-tree and a dog are both *organised*, and they both reproduce: that is all they seem to have in common. How do they differ? In nearly every other possible way. A dog moves about. He responds actively to things that happen to him; he yelps if you tread on his foot by mistake. He eats. An oak-tree does not move about, except so far as it is moved by the wind, nor does it respond obviously to things that happen to it. It does not eat in the ordinary sense of the term. It cannot live without nutriment, but it does not get its nutriment by eating. It absorbs gases through its leaves; that is what they are for. It absorbs dissolved salts through its roots. But it does not take in solid food. That is the really essential difference between plants and animals. Plants can live entirely on inorganic matter, such as the gases of the atmosphere and the salts which are dissolved in the water of the soil. No animal can do that. We take a little common salt with our meals, but we cannot build up the organic matter of our bodies out of it. We rely entirely

on organic matter that has already been built up by plants. A dog's proper food is the flesh of other animals, so that he does not rely directly upon plants; but indirectly he does. If he eats a rabbit, he gets his organic matter from an animal, but that animal has got it from grass. The grass did not get organic matter from anywhere; it made it itself from inorganic matter. If the dog eats a cat, it is only pushing things a stage further. The cat gets its organic matter from cow's milk, and the cow got it from grass. That is the best distinction between plants and animals: animals rely for their organic matter, directly or indirectly, upon plants, while plants can make their own organic matter for themselves. Even here we have exceptions, as everywhere in nature. In the pitcher-plants, the leaves are modified to form buckets, with water in the bottom (see Fig. 32). Insects are attracted by the colour and by the sweet substance produced by the lip of the bucket, and venture inside. The inside is exceedingly smooth and slippery, and the insect falls into the water. The water is not plain water; it contains acids and a digestive juice. The unfortunate insect is digested in the same way as it would be digested in a flycatcher's stomach. Are we, then, to be logical and call the pitcher-plants animals? No, because in every part of their structure except the pitchers they are typical plants. They are closely allied to other forms which in every way are certainly plants: so they are plants. The fungi, again, do not get their nutriment as typical plants do. They rely on decaying organic matter, which is no good to them if it has decayed so far as to be reduced to its inorganic components. Although it must be supplied with organic matter, yet no one would be likely to mistake a mushroom for an animal. Why? Simply because there is no evidence whatever that it is related to any animal, nor does it move about, nor does it respond to anything that one does to it in any obvious way. In all these respects it is plant-like, and it is only reasonable to suppose that fungi are simply lower plants that have given up the habit of making their own organic matter, and have started to rely on organic matter produced, ultimately, by other plants.

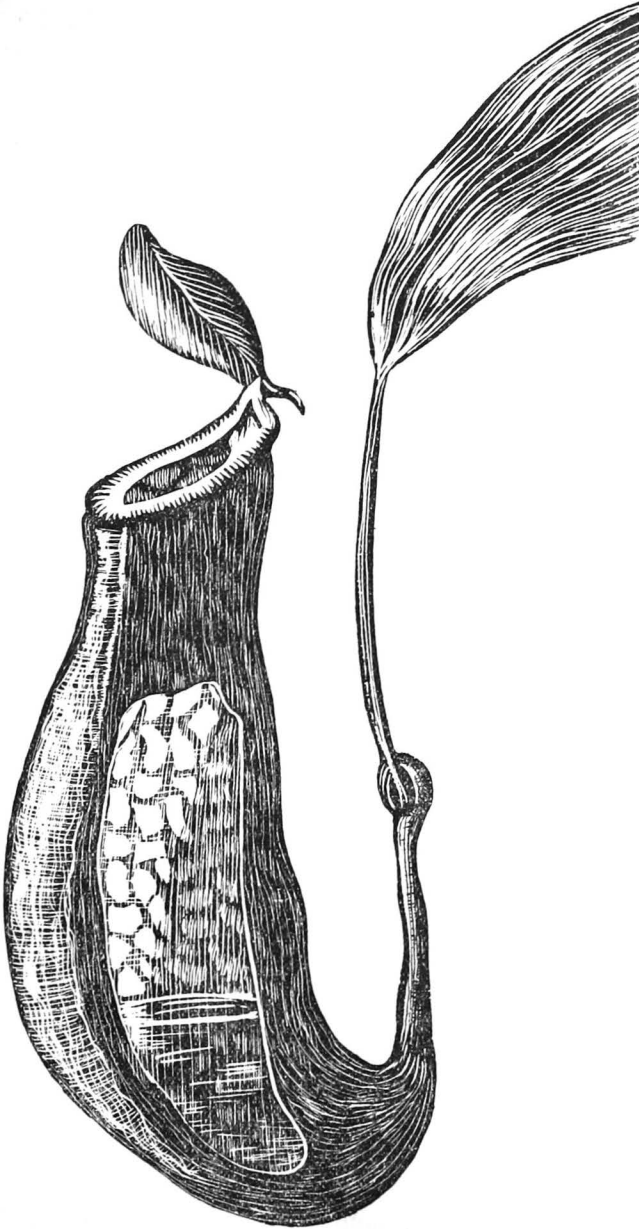


Fig. 32. A PITCHER PLANT

A pitcher plant, with a portion of the wall drawn as though transparent, to exhibit the digestive fluid.

If a fungus were to start moving about, and responding to irritation, we should have difficulty in classifying it as a plant.

Fungi do not respond obviously to irritation, and in that way they agree with the great majority of plants. But here again we must not lay down the law, for very sensitive apparatus has been invented which shows that many plants, which do not appear to move, actually respond by minute movements when irritated. The leaves of the sensitive plant, *Mimosa*, droop at once when one touches them. In every other respect *Mimosa* is obviously a plant.

Although most animals can move about, yet many are absolutely stationary. The sea-squirts, which are common on rocks between tide-marks, are good examples (see Fig. 33). Sea-anemones are also stationary, but the movements of their tentacles show their animal nature more obviously. Why do we regard the sea-squirts as animals? Partly because they respond to a touch by giving a most noticeable response, namely by squirting water out. But the main reasons are that they rely for nutriment on ready-formed organic matter, and that a close study of their anatomy and development proves them to be related to a form which in every way is an obvious animal, the little marine lancelet, which is itself a very simple member of the great group of animals that includes fishes, frogs, lizards, birds, and men.

We may say, then, that an organism which makes its own organic matter and does not move about or respond obviously to irritation is a plant, while an organism which relies for its organic matter on other organisms, and moves about and responds to irritation, is an animal. When an organism does not fall into either of these two categories, we use our common sense and find out, from a study of its structure, whether it is allied to forms that are obviously plants or to forms that are obviously animals.

CLASSIFICATION

We could quite easily imagine a universe in which every living thing was completely different from every other living thing; but of course we all know that on our earth plants and animals belong to what we call kinds or species.

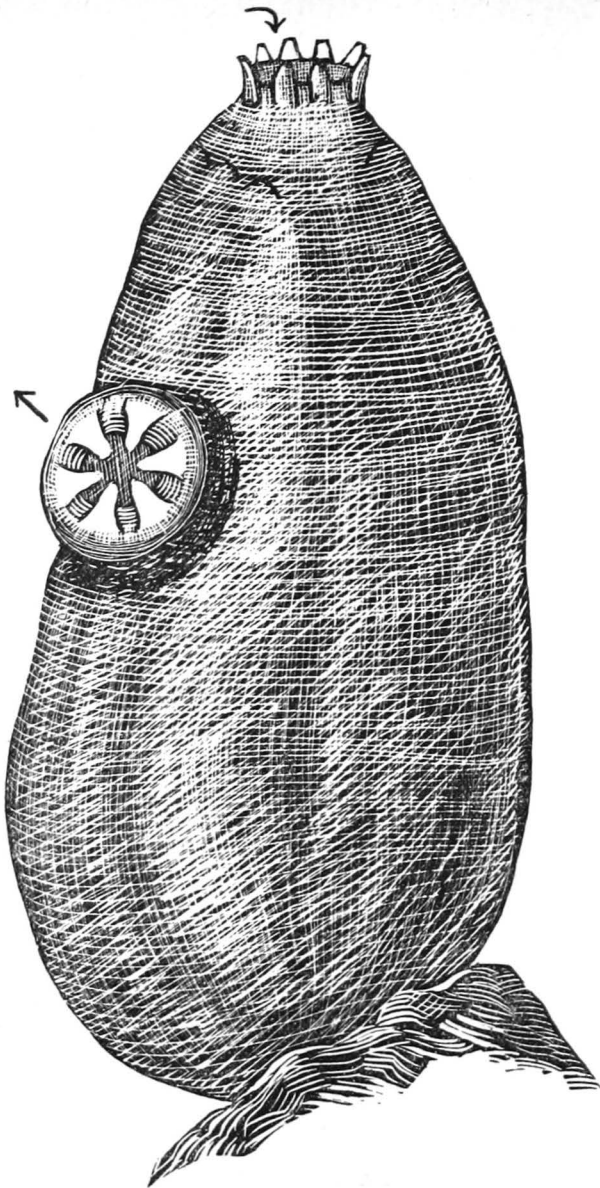


Fig. 33. A SEA-SQUIRT, ATTACHED TO A ROCK
A current of water passes in at one opening and out at the other as shown by the arrows.

The members of one kind resemble one another closely, and they breed with one another. We are so accustomed to the idea of there being kinds of plants and animals that we are rather apt to take it for granted, but in science we must never take anything for granted. We must try to find out the cause of it. That means that we must try to find other facts, hitherto unknown, which make it easier to understand. We have not got very far with understanding why there should be such definite kinds of animals, but something is known about the origin of the different kinds, which must be discussed later on. Perhaps we have an exaggerated idea of the distinctness of the kinds of organisms, because most of the very common kinds happen to be very distinct. For instance, you will never make a mistake in distinguishing a blackbird from a thrush, but in other parts of the world there are kinds of birds which are half-way between blackbirds and thrushes.

It would be possible to make a list of all the different kinds of plants and animals, and we could arrange the names in alphabetical order. It would obviously be rather a useless list, as it would not help us to form any clearer idea of plants and animals as a whole. But if we group together those which are like one another, then we can make the list far more interesting. Take the sheep. There are several wild kinds of sheep, which you may have seen at Zoos. Sheep have two toes on each foot, and a hoof on each toe; they have long hair; the males (and sometimes the females also) have coiled hollow horns. What animals shall we group with the sheep? The goats are obviously their nearest allies, and there are some animals which some people call goats and others call sheep. In general, however, we can distinguish them, because goats' horns are less curled and are carried over the back, and also the male has a beard and an unpleasant smell. The cattle and antelopes have feet very similar to those of the sheep, and are evidently also allied to them. Cattle (including buffaloes) are bulky animals with short coarse hair and bare noses. Their horns are not ringed like those of sheep, and they tend to stick out sideways from the head and then turn

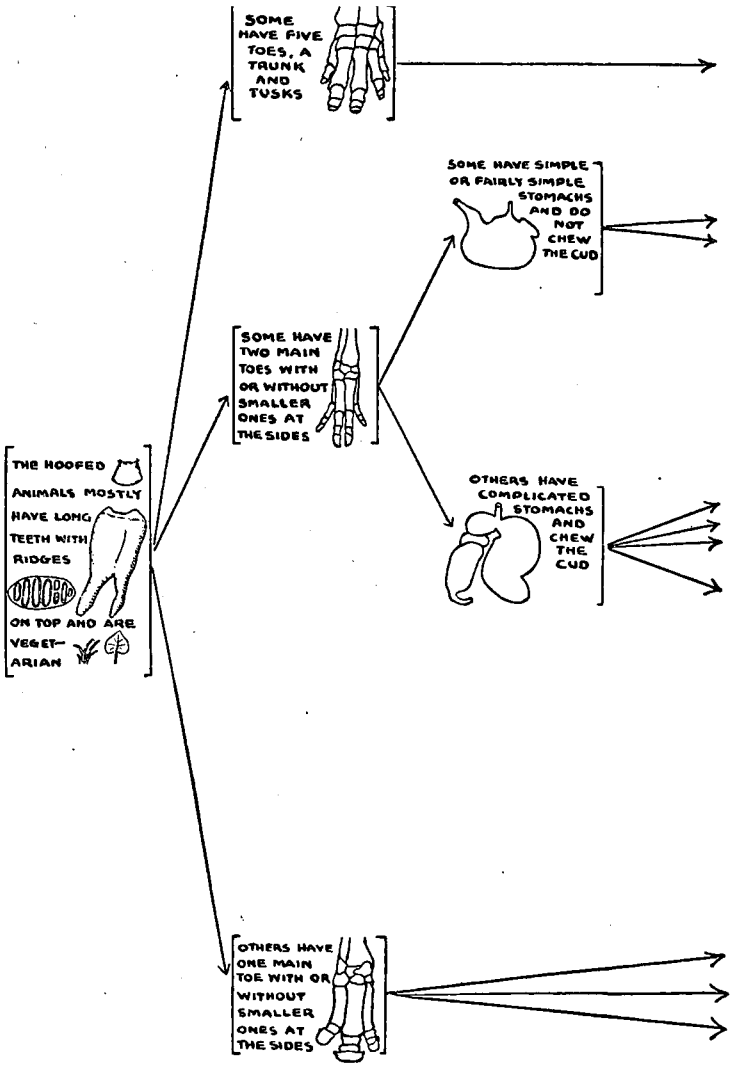
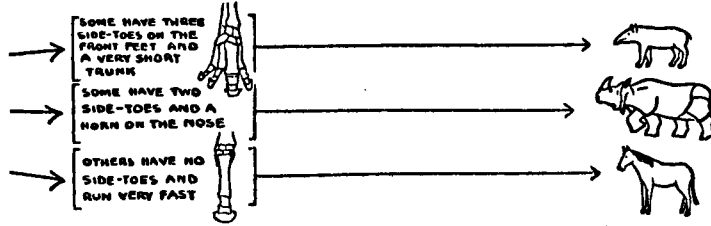
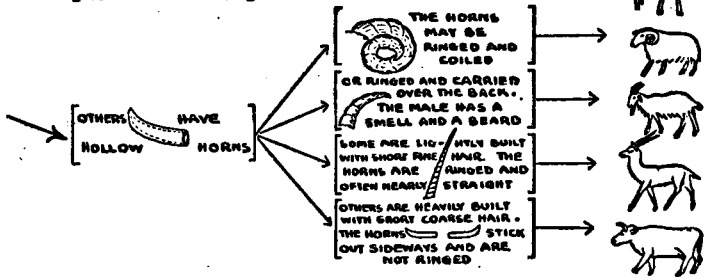
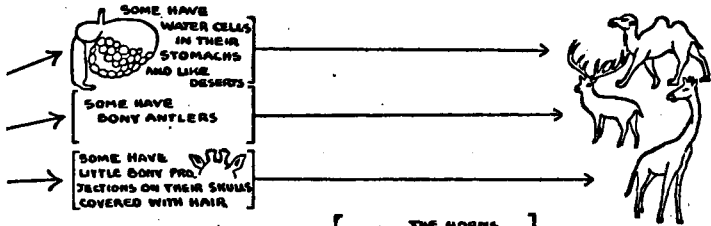
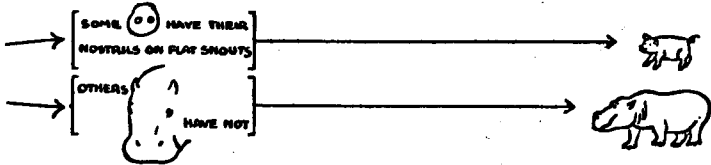
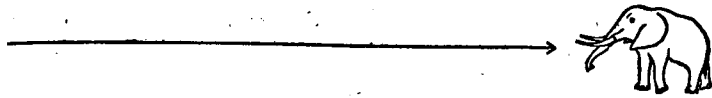


Fig. 34. THE CLASSIFICATION OF



THE HOOFED ANIMALS

upwards or forwards. Antelopes have ringed horns, often straight or slightly curved. They are graceful animals with smooth short hair. All these animals—sheep, goats, cattle and antelopes—are grouped together in one *family*, the cattle family. There are other allied families—the deer family, the giraffe family and the camel family. Each family has its distinguishing characters, such as the bony antlers of the deer family. All the animals mentioned so far have complicated stomachs, which send the food back to the mouth for further chewing. Animals which chew the cud are called *ruminants*. They are all hoofed animals with two toes on each foot, or two main toes and a small toe on each side. The pigs and hippopotami are similar as regards their toes, but they do not chew the cud, so we must separate them.

There are other hoofed animals besides the ones we have mentioned so far. The horse, donkey, and zebra all have one toe on each foot. The rhinoceros has one main toe and a smaller one on each side, and the tapir has the same arrangement, with an extra small toe thrown in in front. We must classify all these together.

We have not finished the hoofed animals yet. The elephant also has hoofs, but differs from the animals we have dealt with so far in having five toes on each foot.

All the animals so far constitute the great vegetarian *order* of hoofed animals. Fig. 34 shows their relationships to one another diagrammatically.

There are many other animals which show a general resemblance to the hoofed animals, in that they have hair, bear their young in an advanced state of development instead of laying eggs, and provide milk for the young after birth. As examples we may mention the mole, mouse, rabbit, weasel, dog, cat, monkey, and—ourselves. All of us together constitute the *class* of mammals.

There are plenty of other animals which have not got hair, which lay eggs, and which do not provide milk for their young, but which nevertheless are built on the same general plan as the mammals. The general plan is that there are two pairs of limbs, and a backbone consisting of a lot of short separate joints, and a nerve-cord along the

back, swelling into a brain in front. The other classes of animals built on the same general plan are the bird class, the reptile class, the amphibian class, and the fish class, and together all the animals we have mentioned so far, from man to fish, are grouped together in one *great branch* of the animal kingdom, the backboneed animals.

There are many great branches of the animal kingdom, but only the most important need be mentioned here. The most important are (1) the single-celled animals (a term which will be explained later); (2) the sponges; (3) the sea-anemones and animals built on the same plan; (4) the ringed worms; (5) the jointed animals (such as lobsters, crabs, millipedes, centipedes, insects, spiders and scorpions); (6) the molluscs, or soft animals with chalky shells (such as snails and oysters); and (7) the backboneed animals.

Each of these great branches can be divided up into classes, the classes into orders, the orders into families, the families into smaller groups, and finally into kinds or species. Perhaps you will be surprised to find the sponges among the animals, but there is no doubt that they belong there, although they cannot move about. They cause currents of water to pass through them, and feed on the microscopic organisms swept in with the water (Fig. 35). They cannot live except on organic matter. Notice that the insects form a group (class) of the jointed animals. The word insect is used with a very precise sense in biology. It means a jointed animal with six legs and generally four wings, having the body divided into three parts, called head, thorax, and abdomen. Examples are cockroaches, grasshoppers, water-boatmen, plant-lice, beetles, butterflies and moths, and bees. The number of kinds of insects is greater than the number of kinds of all other animals put together. We must not use the term insect for any small animal. Although the term has a precise meaning, yet a biologist cannot afford to be dogmatic, and it must be confessed that there are animals which we group as insects which have only two wings, or none at all, and others which appear to have more than six legs. We group these as insects because in other respects they are closely allied

to animals which are obviously insects. In biology we always find exceptions to the best definitions.

The most important great branches of plants are (1) the bacteria (some of which, called germs, are the causes of many diseases); (2) the algæ (seaweeds and their allies); (3) the fungi; (4) the mosses; (5) the ferns; and (6) the flowering plants.

It is a tremendous undertaking to get a thorough general knowledge of animals and plants. Students at Oxford

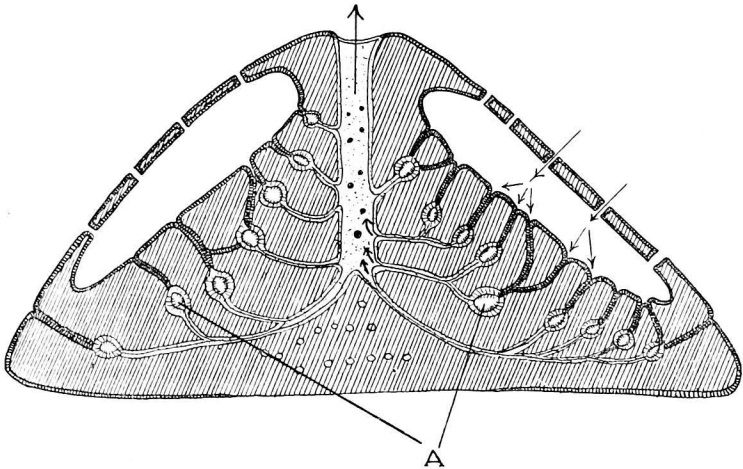


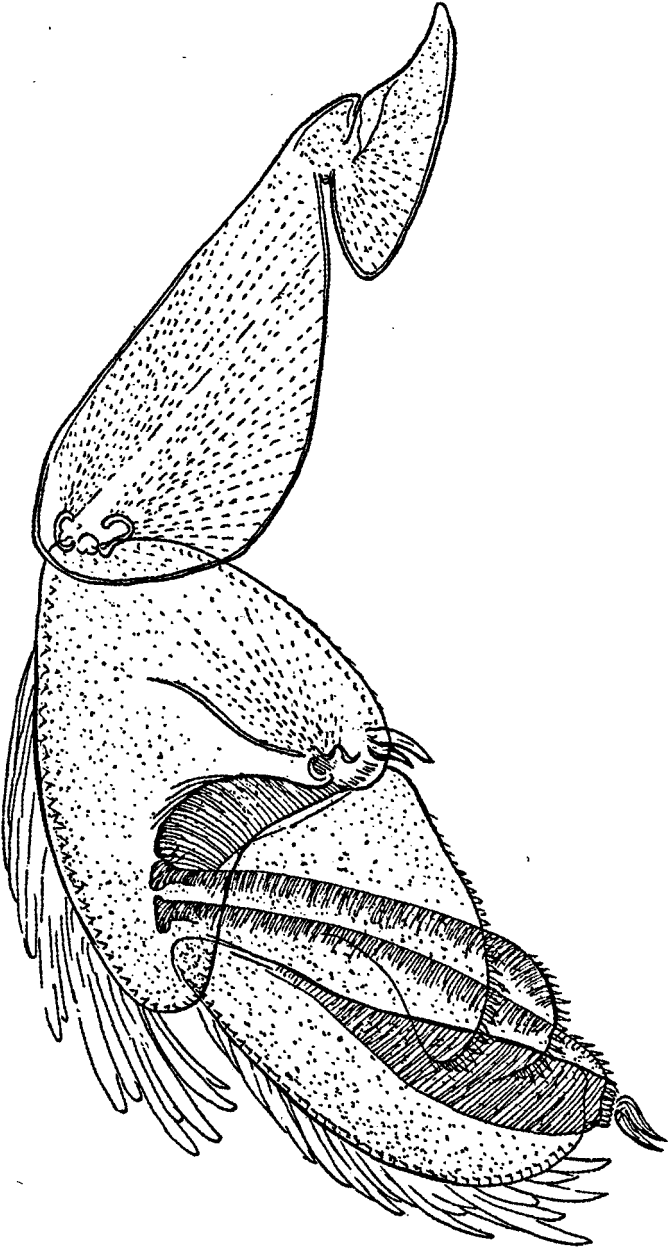
Fig. 35. A DIAGRAM OF A THIN SLICE THROUGH A SPONGE

A sponge is a mass of tubes through which a current of sea water flows, as shown by the arrows. The little whip-like structures at A and elsewhere cause the current. Microscopic living organisms in the sea water are absorbed by the part of the sponge from which the little whips project.

spend a whole year studying the backboneed animals only. For most people it is best to get some general knowledge, and a thorough knowledge of a small group. Many people collect specimens of some group of plants or animals. The great naturalist Darwin collected beetles. But it is probably a pity for you to collect plants or animals. It is very important that the great museums should have as complete collections as possible, in which experts in the various groups can study specimens from all parts of the world and

describe them. Their work corresponds to the making of dictionaries in the realm of literature. It is a most necessary work, and a work which requires great patience and skill ; but any boy or girl who started "collecting" all words beginning with "en" would not be encouraged by wise people. The private collection of words is useless !

It is the same with plants and animals. By all means study a group, and make out the characters of each species ; but it is the study that is worth while, not the collection. People who collect imagine that the rare kinds are tremendously interesting, but actually their value is usually only a rarity-value. The great auk is extinct, and very few of its eggs still exist. They are therefore very valuable to collectors, who pay perhaps £200 for them. But their scientific value is small, because they are not very peculiar or interesting eggs. There are many extremely rare beetles which have no points of special interest ; but the common whirligig is very interesting on account of the most remarkable structure of its legs (see Fig. 36). It is far better to study and comprehend these legs than to hunt for, and eventually proudly to pin out, some rare specimen which is of no particular significance to anyone. It does not seem likely that the collecting of rare species will ever result in great scientific discoveries in the future : the main types of plants and animals are already known, and it only remains to fill in details. But what a wealth of unknown things surrounds us on every side, asking for an inquiring mind to study them ! How comes it that the whirligig beetle is just as abundant as it is ? Why is it not ten times rarer, or a hundred times as abundant ? What controls its abundance ? What plants and animals are directly or indirectly affected by it ? What caused the egg that gave rise to it to go through the complicated series of changes which resulted in the adult form ? Do whirligigs vary in structure, and, if so, is the variation inherited ? Endless questions present themselves. If we transfer the whirligig to somewhere else, can it survive ? On rivers, how does it prevent itself from being gradually carried down to the sea ? Does it know the direction of the current ? If so, how ? By sight ? How far can it see ?



**Fig. 36. THE LAST LEG OF THE WHIRLIGIG BEETLE,
MAGNIFIED**

An infinity of unanswered questions presents itself about every kind of plant and animal to everyone who has an inquiring mind. Find the answers to questions which occur to you by study and experiment. Your observations and experiments are worth exactly as much as anyone else's, provided that you simply seek truth for its own sake, without any preconceived ideas and without wanting to prove that anything is other than it is. That is science: mere collecting is not.

THE CELL

In the second chapter of this book you have learnt how the body is made up of systems of organs. There is the skeleton system, the muscular system, the digestive system, the breathing system, the blood system, the excretory system, and the nervous and sensory systems; and these are enclosed in a protective skin. Let us push the investigation further. What are the organs themselves made of?

To find out, we must use the microscope. Unfortunately, the ordinary microscope has a limited power of magnifying. It cannot usefully magnify more than about 1,400 times. I say usefully, because you can make a microscope magnify ever so much more if you want to, but you cannot make it show anything that cannot be seen with a first-class microscope magnifying 1,400 times. It is tantalising not to be able to go beyond that. It is like exploring an unknown country, and finding yourself held back by obstacles. Here the obstacle is the wave-length of light. You know that wireless waves are enormously long. The waves produced by the National transmitter are about a mile long. We have no organ for detecting them, and can only prove their existence if we have a receiving set. Light waves are the same, but very much shorter. Instead of being nearly a mile long, each wave of ordinary light is only about $\frac{1}{50,000}$ inch long. We have an organ for detecting waves of lengths round about that figure, namely the eye. But that wave-length sets a limit to the power of the microscope, because no

microscope can show an object when it is so small as to be only about the size of a wave-length. What can we do? We can use light of shorter wave-length than ordinary light—what is called ultra-violet light. This does not appear to us as light at all. You can have a room filled with ultra-violet light, and yet it appears pitch dark, because our eyes are no more capable of detecting it than they are of detecting wireless waves. Luckily, photographic plates are sensitive to it, so we can take photographs with it. Instead of shining ordinary sunlight or electric light through the microscope, you shine ultra-violet light, produced by a special apparatus called a mercury vapour lamp. Unfortunately, ultra-violet light will not go through glass, so all the lenses of your microscope must be made of quartz instead, which is very expensive. Such a microscope, with all its accessories, may cost as much as a powerful motor-car. Here is a microscope which does not use ordinary light, and which is not constructed to be seen through! Inventors have to make strange instruments to probe further into the unknown.

There are objects, however, which are too small even for the ultra-violet microscope, but the scientist is not beaten yet, for even these he can detect with another sort of microscope, called the ultra-microscope. You must often have seen a bright beam of sunlight passing across a darkened room, and noticed the particles of dust in the beam, which were quite invisible elsewhere. The particles would also have been invisible if you had looked along the beam. The particles were far too small for ordinary vision, but the light made little haloes in passing round each, and thus invisible objects were detected by your eyes. The ultra-microscope is arranged to magnify minute haloes formed by incredibly minute particles. One sees magnified images of the haloes, not of the objects themselves; but one is at least made aware of the existence of the objects.

Such, then, is the equipment we must use if we want to explore living matter and resolve it into its minutest components. But luckily we can do much with an ordinary microscope.

It is generally very hard to make out much by microscopical examination of living matter, but fortunately this is a branch of study which is progressing very rapidly just now, and which is bound to lead to very important discoveries. At present most work is done on killed tissues. An enormous number of things has to be done before one can put the material under the microscope and examine it. First one must prevent it from decaying, by putting it in some such fluid as formalin. Then one must remove all the water from it by alcohol, and then, by a roundabout process, substitute melted paraffin wax for the alcohol. Then one cools the paraffin, and one has the tissue in a solid block of wax, which one cuts into very thin slices by a machine like a bacon slicer. The slices are so thin that it would take about three thousand of them, piled one above another, to make an inch. These are fixed to glass slides, the wax is removed, and the slides are dipped into various stains, which stain various parts of the tissue in various colours. Finally the tissue is rendered transparent by soaking in a special fluid, and it is kept transparent by placing a drop of a special resin on it and applying a very thin slip of glass on top. When the resin is dry, the specimen may be examined under the microscope. An ordinary microscopical preparation has been moved from one fluid to another between twenty and thirty times, and the process generally takes days, and may take weeks.

When it is all done, what do we see? We see that organs consist of separate bodies, just as houses consist of bricks. These minute separate bodies are called cells. Most cells are far too minute for us to be able to see them without a microscope. If you put five hundred ordinary cells in a line, they would not stretch an inch. The word cell unfortunately conveys no idea of what they are like. I am going to try and show you in a very rough way what a cell is like (see Fig. 87). You must remember that I am not trying to give an exact idea, but only quite a rough idea. Take a small child's rubber balloon and put it inside another larger one. Dissolve some white of egg and some phospherine (phosphoric acid) in some water and fill the inner

balloon with it. Dissolve some white of egg and some sugar in water and fill the outer balloon with the solution. Also put some round or rod-shaped pieces of suet into the outer balloon (M in Fig. 37). Then make a lot of banana-shaped

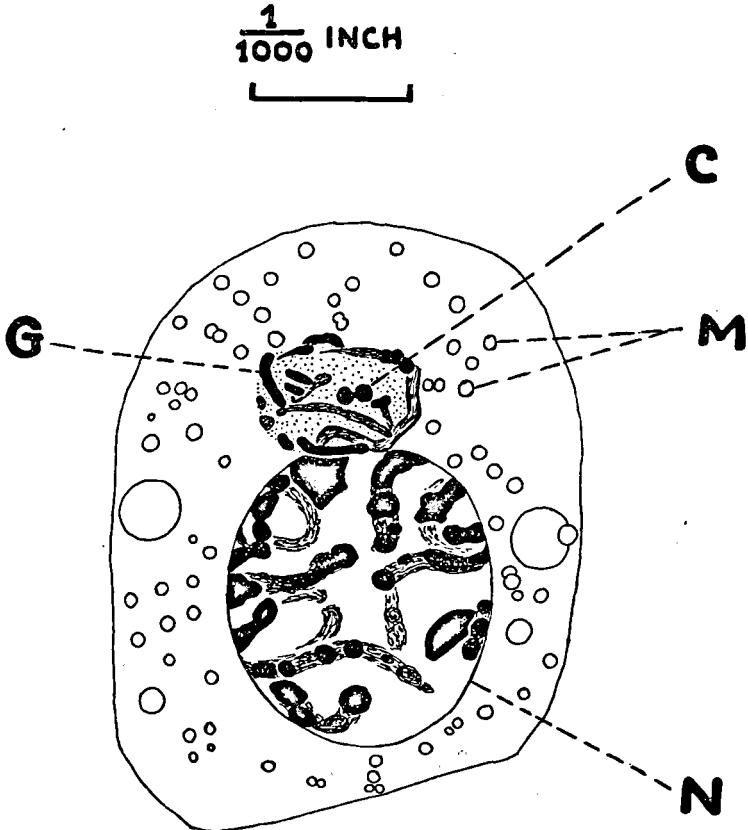


Fig. 37. A CELL (FROM THE REPRODUCTIVE GLAND OF A MALE GUINEA-PIG)

This figure is an exact drawing, not a diagram. The nucleus (N) is seen to contain chromosomes, which will be described later in this chapter.

pieces of suet and stick them together to form a sort of network (G in Fig. 37). Put this network bodily into the outer balloon. Finally, insert a marble (or two marbles close together) into the outer balloon, close to the inner

one (C in Fig. 37). You then have a very rough representation of a cell. It is not really exact. The substances you have used (white of egg, phosferine, ordinary sugar, and suet) are not the actual substances which occur in cells, but they are allied to them. The inner balloon is called the nucleus (N in Fig. 37), and it consists of water with a very complicated substance dissolved in it. This is a substance allied to white of egg, but containing phosphoric acid. The outer part of the cell consists of water with substances allied to white of egg and substances allied to ordinary sugar dissolved in it. The substances allied to white of egg do

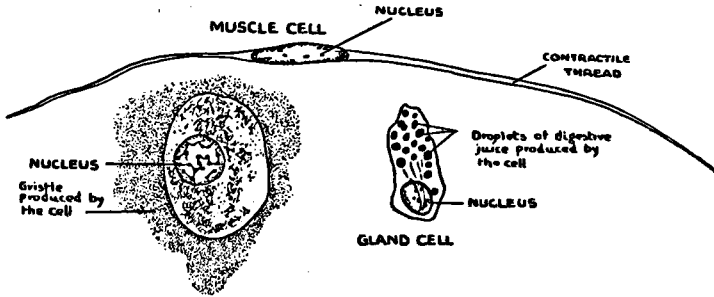


Fig. 88. A muscle cell from the bladder of a cat; a gristle cell from the rib of a rabbit; and a gland cell from the pancreas (sweetbread) of a frog. Highly magnified. In these figures several important constituents of the cells are left out for the sake of simplicity.

not form a smooth solution, but occur in the form of extremely small particles which can be detected by the ultra-microscope, while the sugary substances dissolve completely, so that the ultra-microscope cannot detect the still smaller particles (molecules) into which they are broken up.

The round or rod-shaped bodies are not actually formed of suet, but of a substance allied to fat. It is only recently that much has been known about them, as they are not preserved in ordinary microscopical slides, and are rather difficult to show. Nobody knows just what they are for even now. Here is a splendid field for discovery. Every cell in your body contains them, except your red blood cells; and no one knows why they are there! The network of

banana-shaped bodies is even more difficult to show, and even less is known about it : but it is always there. We do not even know what it is made of, but it seems to be a substance allied to fats, with very peculiar properties. The marble represents a body which is quite easily shown, but no one knows exactly what it is made of, so I have not represented it by a piece of organic matter.

Plant cells are much the same as animal cells in fundamentals, but they usually have a thick wall round them. We could best represent one by putting the various things I have told you of into a box of thick cardboard instead of a balloon.

Some microscopical plants and animals consist of one cell only, but most consist of millions of them. The cells of your body are not all the same, like bricks (see Fig. 38). Some sorts are even more different from one another than bricks are from tiles. Many of the cells lining your intestines are shaped rather like bricks. They produce drops of digestive juice, and push it out of themselves into the cavity of your intestines, where it dissolves the food which you have eaten. You have probably noticed the shiny, transparent sheet of tissue which holds all the intestines together, if you have ever gutted a rabbit. That is formed of cells shaped like crazy-paving stones, and fitting together in the same way. The cells of the surface of your skin are like tiny scales. Your brain consists of special cells, and so do your muscles and every part of you. Each cell is adapted to perform its special job. A brain cell would be useless as a protection if you put it on the surface of your body instead of a skin cell, and a skin cell would be quite incapable of making digestive juices, and a digestive cell would be a most unsuitable cell for making the sheet which holds the intestines together. But although these cells are all so different, yet they have a lot in common. They all have a nucleus, containing a substance with phosphoric acid in it, and they all have bodies corresponding to the round or rod-shaped and banana-shaped bodies which I have already described. We do know what the nucleus is for, and I shall tell you later. We also know

the use of the body which we have represented by the marble, but the others are still unexplained.

Quite recently a most ingenious apparatus has been invented, by means of which we can poke an extremely fine glass needle into a single living cell and watch what happens under the microscope. One can put chemicals into a single cell, or take things out of one. That is an extraordinary achievement. Another most exciting line of research is to take a few cells out of a living body and keep them alive in a little glass compartment, and examine them from time to time under the microscope. It is astonishing how long they live if you are very careful to seal them into their glass compartment without letting any germs get in. These studies of living cells are going to form a very important branch of the science of life. Life is, after all, the main characteristic of living things, and it is a pity to destroy the main characteristic before starting study. The trouble is that it is usually much easier to study organisms when they are dead. We must resist the temptation to do always what is easiest.

REPRODUCTION

Why do plants and animals reproduce at all? Even if there were no such thing as dying of old age, reproduction would be necessary, or organisms would die out, and our earth would be as lifeless as the Sahara all over its surface. Flesh-eating animals would eat up the vegetarian ones, and the vegetarian ones would soon be finished off, so the flesh-eating ones would starve. A few droughts would kill off most of the plants, and there would be no new ones to replace them. A few giant trees would probably survive longer than any other organisms, if all reproduction were to stop. Then there would be nothing left alive.

You have probably noticed feeble little green insects crawling about on rose-leaves in summer, and you may have helped to destroy them by squirting soapy water over them. These plant-lice reproduce in a very simple

way. Each one produces one egg, which is simply a cell corresponding to all the other cells in the body. The egg grows up into an adult exactly resembling the adult which produced it, and the performance is repeated.

That simple method of reproduction is rare. Usually there are two sorts of individuals in any one kind of organism, called male and female. The female produces eggs, and the male produces very active microscopic cells called sperms, which resemble tadpoles in shape and swim about in much the same way. Sperms and eggs are shown diagrammatically in Fig. 42. The egg does not develop at all unless a sperm meets it and penetrates into it. That is called fertilisation. The fertilised egg goes through the complicated series of changes which gradually cause it to become an adult. In most simple organisms which live in the sea, the females set free the eggs and the males set free the sperms, and it is left to chance to bring them together. Naturally enormous numbers of sperms perish without ever finding an egg, so this simple method is a very wasteful and uncertain one. Some plants which live on land use this method, but only plants which live in very damp places, for sperms die if they are removed from water for a moment. Land animals have a far more certain method of making sure that fertilisation will take place. The male places the sperms within the body of the female, and they swim along a tube to the eggs. Both sexes have a strong instinct to come together for this purpose, and in the higher animals the act of transferring the sperms gives a great pleasure to both which can be compared to the pleasure of eating. If eating were not in the slightest degree pleasant, a dog would not eat, and he would starve. If the transferring of sperms were not pleasant, he would fail to reproduce himself, and his race would die out. In the lower animals we have no proof of the existence of pleasure and pain, and quite possibly the transference of sperms takes place without consciousness.

When the egg has been fertilised by a sperm, it is usually laid ; but in the hairy animals, which are the highest of all animals, egg-laying does not occur. The egg develops into

a form more or less resembling the adult inside the body of the mother, and then is born into the world. After birth it is provided with milk from the milk glands of its mother, because at first it is unable to digest ordinary food.

EVOLUTION

You will probably be wondering why the method which the plant-lice adopt is not adopted by all animals. This seems the most likely explanation. An egg produced by a plant-louse grows up into an adult exactly like its parent. It is simply a bit of its parent which grows up in the same surroundings, so it is natural that it should be exactly the same. Sexual reproduction gives far more variation. Unless you happen to be one of a pair of identical twins, there is not, and never has been, anyone exactly like you. If human beings reproduced like plant-lice, you would be exactly like your mother in every respect, mental and physical. The result of sexual reproduction is that different persons or animals bring together various combinations of characters, and an enormous, almost infinite, number of different sorts of persons or animals are produced, each one differing from every other one. That is what makes it so exciting to be alive.

Among wild animals, only the individuals which possess favourable combinations of characters can survive. Enormously more young are being produced than can ever grow up and produce young of their own. That applies to every kind of organism, even to the slowest breeding of all, the elephant. If no sparrows died except from old age, in a quarter of a century there would be enough sparrows to cover the surface of the whole country so thickly that it would not be possible to see the ground anywhere. Many animals would multiply very much more rapidly than that. Nevertheless, although different kinds of animals fluctuate in numbers, yet the average number over a long period does not change much. We must suppose that it is those individuals which are best adapted

to their surroundings that survive, while the less well adapted and the ill adapted die. It is probable that this has caused plants and animals to get more and more complicated, better and better adapted, as time goes on. Nothing is known about the actual origin of life on this earth, millions of years ago, but fossils prove that there has been a continuous evolution (see *Structure of the Earth*, p. 380). Simple animals are found in all rocks, from the oldest to the newest, but complicated animals only in the newer ones. Fishes appeared before the amphibia (newts, and frogs and their relatives), and these before reptiles, and reptiles before mammals and birds. A minute study of their anatomy makes it almost certain that amphibia evolved from fishes, and reptiles from amphibia, while both birds and mammals sprang separately from reptiles. The duck-billed platypus of Australia is in nearly every part of its anatomy intermediate between reptiles and mammals (see Fig. 39). It has hair and suckles its young, but still lays eggs. It is one of the very earliest mammals, which has changed little since the time of its origin from reptiles, while the other mammals were evolving into the mole and rabbit and horse and monkey and the host of others which we know so well, including ourselves.

No one knows exactly why some kinds of animals evolve quickly, while others, like the platypus, seem to get stuck and remain in their primitive condition. Competition seems to have something to do with it. The early mammals, one stage farther advanced than the platypus, were at one time distributed over most of the world. At that time Australia was joined to Asia. Then Australia got separated off, and its mammals (the pouch-bearing kangaroos and wombats and their relatives) are still primitive. These animals bear their young in a very undeveloped state; a new-born kangaroo is only about the size of one's little finger, and nothing like an adult in shape. Some of these primitive mammals still have shells to their eggs, like reptiles. In the rest of the world the higher mammals were evolving, and the relatives of the kangaroo could not compete with them in the struggle for existence, and died out.



Fig. 39. THE DUCK-BILLED PLATYPUS

DISEASE IN NATURE

You must picture hundreds of thousands of kinds of plants and animals, all producing far too many young ones. You must imagine the young ones varying. Later we will discuss variation more fully : for the moment you must accept the fact of variation. The young ones which varied in favourable ways would be likely to survive, and to pass on their favourable characters to their offspring. Thus one kind of organism might change until it was a distinctly different kind of organism, or it might give rise to several different new kinds of organisms.

Every possible mode of life would be filled in this way. If no other animal had started feeding on dung, then any kind which started this habit would tend to survive, and every variation which fitted it for this life would be incorporated in it, until it evolved into an animal which was adapted in every way for a life among dung. Other kinds evolve which feed on dead bodies. Others attack living animals, with or without killing them. The hag-fish attaches itself to fishes by its mouth and gradually bores its way into the living flesh. The ichneumon-fly (see Fig. 40) lays its egg on the egg of the sawfly, and the caterpillar of the ichneumon fly lives within the caterpillar of the sawfly and gradually eats it up. It begins by eating the less essential parts, because it would die itself if the sawfly caterpillar died too soon. The tapeworm is a huge animal, six feet long, which lives inside the intestine of man and other animals. Microscopic plants and animals, called germs, cause disease not only among men and domestic animals, but also among wild animals. It is becoming clearer and clearer that disease is widespread in nature.

The struggle for existence has often forced plants and animals into most horrible forms of life, which make life a misery for other creatures, if the other creatures have evolved sufficiently to be conscious of pain. Life was not designed as one designs a machine ; it evolved because evolution was a necessary consequence of variation and the struggle for existence. Each kind of organism thus

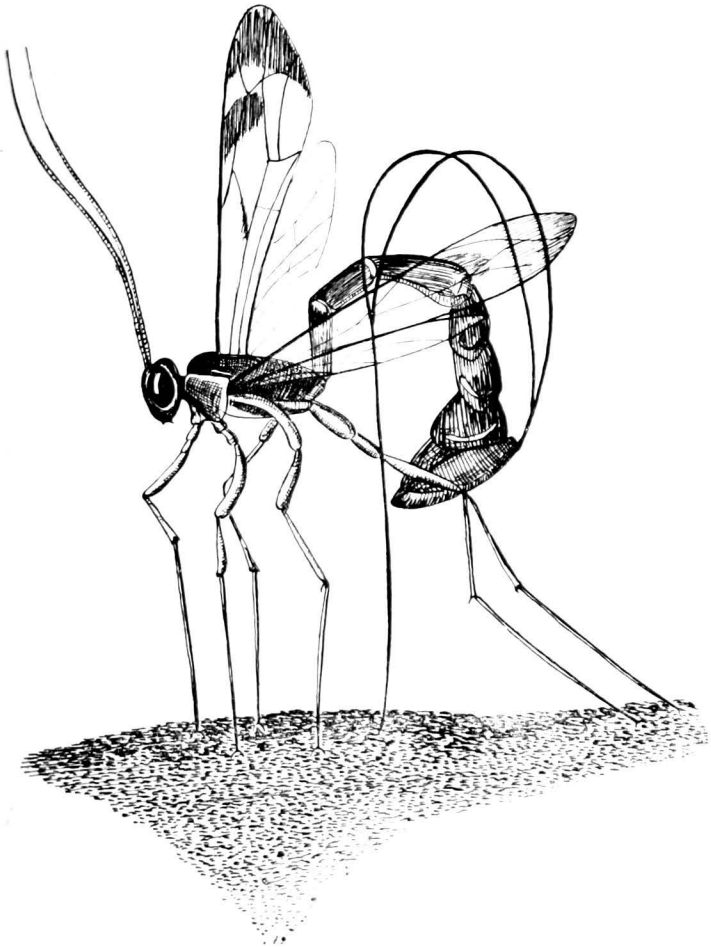


Fig. 40. AN ICHNEUMON FLY

From the hind end of the body springs the long egg-laying apparatus, which bores through the solid wood of fallen tree-trunks so that the eggs may be laid on the caterpillar of the wood-wasp. The caterpillar of the ichneumon fly gradually eats up the caterpillar of the wood-wasp, without killing it for a long time.

evolves for itself : ner organism is a possible prey to be made use of ruthlessly. Only man has evolved so far that he can consider what is good and what is bad ; yet even he is seldom deeply concerned with the happiness of other animals, or even of people of races other than his own. Animals are operated upon on farms without anæsthetics, so that we may get more tender meat. Afterwards they are often brutally slaughtered, although humane methods exist. We are often prepared to believe the worst of other nations without carefully considering both sides of any argument with open minds. We have evolved from ape-like ancestors, and we still bear the mark of the beast.

THE EVOLUTION OF MAN

From our anatomy it is clear that we belong to the monkey order. The monkey order is divided up into families, like any other order. There is the family of the South American monkeys, which have prehensile tails ; the family of Old World monkeys, whose tails are not prehensile, and which have pouches in their cheeks for storing food ; the family of apes (the chimpanzee, orangutan, gorilla, and a few others, none of which have tails) ; and the family of men. There is no doubt that the apes are our nearest relatives. We agree with them in having no tail, no cheek-pouches, and no swellings on the buttocks. Also both men and apes have an appendix, while the monkeys have none. Those are just a few of the striking ways in which we resemble the apes. There are other resemblances in every part of the body. We do not come in the same family, because there are certain quite definite differences. We cannot oppose our big toe to our other toes, so our foot is not a grasping organ. Our arms are shorter than our legs ; our jaws do not protrude forward like an ape's ; we have definite chins ; our dog-teeth do not project ; we have not got great bony ridges over our eyes ; we have very little hair on our bodies ; and, last of all, our brain is much bigger and cleverer.

Parts of fossil skeletons have been found which are half-way between apes and men. They are far more man-like than any of the apes, and far more ape-like than the natives of Australia, who are about the most primitive men. Parts of several such skeletons have recently been found near Peking, and when they have been fully examined we shall know a lot about the evolution of man from ape-like ancestors. You must not imagine that man is descended from the chimpanzee or orang-utan or gorilla, but only that there once existed an ape-like creature from which both the apes and man are descended.

Searching for fossil skeletons of man's ancestors is like looking for a needle in a haystack, and requires years of patience, with uncertainty all the time as to whether anything will be found. One man spent two years searching in the East Indies before he found what he wanted. The man who has described the skulls from Peking got a job in China simply because he thought that skeletons of ancestral man might be found there. He had to wait years before he got even a single tooth, but later on his patience was enormously rewarded. One of the most interesting fossil skulls of all was found in Sussex. Very unfortunately, the workmen who found it broke it up and threw it on to a rubbish-heap. The experts have spent years trying to fit it together again properly.

Many people find it difficult to believe in the evolution of man from an ape-like ancestor, because our minds are so enormously better developed than the minds of any animals. Perhaps they rather overestimate our own minds, and underestimate the minds of apes. Speech and writing give us an exaggerated idea of our own minds, because they enable us to benefit from the experience of previous generations in a way that is impossible to apes. We should not seem very clever if no one had ever spoken to us and if we had never read a book. We should probably not learn even to count up to six unless we were instructed, but with instruction by speech and books we learn algebra and geometry. Chimpanzees can make sounds indicating that they are happy or angry or in various other states of mind,

but they have no sounds indicating concrete objects. The evolution of speech was the most important step of all in the evolution of man's mind, and marks him off more clearly than anything else from other animals: but it makes him unduly proud of his mind.

The chimpanzee's mind is very simple, and does not work exactly like ours: but the fundamentals are the same. It has been shown clearly that he can reason. It is not simply that he can imitate, or that he does clever things by random movements at first, and then remembers how to do them. Not at all. If you set him a problem, he thinks it out and solves it, unless it is too difficult. This is about the hardest problem a chimpanzee can solve: Put him in a large cage, and put a fruit outside the bars, beyond his reach. Hang a stick upon the wall so high that he cannot reach it. Put a large box in the cage. A clever chimpanzee, without any instruction of any sort, will put the box under the stick, climb on to the box and unhook the stick. He will then use the stick to pull the fruit within his reach. He is not a fool.

HEREDITY

The inherited characters are passed on from one generation to the next by the (generally) minute egg and the still smaller sperm. The structure of every part of you is determined by what was in the sperm and the egg which made you. Each parent contributed equally to your inheritance. Does it not seem extraordinary that the sperm and the egg which appear utterly different in every way, should contribute exactly equally? If one looks at the fertilised egg, it does not appear so extraordinary (see Fig. 41). The substance containing phosphoric acid in the nucleus of the egg has condensed into exactly twenty-four rod-shaped bodies, about the shape of the handle of a dinner-knife, though some are longer in proportion to their width and some much shorter. These bodies are called chromosomes. The nucleus of the sperm has done the same thing. There are now forty-eight chromosomes within the egg, half derived from

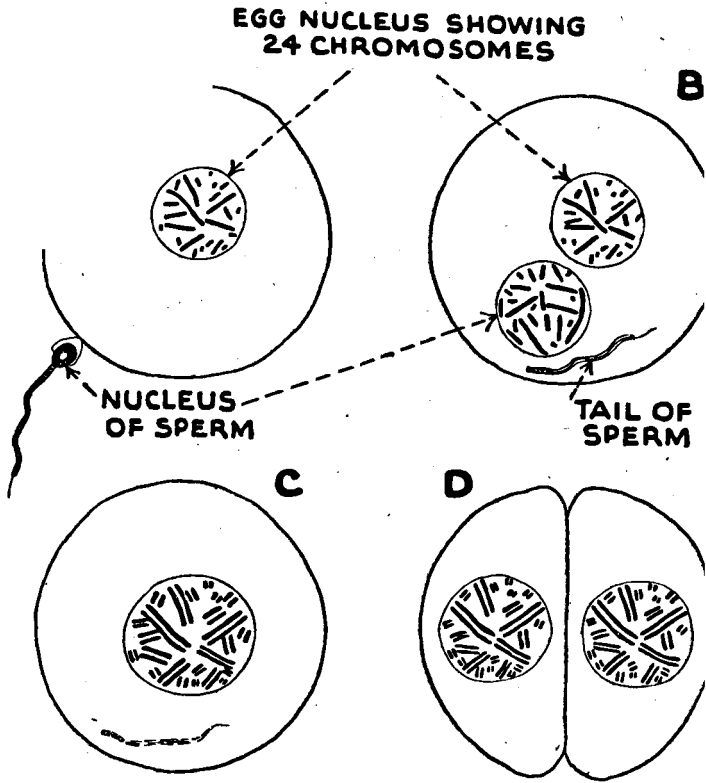


Fig. 41. DIAGRAM OF FERTILIZATION

A. The sperm is seen just beginning to penetrate into the egg. The chromosomes cannot yet be seen in the sperm, but the egg nucleus contains 24 chromosomes of varying lengths.

B. The sperm has penetrated into the egg. The sperm nucleus has swollen up, and is now seen to contain 24 chromosomes of varying lengths.

C. The sperm nucleus has fused with the egg nucleus. The single nucleus now contains 48 chromosomes, in 24 pairs. One chromosome of each pair was derived from the mother and one from the father. (The tail of the sperm is decaying.)

D. The egg has divided into two cells. Each chromosome has divided longitudinally, and one half has gone into each cell. Thus there are 48 chromosomes in each cell. This process is repeated again and again, until all the cells of the body are formed, every one of them (except the sperm cells and egg cells) containing 48 chromosomes.

the mother and half derived from the father. Some are the part of the egg and of the sperm concerned with inheritance, and, so far as chromosomes concerned, the egg and the sperm are similar.

The fertilised egg soon divides into two, the two into four, the four into eight, and so on until the millions of cells which compose the body are produced. Three different things are happening. The cells are dividing, they are becoming adapted for their different purposes, and the total size of all the cells together is increasing. Those three different processes constitute development. Normal development can only go on with normal surroundings. But if the surroundings are normal, the exact course of development depends on the chromosomes. Each time a cell divides, each of the forty-eight chromosomes divides, and so every cell in your body contains forty-eight chromosomes, of which twenty-four are derived from your mother and twenty-four from your father. You could not be a more intimate blend of your parents than you are.

The chromosomes you received from your mother are all different. They vary considerably in length. You received a similar set of chromosomes from your father, and one can arrange the forty-eight in two similar packs of twenty-four. It is as though your mother had given you one pack of cards and your father another. The packs might be rather different from one another, but each card in your mother's pack would have a corresponding one in your father's pack.

A minute part of one pair of chromosomes is concerned with the colour of your eyes. The rest of those chromosomes, and the other chromosomes, are concerned with all the other parts of your body, outside and inside. For the moment let us concentrate on the part of one pair of chromosomes concerned with the colour of your eyes. It is an extraordinary fact that every cell in your body has this part, including the cells of your little toe and your appendix, but it only shows itself in your eye. You could not have expected that, but it is so.

Now suppose your father and mother both have brown

eyes, inherited from all your grandparents. Then the two chromosomes in every cell of your body which control eye-colour will both make for brown eyes, and your eyes will be brown. If both your father and your mother have pure blue eyes, your eyes will be pure blue.

That is all simple. But now suppose your mother has pure blue eyes, and your father brown eyes inherited from both his parents. Then you will have a mixed pair of chromosomes. One of them will be trying to cause you to have blue eyes, and the other will be trying to cause you to have brown eyes. Luckily you will not have brown eyes spotted with blue, or the reverse, because brown eyes win completely, and so your eyes will be as brown as your father's, and so will those of all your brothers and sisters. When you are adult, sperms will be formed. Now sperms, as we have seen, only contain twenty-four chromosomes, not forty-eight. To get an idea of what happens, think of your two packs of cards again. Shuffle them together, and then pick out at random one complete set of cards, not paying any attention to whether any card is from your mother's pack or your father's. It is the same in the formation of sperms. Each of your sperms will contain *either* the chromosome which makes for blue eyes *or* the chromosome that makes for brown eyes. You will form millions and millions of sperms altogether, half of which will contain the chromosome making for blue eyes, and half the chromosome making for brown eyes.

Now suppose that later on you marry a girl with blue eyes. All the eggs which she produces will make for blue eyes. When you have a child, the chances are equal whether the egg was fertilised by a blue-producing or a brown-producing sperm. If the former, your child's eyes will be blue; if the latter, they will be brown. If you have several children, about half will have blue and about half brown eyes.

If you do not understand clearly why children do not exactly resemble their fathers or their mothers or their brothers or their sisters, it will only be necessary for you to take the two packs of cards again, and begin to see how

many different complete sets you can make up. You will see why you may have your father's eye-colour, your mother's nose, your father's long legs, your mother's temperament. Most of these characters are actually controlled by many different chromosomes all acting together, but the principle is exactly the same.

"Identical" twins are formed by a single fertilised egg dividing into two and making two babies. The two are exactly similar simply because they have exactly the same packs of chromosomes. With the exception of identical twins, no two individuals have exactly the same pack. For that reason there are countless numbers of different sorts of individuals, and among wild plants and animals the fortunate ones survive. The badly adapted ones die. A lion which inherited weak muscles and poor eyesight would not survive to pass on these characters to offspring. In this way not only is the standard of excellence kept up, but a gradual improvement or evolution takes place.

Evolution does not consist simply in the survival of fortunate combinations of already existing characters. Every now and then an entirely new variation appears unexpectedly, on account of something having happened to one of the chromosomes of an ancestor. The new variety may differ markedly, or it may only differ in a microscopical detail; but the new character is inherited in the same way as eye-colour. We do not know what causes these new variations to appear in nature; but it has been discovered that if X-rays are applied to the cells which will give rise to sperms or eggs, a lot of new variations are produced. This seems to hold out hopes of wonderful discoveries in the future. Perhaps we shall be able to direct the course of evolution in animals and ourselves in some such way.

There are many ways in which you can alter the growth of plants and animals. You can take two similar greyhounds, and train one of them for the Waterloo Cup and make the other a sleepy, fat, overfed house-dog. Your treatment of them in no way affects their young ones. The puppies of the overfed house-dog are just as likely to win the Waterloo Cup as the puppies of the trained dog. Such

characters, which are caused by alterations in surroundings and treatment, are not inherited. It will make no difference to the inherited qualities of your children whether you improve your mind by making a minute study of this book, or throw it on the fire without reading further. The effects of the use or disuse of the various parts of the body are not inherited.

SEX DETERMINATION

Are you a girl or a boy? It all depended on the sperm which fertilised the egg from which you grew. Eggs have no tendency to grow into girls rather than boys, or into boys rather than girls. The sperm, on the contrary, is either male-producing or female-producing. The two sorts of sperms are produced in equal numbers. The control of sex depends on one of the chromosomes. One of the biggest pairs of chromosomes in the female is called the sex chromosomes. When the egg is formed, the number of chromosomes is reduced to twenty-four from the original forty-eight. When this happens, one sex chromosome stays in the egg, and the other is cast out. With the male it is different.

In boys and men there are not two absolutely complete packs of chromosomes. There is an equal pair of all the chromosomes represented in the female, except the sex chromosomes. The male has, in every cell in his body, one sex chromosome like the female's, but not two. Its partner is an insignificant little chromosome. When sperms are being formed, half of them get the proper sex chromosome, and half get the insignificant little chromosome. If an egg is fertilised by a sperm of the former sort, it will contain two proper sex chromosomes. That is the arrangement which makes for femaleness, and it will grow to be a girl. If the sperm with the little sex chromosome fertilises the egg, the egg will contain one proper sex chromosome and one little one. That is the male arrangement, and the egg will grow into a boy. The sex chromosome of the sperm determines sex. The determination of sex is shown diagrammatically

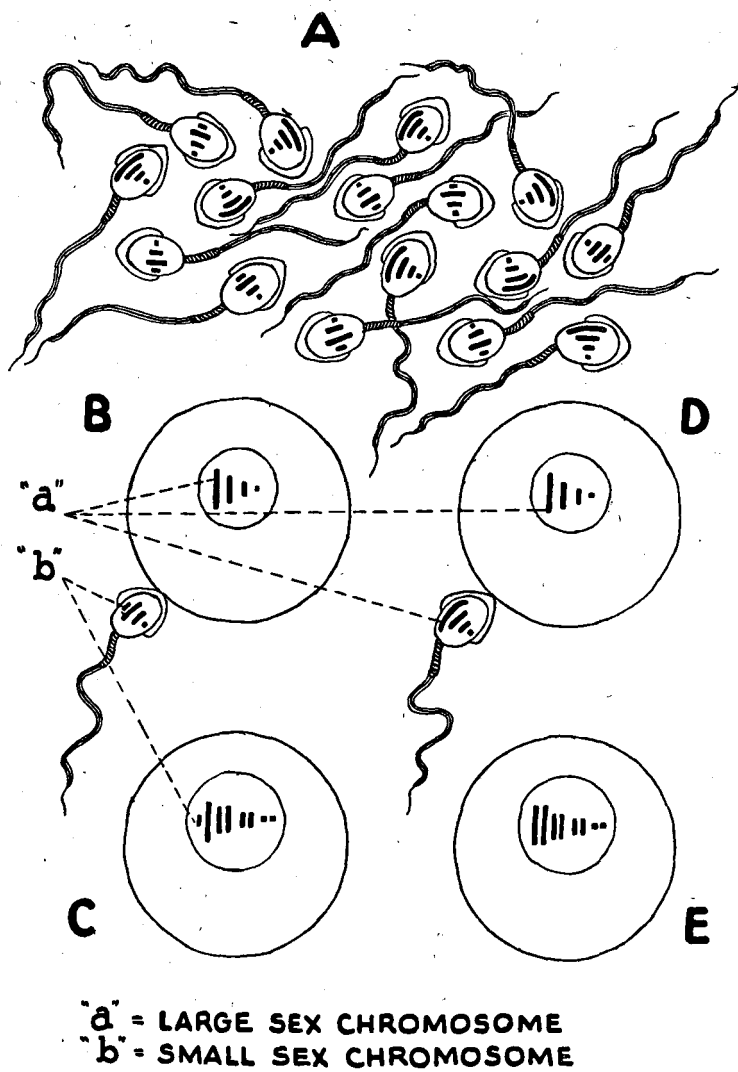


Fig. 42. DIAGRAM ILLUSTRATING THE DETERMINATION OF SEX

EXPLANATION OF FIG. 42

A. A number of sperms, all produced by one individual. Each has four chromosomes, but there are two sorts of sperms in equal numbers. One sort (female-producing) has a large chromosome (sex chromosome) and three smaller ones of different lengths. The three smaller ones are also represented in the other sort of sperm (male producing), but the sex-chromosome is here a small chromosome.

B. A male-producing sperm fertilising an egg. The egg contains a large sex chromosome and three other chromosomes.

C. The sperm nucleus has fused with the egg nucleus. The three ordinary chromosomes are now in equal pairs, but the sex chromosomes are unequally paired. An unequal pair of sex chromosomes determines maleness, and the egg will grow up to be a male.

D. A female-producing sperm fertilising an egg.

E. The sperm nucleus has fused with the egg nucleus. The presence of two equal sex chromosomes will result in the egg growing up to be a female.

in Fig. 42 in an animal which has eight chromosomes in each cell except the sperm and egg, which have four.

In human beings, about five million sperms are deposited in the body of the woman at the same time, and half are male-producing and half female-producing. Only one fertilises the egg. The sperms have a long way to swim, compared with their own size, before they reach the egg, which is several inches away in another part of the body (see *Physiology*, p. 128). The male-producing sperms seem to have some advantage, for a male-producing sperm fertilises the egg more often than a female-producer. About 105 boys are born to 100 girls.

One day we shall probably be able to separate male-producing from female-producing sperms, and then we shall be able to have girls or boys at choice, and also arrange the proportions of the sexes among farm animals to suit requirements.

EUGENICS

All the hundreds of thousands of kinds of animals have evolved from very simple forms of life, and presumably from inorganic matter originally, without the existence of any mind to plan them. Mind itself is one of the products of evolution, and now at last one kind of living thing only has got the ability to control and plan the course of evolution. That one kind of living thing is the human kind. For centuries men have selected certain types of domestic animals for breeding, and have thus created all the variety of horses and cattle and sheep and pigs and dogs that exist to-day. They have improved all these animals for the purposes for which they require them, but they have not improved themselves. There is no reason at all to suppose that the inborn mental capacity of man has increased since prehistoric times.

When men were just evolving from ape-like ancestors, they evolved because the best individuals survived and had young ones, whilst the worst died off and had none. That does not happen in civilisation. With us the weakly

are looked after by the strong. If the weakness is an inherited character, it is unfortunate that the people who have it should have children, because they will pass it on, generation after generation. On the average, the most successful people have the fewest children in most civilised countries to-day, and the least successful the most. It is possible nowadays for ordinary people to arrange whether they will have many or few children, or none at all. It would certainly be better if the most successful people had most children, because success in life is partly due to inherited qualities. Many people with excellent inherited qualities never get an opportunity to show them, from lack of a sufficiently good education. If we wanted to improve our race, we should give everyone an equal chance in life as far as possible. We should then encourage the most successful to have a lot of children. Many people are what is called feeble-minded. Their brain never develops beyond that of a child of six. Often this is a character which is inherited in the same way as blue eyes. If two such feeble-minded people marry, all their children will be feeble-minded. If a feeble-minded person marries a normal person, the children will be normal, but some of their descendants will be feeble-minded. It would be a good plan to prevent people who have inherited feeble-mindedness from having children, because feeble-minded people are not happy themselves, and they are not useful to other people, and they cost other people a lot of money. Unfortunately, they are increasing rapidly in numbers in Great Britain. Before long they will form quite a large proportion of our population, unless we decide not to allow them to have children. Members of Parliament, who decide these things, think it best to let them go on multiplying. When they were young, Members of Parliament did not have an *Outline for Boys and Girls*.

BOOKS TO READ

- C. M. YONGE : *A Year on the Great Barrier Reef.*
F. S. RUSSELL and C. M. YONGE : *The Seas.*
A. R. WALLACE : *Tropical Nature.*
M. I. NEWBIGIN : *Animal Geography.*
L. C. MIALL : *Aquatic Insects.*
O. H. LATTER : *The Natural History of some Common
Animals.*
J. B. S. HALDANE and JULIAN HUXLEY : *Animal Biology.*
H. G. WELLS, JULIAN HUXLEY, and G. P. WELLS : *The Science
of Life.*
E. RAY LANKESTER : *Extinct Animals.*

APPLIED BIOLOGY
OR
GETTING TO WORK ON THE MUDDLES
by
N. W. PIRIE



N. W. PIRIE is a bio-chemist, and works in the bio-chemical laboratory at Cambridge, doing experiments. He feeds rats on odd things. He is a Scot and quite young. He went on an expedition to Spitsbergen to see how the various kinds of plants and animals which live inside the Arctic Circle behave. He camped by himself for two days by a driftwood fire on a corner of a beach between a glacier and high rock ridges ; the wild ducks and seals swam close up to him and the sun never set, because it was the Arctic summer. He has also been to Russia and seen the scientific work which is being done there. Just before this book was finished his eldest son, John, was born.

APPLIED BIOLOGY

HOW THE MUDDLES ARE MADE

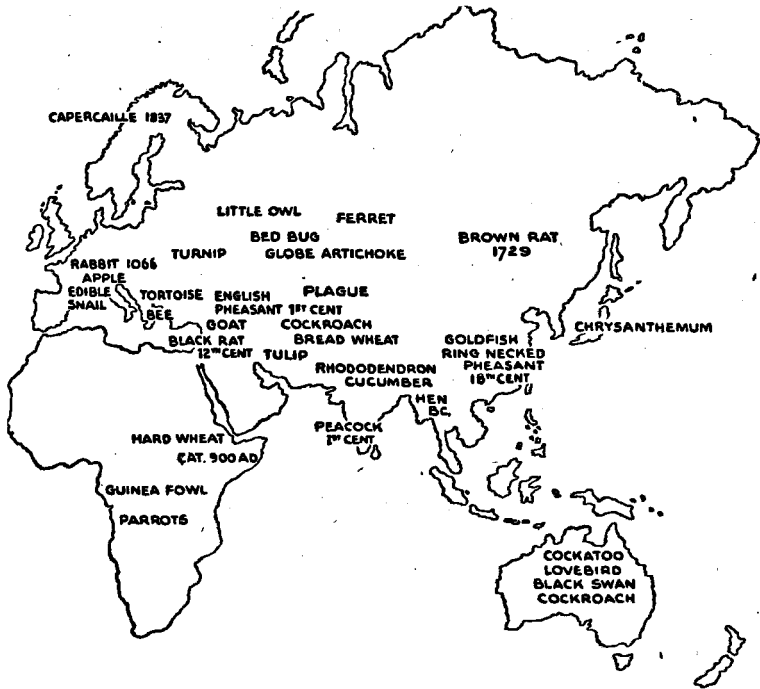
WHEN men travel, they generally take other living things with them. As a rule they want to, but fairly often they do not. For example, they take domestic animals and plants to a colony, but they also take out the insects and diseases that annoy them at home. Foreign animals and plants are brought home in the same way (see Fig. 43). Now wild animals do not often die of old age; they are generally eaten by some other animal or they die of a disease. In each part of the world we find that the animals and plants are able to find food, and can either avoid their enemies or else breed so fast that they are not all killed off. But when men bring in new things, this balance is often upset. The newcomer may not be able to live at all, because it finds an enemy waiting for it. It may, on the other hand, grow too well, because there is nothing to eat it or kill it, and become a plague. In either case, the trouble can be put right by the biologist, and I am going to describe how it is done later.

Things go wrong for a number of other reasons, and the applied biologist can often put them right. The chief reason is man's habit of living in towns and cities. This habit makes it important that sanitation, public health, and methods of dealing with epidemics should be developed. We have begun to improve preserved foods and to supply artificially some chemicals which are essential in the body and which it sometimes cannot make for itself; I am going to tell about this too.

So far I have only mentioned cases where things have gone wrong and the applied biologist has had to put them right again. As time goes on he is becoming bolder. He is improving on nature, and is thinking of wholly new things that might be done. As a result of his labours the domestic



Fig. 43. The map shows where some of the common animals and plants, that have been introduced into Britain, came from. In some cases we have put in the date of their arrival but sometimes we could not find out when an animal came, and sometimes it was not known. Some things did not come to us directly from the country marked, and some animals did not really belong to the country that we got them from ; but the map gives a rough idea of how animals and plants have moved about.



Continuation of Map opposite.

plants and animals are becoming bigger, they are growing faster, and they are becoming much less liable to diseases. New plants and animals are being domesticated, and sometimes even created, by skilled breeders. We are looking for new sources of food for men and animals. We are trying to make fungi and bacteria make things for us that the chemists cannot make easily.

Poets and theologians have written a great deal about man. On the whole they seem to be satisfied with him from the material point of view. The biologist is not so easily pleased. Is it necessary that we should die when we do, or that we should spend a third of our lives asleep, or that learning should be such a slow and difficult business? Questions like these are often asked, and it is the biologist who must answer them. The answer, of course, is "We do not yet know." But we are always finding out more about the way in which the body works and about how we can alter it. Perhaps in the future we will be able to do without sleep for several days on end as a result of taking a drug. It is possible that, when the differences between an old and a young body are better understood, we will be able to put off old age for a long time.

Cattle and plants have been improved enormously by careful choosing and mating of fathers and mothers for many generations. Clearly man might be improved in the same way. This idea is called eugenics, and many people have great faith in it. But at present we know too little about heredity in man to be able to be very hopeful about it yet. Still, we are accumulating knowledge of this sort fairly rapidly, and it should be possible to start eugenic experiments in a generation or two (see *Biology*, p. 204).

To make it easier to read, this chapter is divided into a part on food and a part on health. But there is no real difference between these two aspects of applied biology.

FOOD

Agriculture is as old as history, and is carried out in every part of the world in which it is possible. No living race of men is too primitive to cultivate some kind of crop. Some tribes, of course, such as the Eskimos, do not grow anything, because nothing will grow in the places where they live. The natives of Western Australia are said to bury the heads of the wild yams whose roots they have eaten. This is probably the most primitive kind of "agriculture" that goes on now.

SELECTING AND BREEDING FOOD PLANTS

The selection of good kinds of grain from among the many wild seed-bearing grasses was an early step. There is a primitive wheat called emmer that is still found growing in various parts of Europe and the Near East. Grains of this wheat have been found in Egyptian tombs (5400 B.C.), and even among the remains of Neolithic man (10,000 B.C.). It is probable that men carried it to all the widely separated places where it has been found (see *Outline of World History*, p. 398). If we can find out where this wheat started from, we could then find out more about the early wanderings of man. There is also a practical reason for wanting to know where wheat comes from, but I will explain it later.

You have already read about chromosomes, and about the part played in evolution by mutations (that is, quite new varieties of an animal or plant that appear suddenly, for no apparent reason) (see *Biology*, p. 200). Wheat gives us another example of this. The cells of the most primitive wheats of all contain fourteen chromosomes. Emmer, and some of the wheats which replaced it in the civilised parts of the Old World, have twenty-eight. Still other wheats have forty-two chromosomes; it is these types that are generally used now. All these are definitely wheats, and can in many cases be crossed with each other. Crossing is the usual scientific word for mating between different varieties of plants

or animals. Plants in which the number of chromosomes varies in this way are called polyploids, and polyploidy is very common among domestic plants. It is important because these polyploid plants have a tendency to increase in size. The seeds especially increase in this way (see Fig. 44). Polyploids are often very variable; that is to say, plants grown from seeds that have all been borne on the same plant are not all alike. The differences are sometimes quite marked. It is this fact that gives the clue to the country of origin of a domestic plant. A Russian botanist, Vavilov, has studied the wild wheats that are found in different parts of the world. He finds that there are more varieties of wheat growing together in places that are near northern Afghanistan than in places that are far from it. The same thing is true of Abyssinia. He concludes from this that the polyploid wheats began in these parts of the world and have spread out gradually. In the same way there are many wild types of potato in Bolivia and Peru. We know that the potato came from there, because it came quite recently.

We can still get good plants by selecting them from a natural mixture—that is, by using the primitive method. For example, cattle will not eat lupins because they taste bitter. One and a half million lupins were therefore grown at the Munchenberg plant-breeding station in Germany. A few were found that were not bitter. These breed true and are being used as forage plants. There must often have been sweet lupins growing wild in the same way, but they would not be able to go on because animals would eat them rather than the bitter ones. There are many problems waiting to be tackled in this way, but for most purposes the method of cross-breeding is better.

Plant- and animal-breeders have always selected the parents of each new generation with great care. They hoped that in this way the good points of the parents would be carried on. They often were, but it was sometimes found that certain crosses failed. The early plant-breeders did not therefore get very far, if we judge their plants by modern standards. The work of Mendel, Bateson, and

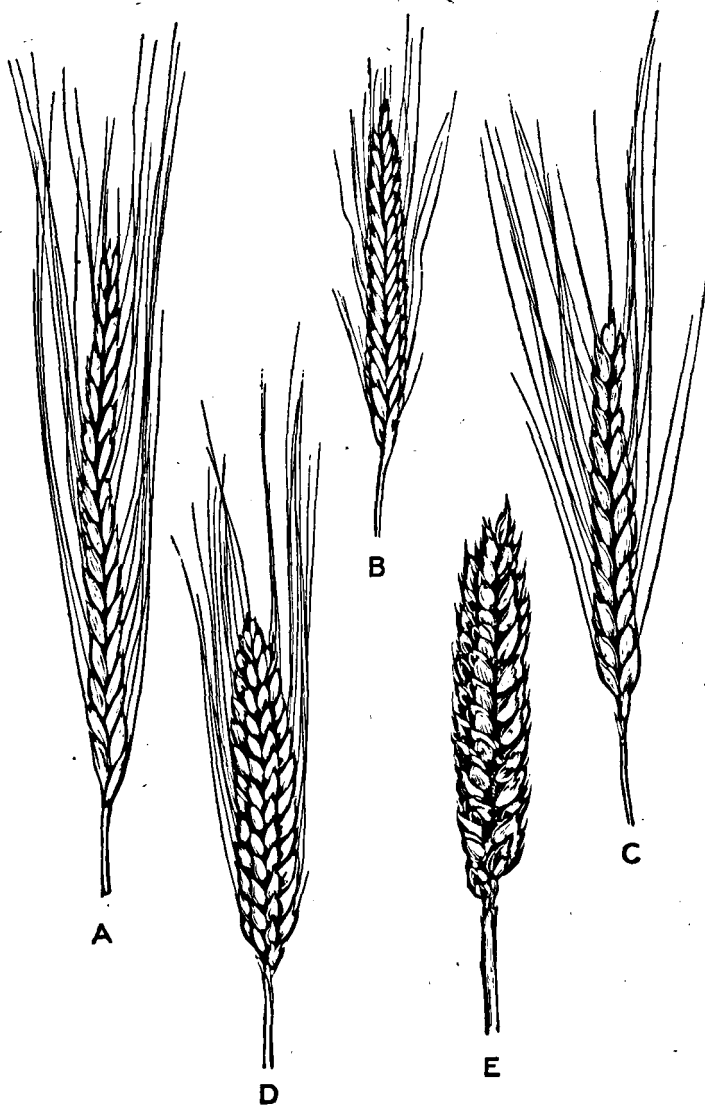


Fig. 44. FIVE WHEAT-EARS

This picture shows how much better the cultivated wheats are than the wild wheats from which they have been developed. Wild Small Spelt (A) is just a grass. It grows in Asia Minor and has 14 chromosomes. Small Spelt (B) is still sometimes cultivated in parts of Europe; it also has 14 chromosomes. Emmer (C) has 28 chromosomes and is quite often grown as cattle food. Rivet wheat (D) and Bread wheat (E) have 42 chromosomes; they are typical modern types.

Morgan has made the results of the early workers seem much less mysterious than they were before. The plant-breeder need no longer grope blindly in a maze of varieties, but can tell beforehand what the result of a cross is likely to be.

Genetics has not yet been so useful to the animal-breeder, but the science is young. When we have more knowledge, and especially when we know how to make animals mutate (that is to say, alter suddenly between two generations; see *Biology*, p. 200), we may expect some big changes in our domestic animals. It will never be so easy to change animals as to change plants. There are two reasons for this. One is that we cannot breed animals in enormous numbers (remember the 1,500,000 lupins). The other is that a plant is often of both sexes at once, whereas an animal is either male or female. The result is that it takes two animals to have a family, whereas it only takes one plant. This makes the study of inheritance more difficult in animals than in plants.

The plant-breeder has tackled very many problems successfully. The old workers, before the time of Mendel, managed to increase the yield of wheat per acre. They made wheats that were partly resistant to the fungus that causes rust. By finding wheats that were not killed by frost they made wheat grow much farther north in Canada and Scandinavia than it had done before. The Swedish geneticist, Nilsson-Ehle, has still further improved these wheats by crossing frost-resistant Swedish wheats with high-yielding English ones. The first generation is "selfed," i.e. each plant is fertilised with its own pollen. The second and later generations are planted in the far north, and the plants that are not killed by frost and which give a good yield of grain are chosen. This work has increased Sweden's production of wheat by half, although there has been no increase in the amount of land under cultivation. In the same way, wheats that will grow with very little water have been made for growing in Australia.

By laborious crossing with wild grasses we have made wheats that will grow on very poor soil. This is an example

of a very important principle in plant-breeding. While we are breeding a plant for one quality, it often happens that other qualities, to which we have been paying no attention, get missed out. Sometimes this does not matter, but it may be that the quality is valuable—for example, the power to resist a disease or pest. We now have to put this missing quality back again, and it is often easiest to do this by crossing with a wild strain of the plant. It is for this reason that it is important to know where our domestic plants have come from, for the missing quality is much more likely to be found among the varieties there than anywhere else.

The Dutch growers in Java have been very successful in breeding sugar-canes which resist disease and give a good yield. They are now faced with a new obstacle. In Java the yield is large and the loss through disease is small, so sugar can be produced cheaply. But the other countries that are interested in sugar production interfere with the people who sell Dutch sugar. So the sugar-growers gain nothing by their skill in breeding! In course of time no doubt politics will become merely one aspect of applied biology.

There is another weapon in the plant- or animal-breeder's armoury which so far has not been used. I have mentioned the finding of a sweet lupin. If we knew why that lupin had suddenly appeared we could try to make other plants do the same sort of thing. We know already that X-rays and some sort of chemicals will change an organism's make-up, and that this change is inherited (see *Biology*, p. 200). Mutants (the new, changed varieties) that have been made in this way are generally weaklings. They are useless, and have no hope of survival. But sometimes it may happen that the mutant is better than its parent, and that a new and useful strain could be grown from it. Much is to be expected from this kind of work in the future.

THE SOIL

In spite of the best efforts of the plant-breeder, a plant cannot produce a good crop unless the soil is manured. The Romans knew how to increase the fertility of the soil by growing peas, beans, vetches, or clover in it. The use of various kinds of organic matter as manure is probably as old as farming. Fertilisers of the modern type were first studied by Lawes at Rothamsted about the middle of last century. The value of nitrogen, phosphorus, and potassium compounds was speedily proved, and the fertility of the land in many parts of England was increased enormously. In some countries, where serious attention is still paid to fertilisers, the fertility has been increased even more.

In 1898, Sir William Crookes said that there would be a food shortage in 1931 unless something revolutionary were done. Almost all the land that was then suitable for growing wheat was being cultivated, and the supplies of nitrate from Chili were rapidly being used up. Since that time the plant-breeder has made wheats that will grow on land that used to be unsuitable because of frost, or drought, or the poverty of the soil. Still more important has been the work of the chemist in "fixing" the nitrogen of the air. We say that nitrogen is "fixed" when it has been turned into some compound which the plant can use. It seems that no plant can make use of the element itself. There are certain plants—peas, beans, etc.—that keep colonies of bacteria in their roots. Since these bacteria can "fix" nitrogen, such a plant is able to increase the amount of it that is available in the soil. As a result of these scientific advances we are now producing more of almost all the important foodstuffs than there is a market for. It is a pity that there is no market for this extra food, because at least two-thirds of the people in the world have still too little to eat (see *Problems and Solutions*, p. 726). That, however, is the fault of the politicians and not of the chemists and biologists.

There is an almost unlimited amount of nitrogen in the air, and any nitrogen that is taken out of it sooner or later

gets back there. So a food shortage cannot be caused by lack of nitrogen. There is lots of oxygen and hydrogen, and the carbon in the food we eat is breathed out as carbon dioxide in a very short time. Green plants turn this carbon dioxide back into food for us. But there are two other elements that are necessary in food and that cannot be picked up anywhere. These are sulphur and phosphorus. There is plenty of sulphur in the sea, and we can get it out if our present supplies are used up. But if we go on using phosphorus as we are using it now, a shortage is certain. A plant contains a great deal of phosphorus, but a plant is not usually eaten in the field in which it was grown, so the phosphorus in the soil is being used up. Of course if grass is cropped by cattle in a field, the phosphorus goes back as manure, but with crops that are used as human food this does not happen (see Fig. 45). In some parts of America, 36 per cent. of the phosphorus that was in the soil has been removed in this way in fifty years. This loss is, of course, being made good by fertilisers, but we are using up the supplies of phosphatic rock at an alarming rate and throwing the phosphorus into the sea. It is not a very common element, and it will be very hard to get it back. The cause of this waste is our method of dealing with sewage. Sewage engineers send almost everything out to sea by the quickest and least unpleasant route that they can think of. We seem to have forgotten that sewage is valuable, and we send millions of pounds' worth of useful nitrogen and irreplaceable phosphorus floating down our rivers every year. We get a little of it back in the form of fish, but we should have to catch a huge quantity of fish before we made good the present waste. This solution is not impossible, and fish will become a very important human food in the future. Before this happens the fisherman will have to become a herdsman rather than a hunter, as he is at present, and much more research into the food and habits of fish will be wanted.

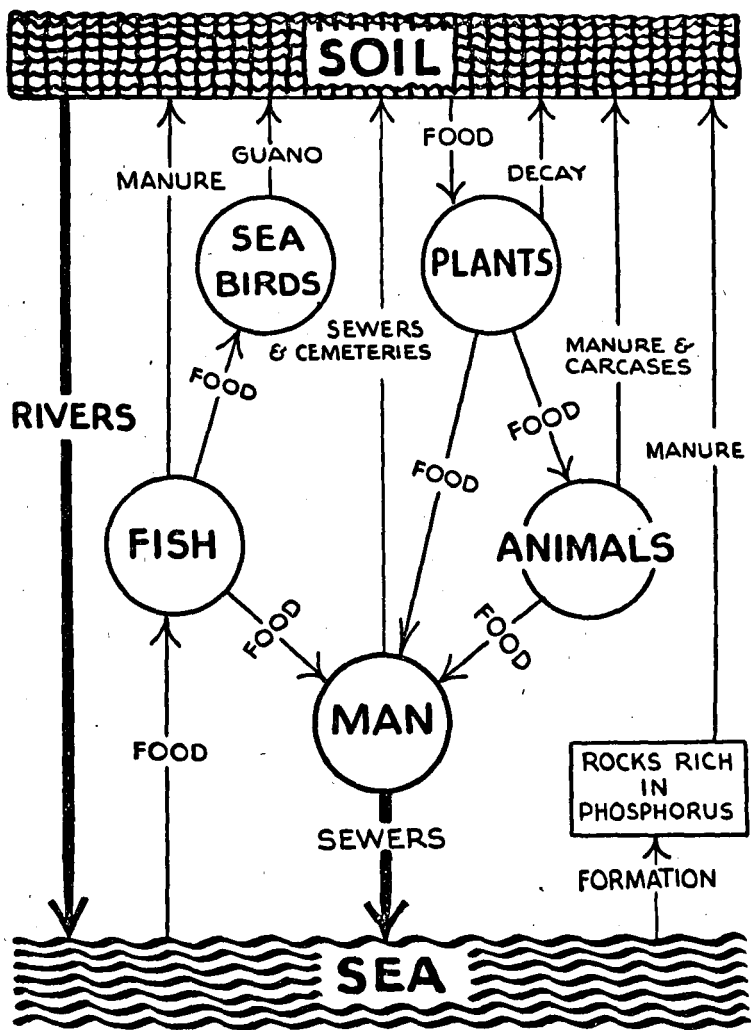


Fig. 45. THE PHOSPHORUS CYCLE

This diagram shows how some of the phosphorus in the world is circulating. A small amount is getting back to the soil but the greater part of our available phosphorus is going into the sea, and staying there. Look what John Baker said about the difference between plants' food and animals' food, on page 168.

MEAT

Meat-eating is very wasteful. It is a luxury that we can afford at present, but we will not be able to if the number of people in the world becomes very much bigger. The meat-eating races will then have to find a new source of meat or become vegetarian. Meat-eating is wasteful, because an ox, in the course of its life, eats many times its weight of food. About half of this could have been used as human food, or is grown on land that could have grown human food. Cattle-breeders have done wonderful work, but it is not likely that they will manage to make an ox grow very much quicker than it grows now. For it is the rate of growth that is important and not the final weight of the ox. The reason for this is that most of the food an animal eats is used to keep it warm and to supply the energy for its muscles. We do not gain anything from the food that is used in this way, so we try to make it as small a part of the total as possible.

Even if the number of people in the world does increase greatly, we will be able to go on eating meat if the animals are stall fed on a more or less manufactured food. Otherwise we will have to find a way of growing meat that is more efficient than an ox. It is already fairly easy to take a bit of tissue out of an animal and grow it in a sort of soup. It will go on growing for ever if we keep the soup fresh and if we can keep microbes out of it. If we cut off pieces, they will grow too. At present it is far harder to make the soup than to get the meat from an animal, but work of this kind seems to have possibilities for the future.

BACTERIA

There is another source of food that has not been used properly yet. Bacteria, yeasts, and moulds have been used to make various foods such as cheese, vinegar, and alcoholic drinks. Except in Japan, they have not been used to nourish plant, animal, or man. This is curious, because

many microbes will live on very simple things, and they have fantastic powers of growth. If one ordinary bacterium were allowed to multiply as fast as it could, there would be a ton of bacteria after a day. After two and a half days the weight of bacteria would, in theory at least, be greater than the weight of the earth! Luckily for less fertile creatures, such as ourselves, this rate cannot be kept up for more than a very short time. The food-supply runs out, and the organism poisons itself with its own waste products. It is well to remember that they have this power of rapid growth, and man will make full use of it in the future.

Bacteria are already used at sewage disposal works. They purify the water so that it can be run into a river without polluting it. In Germany, glycerine was made out of starch by yeast at a time when there was a shortage of fat, the usual source of glycerine. In the next few years processes like this will become more important. There are several things that could be more easily made by microbes than in the ordinary chemical way.

Sometimes we will have to make new bacteria as we have made new plants. This will be slightly dangerous, because some of them may be able to live in man. If they should get loose, the applied biologist will be blamed for a new disease. But it is not likely that any amount of carelessness will ever make us equal the applied physicist and chemist at this! It was their discoveries which made industry possible, and it is industries, and the way they are carried on in industrial towns, which have given about 70% of the inhabitants of Britain rickets. At present there are a whole host of "industrial diseases." These vary from tuberculosis caused by working with certain kinds of stone to cancer that attacks workers in the shale oil industry.

But there is another risk if we make a new bacterium. It might be too well fitted for life on the earth, and might spread to an unlimited extent in the sea and rivers and ponds. A catastrophe like this is very unlikely, and it is no more probable than the splitting of the atom in the explosive way that some writers have imagined.

INSECTS: USEFUL AND HARMFUL

Insects play a very important part in the production of food. They fertilise a great many plants, and they cause or carry about a large proportion of the diseases from which plants or animals suffer. There are about 250,000 definitely known species of insects, and this is probably only about a tenth of the total number. It is not surprising that they are important, for it has been estimated that half of the animal matter on land is in the form of insects.

In round numbers there are :

8,000	species of mammals
10,000	„ „ birds
8,000	„ „ fishes (but we know little of the abysses of the sea)
200,000	„ „ plants.

It is often possible to attack an insect pest directly by spraying the plants with a poison. Unfortunately, this simple method does not always work. We then have to study the insect's habits and life history more carefully, to see when it is most easily killed ; it may happen that it is easier to kill the larva than to kill the adult insect. Birds eat a great many insects. One pair of sparrows were found to carry 2,000 grubs and beetles to their nestlings every day. But birds are little use in fighting an imported insect plague. For one thing, they do not breed fast enough, so that they can never get the upper hand of an insect pest unaided. Another objection to birds is that they are apt to change their diet when taken to a new country. If they started eating the crop instead of the pest, the biologist who brought them in would not be thanked ! It is to other insects, therefore, that we turn most confidently for allies in this battle.

The use of insects to fight an insect pest raises the whole question of parasitism and the rôle of an " enemy " in a group of living creatures. Among men, an enemy is someone who is trying to kill you or do you as much harm as he can. It very seldom turns out that he has really been doing you a good turn all the time. For that matter, it seldom

turns out that he has been doing himself one either. The position is different among animals. As a rule, an animal needs two things—a food-supply to eat and an enemy to be eaten by. Without the enemy the food will soon all be eaten by an animal with the usual powers of multiplication. Starvation and an epidemic follow, and it will take the race several years to regain its old position. This happens among the lemmings in Scandinavia and the hares in North America. At regular intervals they “boil over,” and are found in enormous numbers. Suddenly there is an epidemic. The lemmings make for the sea, and, rushing in, are drowned. The hares die by millions of an infectious disease.

A parasite behaves more in the way we think an enemy should. It is never useful to its host ; at least, when it is we do not *call* it a parasite. There is an institute near Windsor where these parasites are bred for export to countries afflicted with a pest.

As a rule an insect which becomes a pest is a new arrival in a country. One looks, therefore, for a suitable parasite in its country of origin, for it is probably only a pest because it has given its parasite “the slip.” The creature must be very carefully studied, for it may be bad itself, and the cure will be worse than the disease. After a suitable parasite has been found, it is bred on as large a scale as possible (say 10,000). They are then sent to the afflicted place and set free. Sometimes they are sent in cold storage and sometimes they are sent living on their host. The parasite gets firmly established in a few years, and after that the pest will wane. We now see why an inside enemy is better than an outside one. The outside enemy is apt to look elsewhere for food when it has eaten all the pest insects. The inside enemy is hatched out of eggs in the body of its host. As the numbers of the pest diminish, the numbers of the parasite will do the same, and a balance will be reached.

Insects were first used to control an insect pest in 1889 when an Australian ladybird was imported into California to deal with the cottony scale that was ruining the orange plantations. Since then a fly from Malay has rescued the coconuts of Fiji from a moth. The European parasites of

the gipsy moth have been introduced into America to save the trees. Ladybirds have been used in many places; in Kenya they have saved the coffee crop from mealy-bugs. In this case the problem is more complex. There is an ant that farms out the mealy-bug on bushes because it likes a sweet fluid that the bug excretes. The ant, therefore, brings the bug back into a plantation as soon as it has been killed off by the ladybird or an insecticide. The problem of how to get rid of the ant is, I believe, still unsolved.

Out of seventy-three important insect pests in America, thirty-seven were imported. As a rule an insect gets into a country in a cargo of vegetables or grain. Laws have, therefore, been passed in many countries to keep farm produce from a pest-ridden country from being imported. This legislation has been fairly useful for keeping out pests; it has unfortunately also been found useful for keeping out foreign business competitors! Even when it is not misused in this way, it causes a great deal of international suspicion.

Native insects can become a pest too. Before the coming of farming they get their food from scattered wild plants. Then suddenly they find that man has supplied them with acre upon acre of carefully tended wheat and cotton. Naturally they multiply. The Colorado beetle, which attacks potatoes, and a whole host of fruit flies have increased in this way. Other insects are of little use, for if any parasites exist they are probably already there but are unable to cope with their host. We can sometimes breed plants that resist the insect, and chemical insecticides are useful but expensive.

So far I have only talked about bad insects. There are many good ones. The virtues of the bee are well known, but it is an insect the applied biologist has not yet studied enough. Bees can apparently send messages to each other, so there seems to be no reason why we should not send messages to them as a shepherd does to his dog. Now in most cases natural products are not really scarce, but they are widely distributed in small amounts. Trained, or rather instructed, insects with the bee's instinct for collecting

could be used to gather plant products of this type.

Plants often do not grow when there are no insects to fertilise them. Clover grew badly when first taken to New Zealand. It now grows well, because the humble bee has been taken there too. In the same way figs were sterile in California until the insect that fertilises them in their native country was introduced.

Insects are of value in coping with plant pests. Several insects have been used together in a successful attack on the prickly pear in Australia. This pest was itself brought in from Mexico. Another Mexican plant, the lantana, became a pest in Hawaii. A suitable fly was found and the plague is now over.

Very recently a new use has been found for insects. Fly larvae will eat dead tissue but will not touch living; a number of these larvae are sometimes put on to nasty wounds that will not heal up. The result is often remarkable; they clean up the wound and it heals in a few days. Naturally the flies used are bred under clean conditions from carefully cleaned eggs so that they will not infect the wound.

HEALTH

During the last sixty years there has been a revolution in our attitude towards disease. The main reason for this is the idea that the cause of a disease is the most important thing about it. This idea has already been very useful, and it is probable that, by means of it, the present generation will be able to prevent or cure all the ordinary diseases.

CAUSES OF DISEASE

There are six main causes of ill-health, and four of them are living:

(1) Viruses, which are something alive, but so small that they either cannot be seen or can only just be seen under

the microscope. Mumps, measles, and small-pox are caused by viruses, and colds and influenza may be.

(2) Bacteria, which are larger than viruses but not so large as red blood corpuscles. The foundations of modern medicine were laid by Koch when he found that bacteria are the cause of many diseases. Scarlet fever, tuberculosis, and pneumonia are examples of diseases that are caused by bacteria.

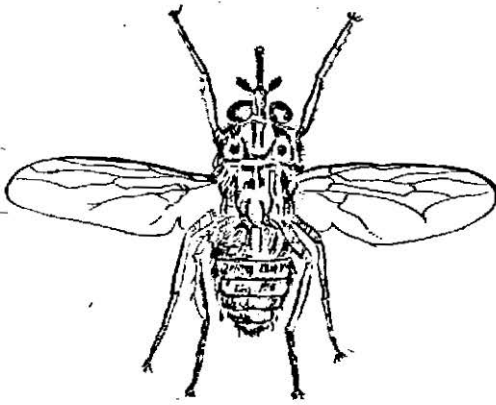
(3) Protozoa are animals that have only one cell; they are bigger than bacteria, and as a rule they are more complicated inside. In Britain there are very few protozoal diseases, but dysentery, sleeping sickness, and malaria are serious problems in warmer countries.

(4) Various other animals, and a few plants, have become parasitic on man and other animals. The tape worm is well known. There are several similar animals, but, although they are very unpleasant, they are not very important.

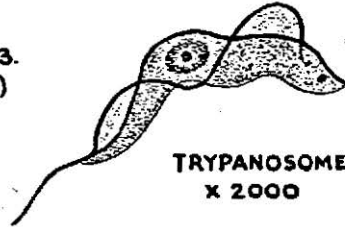
(5) There is a group of "Bio-chemical Diseases," of which the importance has only recently been recognised. The diseases which I have mentioned so far have been caused by the presence of something living; this group is caused by the absence of something dead. Rickets and scurvy are caused in this way.

(6) The sixth group is altogether less satisfactory. It consists mainly of those diseases whose cause we do not understand. We know a great deal about cancer and diabetes, and can often cure them, but we do not yet know why people get either disease. It is probable that by the time Mr. Gollancz has finished printing this book we will have found the cause of at least one more of these curious diseases. They may turn out to be due to one of the other five causes or they may be due to some mechanical injury as definite and as simple as a broken leg.

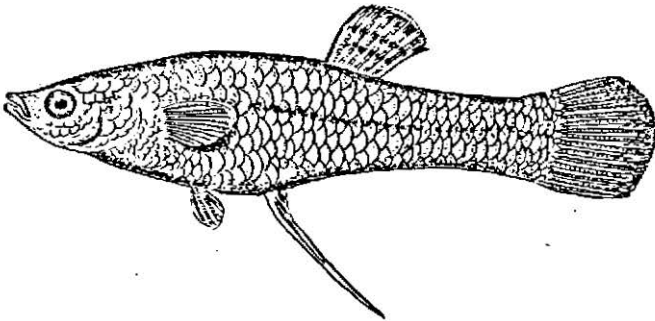
Poisoning is another cause of disease. Many of the industrial diseases are of this type, and they are a disgrace to civilisation. It is possible, by taking care, to keep the men who work with things like lead, phosphorus, mercury, and a number of organic compounds from being poisoned by them. As time goes on the condition of the workers in these



TSETSE FLY X3.
(After Thompson)



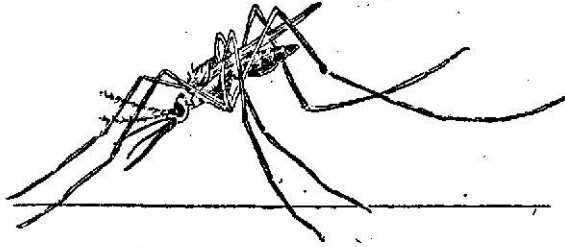
TRYPANOSOME
X 2000



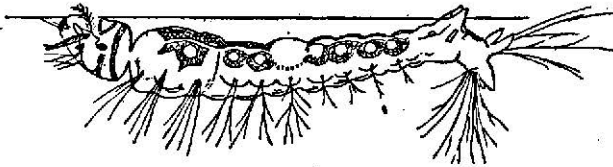
TOP MINNOW . MALE X 2
(After Jordan and Evermann)

Fig. 46. TSETSE FLY, ETC.

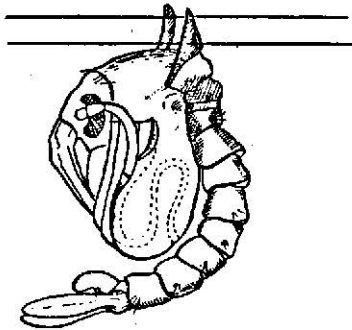
The tsetse fly carries about with it the protozoon (called a trypanosome) that causes sleeping sickness. The protozoon is drawn very much magnified; it is really only about twice as big as a red blood corpuscle. The fish, gambusia, ought to have been on the same page as the mosquito, whose larvæ it eats.



ANOPHELES. Approximately X3



HALF BROWN LARVA OF ANOPHELES
Approximately X10



PUPA OF ANOPHELES. Approximately X10
(After Howard)

Fig. 47. MOSQUITO

The larva and pupa of the mosquito (anopheles) are shown hanging from a water surface. They breathe through the tubes that stick through. The adult mosquito is shown in the position it takes up when sucking blood. The little fish that is used to eat mosquito larvæ is drawn on opposite page.

industries does, of course, get better, but there are still too many cases of preventable poisoning.

PREVENTING DISEASE

The obvious way to prevent people from catching an infectious disease is to get rid of the germ that causes it. As a rule that is not possible, but we can often avoid coming in contact with the germ. The cleaning up of our cities and our bodies that has been going on during the last few centuries has resulted in the disappearance from Britain of many diseases that were very common before. Lice, fleas, and rats carry many diseases, and epidemics have on several occasions been traced to them. It is more difficult to get rid of insects which do not live on man, but simply bite him. It can be done, however, and malaria and yellow fever, which are carried by mosquitoes, and sleeping sickness, which is carried by the tsetse fly, are being overcome (see Fig 46).

The protozoon which causes malaria was first seen in human blood fifty years ago. It was not then known how it got into man. About this time Manson showed that a worm (filaria) was carried from man to man by a mosquito. This worm is probably the cause of elephantiasis, an unpleasant disease in which parts of the body swell to enormous sizes. It was then found that malaria and a number of other diseases were spread in the same way, and by 1904 the fight against malaria had begun.

Many ways of getting rid of mosquitoes have been tried, but methods in which the larva is attacked have been found to be the best. Mosquito larvæ hatch out of eggs which are laid in water. They breathe, so they have to stay at the surface with air tubes reaching through to the air (see Fig. 47). There are three ways of killing these larvæ. One is to drain the country, and so avoid having any still water. Another is to cover the water with a thin film of paraffin, and so prevent the larva getting any air. The third is to encourage a minnow, gambusia, that feeds at the surface

of ponds and is very fond of mosquito larvæ (see Fig. 46). The first method is not always practicable, and the second is apt to be expensive ; also it kills a great many other things besides mosquitoes. But paraffin has often been used very successfully. The third method seems to have no defects ; it is very cheap and it is permanent. In part of Italy 98 per cent. of the children had malaria in 1924, when gambusia was introduced ; now less than 10 per cent. suffer from it.

Tuberculosis is another disease that it is easier to prevent than to cure. Since the chief source of infection is milk, the risk of catching tuberculosis becomes small if this bad milk is avoided. In most countries milk from cows which are not tuberculous can be bought. This disease is, therefore, to some extent avoidable.

IMMUNITY

Generally it is not possible to avoid contact with germs ; we must therefore rely on a second kind of defence, which is called immunity. People who have not had measles are very likely to catch it if they stay close to someone who has measles. Dogs, on the other hand, and people who have had measles recently, do not catch it. We say that a person who has had measles is immune. This immunity lasts for some years, and sometimes for ever. No one knows exactly what the difference is between an ordinary and an immune person, but we can show that the blood is concerned in it. If we inject into a person who has been infected with measles but has not yet developed it a small amount of blood from a person who has just had measles, the former will either not be attacked or will have a very mild attack. In most cases it is easier, and just as effective, to get the blood from an animal than from a convalescent patient. Diphtheria and lockjaw are fairly easy to deal with in this way, but the treatment must be begun before the disease has got a firm hold. We usually get lockjaw from a deep wound which is very dirty. In many hospitals a little blood from a horse that has been given lockjaw is injected

into everyone who comes in with such a wound. This treatment is very successful.

Vaccination against small-pox is really a very similar thing. One deliberately gives a person a mild disease so that he may become immune to small-pox, a very serious disease.

People often get ill in spite of these precautions. Sometimes we can cure them by a method similar to the last. The difference is that one uses artificial substances to kill the invading germ instead of the blood of an animal that has recovered from such an invasion. The chemicals used are generally very poisonous to the patient as well as to the germ. They have to be used very carefully. Protozoal diseases are most readily cured in this way, and several compounds have been used against malaria and sleeping sickness.

VITAMINS AND HORMONES

The "Bio-chemical Diseases" are of two very distinct types. One is caused by the absence of a vitamin (*Physiology*, p. 92). The other is caused by the absence of a hormone (*Physiology*, p. 96). If you read the advertisements of patent foods and medicines you will think there is something mysterious or magical about vitamins and hormones. There isn't. They are perfectly ordinary chemicals, only slightly more complicated than sugar or aspirin, only we do not yet know how all of them are put together. But we only found out the structure of sugar five years ago. The unusual thing about these substances is that only a minute amount is needed every day to keep a man healthy.

Normally we make our own hormones, but we have to get our vitamins from outside. There is probably some difference more fundamental than this, but we cannot yet say what it is.

At least five of the known vitamins are connected with special human diseases, and the diseases can be, and are being, cured by supplying the missing vitamins. Three hundred years ago it was found that fresh fruit would

protect sailors from scurvy. This fact seems often to have been forgotten or ignored since. The absence of vitamin C is now definitely known to be the cause of scurvy. In the same way, vitamin D, which is present in cod liver oil, and all good brands of margarine, will cure and prevent rickets. Sunlight will prevent rickets just as well. In Britain people are seldom able to get any sunlight because of the smoke, and when there is no smoke the sunlight cannot get at them because of their clothes. We are, therefore, forced to depend on our food for this vitamin as well as for the others. Pellagra is a disease which has at times been very common in Italy and the southern parts of the U.S.A. It can be cured with certainty by feeding yeast which is rich in vitamin B. This knowledge has not yet been vigorously applied, and there are still very many avoidable cases of pellagra.

We know much more about hormones than about vitamins, and two of them have been made synthetically. Insulin and thyroxin are the most important from our present point of view. It has been known for many years that a diabetic could not make use of the sugar in his food. Later it was shown that the pancreas was to blame, because a dog that had had its pancreas taken out developed symptoms similar to those of diabetes (see *Physiology*, p. 97). Still later it was observed that these symptoms did not develop if the pancreas was replaced under the skin in any part of the body. Many attempts were made to find something in the pancreas that would enable a diabetic to use sugar. They were successful about ten years ago. We still do not know why a man gets diabetes, but, with the aid of this extract, which has been called insulin, we can enable him to lead a normal life.

In parts of Derbyshire, Switzerland, America, and other places many people used to suffer from goitre—that is, they had swollen necks and were often sleepy and dull-witted. The swelling was due to the growth of the thyroid gland (see *Physiology*, p. 126); this gland normally contains a small amount of iodine. It was found that there was very little iodine in the soil in those parts of the world where

goitre was common, and that the whole trouble disappeared when iodine was added in minute quantities to the food which the inhabitants ate. This form of goitre is now a preventible disease. It is simply iodine starvation. Even when the iodine supply is plentiful the thyroid sometimes goes wrong. It can stop working, but, unlike the pancreas, it can also work too hard. In the latter case, the only thing to do is to cut part of it out. When the thyroid stops working, the effect is similar to that of a shortage of iodine. Children stop growing, and their minds do not develop; such a child may live for twenty years, but it will look like a very ugly baby and will still be unable to think. The effect of feeding it on thyroid, or on an extract of thyroid, is remarkable. Growth starts, the mind develops, and, if it has not been deprived of thyroid for too long, it turns into a perfectly healthy child. The same sort of thing can be done experimentally with tadpoles. By feeding them with thyroid they may be made to turn into frogs while still very small. If, on the other hand, all traces of iodine are removed from a tadpole's food and water, it will not turn into a frog. Unlike a child, it will still go on growing. Tadpoles that are two or three times as big as usual may be grown in this way.

It has recently been found out that traces of metals—for example, zinc and copper—are essential for health. Babies that are being fed on milk sometimes become very pale and bloodless, but if they are given a trace of copper salt they make blood in the ordinary way. This is interesting, because milk is, in all other respects, a perfect food. Until recently, of course, a baby could collect ample copper, along with other dirt, while rolling about on the floor. This is perhaps the first example of cleanliness having been carried so far that it is actually the cause of a disease!

“ THE WICKED GROCER ”

Bad food, and too little of it, is a most important cause of illness, both directly and also indirectly, for an underfed man is more easily infected than a well-fed one. You will

find yourself in prison if you send a man out to sea in an unseaworthy ship, but you will make quite a lot of money if, as the result of a colossal advertising campaign, you ruin a nation's health by making people eat a patent food that just falls short of being poisonous. The applied biologist can still find a lot of truth in Chesterton's song about the grocer :

*He sells us sands of Araby
As sugar for cash down ;
He sweeps his shop and sells the dust
The purest salt in town,
He crams with cans of poisoned meat
Poor subjects of the King,
And when they die by thousands,
Why, he laughs like anything.*

BOOKS TO READ

ELTON : *Animal Ecology.*

DE KRUIF : *Microbe Hunters.*

JAMES RITCHIE : *Influence of Man on Animal Life in
Scotland.*

CHEMISTRY
OR
WHAT THINGS ARE MADE OF
by
JOHN PILLEY



JOHN PILLEY teaches the history of science at Bristol University, but, unlike most dons, he is very well aware that there is a large world going on outside his university. He is very much interested in people, which probably makes him a good teacher; it also makes him ask what science is going to do, what it is for, and how it is going to affect the minds and actions of ordinary people. That is most important, for scientists have so much power—more, probably, than anyone else—and they ought to think what they are doing, and, if they are going to upset the world, they must be prepared to set the world up again and make it a better place. Physics and chemistry are in some ways the most thrilling of all the sciences, once one realises that they aren't all cold and abstract and far away. There is really no boundary between physics and chemistry, but it is traditional to think of them separately, so I have separated them in this Outline; but John Pilley and Richard Hughes are friends, and their articles should really be read

together. John Pilley has written a book about electricity which you might try if you are interested in that. He is rather younger than I, but old enough to have been wireless officer during the last part of the war and to have seen physics and chemistry turned from helping people to destroying them. He is very good at making the most complicated scientific apparatus out of odd bits of things that he finds lying about, and lighting fires without matches, and things like that.

CHE MISTRY

THINGS THAT CHANGE INTO ONE ANOTHER

MOST of us, while we were still very young, began wondering what all the things in the world surrounding us were made of. We wanted to know what we ourselves were made of, or the moon or ink or sealing-wax. The kind of answer that we really wanted was one which told us that things we *didn't* know about were really made of the same kind of stuff as the things we *did* know about. Perhaps that was why people may have teased us by saying that the moon was made of green cheese. But even this shows that they saw we believed things that looked quite different might really be made of the same kind of stuff. Later on we shall see how nearly right we were in believing this.

But we weren't only interested in what things were made of. We also wanted to know about the changes which seemed to happen to some things ; how it is that the white powder called fruit-salts fizzes in water, and makes a drink like soda-water ; how matches burst into flame when they are rubbed on the box ; how milk curdles when you squeeze lemon-juice into it.

And then a time must have come when we suddenly began to wonder at some of the familiar things which we were so used to that they didn't seem worth wondering at. It may, for instance, have suddenly struck us one day as rather wonderful that our bodies build themselves up out of all the different things we eat. Perhaps you remember what Mr. de la Mare once wrote about this :

*It's a very odd thing,
As odd as can be,
That whatever Miss T eats,
Turns into Miss T ;*

*Porridge and apples,
 Mince, muffins, and mutton,
 Jam, junket, jumbles—
 Not a rap, not a button
 It matters ; the moment
 They're out of her plate,
 (Though shared by Miss Butcher
 And sour Mr. Bate),
 Tiny and cheerful,
 And neat as can be,
 Whatever Miss T eats,
 Turns into Miss T.*

There are thousands of other things which happen in the world which we should find just as surprising if only we were a little less used to them. The blade of a fine new penknife rusts if it is left out in the damp, and the shiny metal crumbles away into a brown powder. The coal in the grate burns with bright flames, and there is nothing left behind but a little grey ash. If you leave your cakes in the oven too long, they get burnt, and after a time nothing remains of them but a black crackly cinder of carbon.

Chemistry in general is finding out what things are made of and how they change into one another. That's all. To make it easier, the changes which happen to living things like Miss T, or to growing plants, are studied separately from the changes which happen to non-living things like rusting iron. The branch of chemistry which deals with changes in living matter is called bio-chemistry. The branch which deals with changes in non-living matter (with which we shall be chiefly dealing in this section) is called just chemistry.

BREAKING THINGS DOWN

If you watch very carefully how things change into something else, it gives you a good guide as to what they are made of. Think of the cake that was burnt to a cinder

in the oven. If, instead of heating the whole cake in the oven, you heat just a little piece of it in a glass tube closed at one end called a test-tube, you can see more easily just what happens. The little piece of cake turns to a cinder just the same, but you also see steam coming off; perhaps an oily liquid too. If you weighed the cinder that was left in the tube you would find that it weighed less than the piece of cake you originally started with. This also shows that something must have been driven off by the heating. The black carbon that is left behind isn't in the least like the cake. All the same, it must have been part of the stuff the cake was made of.

If you heat chalk, it too loses weight and becomes changed into something quite different. What is left is not a black mass, as with the cake, but a white powder called quick-lime. This will dissolve in water and differs from chalk in many other ways. At the same time a gas called carbon dioxide is given off. You cannot see this or smell it, but there are other ways of detecting it.

BUILDING THINGS UP

Both these are examples of substances changing by being "broken down" into other substances. But many other changes take place through a "building up" process. If you weighed some iron wire while it was shiny and bright and then again after it had rusted, you would find that its weight had *increased*. That must mean that, as it rusts, it *gains* something from somewhere.

What really happens is that iron rusts by taking up a gas called oxygen from the air. You can prove this by sprinkling some iron filings in a damp jam-jar, where some of them will stick (see Fig. 48). Then you turn the jam-jar upside down in a shallow dish of water, so that the rim is under the water, and leave it for a day or two. You will find that the iron has rusted and that the water has crept up inside the jar. This means, of course, that the water is taking the place of something which has been taken out of the air

inside the jar by the iron as it rusts. But the water never rises more than about a fifth of the way up, however long you may leave it. This is because all the oxygen from the air is then used up. All that remains is a quite different gas, nitrogen, which iron does not take up.

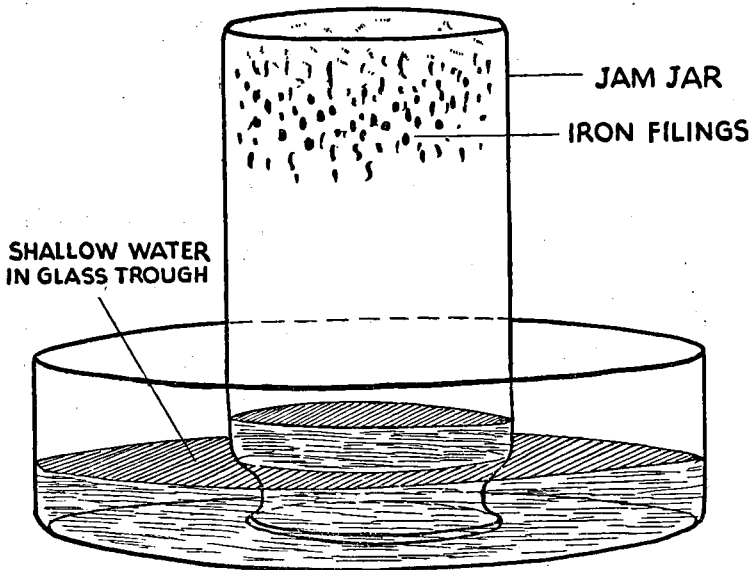


Fig. 48. An experiment you can do for yourself. As the iron filings sprinkled inside the jam-jar rust the water level in the jam-jar rises. But it never gets more than a fifth of the way up the jar. This is because at that point all the oxygen is used up, and only nitrogen remains.

CHEMICAL COMPOUNDS

But what is meant by a "building up" change, like this one in which rust is formed and oxygen is picked up from the air? Rust isn't just a mixture of air and iron. It is a quite separate material or substance; and its characteristics, or "properties," are completely different from both the shiny white metal, iron, and the invisible gas, oxygen. The chemist's name for it is iron oxide.

A substance formed like this from quite different substances is called a chemical compound. The change which happens when it is formed is called chemical combination.

Other substances form compounds by combining with the oxygen of the air. Magnesium ribbon (which you have perhaps seen burning with a brilliant white flame) makes a white powder which resembles lime. This powder is called magnesium oxide, or magnesia.

But the compounds formed with oxygen are not always solids: some are liquids, and some gases. If you burn hydrogen in air, it makes a flame and you don't notice any compound being formed. But, if you put a cold piece of metal in the flame, you see moisture deposited on it. You have perhaps noticed the same thing happen when you put a kettle of cold water, or a cold flat iron on the flame of a gas-ring. Drops of water begin to form on it at once. People sometimes call this "sweating." The drops of water form because the coal-gas burning in the gas-ring contains hydrogen. As the gas burns, it produces water in the form of steam. This settles, or "condenses," as liquid water when there is something cold in the flame, just like the moisture in your breath condenses when you breathe on cold glass. But the drops of water only remain for so long as the kettle or iron remains cold; as it heats up they disappear again. This is because the water forms steam again and passes away as a gas. We say that steam is the same substance as water, because it changes directly into it on cooling and back again on warming. Ice, too, is another form of the same substance.

If you let sulphur burn in air, it makes a substance called sulphur dioxide. This is a gas with a choky smell which does not condense so easily as steam. But if you pass it through a tube, which you cool by surrounding it with a freezing mixture of powdered ice and salt, such as is used in making ice-cream, it turns into a colourless liquid which looks like water. If you take the freezing mixture away again, the liquid forms a gas once more.

When carbon, in the form of charcoal or coal, burns in

air it makes another gas ; this gas is called carbon dioxide and is the gas used in making soda-water. It does not smell, but, if you pass it through a tube that is made very cold indeed—much colder even than you could make it with ordinary freezing mixture—it forms a white solid. This too forms a gas as it warms up.

Chemical compounds, as you have seen, can be broken down as well as built up. Some—as, for example, chalk—can be broken down simply by heating. To break up others you have to set about it in a roundabout way. To get back iron from rust, for example, you must heat it with something which will combine with the oxygen ; carbon will do quite well for this. If you mix rust with carbon and heat it very strongly, you get the iron back. This is rather like the way of getting iron from iron ore in the first place, as the chemical composition of iron ore is very like that of rust.

Many of the substances that are formed by breaking up complex substances are themselves complex. For example, both the quicklime and the carbon dioxide that are produced when chalk is strongly heated are complex substances. Actually, quicklime is produced when calcium (a metal rather like magnesium) burns in air. Carbon dioxide, as we have seen, is produced when carbon burns in air. Chalk therefore contains calcium, carbon, and oxygen as ingredients.

CHEMICAL ELEMENTS

But you find that you cannot go on breaking down complex substances into simpler and simpler substances for ever. There comes a time when you are left with substances that cannot be broken down into anything simpler by any *chemical* means. Calcium, carbon, and oxygen are examples of such substances. You also find that many of the substances that you have left after breaking down quite different complex substances are the same. For instance, you can get carbon by breaking down almost all animal and vegetable substances, and from many minerals,

such as chalk, as well. In the same way you can get oxygen by breaking down all the substances produced by things burning.

The substances you finally get by breaking down complex substances, but which you cannot break up any further, are called chemical "elements." The number of these is immensely smaller than the number of chemical compounds which they can form, just as the number of letters of the alphabet is immensely smaller than the number of words they can spell. There are about ninety elements in all. Many of them have no important practical uses, and you are not likely even to have heard of their names. We should only find thirty or forty different kinds in everyday things. Of these there are some, such as sodium and calcium, which you are not likely ever to have seen in the pure state, because they are very difficult to separate from their compounds, and can only be preserved where the air can't get at them.

The elements fall into two main groups which have very different physical and chemical properties. The first group includes all metals, the second includes all other elements. The metals can be recognised by their bright shiny look. They are also good conductors of electricity.

Here is a list of the elements you are likely to know something about, with short notes about them. After the elements are written the letters which chemists use as a "symbol" for them when they are writing "formulae" of compounds, such as H_2O for water. About these we shall talk later on. With some elements the symbol is made with letters taken from the old Latin name for the element. Where this is done I have put the Latin name in brackets.

METALS

Aluminium (Al).—A metal which you all know, as it is used to make all sorts of everyday things, such as frying-pans and kettles. It is also used to make the "silver" paper that chocolates are wrapped up in. Ordinary mud

contains aluminium combined with oxygen and silicon. Rubies and sapphires are crystals of oxide of aluminium. Compounds of aluminium are very important in dyeing, as they make colours stick to cloth so that they don't run when the cloth is washed.

Arsenic (As).—The most important thing about this metal is that all its compounds are very poisonous indeed. Only a few specks are enough to kill you. Some arsenic compounds are brightly coloured and were once used to make paint. But they are so dangerous that they aren't used for that any longer.

Calcium (Ca).—This metal is difficult to get in the uncombined state. If you expose it to air it combines very quickly with oxygen to form lime. Its compounds are very common. The commonest are chalk and limestone. It is also an ingredient of our bones.

Chromium (Cr).—A very white shiny metal which does not tarnish easily. It is mixed with iron to make rustless steel. It is also used for plating iron and other metals to prevent them corroding in the air. The shiny parts of motor-cars are usually plated with chromium. Most of the compounds of chromium are very brightly coloured. That is why the metal is called chromium, after a Greek word meaning coloured. The best-known compound of chromium is chrome yellow, which is used to make paint.

Copper (Cuprum) (Cu).—A reddish metal used in very great quantities for making wires to conduct electricity. It is also used to make coins and brass. Most compounds of copper have a bright blue colour. In North Wales there is a lake which looks quite blue because its water contains a little copper. Compounds of copper are used for killing blight on fruit-trees.

Gold (Aurum) (Au).—A pretty yellow metal which does not tarnish in air. Nowadays its only important practical use is for stopping teeth. All the same, men have always wanted it so much as to be ready to kill one another to get possession of it. They have also thought of heaven as a place where the streets are paved with this metal. Even to-day armies of men are engaged digging it out of the earth

wherever it is found, carrying it across the sea to large cities where they bury it again underground in places called banks. Hugh Gaitskell will tell you more about it.

Iron (Ferrum) (Fe).—This element makes up a larger part of the universe than any other. The whole of the core of the earth is almost pure iron, so are shooting stars. It is also common on the surface of the earth. It is the most practically important of all metals. It is used to make machines of every kind, also such things as railway lines, furnaces, and so on. An electric current will make iron a magnet; and on this account it is used in almost all electrical machines and instruments. It is necessary to our bodies and forms part of the red colour of our blood.

Lead (Plumbum) (Pb).—The uncombined metal is used for making gas and water-pipes. One of its compounds is used in making the best kinds of white paint.

Magnesium (Mg).—A white metal which will burn in air to make a brilliant white light. It is used to make flashlight powder. Its compounds are very common, and are to be found in most tap-water. Epsom salts and magnesia are compounds of it.

Mercury (Hydrargyrum) (Hg).—A fascinating metal which is ordinarily a liquid, and which is bright like silver. For this reason it is also called quicksilver. It is used in thermometers and barometers. It is also used to make looking-glasses. One of its compounds with chlorine—calomel—is used in medicine.

Nickel (Ni).—A slightly yellowish white metal resembling iron. It is used for plating other metals to protect them from the air. It is rapidly being replaced by chromium for this purpose.

Potassium (Kalium) (K).—A metal very difficult to get in the uncombined state. The metal itself combines very rapidly with oxygen when it is exposed to the air. Its compounds are present in the soil and are used by plants. When any vegetable substance, such as wood, is burnt the potassium is left behind as "potash" in the ash. Compounds of potassium are used in medicine, in photography, and in making some kinds of soap.

Radium (Ra).—A very rare metal. It has important uses in curing certain diseases. It has also helped us a great deal in understanding what things are made of. We shall talk of this presently.

Silver (Argentum) (Ag).—A brilliantly white shiny metal, used for making ornaments and coins. It also forms an essential ingredient of photographic films.

Sodium (Natrium) (Na).—A metal difficult to get in the uncombined state. Its most familiar compounds are ordinary salt, washing soda and soap. Its compounds give a yellow colour when dropped into a blue gas flame.

Tin (Stannum) (Sn).—A white metal which melts very easily. It is used to make "tins." These are really made of iron, but have a coating of tin to protect the iron from the air. It is also used to make solder.

Tungsten (W).—A metal which does not melt even when it is white hot. It is used to make the filaments of electric lamps and wireless valves. It is also used in making the very hardest kinds of steel. The symbol for the element (W) is derived not from the Latin, but from the name of the mineral wolfram from which tungsten is obtained.

Zinc (Zn).—A metal also used to galvanise iron and so to protect it from rusting. It is used to make the containers of dry batteries used in wireless. Compounds of zinc are used to make ointments, also to make some kinds of paint.

NON-METALS

Argon (A).—A gas which exists uncombined in the air, of which it makes up one part in a hundred. It is used to fill some kinds of electric-lamp bulbs.

Boron (B).—The uncombined element you are not likely to have seen. It forms brownish crystals which are very hard and very difficult to melt. One of its compounds, borax, is used as a preservative, as a disinfectant, and also in boracic ointment.

Bromine (Br).—The uncombined element is a dark red liquid with a choky smell; it passes into a brown vapour

very easily. Compounds of bromine are used in photography and in medicine. The compound of bromine with silver is the substance which forms the sensitive part of a photographic film.

Carbon (C).—A very important element. It exists in the uncombined state as diamonds; also as graphite, or "blacklead," which is used to make the core of pencils. Coal, coke, and charcoal contain a large proportion of uncombined carbon. It is the element which forms the basis of all the compounds of which living things are made. It is capable of making an immense number of compounds with other elements.

Chlorine (Cl).—The uncombined element is a yellowish gas with a very choky smell rather like bromine. It is used for bleaching and as a disinfectant. If you breathe much of it you die in a most horrible and painful way. Soldiers use it for killing people with. Compounds of chlorine are fairly common. The most common of them is ordinary salt.

Fluorine (F).—A gas rather like chlorine, but which has a much paler yellow colour. It combines very quickly with almost all substances, and so is very difficult to get in the uncombined state. Its compound with calcium forms clear crystals which are used in making lenses for the ultra-microscope John Baker told you about. Its compound with hydrogen eats into glass and so is used for etching words or patterns on it.

Helium (He).—A gas making up about four parts in a million of the air. It is a very light gas, and will not burn; so it has been used for filling airships. It is given off by radium.

Hydrogen (H).—Another very light gas, present in the gas you get from the gas-company. It is very inflammable, and so is dangerous to use in airships. The most familiar compound of hydrogen is water. It also forms a part of all living things.

Iodine (I).—The uncombined element forms blackish shiny crystals. These when warmed make a violet vapour. A solution of iodine is used to disinfect cuts and bruises. In the combined state it exists in the sea and in many

kinds of seaweed. A small quantity of iodine is necessary to the healthy growth of our bodies (see p. 235).

Nitrogen (N).—A gas making up about four-fifths of the air. Its compounds are necessary to the growth of all plants, and form a necessary part of our food.

Oxygen (O).—A gas making up about one-fifth of the air. It is the part of the air we use in breathing, and that all substances use up in burning. Its compounds make up a large part of the earth's crust.

Phosphorus (P).—This exists in the uncombined state in two forms : one a white waxy solid which glows in the dark when exposed to air ; the other a brownish red solid used to make the striking surface of match-boxes. Phosphorus is necessary to all living things. Our bones contain a considerable proportion of phosphorus.

Silicon (Si).—An element whose compounds make up a very large part of the earth's crust. One of its best-known compounds is ordinary sand. It is a necessary ingredient of glass. Its compound with carbon is called carborundum. This is very hard, and is used for sharpening tools.

Sulphur (S).—A yellow element which burns to form a gas with a choky smell. Also called brimstone ; and, in the past, boys and girls were often told that if they did not do exactly what grown-ups wanted, they would be burned for ever in a kind of lake of burning brimstone called Hell. One of the most important compounds of sulphur is sulphuric acid, used in wireless accumulators.

COMPOUNDS AND MIXTURES

Chemists, besides reducing all substances to their elements, have several even more important jobs to do as well. They have also to discover how the elements are combined in the existing chemical compounds ; then how elements can be combined to form new compounds ; and what the properties of these new compounds when made will be. But, before we can start discussing chemical compounds and their formation, it is important that we should

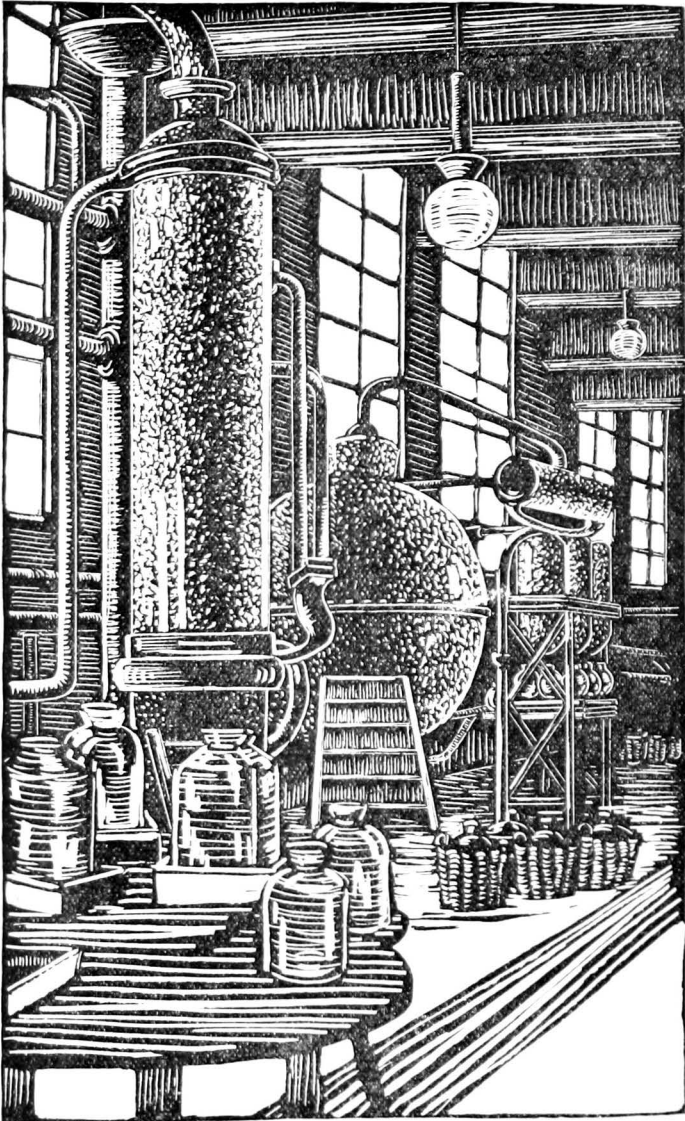


Fig. 49. INSIDE A CHEMICAL WORKS

be quite clear about the difference between chemical compounds and mere mixtures.

The substances produced during chemical combination are, as a rule, quite different from the substances from which they are formed. Rust, for example, has properties which are quite different from those either of iron or of oxygen; its properties give you no clue to what it is made of. The same is true of water, which, as we have seen, is formed by the combination of hydrogen and oxygen. Just by looking at it you could never have guessed that it was a compound of two gases.

But, when substances that do not combine are mixed, the properties of the original substance can always be recognised in the mixture. This is equally true whether you mix two powders (such as pepper and salt) in which the grains of the two substances can be picked out afterwards with a magnifying glass, or whether you mix two liquids (such as two brands of petrol), or two gases (such as oxygen and nitrogen) in which the mixing is much more complete. In all such mixtures you can recognise the properties of the original constituents.

But it is often possible to make mixtures of substances that can combine, without the combination actually taking place. If you mix oxygen and hydrogen together, nothing happens at all. But, if you heat the mixture or send an electric spark through it, combination takes place so violently as to make an explosion: this will burst the container unless it is very strong. As a result of the combination water (or rather steam) is produced.

Petrol vapour mixed with air explodes in the same way when a spark is made in the mixture. It is this explosion, started by the spark of a magneto, that forces down the piston of petrol "internal combustion" engines such as are used in motor-cars and aeroplanes; this provides their power.

So, too, you can mix the ingredients of gunpowder without their combining. But, if the gunpowder is heated, or a spark touches it, there is an explosion and a large amount of gas is produced. It is the force of the explosion that is used to drive shot from a gun.

During a chemical change there is almost always a liberation of energy in the form of heat, and this is one of the best ways of recognising a chemical change. But the liberation of energy is not always easy to observe. When iron rusts, for example, the liberation of energy is so slow that you don't notice the iron getting any hotter.

But it isn't always easy to tell the difference between a compound and a mixture. Think what happens when you put sugar into water. It disappears into the water and makes a sweet liquid. If you let this dry up, you get the sugar back again. You might think this was a mixture, but actually it isn't. Sugar dissolves in water because it forms a loose kind of compound with it. Candle-grease does not form even a loose compound with water, and so does not dissolve in it.

Gases, too, form loose compounds with liquids. The commonest example of this is ordinary soda-water. This consists of water with carbon dioxide dissolved in it. It is this that you see bubbling off when the soda-water comes out of its syphon. Oxygen does not form any such compound with water as easily, and so dissolves much less in it. But it does dissolve to a small extent, otherwise fishes would not be able to live in water, for they need oxygen just as we do ourselves.

You can see that solutions are really a kind of chemical combination from the fact that heat is often liberated as they are formed. If you mix methylated spirit with water, for example, you feel the liquid get quite warm. If you mix sulphuric acid with water, the liquid gets much hotter—so hot that you cannot hold the dish in which you are mixing them. Heat is also liberated when you dissolve sugar in water, but the amount is so small that you don't notice it.

When chemists talk of chemical compounds, they do not as a rule include these loose kinds of compounds that are formed when things dissolve. They almost always only mean compounds (such as rust or water) whose properties are quite different from the substances from which they are formed, which can be obtained pure and which are found to have a definite composition.

The solution you make when you dissolve sugar in water can have any composition you like, depending on the amount of sugar you dissolve in the water. The loose compound that is formed cannot be separated from the water either by filtering or in any other way. But when the two gases, oxygen and hydrogen, combine, the water that is formed is obtained pure and has a perfectly definite composition.

If we mix oxygen and hydrogen in the right proportion, and then make a spark in the mixture, they explode together; both are completely used up in forming the water, which is all that is left behind. But, if there is a little too much oxygen or a little too much hydrogen in the mixture, then that little bit too much *is left behind unaltered*. This shows that the proportions in which oxygen and hydrogen combine to form water are perfectly definite.

Again, if you burn a piece of magnesium ribbon in a stream of air in a tube, so that you can collect all the white powdery magnesium oxide that is formed, you find that its weight is always a perfectly definite fraction heavier than the magnesium you started with. However many times you repeat the experiment, you find the fraction is always the same, never more and never less. This shows that the new white substance, magnesium oxide, always contains exactly the same proportions of magnesium and oxygen.

If you heat copper in a stream of air, an oxide is again formed, but this is black instead of being white. The fraction by which the copper increases in weight is different from what it is with magnesium, but it is always equally definite and never varies. You get the same result whenever you make chemical compounds; this shows that their composition is always perfectly definite.

You also find the proportions are definite when you break up a compound. If you heat chalk, for example, and turn it into lime, you find that the loss of weight is always the same fraction of the original weight of the chalk. However many compounds you may split up, and however often you do each experiment, this will always be

true. This fact about chemical combination is called the "law of constant proportions." Of course, substances don't really "obey" laws, though people used to think they did. To be "obedient," substances would have to be a kind of people, which clearly they are not (see p. 23). All that the law means is that all definite chemical compounds are made up of definite proportions of their ingredients.

And there is another important "law" of chemical combination that you ought to know about; this is called the "law of multiple proportions." Some elements are able to combine to make two, and sometimes more than two, quite different compounds. But in each of these the proportions of the two elements is again quite definite.

Perhaps the example of what happens when mercury and iodine combine will make it clear. If you grind up together in a mortar some mercury and a very small quantity of iodine, you will find that a dark green powder is made. This is a compound of the two elements. Now if you pour away the mercury that is left over, add some more iodine to the green powder, and grind it up again, the green powder changes into a bright scarlet powder. This is because a further new compound has been formed containing a greater proportion of iodine. The green powder, which has the smaller proportion of iodine, is called mercurous iodide; the scarlet powder, which has the greater proportion of iodine, is called mercuric iodide. If we were to analyse these compounds separately, we should find that the proportion of iodine in the scarlet compound was exactly twice that in the green compound.

ATOMS

Now, this is very puzzling. It was surprising enough to find that chemical compounds contained elements in fixed and definite proportions. But it is still more surprising to find that elements can combine in several different proportions, all quite regular and definite. This odd regularity and exactness suggests that perhaps these "laws of chemical

combination" are a clue to something very important about how all substances are made up.

There is only one way we can explain this regularity. We must believe that every element consists of tiny units, and that chemical combination between two elements happens through the units of one element pairing off with one or more units of another element. These units we call atoms. In the scarlet compound of mercury and iodine, twice as many iodine atoms are combined with each mercury atom as in the green compound. From other experiments, about which we must talk presently, we can tell that the green compound of mercury and iodine is formed by the combination of equal numbers of atoms of the two elements. The scarlet compound is formed by the combination of mercury atoms with twice as many iodine atoms.

But you must not think that, because a compound is made of equal *numbers* of atoms of different elements, it also contains equal *weights* of these elements. This would be so only if the atoms of the two different elements weighed the same. But they don't; and we can even measure how much heavier the atoms of one element are than those of another, by finding out the proportions in which they combine.

Consider the mercury and iodine experiment. The green mercurous iodide is formed by mercury and iodine combining in the proportion of 1.575 to 1 by weight. This shows that each mercury atom must be 1.575 times as heavy as each iodine atom. If we examine the composition of a compound called hydrogen iodide which is made up of an equal number of iodine and hydrogen atoms, we find that the combining proportions are 127 to 1. This shows that iodine atoms weigh 127 times as much as hydrogen atoms. Knowing this, we can calculate that mercury atoms weigh 200 times as much as hydrogen atoms.

By studying the composition of compounds formed by a large number of different elements, we can discover the relative weights of their atoms. When we do this we find that the atoms of hydrogen are lighter than the atoms of any other element. So it is convenient to take their weight

as standard and call it 1. The weight of the atoms of any other element compared with hydrogen is called the "atomic weight" of the element.

The atomic weights of different elements range from 1 for hydrogen itself to 236.7 for uranium, the element whose atoms are heavier than those of any other element. The atomic weights of other elements lie between these extremes. The atomic weight of oxygen, for example, works out to be 15.87.

DO ATOMS REALLY EXIST?

We touch and see all sorts of substances every day, and all the time; but there is nothing about the look of them which would make us suspect that they were made up of atoms. You might, of course, argue that since all substances—and especially gases—can be compressed into a smaller volume than they ordinarily have, then they must be made of particles separated by empty space. But this is not very convincing. We can't see atoms either, and never shall be able to. This is because light, though you would not think it, is made up of waves. These waves in some ways resemble the waves that form on the sea, but instead of being several yards long from crest to crest they are so short that it takes about a million of them to make up an inch. Ordinarily you think of light going in straight lines, but actually it bends round corners a little just like sea waves do. This has the effect of giving everything you look at a tiny blur at the edge. But the blur is so narrow that you can never ordinarily see it. If you make a microscope to see extremely small things you find that you begin to see the blur. But, long before you get to the point where you would be able to see atoms the things you look at are entirely lost in the blur. It is this that makes it impossible ever to see atoms. Even if they were a million times bigger it would still be impossible to see them even with the most powerful microscope that has been made (see p. 181).

You may feel, after that, that we don't know much about them, and that unless you can have better evidence you aren't going to believe that there *are* such things as atoms.

But there *is* a way of getting a definite proof of them, and a way of measuring them too. But to explain that I shall have to say something first about crystals and then about X-rays.

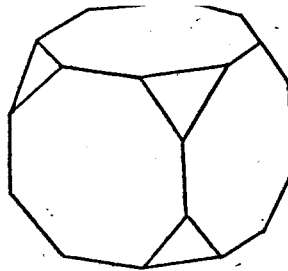
All of you will have seen crystals and will have been struck by the regular shapes they form. Crystals of many substances can be made by dissolving those substances in water and then letting the water dry up slowly. Perhaps you have made sugar or salt crystals for yourselves. The important thing about crystals is that they make quite definite shapes, which are different for different substances. You can, in fact, recognise substances from the shapes of their crystals. The shapes of a few common crystals are shown in Fig. 50.

Now the regular shapes that crystals make suggests that there is some kind of orderly arrangement inside. You can find out about this with X-rays.

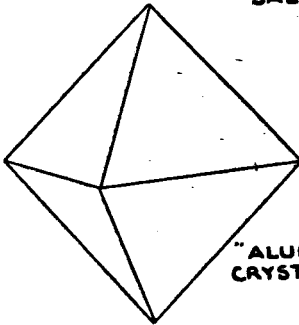
Most of you will have heard of X-rays, and will know that they are able to pass right through substances that won't let ordinary light through at all. These rays are produced in glass tubes that work on the same principle as wireless valves.

You cannot actually see X-rays, as they do not affect your eyes. But, when they strike certain kinds of crystals, they make them light up with a greenish glow. So, if you cover a sheet of cardboard with a thin layer of these crystals, you get a "screen" which makes X-rays visible. If you put your hand between the screen and a tube that is making X-rays, you see a shadow of your hand in which the bones show very much darker than your flesh. This is because the X-rays pass much more easily through your flesh than through your bones. X-rays will also affect a photographic plate; and so, if you use a plate instead of a screen, you can get a photograph of your hand showing the bones.

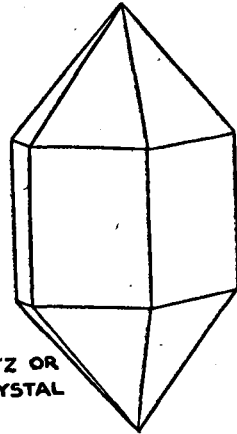
Now a very surprising thing about X-rays is that if you make a beam of them pass through two fine holes in line with one another, so as to make the beam very thin, and then put any kind of crystal in the way of the beam, the X-rays are scattered to make a pattern of which you can take a photograph, by putting a photographic plate behind



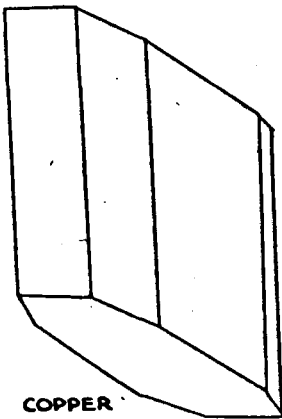
SALT CRYSTAL



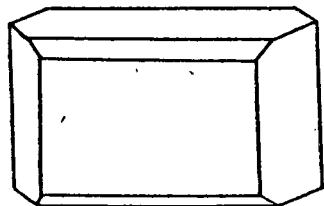
"ALUM"
CRYSTAL



QUARTZ OR
ROCK CRYSTAL



COPPER
SULPHATE CRYSTAL



CANE SUGAR CRYSTAL

Fig. 50. THE CRYSTAL SHAPES OF SOME WELL-KNOWN SUBSTANCES

the crystal. The kind of pattern you get depends upon the kind of crystal you use. With a crystal of ordinary salt the pattern you get is something like you see in Fig. 51.

You get a pattern of much the same kind when you look at a bright point of light, such as a distant street lamp,

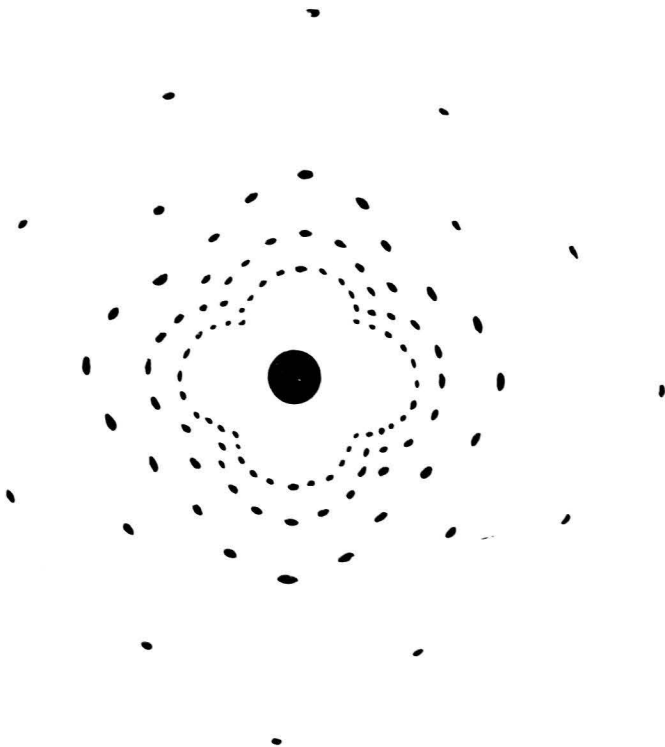


Fig. 51. This shows you the kind of pattern you get when you let a beam of X-rays pass through a cubic crystal, and then put a photographic plate in the way. Patterns like this are usually called Laue patterns after the name of the man who first discovered them.

through a finely woven fabric, such as a silk umbrella. Here the pattern looks something like you see in Fig. 52.

These patterns are produced because both light and X-rays are made up of waves. The difference between the two kinds of waves is that X-ray waves are about 10,000 times shorter than light waves; that is to say, it takes about ten thousand million of them to make up an inch.

From the pattern you see when you look through a silk umbrella you could tell that the silk fabric was made up of strands running across one another. You could also tell what was the distance between the strands. All this would be possible without your examining the fabric of the umbrella at all.

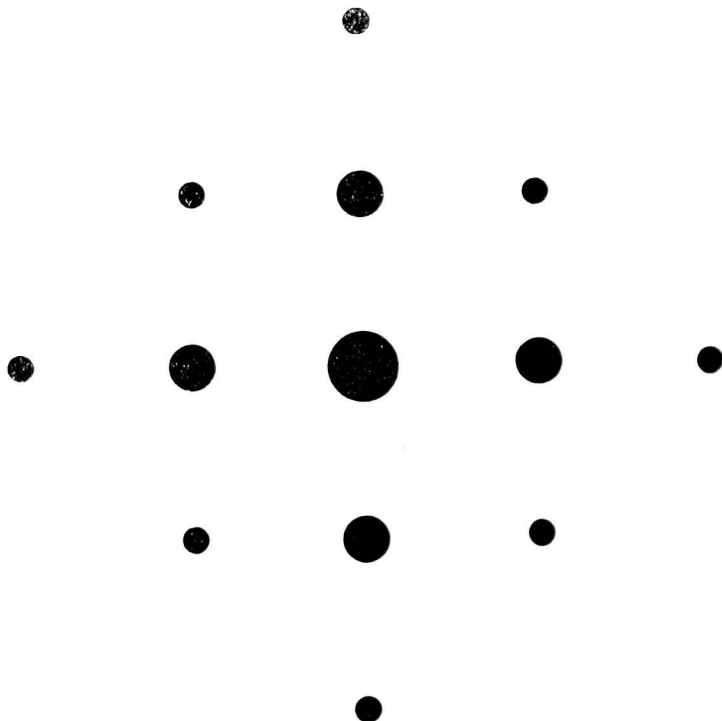


Fig. 52. This is the kind of pattern you get when you look at a bright point of light through a silk umbrella. You should try it for yourself.

X-rays do not make a pattern as they pass through the fabric of an umbrella, because the waves making them up are much too short. But they do make a pattern when they shine through crystals. This shows that crystals are made up of a kind of fabric; but a fabric in which the "strands" are very much closer together than the strands of silk in an umbrella.

You can tell from these X-ray patterns that the atoms in a crystal are all lined up in regular rows to make up the

kind of arrangement you see in Fig. 53. This is rather like what you would get if you packed marbles into a box so as to get the largest possible number into it. The rows of atoms in the crystal play the same part in producing the X-ray pattern as the strands of the silk umbrella play in making the light pattern.

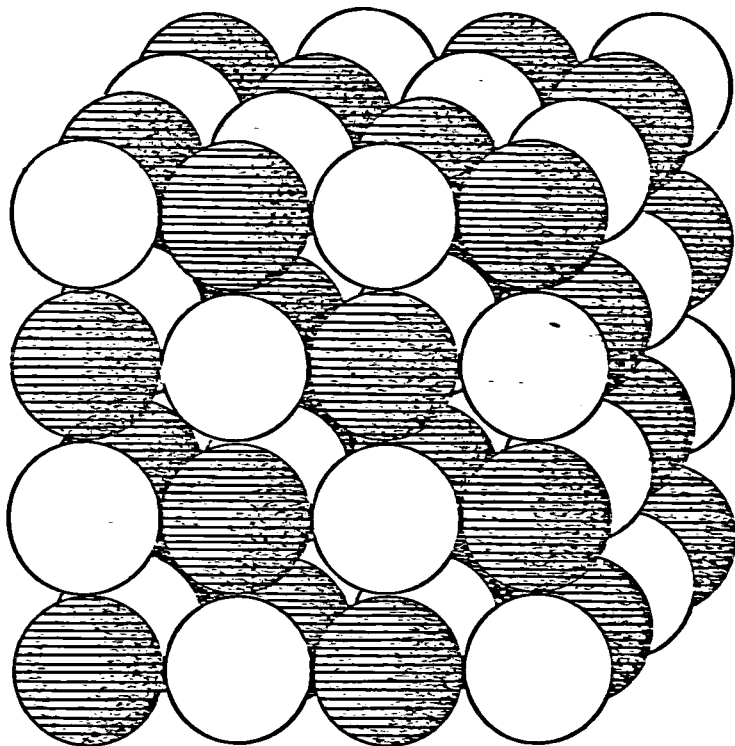


Fig. 53. This picture is to give you an idea of the arrangement of the atoms in a crystal of ordinary salt (sodium chloride). If you take the white balls to represent chlorine atoms the shaded balls represent sodium atoms. But you can equally well assume the other way. You mustn't assume from this picture that the atoms are really like round balls touching one another: we shall talk about that later. The important thing this picture is meant to show you is the *arrangement* of the atoms in regular rows in the crystal.

It is also possible to tell from the X-ray patterns how far apart the atoms making up the "strands" of a crystal are. But as soon as you know this you can easily work out the total number of atoms in any piece of crystal, and how

much room each of the atoms takes up. If in addition you know the weight of the crystal, you can tell how much these atoms weigh all together. From this you can work out the weight of each separate atom.

The answer you get shows that atoms are astonishingly small. It would take over 100,000,000 atoms of carbon, packed closely together side by side, to cover an inch. To make up an ounce of carbon it would take about 1,400,000,000,000,000,000,000 atoms. Hydrogen atoms are only one-twelfth of the weight of carbon atoms. It therefore takes twelve times as many to make up an ounce. Knowing this, you can also work out how many atoms there are in your own body. Your body is chiefly composed of the atoms of the elements hydrogen, oxygen, carbon, calcium, phosphorus, and nitrogen. The average weight of the atoms making you up is about nine times as much as hydrogen atoms. Suppose you weigh seven stone. This is 98 pounds, or 1,568 ounces. The number of atoms you contain is therefore about 2,900,000,000,000,000,000,000,000 !

Ordinarily we only think of things as being made up of crystals when we can see the crystal shapes. But X-rays show us that in almost everything solid, including things like metals or wood or cotton, or even soot, the atoms are arranged to make regular patterns. This means that everything solid is really made up of crystals, although the crystals are often very tiny and jumbled up with one another. In metals you can sometimes actually *see* the crystals. The pattern you see on galvanised iron for example is made by the zinc crystals on the surface of the iron. In Fig. 54 you see a drawing of the pattern that is made by the formation of crystals in iron itself. But in substances like wood or cotton you can never see the crystals, and if it weren't for the X-ray patterns they make you would never know they were there.

WHAT ARE ATOMS MADE OF?

Now that we know something of the size of atoms we may next want to ask how it is that atoms combine together



Fig. 54. This is a highly magnified picture (approximately 3000 times) of the surface of an ingot of iron. The pattern is made by the crystals of iron that formed within the ingot as it solidified. The crystals are very small and are all jumbled up with one another.

to form compounds. But, before we can say how they do this, we must know more about atoms themselves.

If atoms were just like grains of sand, we could hardly account for chemical compounds being so very different from their ingredients. Nor could we even explain why atoms hold together to make up a solid substance. Perhaps it has never struck you as surprising that, when you pick up one end of the poker, the other end comes up too? But this shows that there must be something about atoms which makes them hold together very firmly to form solid substances.

We have said chemical elements cannot be broken up into simpler substances by any of the methods the chemist uses to break up compounds. In other words, elements are substances composed entirely of one kind of atom. But this does not mean that the atoms themselves have not got parts. It only shows that the parts are held together very firmly indeed, and cannot be separated, like the atoms making up a chemical compound, by chemical methods such as heating or the action of other chemical substances. Now, there are several things which seem to suggest that atoms have a very definite structure.

FAMILIES OF ELEMENTS

If you study their properties, you find that some of the chemical elements resemble one another very closely. This makes it possible to arrange them in families. One family in which the family likeness is very great consists of the elements fluorine, chlorine, bromine, and iodine. All these elements are either gases or else are very easily changed into gases by warming. They all combine very readily with metals to give compounds, and these also resemble one another very closely. The compound of chlorine and sodium with which you are all familiar is common salt; it exists in enormous quantities in the sea. Elements belonging to this family, because they combine with sodium and other metals to give compounds resembling common salt, are called the "halogens," from a

Greek word meaning salt. Another interesting thing about these elements is that, if you arrange them in order of their atomic weight, you notice a gradual change in their properties as you pass from one to the next. Fluorine is a very slightly yellow-coloured gas, which it is difficult to liquefy by cooling; chlorine is a more deeply yellow gas, easily liquefied; bromine is a deep red liquid; and iodine is a violet solid.

Another important family of elements is known as the "alkali" metals. This family is composed of the elements lithium, sodium, potassium, rubidium, and caesium. The last two are rare, and you may not have heard of them before, though caesium has recently become important as it is sensitive to light and is used to reproduce the sound of talkies from the sound track on the film. All these elements are metals; they are very soft, and can be cut with a knife more easily than lead; and they all melt very easily. They must be kept away from air as much as possible, because they combine with oxygen like iron does, only much more quickly. Arranged in order of their atomic weight they too show a gradual change of properties. For example, the melting-point of each is lower than the one that comes before it.

Another very striking family of elements is the one composed of helium, neon, argon, krypton, xenon, and radon. These elements differ from all others in that they are quite incapable of forming any chemical compounds at all. They all exist in small quantities in the air and are known as the "inert gases." Without knowing it, you have been breathing them all your life. Helium is used in the electric advertisement signs which spell out words in a bright pink glow. The signs which make a bright red glow contain neon. Argon is used to fill some kinds of electric lamps. Krypton and xenon are both very rare, and exist only in minute quantities in the air. Radon is much rarer still.

All other elements belong to families, but the family likeness is not so striking as it is in these families.

The elements belonging to any family, in spite of their resemblance, cannot be changed into one another. All the

same, the family likeness makes us suspect that the atoms of every member of a family must be built up in something like the same way.

RADIUM

But we get definite proof that atoms are made up of parts by studying radium. Radium is a rare element which belongs to the same family as magnesium and calcium; it forms compounds resembling those of both these elements. But, in addition to its ordinary chemical properties, it has other properties which are very surprising.

If you seal up some radium, or a compound of radium, in a glass bulb, you find that two quite different elements, helium and radon, are slowly but steadily produced. You might perhaps think that this was just another example of ordinary chemical decomposition. But it differs from chemical decomposition in several outstanding ways. First, these two gases are given off, whatever compound of radium you start with. Second, the two gases are given off at a perfectly steady rate which nothing affects. Third, the change cannot be made to act the other way round—to form radium once again. Fourth, there is a release of energy which is millions of times greater than with any ordinary chemical change; this release of energy is so great that radium keeps itself perpetually a little hotter than its surroundings.

All this shows that the change which radium undergoes is very different from an ordinary chemical decomposition of a compound into the elements making it up. It is called a radio-active change, and is due to its atoms actually breaking up of themselves to form two other kinds of atom.

If you bring some radium near to some crystals of zinc sulphide, or to a diamond, the crystals light up. You can see this happening for yourselves if you look at the hands of a luminous watch. These are made luminous with paint that contains zinc sulphide mixed with a minute quantity of radium. If you look carefully through a magnifying glass, you see that the light of the hands is made up of

minute flashes which look rather like a shower of shooting stars. This shows that the light of the crystal is due to a kind of bombardment of the crystal by particles shot off from the radium. The particles which do the bombarding are called alpha particles. Each radium atom, as it breaks up, shoots off one of these particles rather like a bullet from a gun, but with far greater speed—several thousand miles a second. (The fastest bullets do not travel more than about one mile a second.) It is these particles which become ordinary helium gas when they have been brought to rest by the surrounding matter. The radium atoms, when they have shot off an alpha particle, become radon atoms.

The path of alpha particles through the air surrounding some radium can actually be photographed. To do this the air must be made so damp that a mist is just about to form in it. Under these conditions the atoms of the air that a passing alpha particle has bumped against act as centres upon which the first mist-droplets form. The result is that you get rows of mist-droplets formed along the paths taken by the alpha particles. These show up as definite tracks, and can be photographed by the light of a powerful electric spark. The photographs usually show a number of almost straight lines spreading out from the radium into the surrounding air.

WHAT IS INSIDE?

Alpha particles are a very great help in finding out how atoms are made, because they enable you to probe inside the atoms rather like you might probe into a Christmas pudding with a knitting-needle to see if there were any threepenny-pieces inside.

From an X-ray examination of crystals, you have seen how much space atoms take up. If you assume that atoms are like hard balls or grains of sand, it is easy to work out how far you should expect an alpha particle to be able to penetrate into a piece of solid matter, or into a gas, before it was either deflected or stopped altogether. But the

cloud track experiment shows that alpha particles travel in straight lines for distances thousands of times greater than you would expect. This shows two things: first, that alpha particles must be very small indeed—very much smaller than atoms themselves; and, second, that they can pass right through hundreds of thousands of atoms without being turned out of their path at all.

This is a very surprising result. It shows that atoms are really very hollow things—not at all what you would expect according to your ordinary ideas about the solidness of matter.

THE NUCLEUS

But alpha particles tell you something still more important about atoms. Very occasionally the track made by an alpha particle suddenly bends at a very sharp angle and seems to fork into two, as you see in Fig. 55.

This shows that somewhere inside atoms there must be something very heavy, but also very small, which is able to knock an occasional alpha particle right out of its path. When this something is hit by an alpha particle, it recoils and sets off to make a separate track of its own; just as a stationary billiard-ball sets off on a track of its own when is it hit by a moving billiard-ball. This is why the original track forks in two.

The heavy part of an atom which acts as an obstacle to alpha particles is called its "nucleus." By studying the collisions of alpha particles with the nuclei of atoms, you are able to form some idea of how big and how heavy they are. The result is surprising and shows that the nucleus of any atom is hundreds of thousands of times smaller than the atom itself. And yet, in spite of the extreme smallness of the nucleus, almost the whole of the weight of any atom is concentrated in it. The alpha particles shot off by radium come from the nucleus of its atoms. The alpha particles themselves are helium nuclei and become atoms of ordinary helium gas when they have lost their immense speed.

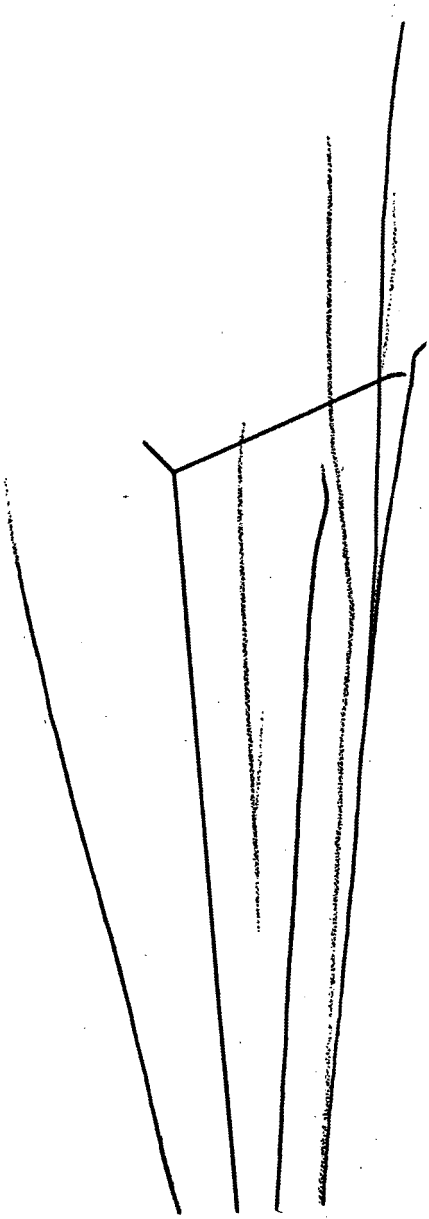


Fig. 55. This is a magnified drawing of the cloud tracks you see formed when alpha particles pass through air overladen with moisture. The sharp forking of one of the tracks is due to the collision between an alpha particle and the nucleus of an atom of the gas.

The nuclei of atoms are so small that, if you could pack together the nuclei of all the atoms making up your own body, you would find that they would scarcely fill a thimble. But, all the same, this thimbleful would weigh the whole seven stone or whatever it is you weigh now.

And this leads us on to the next question. What fills the rest of the space that atoms ordinarily take up?

ELECTRONS

You get a clue to this in something you must often have noticed. When you comb your hair, it sometimes crackles, and, if you brush it, it makes flashes which you can see in the dark. It stands on end, too, and is attracted by the comb; as you move the comb about, your hair seems to follow it. When you see this, you say that your hair is electrified, or charged with electricity. What really has happened is that the comb has carried off something belonging to the atoms of your hair. This something, when separated from your hair, attracts it very strongly.

You can find out something very important about this if, instead of electrifying your hair, you electrify minute oil-droplets, and see how they are attracted by an electrified substance. You can make the oil-droplets and electrify them all in one by forcing oil under pressure through a very fine nozzle, like a scent spray. The oil-droplets that are formed become electrified as they pass through the nozzle. If the nozzle is the right shape, the droplets that are formed are so small that they remain suspended in the air like dust. You next pass the air containing them into a closed box, which protects them from draughts. In the roof of the box you have an electrically charged plate. This attracts the electrically charged droplets and, not only prevents their settling, but actually makes them move upwards in the box. You can watch them doing this if you look at them with a microscope through a hole in the side of the box. From the speed at which they move, you can tell how much of the something that makes things electrified each droplet carries,

just as you could . . . much hydrogen a balloon had in it from the speed at . . . which it rose in the air.

The result of this experiment, again, is surprising. It shows that no oil-droplet ever carries less than a certain minimum amount of this something; but that those oil-droplets which have more than this minimum amount of it always have exactly two or three, or another whole number, of times as much.

This shows that the something that substances pick up or lose when they are electrified, and which makes them attract one another, is made up of units which cannot be divided. The smallest charge which it is possible for an oil-drop to carry is equal to one of these units.

These units are called "electrons." They form part of all atoms, and it is quite impossible to discover any difference between any two electrons, whatever kind of atom they come from. When they are detached from atoms, they seem to exist as minute particles. These are of about the same size as atomic nuclei, but weigh only about a two-thousandth as much as the lightest nuclei—those of hydrogen. As they have size and weight, we must look upon electrons as a kind of material substance.

The force which appears between a comb and your hair is due to electrons being carried off by the comb from a minute proportion of the atoms making up your hair. This force is exactly the same force as ordinarily holds electrons to the atoms to which they belong.

Actually the proportion of atoms in your hair from which electrons are carried off when you comb it is never more than one in millions of millions. If it were possible to carry off all the electrons even from a single hair, an immense force would result. If the comb could be carried off to Edinburgh while you kept the single hair in London you would still have to tie them both up with thick steel ropes to prevent them rushing together! This gives you some idea of how strong are the forces holding electrons to the nuclei of atoms.

Under ordinary conditions, the force between electrons and the nuclei of the atoms to which they belong, acts upon

such a small scale within the atom that you cannot see it at work. You can only do this when the force acts over a considerable distance, as happens when electrons are removed from a substance and it becomes electrified. Ordinarily the electric charges of the nucleus and its electrons seem to neutralise one another completely. This is because atomic nuclei and electrons have different kinds of electric charge. To remind ourselves of this the charges of the nuclei of atoms are called positive, and the charges of electrons are called negative. There is, of course, no reason why one should be called positive rather than the other. The important thing is that they are of opposite kinds and seem to neutralise one another when they are close together.

ATOMIC NUMBERS

By watching the deflection of alpha particles by the nuclei of atoms of different elements, you can measure how many units of positive charge the nuclei of each of them carries. What you find is that the charge of the nucleus is always exactly equal to a whole number of electrons, but is different for every kind of atom. This means that the number of electrons with which any nucleus surrounds itself is also different for every kind of atom. It ranges from 1 in hydrogen to 92 in uranium. For other atoms it is somewhere in between. For oxygen it is 8 ; for calcium, 20. For any atom the number representing the charge of the nucleus and the number of electrons it surrounds itself with is known as the " atomic number."

Particles of the same weight as the nuclei of hydrogen atoms (which are also called protons), but carrying *no charge at all*, are given off from the nuclei of beryllium atoms when an alpha particle collides with them. These particles are called neutrons and can be considered as an element with atomic number of zero. They most likely consist of a proton and a single electron rolled up into a single particle. As they have no charge, they hold no electrons. From what we are next going on to talk about we shall see that they

therefore have none of the properties of any other chemical element.

The atomic number of an element is even more important than its atomic weight ; for, as we shall see, the chemical properties of an element depend upon the number of electrons held by the nuclei of its atoms. The weight of the nuclei has no effect on the number of electrons.

Electrons themselves are of about the same size as the nuclei of atoms, and it is very surprising that quite a small number of them should be able to occupy the whole of the rest of the space which the atom takes up. It is particularly surprising when you remember that atoms, when they are closely packed together with others in a crystal, occupy an immensely greater volume, and behave like little marbles that can only be compressed with great difficulty.

The electrons make atoms behave like this because they race round the nucleus millions of millions of times a second, tracing out a complicated path at a varying distance from the nucleus. By patrolling the whole of the surrounding space, they occupy it in something like the same way as a policeman occupies the whole of his beat. If a policeman were given a racing motor which took him round his beat a million million times a second, there would be little chance of a burglar missing him. The electrons in neighbouring atoms repel one another. This keeps the atoms apart and gives them their apparent solidness.

In spite of their rapid motion round the nucleus, the electrons belonging to an atom cannot fly off at a tangent. This is because they are held in by the very strong electrical attraction of the nucleus, rather like the earth is held in its path round the sun by the gravitational attraction of the sun. This attraction makes it impossible to separate an electron from an atom without the atom tending to pull it back again.

But there are ways in which we can temporarily separate an electron from some of the atoms making up a substance. One of the ways is by friction between a comb and hair. We can also do it by the action of light, by the action of heat, by electric action, and in many other ways as well.

When, for example, an electric spark is passed through a gas, electrons are knocked off some of its atoms and float about independently in the gas. But they do not remain separated for very long. Even while the spark is still passing, some of them join up again with atoms which have lost an electron.

But the electrons, as they jump back into place in an atom, make a kind of vibration. This travels out as light-waves rather like the waves you make when you dive into a pool of water. It is in this way that the light of a spark, or of lightning—which is nothing but a spark on an immense scale—is produced. The light given out by a neon advertisement sign also comes from electrons jumping back into the atoms from which they have been separated by the passage of an electric current.

HOW THE ELECTRONS ARE ARRANGED

If you look at the light given out by a gas through which electricity is passing, with an instrument known as a spectroscope, you see the different colours making up the light spread out like a rainbow. But, instead of getting a continuous band of light of different colours, as you would with sunlight, you get a number of bright lines separated by darkness as you see in Fig. 56. These "spectrum" lines, as they are called, are very important; for, by studying their colour and arrangement, you get very important clues to how the electrons producing the light are arranged round the nucleus.

What you find is that the electrons do not all move with the same energy or at the same average distance. You find that they belong in groups. All the electrons belonging to any particular group have the same energy and move at the same average distance. But the electrons belonging to different groups have different energies and move at different average distances. All the electrons making up any group are said to be at the same "energy level."

The rapid motion of the electrons round the nucleus has the effect of making each group of electrons surround the

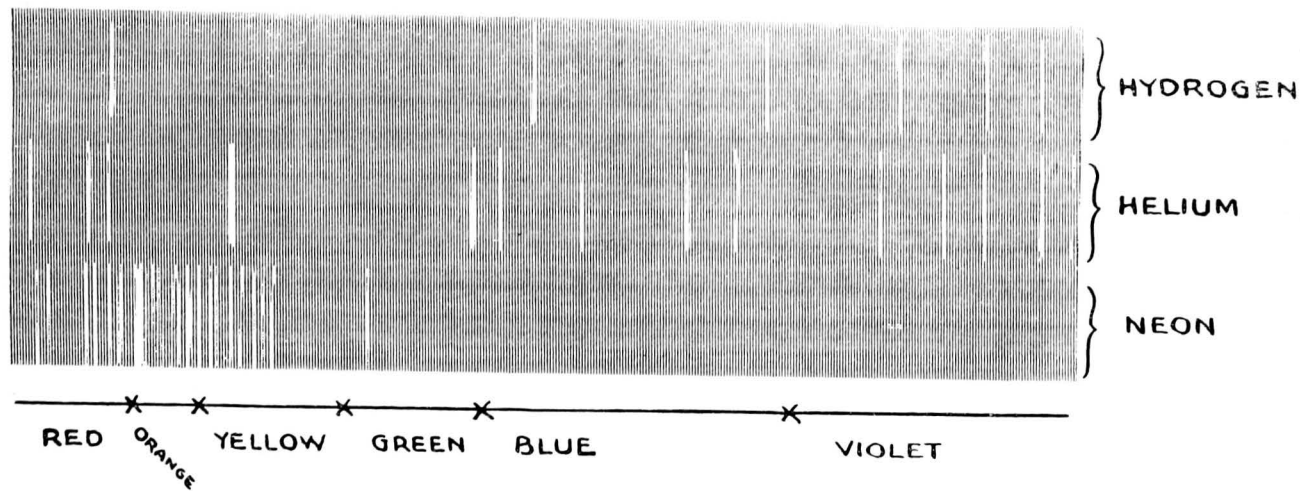


Fig. 56. This shows you the spectrum lines you get when you look through a spectroscope at the light given out by a gas in which an electric current is passing. There are three separate sets of them put together into one picture. The top spectrum lines come from hydrogen, the middle from helium and the bottom ones from neon. You can tell the colours of the lines from the scale of colours underneath ; unfortunately it isn't possible to print the lines in their proper colours. The great crowding of the neon lines in the red and orange is what gives neon lights their livid colour.

nucleus with a kind of electrical layer or shell. These shells lie one outside the other, a little like the layers of an onion. The important difference is that the shells are not sharply separated like the layers of an onion, but blur into one another. This is because the electrons vary in their distance from the nucleus as they circulate round it. The result is that the nucleus seems to be surrounded by a kind of "cloud" of electric charge with no definite outline, rather

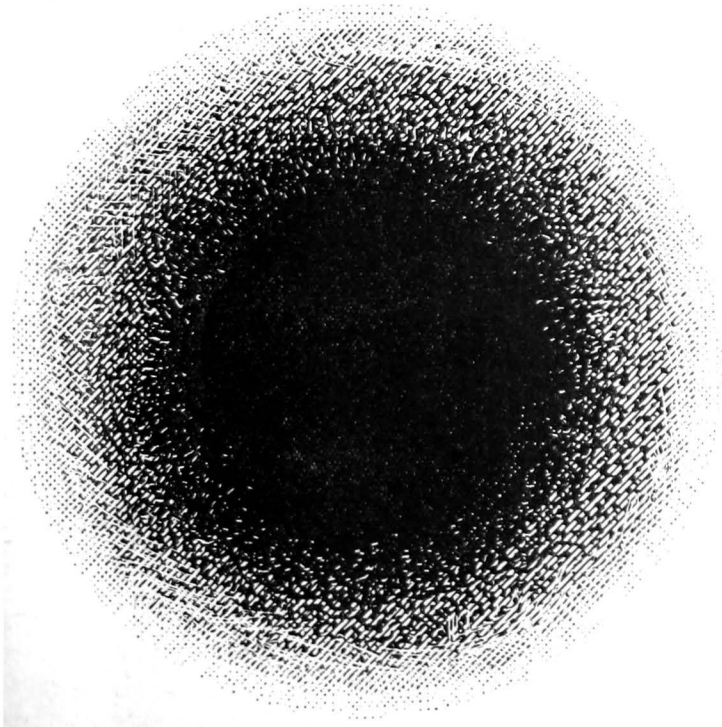


Fig. 57. This is the nearest you can get to making a picture of an atom. It represents a section of an atom in an undisturbed state. You must imagine that the nucleus is a very tiny spot at the centre and that the shading represents the charge cloud made by the motion of the electrons round the nucleus. This is thickest in the places where electrons in their motion round the nucleus are most likely to be at any given instant. To make the picture properly the cloud would have to be shown shading off quite evenly, instead of doing so in spots as you see it here. Unfortunately it isn't possible to do this with a printed block and so you must imagine it.

like you see in Fig. 57. This is the nearest we can get to making a picture of an atom.

The successive shells round a nucleus do not all contain the same number of electrons. The shell nearest the nucleus (called the K shell) never contains more than two electrons. The shell next to this (called the L shell) never contains more than eight; the next (called the M shell) never more than eighteen.

But if you study the elements in the order of their atomic number you find that M and N shells are not built up completely before another shell begins to form. As soon as an outermost shell contains eight electrons (or two in the case of helium) a new shell begins to form. This is rather difficult to follow from a description, but you will see what is meant from this table which shows the arrangement of the electrons in atoms of the elements of atomic number from one to forty. Most of these elements you already know something about, but a few of them are uncommon and their names will probably be new to you.

Element	Symbol	Nuclear Charge	K	L	M	N	O
Neutrons	?	0	—	—	—	—	—
Hydrogen	H	1	1	—	—	—	—
Helium	He	2	2	—	—	—	—
Lithium	Li	3	2	1	—	—	—
Beryllium	Be	4	2	2	—	—	—
Boron	B	5	2	3	—	—	—
Carbon	C	6	2	4	—	—	—
Nitrogen	N	7	2	5	—	—	—
Oxygen	O	8	2	6	—	—	—
Fluorine	F	9	2	7	—	—	—
Neon	Ne	10	2	8	—	—	—
Sodium	Na	11	2	8	1	—	—
Magnesium	Mg	12	2	8	2	—	—
Aluminium	Al	13	2	8	3	—	—
Silicon	Si	14	2	8	4	—	—
Phosphorus	P	15	2	8	5	—	—
Sulphur	S	16	2	8	6	—	—

Element	Symbol	Nuclear Charge	K	L	M	N	O
Chlorine	Cl	17	2	8	7	—	—
Argon	A	18	2	8	8	—	—
Potassium	K	19	2	8	8	1	—
Calcium	Ca	20	2	8	8	2	—
Scandium	Sc	21	2	8	9	2	—
Titanium	Ti	22	2	8	10	2	—
Vanadium	V	23	2	8	11	2	—
Chromium	Cr	24	2	8	13	1	—
Manganese	Mn	25	2	8	13	2	—
Iron	Fe	26	2	8	14	2	—
Cobalt	Co	27	2	8	15	2	—
Nickel	Ni	28	2	8	16	2	—
Copper	Cu	29	2	8	18	1	—
Zinc	Zn	30	2	8	18	2	—
Gallium	Ga	31	2	8	18	3	—
Germanium	Ge	32	2	8	18	4	—
Arsenic	As	33	2	8	18	5	—
Selenium	Se	34	2	8	18	6	—
Bromine	Br	35	2	8	18	7	—
Krypton	Kr	36	2	8	18	8	—
Rubidium	Rb	37	2	8	18	8	1
Strontium	Sr	38	2	8	18	8	2
Yttrium	Yt	39	2	8	18	9	2
Zirconium	Zr	40	2	8	18	10	2

THE PROPERTIES OF ELEMENTS

The building up of the electron shells of the atoms from argon to krypton may seem to you to take place in a very puzzling way. For the present you need not let that worry you. The important thing to grasp is that the outermost electron shell of an atom never contains more than eight electrons.

If you look at the table you will see that the atoms which have the complete number of electrons in their outermost electron shells (two with helium and eight with the others, neon, argon, and krypton) all belong to the inert gas

family which we were talking about on p. 270, and resemble one another closely. There is also a family likeness between atoms whose outermost electron shells have one electron short of the maximum number of eight (the halogen family). There is a family likeness, too, between atoms with a single electron outside a completed shell of eight (the alkali metals). Family likenesses can also be traced between atoms which have two or three electrons short of a completed shell of eight, or which have two or three electrons in addition to a completed shell, but with these atoms the family resemblance is not so striking.

CHEMICAL COMPOUNDS

All this shows that the chemical properties of elements are closely connected with the number and arrangement of the electrons in their atoms. The more you can discover about the number and arrangement of the electrons, the more completely you are able to understand the formation and properties of chemical compounds.

The important thing about completed outer shells of eight electrons is that, in this arrangement, the electrons hold together very much more firmly than they do in atoms whose outer shell contains any other number of electrons. In fact, more than twice as much energy is necessary to remove an electron from such an arrangement than from any other.

Because of the stability of this electron arrangement the atoms of inert gases have very little attraction for other atoms or for one another. This accounts for their inability to form chemical compounds. It also accounts for their existing as gases. Atoms only exist as liquids or solids when there is a strong attraction between them to hold them together.

When atoms with incomplete outer shells are crowded together, something very important happens. The atoms at once rearrange their electrons amongst themselves so as to form complete outer shells. In doing this the atoms

become linked to one another and a chemical compound is formed.

The actual way in which any two atoms become linked together in a compound depends upon the number and arrangement of the electrons in the atoms themselves. It is rather different with the atoms of different elements.

COMPOUNDS BETWEEN ATOMS OF THE SAME KIND

Let us first consider what happens when atoms with only one electron short of a completed shell come together. With chlorine, for example, one electron from the outer shell of each atom, instead of keeping to its own shell, passes to and fro between its own shell and that of another atom which it takes as partner. In this way each atom shares one of its electrons with another atom. This has the effect of making the arrangement of the electrons in both atoms of the pair almost as stable as if each atom had eight electrons in its outermost shell. The sharing of the electrons has the effect of binding the two atoms closely together.

A pair of chlorine atoms bound together in this way is called a chlorine "molecule"; this is represented by chemists by the formula Cl_2 . The word molecule is used to describe any group of atoms linked together firmly. A molecule consisting of two atoms only is the simplest kind possible. Presently we shall see that there is no limit to the number of atoms that can go to make a molecule.

Chlorine molecules, like the atoms of inert gases, have only very little attraction for one another; so they also form a gas and not either a liquid or a solid.

Sulphur atoms, on the other hand, which have two electrons short of a completed outer shell, do not share their electrons with one another so as to form pairs. Instead, each atom shares electrons with several other atoms. In doing this the atoms become linked to form molecules containing sixteen atoms. In these molecules each atom, by sharing electrons with its neighbours, makes up a stable outer shell of eight electrons for itself, just as the chlorine

atoms did. The difference is that, in sulphur, four of the electrons of each atom are shared with other atoms.

But these more complicated atoms have sufficient residual attraction (see p. 296) for one another to hold together to form a solid. In the solid which is formed, the molecules

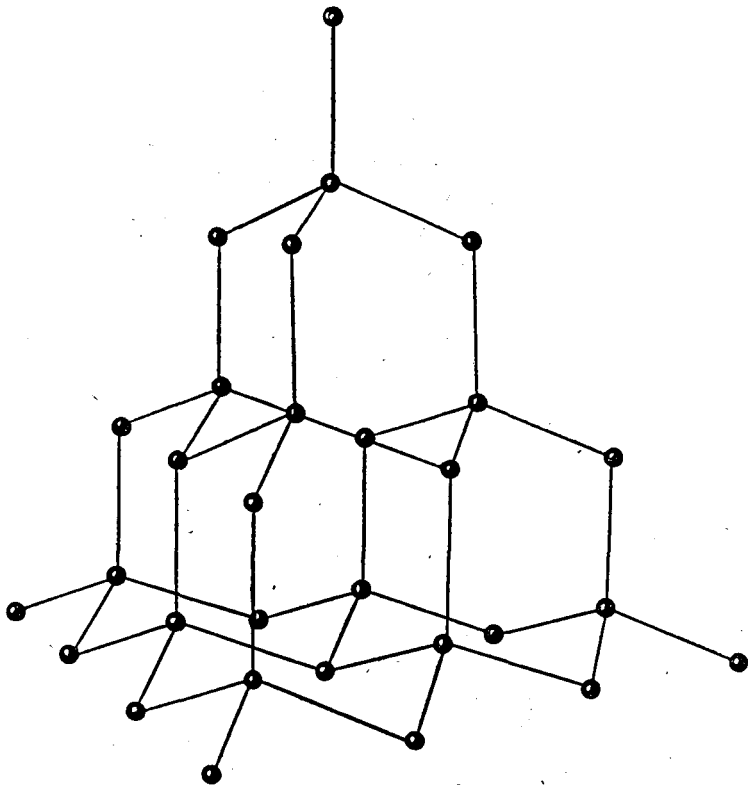


Fig. 58. The arrangement in space of the atoms making up a crystal of silicon. The figure shows only the arrangement of the atoms, not their size. Actually the atoms would be much more nearly touching than is shown here. The arrangement of the carbon atoms making up a diamond is the same as this.

are arranged in a regular order to make a crystal lattice. What this order is can be found out from the pattern which they make with X-rays.

With silicon, which has four electrons short of a completed outer shell, something rather different happens.

The silicon atoms do not link themselves together to form groups containing any definite number of atoms. Instead, they link themselves together to form a regular network, in which each silicon atom shares its four electrons one with each of four neighbours. In so doing, each atom makes a stable arrangement of eight shared electrons in its outermost shell. The network extends continuously in all directions to make a regular crystal lattice, in which the arrangement of atoms can be found out with X-rays. It is like you see in Fig. 58.

With the atoms linked together in this way the whole of any crystal, however many millions of millions of atoms it

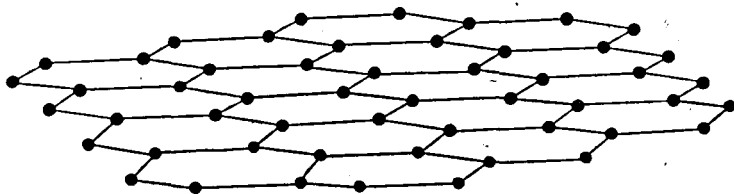


Fig. 59. The arrangement of the carbon atoms in the layers making up graphite or "black lead." These lie loosely one on top of the other and slide over one another easily. As with the diagram of silicon atoms this diagram shows only the arrangement of the atoms, not their size.

contains, is really one enormous molecule. But, as a matter of fact, chemists do not as a rule talk of such whole crystals as molecules. They find it more convenient to keep the word for groups containing small but definite numbers of atoms, usually of different elements.

Carbon atoms, which also have four electrons short of the completed number in their outermost electron shells, also link themselves to form continuous networks. But there are two ways in which they can do this. In one arrangement, the carbon atoms link themselves together as in silicon, so that each atom shares its electrons one with each of four neighbours. This arrangement makes up the clear watery crystals of diamond. In the other arrangement, the carbon atoms link up so as to form sheets as you see in Fig. 59. These lie loosely upon one another and make up

graphite, a substance with quite different properties from those of a diamond. It is the shiny black stuff that is used in the core of blacklead pencils. In both these substances the arrangement of the carbon atoms can be found out from the pattern they make with X-rays.

With substances which have only one or two electrons in their outermost electron shells, there are so few electrons that there is no possibility of atoms making up completed outer electron shells by sharing electrons with their neighbours. What happens instead is that the electrons become shared between a large number of atoms. This also has the effect of binding the atoms together to form a solid, but a solid with rather special properties.

When the electrons have to be shared between several atoms, they become very loosely held and are able to pass over from one group of atoms to another. In other words, the electrons become free to move from one part of the substance to another. But electrons are electrically charged; and when they can move through a substance they make it a conductor of electricity.

The looseness with which the electrons are held in such a substance has another important consequence, which is that they are able to vibrate when light shines on the substance. This is just the opposite of what we were describing just now when we said that electrons gave out light when they gave a jump in combining with atoms that had lost an electron in a spark. When electrons are loosely held in a substance whose atoms have only two or three electrons in their outermost shell, they vibrate under the influence of light. But in doing so they also give out light. This means that, when light shines on the substance, it is reflected, and so gives it a shiny appearance. These substances are metals, and their shininess we call metallic lustre.

All substances whose atoms contain very incomplete outer electron shells are metals. They differ very much in their chemical properties from substances whose atoms have nearly completed electron shells. These are all non-metals. You will see that this is so if you have another look at the table.

COMPOUNDS BETWEEN DIFFERENT KINDS OF
NON-METALLIC ATOMS

Atoms of different elements also share electrons between themselves, and so become linked together. This is how chemical compounds are formed. Some non-metallic elements combine to form definite molecules consisting of groups containing a small number of atoms. Others combine to form networks containing millions of atoms, in which no definite molecules can be traced.

Under ordinary conditions, carbon and oxygen do not combine. This is because both the carbon atoms and the oxygen atoms are held together rather firmly. But, if the substances are heated, the vibration between the atoms loosens the binding between the atoms. When this happens, the carbon atoms begin to link up with the oxygen atoms. If there is plenty of oxygen, each carbon atom links itself with two oxygen atoms by sharing two electrons with each of them. And so a definite molecule of carbon dioxide is formed. This the chemist represents by the formula CO_2 . These molecules have very little attraction for one another, and therefore exist as a gas.

Carbon atoms can also form definite molecules in which they share their electrons one with each of four hydrogen atoms. These molecules once again form a gas; it is called methane or, sometimes, marsh gas, because it is given off by rotting plants in marshes. Its formula is CH_4 .

But compounds between non-metals are not always gases. The compound formed when an atom of oxygen shares one electron with each of two hydrogen atoms is a liquid which you all know very well; it is water. The compound formed when one atom of carbon shares two electrons with each of two atoms of sulphur is also a liquid. It is called carbon bisulphide, and is a liquid with a very nasty smell. The compound formed between phosphorus and sulphur is a solid.

Sometimes non-metals combine to form compounds in which the two kinds of atom are linked up to form networks of millions and millions of atoms, linked together in chains

rather like the atoms are linked in pure silicon. Carborundum, for example, a very hard substance used for sharpening tools, consists of carbon and silicon atoms linked together alternately to make a continuous network. In the carborundum crystal there are no independent molecules; but, as the crystals are formed by the two kinds of atoms linked alternately, the crystal always contains equal numbers of the two kinds of atoms. It therefore has a definite chemical composition and is a definite chemical compound.

Compounds are also produced between more than two kinds of atoms sharing electrons with one another. Chloroform, for example, is made up of molecules containing one carbon atom sharing one electron with a hydrogen atom, and one with each of three chlorine atoms. Its formula is CHCl_3 . Ether is made up of two CH_3 groups linked to one oxygen atom. Chemists represent its structure by the formula $\text{CH}_3\text{-O-CH}_3$. Ordinary alcohol, which is what makes wine intoxicating, is represented by the formula $\text{CH}_3\text{CH}_2\text{OH}$.

Amongst all the non-metallic elements, carbon is by far the most interesting, as its atoms are capable of linking themselves into very long chains in which the individual carbon atoms are also linked to atoms of other kinds. Ordinary petrol is made up of a mixture of substances whose molecules may be represented by formulæ of the kind $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_3$. These substances only differ from one another in the number of CH_2 links there are in the chain. There is no limit to the number of links possible, or to the number of atoms which may go to make up a molecule. In any of these molecules the carbon atoms forming the chain are not arranged in straight lines, but are arranged in the way shown in Fig. 60, to form a kind of spiral.

Many of the substances making up our bodies consist of hundreds, and even thousands, of atoms linked together to form chains. Some of these have oxygen as well as hydrogen attached to the carbon atoms of the chain, and sometimes oxygen atoms form links in the chain itself. Sugars and fats are examples of this. Other chains have

nitrogen atoms attached to them. Compounds called proteins, which make up a large part of our flesh, are examples of this. (See *Physiology* p. 92).

Carbon atoms are also able to form compounds in which they are linked to form closed rings. In these the carbon

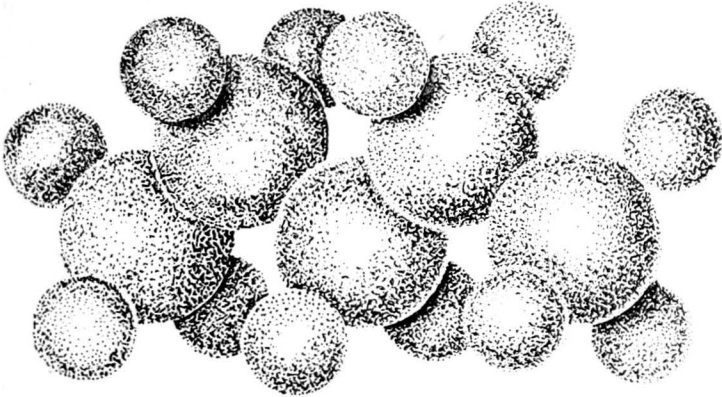
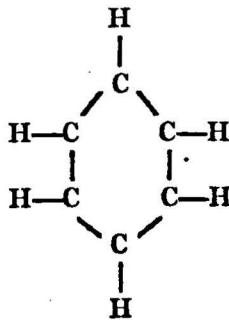


Fig. 60. This is to give you an idea of the arrangement in space of the atoms in a molecule of pentane, one of the substances that make up petrol. The bigger balls represent carbon atoms, and the smaller ones hydrogen atoms. The carbon atoms are arranged in a kind of spiral.

atoms are separately linked to atoms of other kinds. Ordinary benzene, for example, is made up of molecules of which the structure can be represented by the formula :



Ring compounds of this kind make up many of the substances of which living things are composed. The molecules of many dyes used for colouring our clothes also contain such rings.

The complex substances which are formed by carbon atoms linking themselves either to form chains or rings are called "organic" compounds. A special branch of chemistry, called organic chemistry, is devoted to studying them. Living things, both plants and animals, are almost entirely made up of such substances. Another branch of chemistry, called bio-chemistry, studies the part they play in the growth and development of living matter.

COMPOUNDS BETWEEN DIFFERENT METALS

Atoms of two or more different metals can also combine to form compounds. In these the atoms are held together by electrons that are shared between all the atoms, just as in a pure metal. But it is often difficult to tell the difference between a true compound and a mere mixture. The reason for this is that the atoms of one metal can very easily replace the atoms of another in a crystal lattice. Metals only form true compounds when the atoms of the different kinds group themselves in fixed proportions to make regular patterns like the atoms in carborundum. When this happens, a definite compound is formed with a definite composition. The formation of such compounds can usually be spotted because, when the metals are melted up together to form an "alloy," and then allowed to cool gradually, the crystals of the compound separate out separately from the rest of the alloy. The arrangement of the atoms in the crystals of the compound can be found out from the pattern they make with X-rays.

It is only during the last few years, with the discovery of X-ray methods of studying the arrangement of atoms in solids, that our knowledge of compounds between metals has begun to advance. This knowledge will be of immense practical importance in making alloys for such things as aeroplanes, where lightness and strength must be combined; in making cutting tools, which must be very hard and must not soften as they get hot in use; in making alloys that will not be corroded by the air, or by the sea, or by acids; and for numberless other purposes as well.

COMPOUNDS BETWEEN METAL AND
NON-METAL ATOMS

Linking of a quite different kind usually takes place between metal atoms and non-metal atoms. When, for example, chlorine (whose atoms have only one electron short of a completed outermost electron shell) comes into contact with sodium (whose atoms have a single electron over a completed shell), a violent combination immediately takes place, in which common salt is formed. What happens is that each chlorine atom actually captures an electron from a sodium atom, and takes it for itself to complete its outermost shell. Because of this, the sodium loses its metallic appearance and properties, which are all due to its outermost electron. Through the transfer of the electron, both atoms are left with a completed electron shell of eight electrons. But the atoms, when they have completed their electron shells, do not sail off independently like the atoms of an inert gas. The reason for this is that the chlorine atoms, by taking up an extra electron, become negatively electrified, while the sodium atoms, in giving up an electron, become positively electrified. The two atoms therefore attract one another strongly with exactly the same kind of attraction as you notice between your hair and a comb that has been passed through it. In this state the atoms are described as "ions," or as being "ionised."

In such a compound as sodium chloride, the ions cluster together in equal numbers to form a solid. But they don't do this in a haphazard way. They form a quite definite crystal lattice in which the arrangement of the chlorine and sodium ions can be found out from the pattern they make with X-rays. You saw a diagram showing this in Fig. 53.

In such an "ionic lattice," as it is called, the sodium and chlorine atoms, though they exist in equal numbers, are not linked together in pairs; each chlorine atom is surrounded by six sodium atoms, and each sodium atom by six chlorine atoms. The whole crystal, here again, is really one enormous molecule. The chemist's formula for sodium chloride is NaCl , but this must not be taken to mean that the salt is

made up of separate molecules of this composition. All that it means is that the sodium and chlorine atoms are combined in equal numbers to form the salt. The kind of pattern they form was illustrated in Fig. 53.

Similar compounds are formed when metals whose atoms have more than one electron in their outermost shells (such as calcium) combine with a halogen. A calcium atom is able to give up an electron to each of two chlorine atoms, and form a compound made up of twice as many chlorine atoms as calcium atoms. The chemist represents this substance by the formula CaCl_2 . Other combinations of atoms give such compounds as Na_2S , CaO , and AlCl_3 . These are only a few of an immense number that are possible.

Some ionic compounds are formed by a group of atoms linked together by shared electrons acting as an ion. Ammonium chloride (sal-ammoniac) is an example. In this compound, groups of four hydrogen atoms, linked by shared electrons to a single nitrogen atom, form ions which carry a positive charge and are bound by electrical forces to an equal number of chlorine ions. The chemist represents this substance by the formula NH_4Cl .

Another example of such a compound is sodium carbonate, better known as washing-soda. Here groups consisting of one carbon atom and three oxygen atoms carry two negative charges and are bound by electrical forces to twice as many sodium atoms. The chemist represents this substance by the formula Na_2CO_3 .

All these various kinds of ionic compounds are of quite definite composition and may be represented by definite formulæ. All the same it is important to remember that a crystal of an ionic substance is not made up of independent molecules, but is really one enormous molecule.

An interesting and important thing about ionic compounds of this kind is that, when you melt them, the ions of the two kinds cease to be held rigidly together, and become free to move independently. But, as the ions of both kinds are electrically charged, they can act as carriers of electricity in the liquid and so make it a conductor.

When an electric current is passed through a melted

ionic compound, the metal ions all start moving in one direction through the solution (towards the negative pole), while the non-metal ions start moving in the opposite direction (towards the positive pole). And so the compound is broken up. This can be made use of in obtaining metals, such as sodium, which are very difficult to separate from their compounds in other ways. It is in this way also that aluminium is separated from the other elements with which it is combined in its ores.

Many ionic compounds also dissolve in water to give solutions in which the ions of the two kinds again become separated so as to be able to move independently through the solution. Such solutions also act as conductors of electricity. The dilute sulphuric acid used in an ordinary wireless accumulator is an example of this. Sulphuric acid—of which the formula is H_2SO_4 —when it dissolves in water, produces hydrogen (H) ions, which are positively charged, and sulphate (SO_4) ions, which are negatively charged. These ions are able to move independently through the solution and so carry the electric current between the plates of the accumulator.

Some metals can be separated from their compounds by passing a current through a solution containing them. This method is actually used for making the very pure copper that is best for making wires for conducting electricity. It is also used for electroplating a layer of a metal, silver for example, on other metals.

But all ionic compounds do not dissolve in water to give a solution which is a conductor of electricity. Many of them do not dissolve in water at all, because the force holding the ions together is too great to let them separate.

Most stones belong to this class. The three commonest kinds of stone are : limestone, which consists of calcium carbonate ; granites, which are silicates of calcium and other metals ; and quartz and flint, which are oxides of silicon. Another member of this class is ordinary clay, which becomes mud in wet weather, and which is used in making pottery and bricks. It consists chiefly of silicate of aluminium.

LINKING THROUGH RESIDUAL FORCES

If you make any gas cold enough, it turns to a liquid; with further cooling, it turns to a solid. This is true, not only of gases made up of molecules containing several atoms, such as carbon dioxide (CO_2) or marsh gas (CH_4), but also of the inert gases, which are made up of separate atoms. This shows that there must be some residual force of attraction which can hold together the molecules or the atoms, as the case may be.

If it were not for the residual attraction no gas could ever form a solid, however much it was cooled. The residual attraction arises from the fact that the positive and negative charges (of the nuclei and electrons) making up the molecules and atoms are not close enough together to neutralise one another completely. This means that the positive parts of molecules have some slight attraction for the negative parts of others. These forces are also sometimes called Van der Waals forces, after the man who first realised their existence between the atoms of a gas.

What ordinarily makes a substance a gas is the violent jostling which goes on all the time between the molecules. This jostling makes what we call heat. Scientists call it by the rather grand name of thermal agitation. This goes on between the atoms and molecules of all substances, whether they are gases, liquids, or solids. You call any substance hot when the thermal agitation is rather more violent than usual, and you call it cold when it is rather less violent.

You cannot, of course, see the jostling of the molecules in a substance, because they are too small to see anyhow. But there are ways in which you can see that it is going on. If you mix a little milk with a lot of water and then look through a microscope at the little white droplets of unseparated cream, you see that they are all dancing about, even when the liquid is quite still. This is because they are being jostled by the surrounding molecules, just like an elephant might be slightly jostled by a crowd of people. For this to show clearly, the droplet has to be very small. Anything bigger, such as a speck of dust, would hardly show it at all.

When you heat some water in a kettle, the jostling of the molecules increases. At the boiling temperature it becomes so great that all the molecules sail off as steam. If you cool the steam again, the jostling becomes less again, and water forms.

For a substance to be a gas at ordinary temperature the attraction between the molecules must be quite small. If it is strong, the molecules cluster together to make a liquid or a solid, in spite of the jostling which tends to make them scatter as a gas.

Molecules such as those of hydrogen (H_2), oxygen (O_2), methane (CH_4), or sulphur dioxide (SO_2), ordinarily exist as gases, because they have very little attraction for one another. But, if you cool any of these gases, and so decrease the jostling, they liquefy; with greater cold they turn into solids.

But some gases are more easily liquefied than others. Sulphur dioxide, for example, liquefies when you cool it with a mixture of ice and salt. To liquefy oxygen or methane, a much greater degree of cold is necessary. Helium can only be liquefied with the very greatest difficulty. This shows that there is more residual attraction between sulphur dioxide molecules than between methane molecules. Between helium atoms the residual attraction is extremely small.

Some molecules, such as bromine (Br_2) or water (H_2O), have sufficient residual attraction for one another to be able to form liquids even at ordinary temperatures. Others, such as sulphur or sugar, form solids even at ordinary temperatures.

If you use X-rays to examine any of the solids which are made up of molecules held together by residual attraction, you find that the molecules are arranged in regular order to make a crystal lattice. The crystals of a lump of sugar, for example, are made up of molecules linked together by the residual forces they have for one another, so as to make up a regular pattern. This residual force between the molecules is much less strong than the force between the atoms within the molecule due to shared electrons. When

sugar dissolves in water, the molecules separate, while the atoms remain grouped in their molecules unchanged. When the solution dries up the molecules rearrange themselves to form a crystal once again.

Up to this point we have been talking as though there were four quite different kinds of binding that could hold atoms or molecules together. First, there was the binding due to electrons shared between non-metal atoms. Second, there was the binding due to electrons shared between all the atoms of a metal, or mixture of metals. Third, there was the binding due to transfer of an electron between a metal and a non-metal atom. Fourth, there is the binding due to what we have called residual forces. But we must not run away with the idea that these kinds of binding are altogether different from one another. They are all due to electrical forces between electrons and the nuclei of the atoms which are held together. The distinction that we have made between them is largely a matter of convenience. In some compounds it is a little difficult to know under what heading the binding should be included, just as it is a little difficult to know whether plasticine or treacle should be called solids or liquids. All the same, the differences between the kinds of compounds we have described is sufficiently clear for the distinction to be a useful one.

THE PROPERTIES OF MATTER

Many of the properties of material substances depend upon the way in which the atoms in them are linked together. The hardness of a diamond or of carborundum, for example, is due to the atoms being linked up to one another continuously, right through the solid, with very strong binding. The slipperiness of graphite is due to the carbon atoms being arranged in sheets in which the atoms are held together very firmly by shared electrons, while the sheets themselves are held together much more loosely by residual forces. These leaves are able to slide over one another very easily, and so give the graphite its slipperiness. The property of pure metals which makes them easy to bend or to

hammer into complicated shapes is due to the loosely bound electrons allowing the atoms in the crystal to slide easily over one another. The strength of some materials, such as cotton or silk fibres, is due to the fact that they are composed of very long chains of carbon atoms very firmly linked together, and that these chains lie parallel with one another along the length of the fibre.

In addition, we shall be able to understand all the other properties of material substances as soon as we know enough about the arrangement of the atoms making them up, and the grouping of the electrons between them. For example, we shall be able to understand their electrical properties, their colour, their resistance to heat and to the action of other chemical substances, and so on with all their other properties.

Before chemists began to make use of the methods of physics, it was only possible to find out about the arrangement of the atoms in any substance by letting other substances act on it and watching what happened. By arguing back from this it was possible to tell what the arrangement of the atoms in the molecules of the original substance was. But this method does not help you to find out how the separate molecules arrange themselves in a solid. This is a very serious drawback, as it is just upon the arrangement of the molecules or atoms in a solid that many of the most practically important of its properties depend. Without this knowledge, it is impossible to foretell what properties any new compound is likely to have.

X-rays have done a great deal to fill in this gap in our knowledge. They make it possible for us to find out what the arrangement of molecules in any substance is, without our having to break it up or change it in any way.

Our knowledge of the way in which the physical properties of a substance depend upon the arrangement of the atoms making it up is growing rapidly; it is already providing a very important guide in making new materials of practical importance, such as alloys with various useful properties, cement for building and decorating houses, and materials such as artificial silk for making clothes. Later on it may

even help in building up substances that will be good to eat, starting with carbon from coal!

And chemistry, working hand in hand with physics, does not have to stop short in applying its newly discovered methods of discovery to the study of non-living things. It can also help the bio-chemist to understand the chemical changes which underlie the growth and development of living matter. With the help of X-rays it will even be possible to watch the formation of new substances in living animals and plants.

At present, bio-chemistry is still a relatively new science. But with the new methods of discovery which the bio-chemist has taken over from physics, his knowledge of living matter is increasing rapidly. It is only a matter of time before bio-chemists discover what the chemical changes are that happen in people's bodies and make them grow old. When this is discovered, people might be made to live for ever. But you will remember, from what Winifred Cullis said, that this might not be a good thing at all. It is also only a matter of time before bio-chemists discover enough about the chemical conditions under which babies grow inside their mothers' bodies before they are born, to make it possible to bring them up artificially from the egg stage in a laboratory, rather like chicks can be hatched from eggs in an incubator. When this can be done, mothers will no longer have to put up with all the trouble and danger of bearing children.

But you must not think that biology will, in the end, be swallowed up by chemistry and physics. The life of living things depends upon the whole of the living body, whether it is of animal or plant, working together. Chemists and physicists, by dividing living things into smaller and smaller pieces, may find out how to control their development. But they must also remember that the plant or animal as a living whole can never be completely understood by studying it in pieces, just as a musical composition can never be understood by studying the vibrations of the separate notes that go to make it up. Both can only be understood as a whole. The problems of the animal or plant

as a living whole belong to the biologist, to the physiologist, and, finally, to the philosopher.

BOOKS TO READ

- E. N. DA C. ANDRADE : *The Mechanism of Nature.*
BARRATT : *Chemistry* (Clarendon Science Series).
SIR WILLIAM BRAGG : *Concerning the Nature of Things.*
J. B. S. HALDANE : *Possible Worlds.*
E. J. HOLMYARD : *Makers of Chemistry.*
JULIAN HUXLEY and E. N. DA C. ANDRADE : *An Introduction to Science.*
T. R. PARSONS : *The Materials of Life.*
J. G. PILLEY : *Electricity* (Clarendon Science Series).
P. E. SPIELMAN : *Chemistry.*
J. W. SULLIVAN : *How Things Behave.*

**PHYSICS, ASTRONOMY, AND
MATHEMATICS**

OR

BEYOND COMMON-SENSE

by

RICHARD HUGHES



RICHARD HUGHES is a very surprising man. You never know what he is going to do next. Poets are often like that, but, besides being a poet, he is a story-teller and an adventurer. He sees things suddenly, sharply, newly; sometimes he sees them blazingly beautiful, and sometimes he sees them grim and dreadful, and sometimes he sees them funny. He sees things in the kind of mixture there is in *Midsummer Night's Dream*. He can't help telling stories, and, if you have not read them, you had better start at once. When I first met him he was living partly in a cottage a long way from anywhere in the middle of the Welsh hills, and partly on a slightly wrecked ship. There were a few very lucky boys and girls whom he asked to stay with him, and they always had adventures. Sometimes, for instance, they would nearly get drowned, but never quite. Now he lives partly with Arabs in Morocco (see the picture on page 514), but he might easily start living somewhere else such as America, or a ruined

castle. Once he joined in a very small revolution. He can invent the most wonderful games. He is rather younger than me and has very bright blue eyes. One is apt to think that because people are writers they are not interested in anything else, but Richard Hughes has always, ever since he was a boy, been excited by mathematics and physics. So when I asked him to write about the arts (having made the mistake of thinking that was the sort of thing he would be interested in), he said he wanted to write about physics. He does not see either physics or mathematics quite like a pure scientist, but he does see them newly and excitingly and in a way that connects them with the rest of life.

PHYSICS, ASTRONOMY AND MATHEMATICS

I

SMALLER AND SMALLER

IF YOU have been reading this book straight through, you will have noticed by now that the different realms of knowledge you explore come in a particular order (see Preface, pp. 5, 6). You studied yourself first, and then began looking outwards to the world in which you live.

First you had a chapter about your body—a chapter on physiology. Then came one on biology—an account of all life, as well as the kind of life your own body leads. After biology came chemistry. In the chapter on chemistry we were no longer studying only living things; we were trying to find out about the general behaviour of all matter—the stuff that everything, alive or dead, that you see or feel or walk on or eat or bump into or breathe or swim in—is made of. And chemistry showed you that, although the world seems to contain such thousands of different kinds of things, they are all made up from the atoms of ninety-two elements combined together in different ways.

It was with the rules and reasons of this combining that the chapter on chemistry was chiefly concerned.

But *this* chapter is going to carry you further still. It is going to try and really see if it is possible to “get to the bottom of things.” For it is going to explore smaller and smaller: and to try and find out what matter itself *is*. We shan't be interested any more in the different behaviour of the different elements it forms; what we now want to find out is this: what *are* those electrons and protons, which John Pilley has already told you are common to the atoms of all the different elements? We shall dig on, down and down, examining things smaller and smaller:

and, when we have found out what is the smallest possible piece of matter, we shall try to find out what underlies and composes that.

At first it may seem difficult to you that there *can* be anything else underlying it ; that matter should not be, when you finally take it to pieces, made up of what common sense would recognise to be matter, but of something quite different. But think for a moment. A house, when you take it to pieces, isn't made up of "house" ; it is made of bricks arranged in a certain way. "Bricks" and "houses" are two perfectly different ideas, and you would laugh at anyone who got them mixed up.

But there are also lots of "things" in the world which obviously are not matter. Perhaps you would describe them instead as ways in which matter behaves. I mean such things as sound and light, heat, movement, heaviness, electricity, wireless, and so on, which have already been touched on in the last chapter. Though they are not matter, they are just as astonishing and interesting when we try to find out about them. We shall find, too, the more we examine things smaller and smaller, the more we shall need to know about these other things in the physical world.

But there is another direction (besides smaller and smaller) which we shall have to go in, a direction which seems, at first sight, the opposite ; for we are also going to look at things larger and larger, things at last so large that our world seems less than a speck of dust when compared with them : and distances so enormous that, although we can talk about them, we cannot really imagine them. You probably know already that the moon is a ball moving round the earth ; and the earth a ball moving round a much bigger ball, the sun. Further, that the sun is a fairly average star, one of millions of others : and that the ninety-three million miles between us and the sun are nothing compared with the vast distance between the sun and the nearest other star. We are going to try and find out about the stars ; what they are, and how they move. Astronomy is the science which helps us to do that. We

are going to look at things larger and larger, until we at last find out what (as well as the smallest) is the *largest* possible collection of matter. In other words, we shall try and find out how the whole universe is made, and whether it is possible to say that it has a certain size, and even if we can discover anything about its shape!

We shall then be ready to face a question which at first looks unanswerable, and which may have bothered you already. Suppose I went away from the earth in a straight line, past the sun, past the moon, past all the stars I can see and perhaps past stars I cannot see, what would happen in the end? Could I, travelling in a straight line, go on *for ever*?

The difficulty of the question of course is this: you can neither imagine yourself going on for ever and never stopping (going on "to infinity," it is called); nor can you imagine, if you did stop anywhere, there should be no "beyond." When your parents were young this difficulty seemed quite unanswerable: but nowadays we are finding a way to answer it, and some of this answer at least you will find quite easy to understand.

Whichever way we go, whether towards the enormously large or towards the minutely small, common sense expects to find at least certain things still true that are true about medium-sized objects like ourselves. You expect the same geometry to be "true," for instance: and you expect to be able to say quite definitely where something is, or when something happened. But this is not so. The three angles of a triangle do *not* add up to make two right angles, if the triangle is big enough. You can't say which of two changes happened first, when the things to which they happen are moving enormously fast. And you can't say definitely where something is in space and time if it is minutely small!

I don't expect you to understand these things yet—I am only mentioning them now to make your head reel a bit. I want you to see that a scientist must take nothing for

granted, however obvious it seems, that he cannot actually observe. In taking you to the very large and the very small I am taking you *beyond* common sense. Before starting on that journey your mind will have to turn a complete somersault, and come up ready to think things and believe things that common sense would say are untrue and impossible.

After all, this may not be so difficult for a boy or girl as for a man or woman. When you are young, *all* thinking is something fairly new, which you have only been doing for a few years. It will be much harder for someone older, who has been thinking in the same way and believing the same things for half a life-time, to turn the somersaults that modern science demands. For that reason, I may very likely expect *you* to tackle new ideas too difficult for the average grown-up.

But, even if our minds can manage to think in new ways, how are we to manage to say what we think? Word-language won't do it properly: word-language was invented for the old ways of thinking, and that is all it is good for. There are other languages than word-language, of course: music is one, and painting another; both say things that can't be said in words. But neither of these two is of any use to scientists.

Actually (as you may have gathered already), the language scientists use when they are writing for each other is number-language, or mathematics. Without it, they could no more describe their discoveries accurately than a bird could say accurately how it feels without singing.

It may surprise you to hear mathematics spoken of as a language. To you mathematics probably means arithmetic, algebra, and geometry; it means working out difficult sums. But arithmetic, algebra, and geometry are not really mathematics; they are only the grammar of mathematics—just as what you are taught about nouns and adjectives and verbs is the grammar of word-language, not word-language itself. Working out difficult sums has no more to do with being a mathematician than parsing difficult sentences has to do with being a poet.

But, though number-language may be all very well for one scientist writing to another, it is hardly much use to you and me now. We have got somehow to put in word-language these things that can only properly be said in numbers. How is it to be done ?

Those of you who have read the Bible will remember how Jesus, when He had something to say which He could not put directly into words, spoke in parables. He told a story, not because it was true in itself, but because it somehow had what He wanted to say hidden in it. He spoke of God, for instance, as "a certain man who planted a vineyard." No one in his senses would think that He meant this literally. Well, we shall have to do much the same : for we, too, shall be using parables when we speak of light as "waves," and of electrons as "particles," and space as "curved." Such parables are very useful—in fact, one cannot help using them, if one must talk in words instead of numbers. To describe things outside common sense, the only possible way is to liken them to things inside common sense. But the danger lies in forgetting that these descriptions are parables, and in taking them literally. Indeed, many of the mistakes that from time to time have been made in the history of science have sprung from this : a scientist has found a good parable to help him describe his discovery, and has thought instead that his description was the literal truth. Then he argues from it that something or other must be true which isn't, in a manner as absurd as if you argued that because Jesus called Himself a Shepherd, presumably He sometimes sells some of His flock to the butcher for mutton.

One of the best examples of a scientific parable that got taken literally at first is the wave-theory of light. And, since light is one of the most important of those non-material "things" I spoke of, we have two reasons for tackling the subject now, before we continue searching "smaller and smaller" in matter.

LIGHT

The wave-parable

The kind of waves you know best are those that form on the sea ; but there are many other kinds. The simplest kind occurs when you tie a piece of string to the door-knob, stand holding the other end not quite tight, and move your hand up and down. Seeing that both ends of the string are fastened, the string itself can't flow from your hand to the door-knob : but something does, and that something is called a " wave." Another variety of wave is set up if you drop a pebble into a pond—a series of rings, which spread out across the water from where the stone fell. Here again it is not the water itself which moves outwards (let a cork float on it if you want to prove this). A third variety of waves—invisible ones this time—are the waves of sound which are set up when you strike a gong or make any other noise. All these three varieties of waves have one thing in common : they are waves in matter, which, by a sort of pendulum-movement, or by tensing and relaxing, passes them along. If there was no string, no wave could pass from your hand to the door. If you rang an electric bell in a vacuum, you could see the hammer at work through the glass sides, perhaps, but you would hear nothing.

Now, you are probably aware that we talk quite freely of " light-waves," as if they were something of the same kind as the waves in a pond, or sound-waves in air : yet light *can* pass through a vacuum. If it couldn't, our world would be plunged in black, perpetual night : for all the light we ordinarily see by, the light of the sun and stars, only reaches us in the first place after crossing the most enormous vacuum—the emptiness which lies between us and them ! But are light-waves, then, waves of *nothing* ? That sounds nonsense. Then what are they waves of ?

The answer is that the question doesn't really arise : for in calling them waves *we are only using a scientific parable*. All we really mean is that the behaviour of light, as it radiates from some centre such as a star or lamp, reminds us in many ways of the movement of waves—

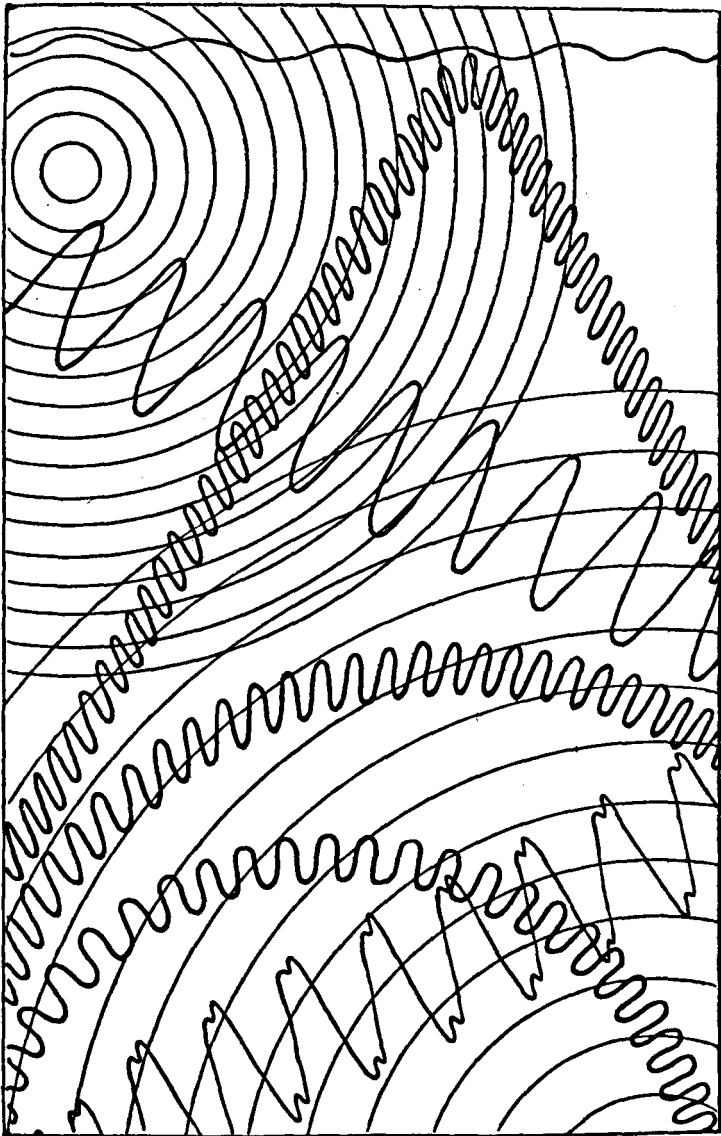


Fig 61. "The kind of waves you know best are those that form on the sea; but there are many other kinds. . . ."

waves are the "picture" it conjures up first in our minds.

Or (to put the same thing a little differently) when we come to describe light in number-language, we find that many of the phrases we have to use are the same as we should use in describing the waves in a pond.

But when scientists began first to speak of light-waves, they had no idea at all they were only using a parable. They were convinced (so many were the points of likeness) that these were *real* waves they had to deal with. Partly as a warning how dangerous it is to trust in common sense and take one's parables literally, I am going to relate the difficulties it led to in this particular case.

The first problem was, of course, that if light-waves were real waves, they must be waves in *something*. They were plainly not waves in matter: it was necessary therefore to invent something else, which was not matter, for them to be waves in. This something they called the "ether"; and imagined it as an utterly thin and utterly elastic fluid, that flowed undisturbed between the particles of the material universe, and filled all "empty" space of every kind.

What was this ether like? Difficulties and contradictions appeared at once. For it was proved to be: (1) Thinner than the thinnest gas; (2) More rigid than steel; (3) Absolutely the same everywhere; (4) Absolutely weightless; and (5) In the neighbourhood of any electron, immensely heavier than lead!

Further, if all material bodies are really swimming through a sort of limitless ocean of this ether, it follows that it must be quite easy to find how fast they are moving through it (provided always that there is anything for them to move through). So, to test this, a most ingenious and most important experiment was devised, about fifty years ago, called the MICHELSON-MORLEY EXPERIMENT.

The idea of the experiment was this. It actually takes longer to row a boat a certain distance up a swift river and down again than it takes to row the same distance across the river and back. The proof of this is too complicated to give here, but you will find it in any book on Relativity.

Even if the water were invisible, you could find out how fast it was flowing by measuring the time it took either way. In the same way, the experimenters argued, if the earth were really moving through the ether, it should take a flash of light longer to go to a mirror and return a certain distance *along* the earth's motion than *across* it.

If there was any such thing as the ether for the earth to move through, this seemed bound to be so. They tried the experiment; but found, however, that both journeys took exactly the same time.

Now this experiment is one of the most important in the history of modern physics. For one reason or another, we shall have to refer to it again: so don't forget about it. But all we are concerned with at the moment is this: it shows that there is no such thing as "motion through the ether" to measure—in other words, it made it impossible to "believe in" the ether any more, except as part of a general wave-parable of light. It showed that to try seriously to find out facts about the ether, as if it was a "real thing," would be almost as absurd as to try and find out what wood the Good Shepherd's crook is made of!

The particle-parable

If you take scientific parables literally, sooner or later you are bound to run your nose like this into the brick wall of a contradiction. But if you treat them as parables, you will find they make some of the most difficult notions quite easy to grasp. For instance, there are many facts we are coming to shortly about the behaviour of light which don't fit in with a wave-theory at all: the picture they conjure up is rather that of a stream of minute separate particles. The literal-minded person will jump to the conclusion that this means that the wave-theory of light is "wrong"; for how can a thing be both a wave and a shower of bullets at the same time? But the parable-minded will be no more surprised than he is when, in reading the New Testament, he finds mankind in one place called a flock of sheep, and in another called the ground where a Sower sows His seed!

He will simply group the facts he discovers in whichever picture suits them best.

First, let us see what fits in with the wave-picture. To begin with, we find the most easy method of arranging light of different colours in order. We class them much as we would class sound-waves ; we class them, that is to say, in the order of their wave-length, or " frequency."

Perhaps you already know something of the nature of sound-waves—why, for instance, some notes are " high" and some are " low." High notes are sounded by things that vibrate thousands of times a second (that is, with a " high frequency "). The waves they send out are crowded closely together, and so have a short wave-length. Low notes are sounded by things that vibrate at less than a hundred times a second (that is, with a " low frequency "). Here the waves are less crowded together, and so have a long wave-length. Perhaps you also know that there are many sound-waves either too short, or too long, for us to hear them at all. It is said that the highest note we are able to hear is the note of a bat's squeak (indeed, many people cannot even hear this one) : while the noise of a distant gun may be so low that our ears cannot hear that either, although it rattles the windows, and quivers a piece of paper in our hands.

When we turn to " electromagnetic " waves (this is nowadays considered a more proper name for them than " ether " waves) we find here also an enormous variety in their length and frequency : and, just as only a small piece out of the middle of the whole scale of sound can be heard by the ear of man, so only a small fraction of the electromagnetic scale appears to the eye of man as visible light.

Difference of wave-length in sound produces difference of note : difference of wave-length in visible light produces difference of colour. The shortest light-waves that the human eye can see (the " bat's squeak ") are the waves of violet light. As they lengthen, one passes across the rainbow : violet becomes blue, blue becomes green, green becomes yellow, yellow becomes orange, and orange becomes red.

When they lengthen beyond that, they become too long for the human eye to see. But they are not at first too long for the human body to feel (the "cannon's boom"). Beyond the red waves are the infra-red waves (as they are called); these waves make up the radiant heat you feel when you hold your hand in the sunlight, or near a hot iron. But even these waves are measured in minute fractions of an inch, while the scale can actually be extended till we reach waves so long that the distance from crest to crest can be measured in hundreds of yards. What *they* are I expect you know already: they are the electromagnetic waves on which the wireless message is superimposed.

Now let us turn to the other end of the scale, to the waves that are too *short* for the human eye to see. Although he cannot see them himself, the scientist has another eye besides the eyes in his head—he has his camera. For the range of light to which the photographic plate is sensitive, is not exactly the same as that to which the eye is sensitive. Red light hardly affects a plate at all: while blue and violet affect it most strongly of all visible colours, so that a photograph of somebody in a blue dress—even quite a dark blue—often looks as if she was wearing white. At this end of the scale, moreover, the plate is sensitive to many ranges of light which the eye cannot see at all: the X-ray, whose wave-length is so short that it can pass through opaque obstacles, such as the flesh of your hand; the gamma-ray, far shorter still, that radiates from radio-active substances (see p. 324), and whose wave-length is about one ten-thousand-millionth of an inch.

Incidentally, if you would like to experiment with these gamma-rays for yourself, you can. X-rays are not safe to play about with, as you can get dangerous electric shocks from the tubes used for making them; besides, in time they kill your flesh, and make sores that look like burns. But some radio-active substances are safe to handle. There is one called thoria, for instance, which is used for making gas-mantles.

Take a photographic plate, and in a dark room wrap it up carefully in black paper, so that no ordinary light

can get to it. Cut out a face from a piece of silver paper, and stick it outside. Then break up a gas-mantle, lay it on top, wrap the whole thing up, and put it away somewhere dark for a fortnight. At the end of that time, develop the plate. You will find that the short-length radiation from the thoria has passed through the black paper that ordinary light can't pass through, and has only been slightly hindered even by the silver paper. You will find perfect photographs of the bits of gas-mantle ; and across them the shadowy "ghost" of the face you cut out.

Or there is another experiment you can do. Ask your chemist to get for you a tiny quantity of a solution of uranium nitrate : and, with this as ink, write a letter to a friend. Write on one side of the paper only, and don't fold it. When it is dry, put it in an envelope and seal it carefully. If your friend puts this away with a photographic plate (as you did the gas-mantle) for a fortnight, and then develops it, he will be able to read in the photograph whatever was in your letter without having ever opened the envelope !

For the classification of light of different colours, therefore, we can say that we find the wave-picture all right. But when we consider the motion of light, we can only say that we find it *sometimes* all right. For light, to take an instance, has weight—and that doesn't fit in at all with a wave-picture ! A ray of light passing close to the sun actually falls towards it slightly—its path, that is to say, is slightly bent, as the path of a bullet is bent by the gravitation of the earth. This bending is so slight that it was only discovered in 1919, after Einstein had already worked out how much it should be and had told physicists to look out for it. But, slight though it is, it suggests that in our description of light we are going to need a bullet-picture, or particle-picture, as well as the wave-picture we have got already. And when we come to study what happens when light is given out, or absorbed, we find the particle-parable absolutely necessary to describe the facts.

The reason is this. When we study the structure of an

atom, we find that the smallest possible change that can take place in its state is the "jumping" of an electron from one energy-level to another (see p. 279). It is the smallest because an electron cannot be between one energy-level and the next—it must be on one or the other, just as a ball on a flight of stairs must rest on one stair or the next, and cannot rest in between. Put less pictorially, this means that the energy of an electron can only change by definite amounts; energy, in short, can itself be divided into a sort of "atoms" and then can't be divided any further. This "atom" of energy has a name of its own; it is called a QUANTUM (which is Latin, so the plural of it is not "quantums" but "QUANTA").

If the change of state of the electron is a "jump" to a higher level, a quantum of energy is absorbed. If it is a "fall," a quantum of energy is given out. If, that is to say, a beam of light is falling on an object and being absorbed by it, the electrons in the object will rise to higher energy-states by just as many "jumps" as there are quanta of light absorbed: and if the electrons in an object are falling to lower states of energy, light will be given out of just as *many* quanta as the falls that take place.

Now, you already know that all the atoms of matter in the world are not the same size—though all the atoms of any particular element are. In the same way, all quanta are not the same size—but the quanta of light of any particular wave-length are. That is to say, the *size* of the quantum differs according to the *colour* of the light—it is only the *number* of the quanta that differs according to the *brightness* of the light. And actually it is quite easy to calculate what will be the size of the quantum of light of any particular wave-length. You only have to multiply its "frequency" (see p. 316) by a certain fixed number, called PLANCK'S CONSTANT (Planck was the man who discovered it, and it is called a "constant" because it is always the same number). This number mathematicians call h . Why h should be this particular number, no one knows: and, because we have not found out why, it is called one of the "fundamental constants" of modern physics, as you will find later on

p. 328. It is very important : so if, when you come on it later, you have forgotten what h stands for, look back to this page to see.

Now let us take an everyday example of the way this quantum-business affects the way light behaves. Suppose you have three photographic plates : one you expose for a very short time ; one you expose a little longer ; and the third you expose longest of all. When you develop them, the first will appear light grey, the second dark grey, and the third black. Actually, this greyness is only an appearance : it is the result of a mixture of black and white spots. Some of the grains making up the plate's surface have been completely changed by each absorbing a quantum of light, so that the developer can turn them black, while others have not been changed at all : there is no " betwixt and between " state possible : and so the developer " brings up " spots. The darkness of the plate depends on how many spots are crowded on to a small piece of the plate.

Now, how has this happened ? How has it come about, I mean, that some atoms have been affected before others ?

If light spread out in a purely wave-like manner, growing evenly weaker and wider, faster and faster the farther it got from its source, this couldn't happen. Instead, all the particles of the plate's surface would be equally affected. At any stage of exposure all would have exactly the same greyness. But this you find doesn't happen. What you *do* find is that the plate is affected as though it had been fired at with minute bullets each of which made a black speck.

In short, the wave-parable is no good here. Imagine instead that a revolving machine-gun is being fired from the middle of a circle of men. If the circle is small, probably every third man will be hit in the first round : if the circle is larger, only every tenth man. The point is this: each man will, in either case, be either hit or not hit, according to luck : the bullets as they fly will become farther apart, but they will still remain bullets of the same size and shape : *no one* would expect them, as the circle gets bigger, to strike each man equally with a thinner and thinner mist of lead !

So now we have a bullet-parable, or, rather, a particle-parable, to use about light, as well as a wave-parable. If you are obstinate (and stupid), and say you don't see how a thing can be both a wave and a bullet at the same time, I agree. But, then, if I said I didn't see how mankind could be both a flock of sheep and a patch of ground at the same time, *you* would have to agree. Don't think of them as contradictory ideas: simply think of them as two pictures which, between them, describe in parable form most of what we know about the nature of light. If you want these facts said, not in parable, but literally, word-language and word-ideas can't do it. As I told you before, only number-language can do that.

And don't forget that when we got to the "bottom" of light, when we could dig no farther, what we came up against was an unexplained number—that important little number, "h."

MATTER

We are used to the matter of our common sense, middle-sized world taking one of three possible forms—solid, liquid, or gas. We are also in the habit of calling it hot or cold.

There are a few cases which are difficult to be sure about at first sight: vulcanite, for instance, which fountain-pens are made of, is really a liquid; though such a stiff, treacherous one that no one would guess it—it takes a century or two for it to show any signs of "pouring." But, on the whole, we know pretty well what we mean by these three states. A solid is something which resists attempts to alter either its shape or its size. A liquid alters its shape readily, but retains its size almost as obstinately as a solid (a pint of milk remains a pint, even when you pour it into a different shaped jug). A gas, on the other hand, readily alters both its shape and its size to fill any unoccupied space. A jugful of gas will not stay quiet like milk: it soon escapes all over the room.

Instead of "hot" and "cold," it would be better to
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say "hotter" and "less hot." For cold is not a separate thing; it is just lack of heat.

Now, these common sense qualities depend on something on the borderline of common sense—the fact that all matter is composed of particles, and that these particles are in a continual state of agitation.

I call this fact a "borderline" one, because, although these particles and their movement are too small to be seen with any microscope, they are not so small as to be altogether beyond the reach of our senses. John Pilley has already told you (see *Chemistry*, p. 296) how you can see the cream droplets in an apparently still liquid being "jostled" by them. They don't behave altogether like middle-sized things, it is true; but, on the other hand, there is no question of their being "parable" particles—they are "real" enough.

Travelling "smaller and smaller," we have now reached the front door of the atom. To go in there, we shall have to leave common sense *altogether* behind. But before we do that—before we turn our backs on "real" particles and concern ourselves with ones that can only be described in parables—there is still one lesson the real ones have to teach us which is well worth learning.

How crowds behave

It starts from this. In a pint of water there are nearly 20,000,000,000,000,000,000,000 molecules. Moreover, we sometimes speak of the molecules of a gas as flying about loose and "occasionally colliding," as in Blind Man's Buff. Well, a single molecule of air can expect to meet with about 3,000,000,000 such collisions every second.

In short, when we speak of the particles making up ordinary things as a "crowd," we don't mean a crowd—we mean a CROWD! The tiniest dew-drop, the smallest speck of dust, is a bigger crowd than you are likely to see of human beings anywhere—even on the Day of Judgment. When a ball bounces on the floor, it isn't a single thing; it is a rabble of millions and millions of things.

This promptly becomes a very serious matter, if we stop

to think what we mean by a " Law of Nature." Most people think of these laws as the most iron and necessary happenings : something which absolutely *cannot* be disobeyed, something which *must* happen. But take, for instance, the laws of a ball's bouncing. One can understand laws being iron and necessary about a single thing, but how *can* they possibly be so about this countless, jostling rabble ?

You might argue that they only can be so, that we can only know *for certain* what the whole ball will do, when we have worked out mathematically the behaviour of every separate particle in it, and the effect of every separate collision with a molecule of air on the way. You *might* argue that way, I say ; and, if scientific laws are to have the absolute and holy necessity they are publicly supposed to have, you *must* argue that way—you *must* observe every tiny cause before you can calculate the whole effect. But practically speaking, of course, we do the very opposite. It would be impossibly difficult to calculate the movements of half a dozen molecules for a fifteenth of a second—let alone a few billions for five seconds ! Yet we prophesy quite readily what will happen to the ball when it leaves our hand : we say we *know* it won't fly up to the ceiling, or turn into a frog on touching the ground !

How do we know ? We know, not because of the laws of certainty, but because of the laws of chance. We know, not because we know what each particle will do, but because there are so many that we don't need to. We know, because it is actually easier to know what a crowd will do than a single person, not harder. We know, in the same way that a politician might know, perhaps, whether England will vote Labour or Conservative at the next election—though he couldn't tell you how Mr. Smith next door is going to vote.

For, of course, Mr. Smith might not vote at all. He might fall downstairs and break his neck that very morning. It is not too improbable : such things *do* happen. But that every single man in England should happen to fall and break his neck that morning, and so no one vote, is so *improbable* (though it is *possible*, of course) that we say such things *don't* happen.

Now there are very, very few scientific laws which are impossible to break. But the "crowd" concerned is so enormous that breaking them by chance is so improbable that we leave it out of account, that is all. It is not, for instance, *impossible* for a motor-tyre to pump itself up. The molecules of the surrounding air *might* all happen to rush in the same direction at the same time by chance. But the chances against it are far greater than the chances against everyone in England breaking his neck on the morning of the General Election.

Thus we see that most of the laws of nature, instead of being cast-iron certainties, are really only what is extremely probable will happen. Further, by counting the chances of their being broken, it is actually possible to *measure* how nearly laws are likely to be obeyed, and so to describe their truth by a *number*.

Remember that. When we ask what we mean by a law of nature, *what we find underlying the idea of "law" is a number.*

Parables within the atom

When an atom comes to pieces in the radio-active process, any of three things may be given off depending on the kind of atom: alpha-particles, beta-particles, and gamma-rays. The alpha-particle is a helium nucleus, the beta-particle a free electron, and gamma-rays (which you have already experimented with) are radiation with a wave-length only about one hundred thousandth the wave-length of visible light.

You will notice that the first two are called "particles." We call them this because we can photograph them moving through damp air like bullets. John Pilley told you about the tracks alpha-particles make, and even showed you a picture of what they look like (Fig. 55). Beta-particles make tracks very like them. But with gamma-rays you don't get any tracks of this kind, and so you don't call them particles. But when we talk of an electron as a particle, we are passing, I warned you, the frontiers of common sense: and, particles though these electrons first appear to

be, we must not be surprised at their sometimes behaving in ways which would be totally impossible for a "real" particle such as a grain of sand, on which our parable is founded. You find electrons doing things that don't fit in with the particle idea, when, for instance, they pass in a stream through a crystal. For they don't scatter irregularly, as they would if they behaved like particles; they scatter to form a perfectly regular pattern, very like the pattern X-rays make, when they also pass through a crystal (see p. 262). But a pattern like this *can* only be formed by waves, and so we have to face the fact that electrons *sometimes show themselves to be acting as waves!*

This was a tremendous surprise to the scientists who first discovered it. It made them wonder whether some of the various very awkward difficulties that had arisen in trying to explain the motion of electrons *inside* atoms might not also be due to their behaving like waves.

But—particles that behave like waves? This is rather a difficult idea for common sense to swallow! On the other hand, we have already found, in studying light, that we had to deal with waves that behaved like particles—or, rather, we found that the wave-parable of light needed another, the particle-parable, to help describe the way radiation behaves. So perhaps we can get out of this contradiction also in the same way: we can say that our electrons, which we thought were "real" particles, are only "parable" particles; and then there will be no contradiction at all in calling in a wave-parable to describe another side of the truth about them.

Now, the first suspicion of this wave-likeness appears, as we have seen, in studying beta-particles, which are electrons that have escaped from the atom. But an electron which has escaped from an atom as a beta-particle is a much more commonsense thing than an electron *inside* an atom. Like a partially cured lunatic let out of an asylum, it shows some signs at least of behaving as the outside world would expect it to behave. The electron *within* the atom, on the other hand, is so strange that it soon beggars even our power of parable-telling. It certainly lacks any but the

remotest likeness to a particle, or to anything else we are familiar with. When we get inside the atom, we are driven, absolutely *driven* to give up words, and talk in mathematics. But, even so, it is hard enough to describe what we find! Various methods have been devised for the purpose—various systems of “wave-mechanics,” as they are called. There is no question but that they are a brilliantly successful invention. But as yet the mathematical descriptions they have given us are a sort of traveller’s tales, such as early explorers bring back of some undiscovered land they have fearfully visited, rather than a proper geographer’s account of a well-mapped country.

The reason that parables are no longer any use is that, in using a parable, what we do is to say that something we don’t know about is like something we do know about. We can’t do this with the electron, because it isn’t really “like” anything at all! When we talk of anything as a particle, for instance, we are really comparing it to a grain of sand, to something that we can see and measure. But an electron isn’t like a grain of sand, because it isn’t possible ever to observe it as you can a grain of sand. There is no way of finding out about the exact position and motion of an electron except by letting light shine on it. But, when you do that, the electron doesn’t stop still like a grain of sand would. It shoots off at an immense speed under the recoil of the first light-quantum that hits it. And so, in any experiment arranged to find out about electrons, the unfortunate scientist finds himself rather in the position of a blind man trying to discover the whereabouts of a thimble, and having to use a battering-ram to do it.

But you mustn’t take this analogy to mean that the scientist can find out *nothing* about individual electrons. It only means that an element of uncertainty creeps in, which, from the nature of things, he cannot possibly avoid. The amount of this uncertainty depends upon that little constant h , Planck’s constant, which we came across in studying the quanta of which light is made up (p. 319). This makes it one of the most important numbers in the world.

But all this about *observing* electrons may seem to you to have very little to do with what electrons really are. Yet it is very much to the point really, for it is this very impossibility of ever getting accurate knowledge about electrons which is one of the most important things about them! Remember the warning you have had; a scientist must only talk about what he can actually observe, and what he can infer from it. Owing to the difficulty which arises over observing electrons, we have to admit that it is quite impossible *ever* to describe the position and motion of an electron according to our ordinary conceptions of space and time: wave-parables are the nearest we can get to it, because these are able to describe things that are *indefinite* in space and time.

But there is another important point. The discovery that we cannot completely describe electrons (and protons, over which the same difficulty arises to a lesser extent) according to our ideas of space and time, does not only tell us something about electrons and protons: it tells us even more about those ideas themselves. We have formed our present common-sense ideas of space and time because in our middle-sized world we can observe things without upsetting them. If we had been born in a world where everything started moving or changed its motion in a way we could never be sure about, as the goods in the sheep's shop did in *Alice through the Looking-glass*, just as we were going to look at it (or, rather, as we shone a light to see it), our ideas of space and time would have grown up very differently. All the same, we should be much nearer understanding about electrons and protons, because this is just how *they* behave. Our common-sense ideas of space and time, which we have built up to suit a world where nothing is appreciably affected by our observing it, fail us when we try and apply them to electrons and protons. This means that electrons and protons must necessarily lie beyond common sense.

But it isn't only over very small things that our common-sense ideas break down; they do again, though differently, when we try and apply them to the immensely big things

which astronomers study. We shall have more to say about this when we pass on to our next section.

It is only a short time ago that scientists realised that you could never get accurate knowledge of individual electrons. When first it was realised that atoms contained electrons, physicists thought they could describe electrons as going round the nuclei of atoms just like planets in their orbits round the sun. But now they realise that it is nonsense to talk of an electron being at any particular point within the atom at any particular time—or moving in anything like the orbit of a planet. John Pilley has told you that the electrons belong in “energy-levels” (see *Chemistry*, p. 279), but this phrase does not refer to their position, but to their energy. We can say that electrons belonging to different energy-levels move so as to form concentric shells round the nucleus which are very roughly like the skins of an onion. But this is only a parable, and not a very good one at that. Actually no parable for the motion of an electron within an atom has been found which is even as satisfactory as, in its time, the wave-parable of light once was. When we get at last inside the atom, we are driven, absolutely *driven*, to give up words, and talk in mathematics.

Words, and word-thoughts, reduce matter as far as electrons, protons, and quanta of radiation (which are also sometimes called “photons”). They can get no farther because, once they get even that far, they fail to be able to explain what they mean. After that, number, and number-thoughts, are needed to travel smaller still. On that farther journey we cannot go now; but we might just take a glimpse at what the number-traveller finds, the final things at which he, too, has at present to stop, even if we fail to understand what it is all about. These things are of two kinds: Constants (I told you what they were on p. 319), and Pure-Number-Relations. There are six of these constants; one is your old friend h ; and another, c , you are going to have a lot to do with later on, because one definition of it is to call it the speed at which light always

travels. The other four are M , the mass of the proton, and m , the mass of the electron; e , the electric charge of the electron (which is exactly the same as that of the proton), and G , the gravitational constant. There are three Pure-Number-Ratios. The simplest is $\frac{M}{m}$: the ratio, that is to say, of the mass of the proton to the mass of the electron (it is about 1,750 times as big). The other two are more complicated: $\frac{2\pi e^2}{hc}$, called the "fine structure constant," and $\frac{e^2}{GM^2}$, which compares the electric and gravitational forces between two protons.

That, to-day, is how things stand. Perhaps in the future it will be possible to reduce the number of these constants; to find out why $\frac{M}{m}$ equals 1,750, for instance, and so have only one constant there instead of two (to find a common origin for both electron and proton, word-language would call it).

It may seem a strange thing to you to find, at the "bottom" of things, six numbers. How did they get there? That is a question which we shall certainly have to hint at at the end of this chapter. And, indeed, all I have said about the inside of atoms may seem to you stranger than magic, and madder than nonsense. We have left common sense behind with a vengeance! But notice, please, how we got there: it was only by sticking to that commonplace rule: *Believe in nothing which you cannot observe.* We are now going to start again from the middle-sized world, and travel larger and larger; and, I warn you, your mind will have to make wilder leaps, to disbelieve more obvious things, than any it has met with up to now!

II .

LARGER AND LARGER

When I was a schoolboy, somebody told me how to make a telescope, and in my spare time and out of my pocket-money I made myself quite a good one. I use it still. The tubes are only made of cardboard; but they are quite

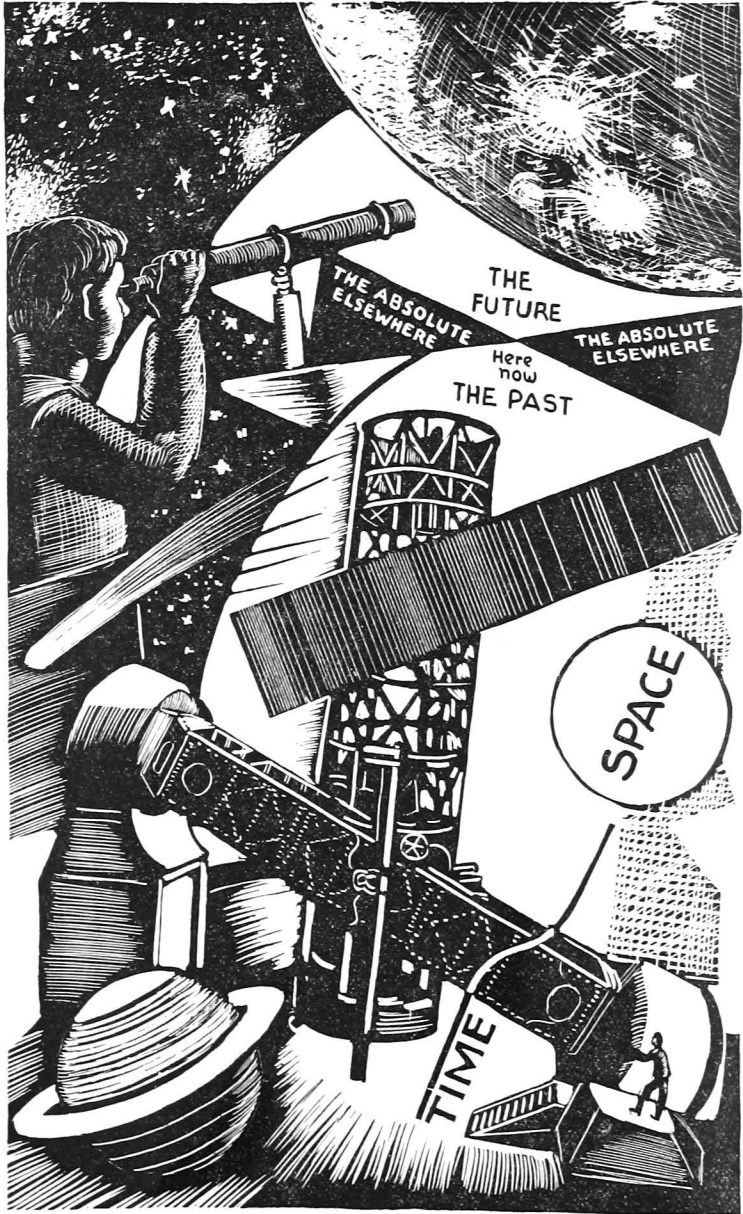


Fig. 62. "... Things at last so large that our world seems less than a speck of dust when compared with them."

rigid, and have the advantage of being very light. The lenses I bought, of course ; they were cheap second-hand ones. I don't think that the whole thing cost me more than fifteen shillings. But it would magnify up to sixty times (or make something sixty yards off seem only one yard off). I could easily read a book sixty yards away, for instance. In fact, this little telescope of mine was as powerful as the one Galileo used when he made the discoveries that revolutionised the whole science of astronomy !

With it I could see quite plainly that the moon is a world like our own, above which I seemed to be flying in an aeroplane at an enormous height. The bare and desolate peaks, the huge circular ramparts of its ring-mountains, that great gash known as the Valley of the Alps, all glittering in the level sunlight—far, far they seemed beneath me. In time, I grew so familiar with the surface of the moon, exploring it night after night, that I felt that if I had somehow been landed on it, I could have found my way about more easily than I could on my own world ! Yet it is a world very unlike ours in many ways. There are no clouds, nor even air, to blur the view : there is no water, no vegetation, no life at all (so far as it is possible to discover—and there are telescopes now powerful enough to discern St. Paul's Cathedral, if it were on the moon). Only sharp, unweathered rock, more desolate than any earthly desert, cracked by enormous chasms, or grouped in those circular ramparts of which I have spoken—rings, sometimes hundreds of miles across and thousands of feet high, which look as if the ripple made by dropping a pebble into water had suddenly solidified. Last summer, when I was flying in an aeroplane at a great height over the desolate eastern part of Spain, I was vividly reminded of the moon-landscapes that used to fascinate me so as a boy.

But my telescope could carry me much farther afield, than that. It showed me the planets also, which appear to the naked eye almost indistinguishable from stars, as bright, small balls. I could just make out the rings of Saturn. I could see some at least of the moons of Jupiter. I could see Venus (because it lies between us and the sun,

go through phases—crescent, half, and full—as you have all seen our moon do (see *History of Science*, p. 65).

When I turned my telescope on to the sun itself, instead of looking at it through a smoked glass because of its intense brilliance, I found it more convenient to let the telescope throw an image of it on to a sheet of paper. Thus I was able to observe easily those curious dark marks that appear and disappear on its fiery surface, and are called sun-spots.

Then it occurred to me that, if I used photographic paper instead of ordinary paper, I could make this image permanent, instead of temporary. So I attached an old camera that had lost its lens to the end of the telescope. I used gas-light paper instead of a film. By taking photographs like this day after day, I was able to observe the changes in the spots far more easily than if I had had only my memory to go on.

Then I turned my telescope on to the stars.

When I looked at the planets, they appeared, as I have told you, like little bright balls. But the distance from us to the nearest stars is so great that no telescope, not the strongest ever made, can make them look like this—even stars much larger than our sun! But if a telescope cannot make them look larger, what it can do is to make them appear very much brighter. Some of the stars which ordinarily appear bright—such as Sirius and Vega—twinkled through my telescope with a most intense and lovely brilliance. And in the dark spaces between, where the bare eye saw no stars, new stars were revealed. Indeed, even with the small instrument I was using, hundreds of times as many stars were visible as can be seen by the naked eye.

On a fine night you can see the Milky Way, like a wisp of luminous white mist, stretching right across the sky. I turned my telescope on this too, and found (as Galileo had found) that what looked like mist was in reality uncountable thousands of faint stars crowded closely together.

What did this mean? Why should the sky have a sort of “equator,” where the stars seemed more closely crowded than elsewhere? How far off were these stars, and what

size were they? And what were those misty objects I saw called *nebulae*—such as the one in the middle of Orion's dagger—that my telescope did *not* reveal as composed (like the Milky Way) of thousands of faint stars?

If, instead of my little home-made instrument, I had had the most powerful telescope in the world, I should have seen incalculably more stars, it is true. I should have found that, whereas some of the "*nebulae*" I had seen turned out to be really star-clusters, others really did seem to be of a cloud-like nature. With the aid of a camera I might also have discovered, if I could have taken photographs over a long enough period, that some stars seem to belong in pairs, and move round each other. But apart from this I should, by direct vision alone, have discovered little that my own small telescope could not have taught me. To discover more I should have needed a spectroscope.

Sorting out light

Just as the sounds of everyday are a mixture of a great many notes, so the light of everyday—sunlight and starlight—is a mixture of a great many wave-lengths: a mixture of colours. If you play a chord on the piano, the ear of a musician can sort out the different notes which compose it. But the eye cannot do this. To sort out the different colours in sunlight, an instrument is needed. The instrument, of course, may be natural: raindrops can do it (hence the rainbow). A glass prism can do it. John Pilley's umbrella can do it (p. 265). In the umbrella pattern each spot has coloured edges which you can just see.

When we make an instrument specially for the purpose, we call it a spectroscope. And the "*rainbow*" it produces is called the spectrum. The kind most used for star-purposes is modelled on the umbrella-method—the "*diffraction grating*," as it is called. Instead of the threads, a number of very fine lines are ruled on a piece of glass.

The wave-lengths given out by the atoms of any particular element are distinctive: hence its spectrum is distinctive. If you burn sodium, for instance, most of the spectrum is dark, but there is a most brilliant bright line in the yellow

part. Other elements give different lines in different places: John Pilley showed you the spectra of a few of them. If an analytical chemist wants to find out what something is, he often can by simply heating it and examining its spectrum.

When you look at the spectrum of sunlight, you find it is very complicated. Instead of bright lines, you see dark ones: but nevertheless you soon see by their position that these dark lines correspond with the bright lines of all the elements known on earth. This means that the outermost layer of the sun contains all these elements, and their atoms absorb light coming from within of just these very lengths. In short, you can largely tell what the sun and the stars as well are made of, simply by sorting out their light!

Secondly, spectra (the plural of spectrum) vary according to temperature. So you can also tell how hot a star is by the same means.

But even this is only the beginning of what we can find out. In the spectra of some stars, the whole thing, all the usual lines, seem to be shifted towards the violet end: in others, towards the red. In the first, all the waves are shorter than they should be: in the second they are longer. What could produce this?

Suppose you are in a ship at sea. First you go towards the waves: they will *seem* short and choppy. Then you go in the opposite direction: the same waves will *seem* wider apart. Suppose that light-waves work in the same way, becoming more or less "frequent" according to the direction you are moving in. This would account for the shift in the spectrum. When we see this shift, therefore, we conclude that in the first place we and that star are approaching each other; and in the second place that we are moving rapidly apart. By measuring the shift, too, you can actually calculate what the speed of approach or separation is.

Now, you will remember that we found with the telescope that certain stars are in pairs, which go round each other. Suppose we now find that the spectrum of a star appears to be really two spectra, shifting backwards and forwards on each other. This suggests that we are really looking at

two stars, so close to each other that we cannot see them apart : and the two shifts mean that in turn they approach us and recede from us—in short, go round each other like the other pairs.

You will also remember that some stars are “ variable ” : their light-strength goes up and down. There are various kinds of these. In one kind we are again really looking at a pair : when they are side by side they look bright, and when one is behind the other they look less bright. But there is another kind, called CEPHEID VARIABLES. Why they vary we do not really know : but, all the same, to an astronomer they are one of the most useful objects in the sky.

The distance of the stars

The sun is ninety-three million miles away. Its light, travelling at the speed c , or 186,000 miles a second, takes about eight minutes to reach us. But the nearest other star is twenty-five million million miles away : *its* light, travelling also at the speed c , will take more than four and a half years !

Because the distances between the stars are so enormous that it would take several lines to write some of them down in miles, it is more convenient to measure them in “ light-years.” There is nothing mysterious about this : a light-year is simply the distance light travels in one year. The nearest star, then, we say is a little more than four and a half light-years away : the distances of others run into hundreds of thousands of light-years.

How do we know this ? If you stand near the window and look out, shutting first one eye and then the other, the whole view will appear to shift slightly (or, rather, the window to shift on the view). This is because your eyes are not in the same place : you get a slightly different view with each (see *Physiology*, p. 77). But the farther you stand from the window, the less will this shift be.

If you photograph the sky one night, and again six months later, you will see a slight shift in a very few stars. This is because, since the earth is going round the sun, the

positions from which the two photographs were taken are twice ninety-three million miles apart: and the shifting stars were comparatively near. It is by measuring these shifts that we know how far off these stars are.

But only a few stars are near enough for us to find their distances in this way; with most stars the shift is far too small. It is in finding the distances of other stars that cepheid variables are so useful.

The method is this. By examining the cepheid variables in one group of stars all much the same distance from us, it was found that the brighter ones (which, being about as far off as the others, were also presumably the biggest) varied more slowly than the dim ones. Therefore if a cepheid anywhere varies slowly, we presume it to be large: if it varies quickly, we presume it to be small. But suppose a slow cepheid somewhere appears dim, and a quick one somewhere else much brighter? The answer is obvious. The second must appear brighter because it is near, the other dim because it is far.

Now I have put this quite vaguely: actually, given the apparent brightness, and given the rate of variation, we can *calculate* the comparative distance of any cepheid variable in the sky. But we already know by the shift-method the distance of the nearest cepheids: we thus know the distances of them all. Further, since there is one, or more, such star in most of the main star-groups, we thus have a measuring-rod with which to measure the distance from us of most of the stars in the sky!

When we have mapped out the stars like this, we find an answer to our question: Why the Milky Way? We find that almost all the stars we see with the naked eye are grouped in the shape of an enormous disc. We, within, looking towards the edges of the disc, naturally see what we take to be a lot of small stars close together in that direction; while, looking towards its nearer faces, the stars seem larger and wider spaced apart. (Stand in a long, narrow plantation of trees with a field on each side, and you will see how this is.)

The size of this disc, which includes most of the visible

stars, is enormous; it is something like a quarter of a million light-years across. The light which reaches us from its edge, the light by which we see the farthest stars in it, left its source about the time that man first appeared on earth!

Extra-Galactic Nebulæ

Yet, enormous as is this disc (called the Galactic System, in honour of the Galaxy, or Milky Way), it is very far indeed from containing all the stars in space. You may remember the mention of *nebulæ*—small, misty objects. Of these *nebulæ*, no less than two million have already been observed that lie outside the Galactic System: the nearest nearly a million light-years away, and the farthest yet sighted no less than a hundred and forty million light-years off.

Moreover, when we examine these *nebulæ* with a powerful enough telescope, we find that they too, like the Galaxy, contain stars: that among these they too contain cepheids (which is how we calculate their distances): in short, we conclude that they too are huge groups of stars—two million other Galactic Systems like our own!

Nor is there any reason to suppose that their real number is limited by anything except the weakness of our telescopes to the mere two millions we have already discovered.

If I had space, there are many other branches of astronomy to explore. There is the weighing of the stars, for instance; there are the laws of gravitation, which describe the interrelation of their movements. There is the study of their ages: how they begin and how they end. Some of this last question you will find discussed in *The Structure of the Earth*. But if you are interested at all in astronomy, I would advise you to get Sir James Jeans's *Universe Around Us*. You will find most of it not too difficult: and it is full as an egg of facts and astonishment and conjectures and reasons. In what I have said here, I have had to limit myself to what would bring us in the direction of "larger and larger," as far as John Pilley had already brought you in the direction of "smaller and smaller" before I began.

“Size” and “Shape”

Up till now, we have explored “larger” without bothering to consider whether our shadow, common sense, was keeping up with us : or whether we should find that in this direction too the laws of middle-sized things failed to apply. But, having got as far as we have, it is high time we stopped to consider that question rather carefully.

What differences do we already find between the “large” and the “middle-sized”? In the first place we notice that the “larger” we travel, the more important something becomes that in middle-sized things we don’t bother about at all—the time taken by light to perform a journey. On the earth this time is so small we usually treat it as nothing. A wireless-wave (which is the same thing, you remember) only takes a fifteenth of a second to go from England to Australia. But the distances across the earth’s surface we *see* are only a minute fraction even of that distance ; so that if we *see* two things happen on the earth at the same time, even though one is near by and the other a little way off, we are in the habit of saying they *do* happen at the same time.

Now it is quite obvious that in talking of events among the stars we must be a lot more careful than that. If the light we see something by has taken a hundred years to reach us, it would be only silly to insist that everything we see now is really happening now.

This idea, though strange, would be only sensible, if it merely meant that in talking of “now” we had to allow for the time light takes to reach us, just as on earth, in listening to distant thunder, we allow for the time sound takes to reach us. And this is all it would mean if the speed of light were the same kind of thing as other speeds. But it isn’t. The Michelson-Morley Experiment (I told you on p. 315 we should need to remember about that) showed us it was a very peculiar kind of speed indeed. It is peculiar in that whatever speed *you* think you are travelling at, light still seems to you to be always travelling at the same speed as ever—namely, 186,000 miles a second.

Do you realise quite how peculiar this is? Suppose you

are driving a car along a road. If you want to calculate the rate at which you will overtake another car, you only have to subtract their road-speed from yours : that gives your speed "relative" to them. Now, the first thing the Michelson-Morley Experiment showed us was that *there is no road*. But if there is no road, there can be no road-speed, no "real" speed : the *only* speeds are our speeds "relative" to other cars. That is a bit of a nightmare in itself, at first : but the idea is quite easy to get used to. After all, we still have these speeds relative to other cars to go on. But there is worse to come. For now suppose a police-car appears on the scene. Such police-cars, we know, go very fast indeed : moreover, they always go at the same pace. Well, we can go fast too : if we can go nearly as fast as the police-car, it won't overtake us so quickly, we suppose. So we go faster. And now the nightmare gets really bad ; for we find that, however fast we go (relative to any ordinary car on the road), that magic police-car still overhauls us *and* all other cars (even cars we should call standing still) at *exactly the same pace* !

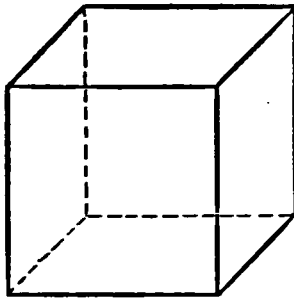
After all, the "sensible" thing about this relative-speed business is that if two other cars are going at different speeds, our speed relative to each in turn will be different. By adding and subtracting relative speeds, we get sensible answers, which fit in with each other. What is nightmarish about our speed relative to light is that it is always the *same*, and so by adding and subtracting other speeds from it we get answers which *don't* fit in with each other. And that leads to even more nightmarish things. It means, for one thing, that we cease to know exactly what we mean by "now." "Seen" now, yes—for everyone *here* that will be the same. But the "real" now : that we shall calculate quite differently, for distant happenings, according to the speed we think we are travelling at ! "Now" broadens away into the remote distance like a wedge—that division (which we thought was only a line) between the past and future ; that "Absolute Elsewhere," as Eddington calls it, because we can never conceivably travel to any other part of it, as we can imaginably do to any future

place, nor can anything have reached us from it, as it can from anywhere in the past. (Look at Fig. 62.)

Secondly, it means that space itself *won't fit*. In mapping it out, we shall find that for objects travelling very fast relative to ourselves there is actually not enough room in our picture of the universe : we shall find, for instance, that for an object travelling at 171,000 miles a second there is only exactly half enough room to spare !

This lack of room in the picture for very fast things has a name of its own : it is called the FITZGERALD CONTRACTION. Usually it is one of the hardest notions in the whole relativity theory for people to get hold of. " Is it a *real* contraction ? " they ask. Calculation says it must be : common sense says it can't be. But the notion need not be a difficult one : there is a parable to help us, a similar contraction which we are quite used to.

Draw a picture of a square box :



Now look at it. Each side of the box you *know* is really a square ; yet if you were to draw it as a square there would be *no room* for it within the outline on your paper. The amount of room for each side depends on the angle that side makes with your line of sight—in short, on its position relative to yours. Or take another example which is an even closer parallel. Open an atlas. Anywhere where there is a map of a large surface, such as a hemisphere or a continent, you will find that only those countries which come in the middle of it correspond properly to the shapes of those countries as you will find them in their own maps.

If you try to make them all the proper shape, you find they won't fit, because the map is flat and the world has a curved surface.

Still keeping this parable in mind, we are at last in a position to approach the question which I promised you at the beginning of this chapter we should attempt, but which then looked impossible: the question of whether or not space is "infinite." The difficulty seemed to be that if space is not infinite, it must surely be bounded by something: and the very idea of a boundary suggests something outside it as well as something inside it, which leaves us no better off than before.

But the surface of the earth or any other ball, we know, is *not* infinite—and yet it has no boundary. Although it can only be measured approximately (because π is a "transcendental" number—see p. 352), it is as truly a limited area as if it was flat—and yet, travel you never so far, you will never reach an edge!

This "ball-parable" then is the parable which scientists, *thinking* in terms of a four-dimensional geometry, *picture* to themselves when they talk in words about the "curvature of space." Like most parables, as well as being a help, it has led to a great deal of confused thinking, and many naïve arguments of the material-of-the-Good-Shepherd's-crook variety.

You will have noticed that, in using it, we are taking for granted that there *is* a fourth dimension—that time and space enter into partnership to provide us with another, as well as the length, breadth, and thickness we are used to. You may object to this; you may say that it is all very well to talk about a fourth dimension in parables, but in *fact* the solid world is only made in three, and everyone knows it! It is the *nature* of the universe to be three-dimensional!

But is it the nature of the universe? Or is it only our nature to see it like that?

Suppose there was an animal whose only sense was the sense of hearing—he couldn't see, and he couldn't feel. All he would know about the world would be a number of

sounds, coming one after the other. His world would be a world of only one dimension : everything, that is to say, would be either before or after something else ; there would be no other direction in which they *could* be related. He would think it quite absurd that anyone could imagine that the world had two dimensions, much less three or four.

And now let us imagine another animal, a sort of barnacle. This time the only sense he has is sight. He has only one eye; so that all things look the same distance away to him (see pp. 77 and 335), and he cannot move about. The world to *him* would be a flat picture (a moving picture, of course). It would be a two-dimensional world, built of length and breadth only—for “near” and “far” would mean nothing to him. If something is coming towards him he will think it is growing bigger ; or if it is going away he will think it is shrinking ; or if it goes behind something else and disappears from view he will argue that it must have altogether ceased to exist, because two things can't be in the same place at once !

Now we are, comparatively speaking, just as much tied down by being used only to small relative velocities as *he* is tied down by seeing only from one spot. We think we are not : we think we can vary our speed considerably ; and you might ask why, if all this is true, don't we notice a train shortening as it gathers speed and steams out of the station ? But even the barnacle we have imagined might be able to vibrate a millionth of an inch on his stalk. *He* would think this a very considerable change of position : and, because it was not enough to alter his view of the world, he might well argue that it proved there was no third dimension ! And our changes of speed are really only comparable to that millionth of an inch. The speed of our fastest bullet is a snail's pace, compared with the speed of light. It is not till you leave the middle-sized world altogether and get to the very large and the very small that you find speeds and distances—the speed of a beta-particle, for instance, or the distance of an Extra-Galactic Nebula—which makes it possible to observe this failure of things to fit. For middle-sized speeds and middle-sized

distances it is no more surprising that we fail to notice it, than that we fail to notice the curvature of the surface of the water in a bath.

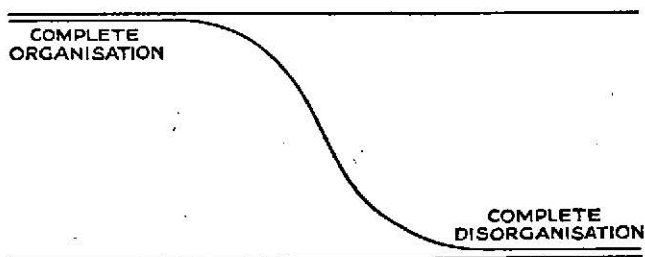
There still remains one grave obstacle to our belief in a time-dimension ; and that is the difference we all feel between past and future. Other directions do not have this same difference : it is easy to mistake east for west. It is even possible to mistake up for down. But we feel in our bones it would *never* be possible to mistake future for past.

Now the curious thing is that, when the scientist tries to discover wherein this difference lies, he finds that in the world of the very small it is hardly noticeable at all. It is not till you are dealing with large numbers of things—such as you will remember that a bouncing ball is—that the difference seems to creep in, like so many of the other “ laws ” of nature, as a law of the behaviour of crowds ! This law we call the “ Second Law of Thermodynamics ” : and it is rather a curious one. It says that the *only* way in which you can tell future from past is that you will find more chance and higgledy-piggledy in it ! To take a simple case. Suppose I made a cinema-film, in which some children came into a tidy room and played about at random till it was thoroughly untidy, then left. Now it would be possible to show that film backwards—then you would see the children go into the room, and romp about till it was thoroughly tidy—but *you wouldn't believe it*, you would *know* the film was being run backwards. Well, the whole universe is a vast room, in which innumerable energy is arranged. To muddle thoroughly such an enormous room will take many æons. But the process is slowly and inexorably going on : and it is this increase of muddle on the one side of us, this decrease on the other, which we *feel* as a difference between past and future : this growing disorder which we call the “ passing ” of time.

It follows from this that the time-dimension cannot come round full circle as we imagine space to do. By going far enough into the future we shall never reach the past.

And yet it is not necessary to imagine that time either had a beginning or must have an end. There is no moment at which one can really say of a room that it is "completely untidy"; only, as the process continues, the increase of muddle becomes less and less noticeable. As what remnants of order remain in the universe tend ultimately to disappear, so the passing of time will become less and less noticeable; till at last, whether it is passing or not, and if so in what direction, who shall be able to say?

If space, then, can be symbolised by a ball, time can be symbolised by some curve more like this:



But this, of course, is only a parable among parables. Actually, it must be confessed it is not possible to make a *complete* physical description of the world using even *four* dimensions: to describe some things according to wave-mechanics demands an almost infinite number! But why *should* descriptions, involving a definite number of dimensions, be expected to work? We have already seen that dimensions are not inherent in space, but depend on the circumstances of the observer. Probably the physics of the future will make more and more use of that "Geometry of No Dimensions" now in its infancy. But to do that we shall have to alter altogether our conceptions of our constants: we shall have to cease calling c a velocity at all. And that, for the present, is too hard.

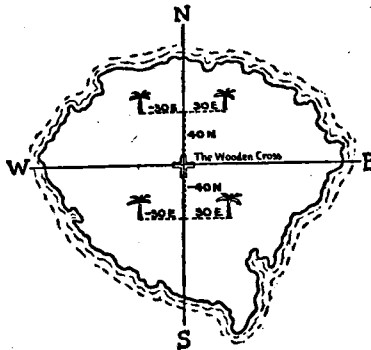
III NUMBER

Numbering space

In the stories of buried treasure, the instructions found in the dead sailor's chest generally read something like this :

In the Middle of the Island you will find a Wooden Cross. Starting from thence, walk forty feet due North : then turn to your Right hand, and walk thirty feet due East. Thus you will find yourself at the Foot of a certain Palm-tree (the same tree on which Jim Bones was Hanged) ; and in this way you shall know it from Every Other tree on the island.

The convenience of this method is obvious. For, given a central point to measure from (the wooden cross), and given two " axes " (in this case the north-south and east-west lines passing through the cross), you can define *any* point on the island by two numbers—in this case (40, 30).



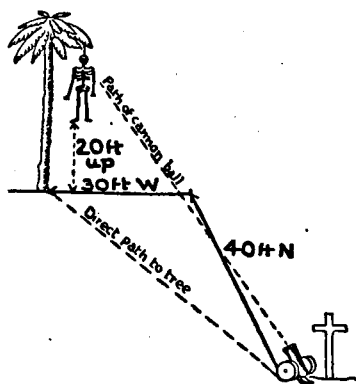
The case I have taken, of course, is the simplest possible one, in that the special tree lies in the north-east quarter of the island. But suppose the tree had lain in another part—even then we could have defined its position without having to use the words "south" or "west." You may even suppose, if you like, that the pirate captain ran away to sea so young, and with his education so incomplete, that "north" and "east" were the only two names for points of the compass he had learnt.



Fig. 63. "In the stories of buried treasure . . ."

If, instead of telling you to walk forty feet north, he had told you to walk sixty feet north and then twenty feet back again, you would have done a little sum in your head, and said $60 - 20 = 40$, and known he meant the same thing. But if, instead, he had told you to walk twenty feet north and then sixty feet back again, the sum would have worked out as $20 - 60 = -40$; and how can one walk a *minus* distance? Yet, if you obeyed his instructions, where you would find yourself, of course, would be forty feet *south* of the cross. In short “ -40 ” feet *north* means forty feet *south*; and in the same way “ -30 ” feet east means thirty feet *west*.

We are now arrived at the foot of the palm-tree. But the key of the treasure-chest is fastened to poor Jim Bones’s watch-chain, and Jim Bones’s skeleton is swinging twenty feet above the ground. We now have a third dimension to consider in defining its position; and a third number to add to the two we had already. So now we define its position as (40, 30, 20).



Now you will have already noticed that the actual fifty feet of distance lying between the cross and the tree *direct* have been resolved into two distances (forty feet and thirty feet) at right angles to each other. Suppose, now, that the tree is too slippery to climb, and the only way to get the key is to shoot the skeleton down with the old brass cannon lying by the wooden cross. We now see that

the distance the cannon-ball will have to travel has been resolved into *three* distances, each measured in a direction at right angles to the other two.

And here again, should the dead sailor's letter tell you the skeleton is not twenty, but *minus* twenty feet up the tree, you will know it lies twenty feet underground. And should warning reach you that the villain is so close on your tracks that he may be expected to reach the island — 3 days after you, then you will know that he got to the island three days before you, and you are too late, for what you have now learnt about the nature of *c* (p. 338) will tell you that it is impossible to fire your cannon-ball faster than the speed of light, and so, firing from the wooden cross *now*, hit the skeleton three days ago!

Thus the pirate captain—little though he probably prided himself on being an expert in analytical geometry—shows us that it is possible to substitute for any point in three-dimensional space (or point-event in four-dimensional space either, for that matter) a group of three (or four) numbers. Moreover, we have already found in the first section (p. 328) that the final discoveries of physics reduced themselves to certain numbers—to *h* and *c* and *e* and *m* and *M* and *G*, and to certain ratios between them. If, then, the ultimate governors of light and matter are numbers, and space-time itself is but a collection of number-groups, can it be that the ultimate reality at the “bottom” of the whole universe is number?

The Pythagoreans in Ancient Greece worshipped number—and there are certain modern physicists who came very near to doing the same. Are we to accept this attitude?

Now it seems to me that, if we do so, we are allowing at least one very serious mistake to creep in. We are taking for granted that the mathematics of the physicist, and the mathematics of the mathematician, are the same thing. It is an easy mistake to make, because they resemble each other closely, and largely use the same terms: but you will generally find that they do not mean quite the same thing by these terms—just as Americans and English people

often mean something slightly different by the same words.

The physicist, as I said already, *uses* mathematics as a language to describe what he discovers in the world. So, if he finds that some particular system does not describe these things correctly, he says that it is wrong, and looks for another. The mathematician, on the other hand, starts from a few primary assumptions and, arguing from them, builds up a logical and imaginary system which *cannot* be "wrong," for he doesn't care at all whether it accurately describes the things the physicist finds in the universe—any more than a musician cares whether his sonata reproduces accurately the noises of everyday life.

However much these two kinds of mathematics appear to resemble each other, therefore, the difference of the ideas on which they are based *should* warn us of the danger of treating them as one and the same.

Take, for instance, the case of geometry. I suppose we most of us conclude that the purpose of geometry is to describe space. Now three-dimensional geometry proves that the three angles of a triangle are together equal to two right angles. The astronomer says no: if the triangle is very large, this is not true—therefore, three-dimensional geometry is *wrong*. The mathematician replies that, while he is just as ready to devise a four-dimensional geometry as a three-dimensional one, neither *can* be wrong, because neither makes any pretence at being a description of the physicist's space. "The simplest concept of Euclid's geometry," he says, "is the point. The point is something defined as having neither length, breadth, nor thickness. But in the whole universe there is *no such thing* as a point! Our journey 'smaller and smaller' has already shown that a limit of smallness is reached, beyond which our ordinary ideas of space and time break down. Geometry goes on to define a line in terms of the point, a plane in terms of the line, and a solid in terms of the plane. But, in nature, just as there is *no* point, there is *no* line, and *no* plane—only rough approximations to them. Is it, then, surprising that a geometry built on ideas which do not exist in all nature, and logically developing from them, should fail in the end

to describe nature accurately? No, if I were building a geometry to describe 'real' space, I should have had to begin at the other end; I should have had to start with the solid, and define approximate planes, lines, and finally even points in terms of solids!"

Pure geometry, therefore, is a work of art built by logic on a basis of imagination—built on the peculiarities of those *imaginary* beings, the point, the line, and the plane. Likewise, the science of number differs fundamentally from all other sciences in its point of view. For the idea of experiment, which is the keystone of modern scientific method, is altogether foreign to the study of number. Experiment at best can only prove that something is true in a great number of cases, and is therefore probably true in most cases: mathematics has no use at all for the *probably* true. Mathematics does not look to see whether something *is* so: mathematics deduces out of her own rules that something *must* be so. Mathematics gave the laws of chance to science—but she will not allow them to be binding on *herself*. Any proposition has to be inescapably true—it has to be proved, as they say, with full *rigour*—if the mathematician is going to allow it any place at all in the structure he builds.

Mathematics, then, is the rigorous study of certain beings called numbers. What are these beings, and how many different kinds of them are there? To find out that is one of the mathematician's chief aims.

Learning to count

The simplest form of a number-sense does not require "numbers" at all; it is simply a sense of "more" and "less." Suppose, for instance, a family of children sit down to supper, each one rushing to the nearest available chair. You can easily tell, with a glance of the eye, whether there were more seats or more children, or whether there were the same number of both. You tell by the "principle of correspondence"—by whether each child corresponds to a chair, or whether there is a chair or a child left unpaired.

Now, suppose that the children are on a visit, and it is

agreed that for the term of their visit one child shall clear away the supper each evening. If, by the end of the time, each child has cleared away once and once only, the same principle of correspondence tells us that the number of chairs equals the number of days in the visit ; and it tells us this by comparing both with one standard group—the family of children. Number, then, is something which can be common to a family of children, a set of chairs, the days in a visit—in short, to any *group* we like to name. It is what is left when, in thinking of a group of objects, we cease to think of what the objects are, or the order in which they occur.

Now, the names we give to numbers are really only such standard groups with which to compare all others we come across. We easily might, for instance (and some primitive peoples do), say “ hand ” for “ five,” “ legs ” for “ two,” and so on. But, even when we had invented and memorised the names of a sufficiency of these groups to serve for all possible cases, we still should not be able to count. To do this, we have to make a new discovery—that these standard groups can be arranged in a certain order, so that each number has a successor, which shall be one greater than the number it succeeds.

Already you will see this takes us beyond the possibility of experiment. For the statement that “ each number has a successor ” means that there can be no last number—there must be an infinite number of numbers. Only logic can tell us whether or not this is so ; there are certainly not an infinite number of objects in the universe, even if we we had all eternity to verify the fact. And yet, if it were not so, the ordinary processes of arithmetic would not be always possible. For let us suppose that the “ last number ” was one million. We could add 500,000 to 500,000, then ; or we could multiply 10,000 by 10,000 : yet we should not be able to add 500,000 to 500,001, or multiply 10,000 by 10,001—an absurd restriction ! And the same, of course, applies, however high we fix our limit.

Mathematical infinity, therefore (which must not on any account be confused with the spatial infinity of the physicists), is a logical necessity.

Extending the number-field

Now you might think the mathematician would be content with an infinite number of numbers to operate on ; but actually this is only the beginning. He calls the series (1, 2, 3 . . .) "The sequence of natural numbers," and then begins to look for others. For he soon sees that without others the "ordinary processes of arithmetic" are still not possible in all cases. He cannot subtract 10 from 10, for instance, or 5 from 5, unless he is willing to admit that 0 is a number. And he cannot subtract 10 from 5 unless he is willing (like the pirate captain) to include the minus numbers—another infinite sequence. Moreover, unless it is to be impossible to divide 3 by 2, or 9 by 7, he must also include fractions, and give *them* the rank of numbers.

This extended class of numbers is called the "rational domain of numbers" : and how rich it is you will see when you realise that between any two rational numbers you can always insert a third—between a half and three-quarters you can insert five-eighths; between five-eighths and three-quarters you can insert eleven-sixteenths, and so on for ever.

Now between the rational numbers, you would think, there is certainly no room left. But what about such numbers as $\sqrt{2}$? They differ very seriously from rational numbers ; for, whereas a rational number is an exact number—you may need many figures to describe it, but you will not need an infinite number—these "irrational" numbers will never "work out" : there is *no* exact square root of 2 : all you can say is that it lies *between* two close rational numbers. And an infinite number of such irrationals can lie between any two rational numbers, however close, that you like to name !

This field of numbers (including the irrationals) is called the algebraic field, because it includes solutions of all possible algebraic equations. But that is not the same as saying that it includes all numbers, even now ! It leaves out the "transcendentals."

With one transcendental number you are probably already familiar—the number π , which is described as the ratio of the diameter of a circle to its circumference. For

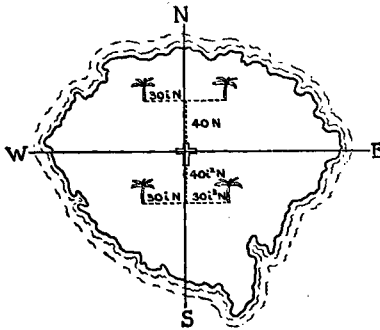
not only will π never work out to an exact answer—it can never even be the solution of an algebraic equation.

Now, all this time you will notice that we have had again and again to use the word “infinite,” and that we have generally used it about a number of operations that could never be all performed experimentally. One cannot, for instance, conceivably imagine oneself adding up the whole sequence of natural numbers and arriving at an answer. But there are other infinite processes in mathematics which do produce answers. If I walk from here to the door, I am, for instance, halving my distance from the door an infinite number of times—and yet I shall get there in a finite time. Such an infinite series of operations, therefore, if it is (as in this case) “convergent,” is said to define the number towards which it converges. Now though each convergent infinite process can only define one number, each number can be defined by an infinite number of such sequences. We thus have to stretch the meaning of number again; and, having done so, we have the “Field of Real Numbers” —the “Arithmetic Continuum.” Between the Real Numbers it is not possible to insert any more.

Yet, though not part of the Arithmetic Continuum, other numbers exist. There is, for instance, the square root of minus one. How can such a number exist? Two minuses multiplied together make a plus, we are taught: what number multiplied by itself could possibly leave a minus? “It is only imaginary,” people said; and so the name “imaginary number” was given to it, and to the complex numbers in which it plays a part. But the name is a pity, for either all numbers are imaginary or none are—we cannot make these distinctions *within* number. Moreover, this number (which is generally written i) turns out to possess a considerable importance. It appears in many calculations, like the fairy godmother in the stories; it appears, that is to say, some time after the story has begun, plays its part, and then disappears mysteriously before the end—or else waits for the grand transformation scene, when it contrives to square itself and so become a “real” number like the others.

No

Moreover, i plays a most important part in modern physics—it could even have been of use to the pirate captain. By employing i , he need have known *no* other direction than north! For when a number is considered as having direction as well as size—when forty, for instance, means forty feet north and not just forty feet in an unspecified direction—multiplying it by i has the curious effect of turning it through one right angle. To lead us to the palm-tree in the north-west corner of the island, he need only have told us to walk 40 feet north, and then another $30i$ feet north, to get us to the same place as if he had told us to walk 30 feet *west*.



This works, as you will readily see, all round the circle. For i^2 , as you know, equals -1 ; so that to multiply a number by i^2 is the equivalent of turning it through *two* right angles—which you have already seen is what a minus direction means. And i^3 will bring us round to the east; while i^4 , of course, $= 1$, and brings us back where we started.

And now see how this applies to problems of the fourth dimension. You may have heard that physicists, when trying to bring the time-dimension in with the other three in a calculation, first multiply it by the square root of minus one. This may have seemed nonsensical, but the reason is obvious: all they are really doing is to turn it through a right angle, in order to bring it "in line" with the other three!

BEYOND COMMON SENSE

Now at last this journey of exploration into the field of number brings us, as our other journeys did, beyond common sense. For now we are going to consider infinity.

Mathematical infinity, you must remember, is not the same thing as spatial infinity. But it is, all the same, a very odd conception. *Is mathematical infinity a number?* Galileo, I think, would have said no. It is not subject to finite arithmetic. You can't add and subtract infinities from each other, he said; you can't even say whether or not two infinities are equal.

But modern mathematicians, beginning with Cantor, have not been content to leave the problem there. They even *have* evolved a system for comparing infinities—for saying that some infinities are of one "power" and some of a greater or less "power." But they have not made them obey at all the rules of finite arithmetic. Certain fundamental "common sense" laws—such as that the part cannot equal the whole, for instance—have no longer jurisdiction in this realm; for here, in considering infinities, it is a fundamental rule that the part *can* equal the whole!

These "powers," as you will imagine, by which infinities are classified, are not ordinary numbers, real or imaginary. They are something altogether new—"parable" numbers one is almost tempted to call them. They are known as *transfinite* numbers: and over them a bitter battle is still raging. For it is necessary to Cantor's theory that, just as there is no last finite number, so there is no last transfinite number—that there is an infinite number of transfinites. But, it has been objected, this infinite number of infinite numbers (the "aggregate of all aggregates," it is called) must *itself* be the highest-powered infinity possible: there can be no transfinite number higher than this power, therefore it must be itself the "last" transfinite number, which was declared not to exist!

The paradox is as yet unresolved.

Salting the mine

This short survey will be enough to give you some idea of what an enormous structure logic has erected on the primitive notion of "more" and "less," and the ordered sequence of natural numbers. You will have seen by now what I meant when I said that the physicist's mathematics and the mathematician's mathematics were different things (though admittedly closely related): that mathematics as an art and mathematics as a language are not strictly the same. The *kind* of reality, therefore, which the mathematician claims for the product of his art, cannot be expected to belong also to the applied mathematics which the physicist uses as a language to describe the universe.

There is a reprehensible habit among those who discover gold-mines of "salting" any area of it from which they expect a sample to be taken for assay with a little extra gold out of their own pockets. Well, it is at least arguable that man first "salts" the universe with the Number he afterwards finds in it. You can read this between the lines of *What Science Can Do* (p. 30).

There is a natural tendency in man called "anthropomorphism"; a tendency, that is, to see everything in his own image. When he first studied nature, he thought that rough seas were angry, that lightning struck him because he had offended it, that the sun ripened his crops out of kindness of heart. Beginning to know better, in the nineteenth century he still thought of the stars in their courses as obeying "laws," like any human population. Bit by bit, and with immense difficulty, he continues to pare away from his conception of the universe each false and clinging remnant of his belief in its likeness to himself. In each age he discards some of the anthropomorphic beliefs of the past as superstitions; but in each age he is deluded by fresh examples which escape his notice. In the present age there is a fashion to say that "God" (whatever that means) is a mathematician. He no longer reveals Himself as any angry God in the thunders, or a benign God in the warmth of summer;

but He reveals Himself as a calculating God in π and c and e and h and m and M .

Science, being human enquiry, can hear no answer except an answer couched somehow in human tones. Primitive man stood in the mountains and shouted against a cliff; the echo brought back his voice, and he believed in a disembodied spirit. The scientist of to-day stands counting out loud in the face of the unknown. Numbers come back to him—and he believes in the Great Mathematician.

BOOKS TO READ

- EINSTEIN : *The Theory of Relativity*.
 JEANS : *The Universe Around Us*.
 EDDINGTON : *The Nature of the Physical World*.
 JAMES RICE : *Physics*. 6d.
 J. W. N. SULLIVAN : *Three Men Discuss Relativity*.
 " " *Aspects of Science*.
 " " *The Basis of Science*.
 A. N. WHITEHEAD : *Introduction to Mathematics (Home University Library)*.
 J. RICE : *Relativity*. 6d.
 TOBIAS DANTZIG : *Number, the Language of Science*.
 FORBES : *The Stars*. 6d.
 " A SQUARE " : *Flatland (a kind of story)*.
 DAVID EUGENE SMITH : *Number Stories of Long Ago*.
 J. D. BERNAL : *The World, the Flesh, and the Devil*.

THE STRUCTURE OF THE EARTH
OR
OUR PLACE IN THE UNIVERSE
by
ROBERT STONELEY



ROBERT STONELEY is a mathematician and physicist. He lectures in applied mathematics at Leeds University, and is the astronomical observer there. He has done research work on geophysics—the physical structure of the earth—especially earthquakes, what and why they are. There are very few earthquakes near Leeds ; as a matter of fact, there was a small one quite a short time ago, but unfortunately it came in the middle of the night and he slept through it. He also very much likes spiral nebulae, partly because they are interesting and mostly because they are beautiful. He has two small children, a boy and a girl, and I expect he tells them about stars and earthquakes.

THE STRUCTURE OF THE EARTH

THE VERY BEGINNINGS

HOW DID it all start? How far backwards can we trace the course of the events that left the world as we now know it and live in it? To these and many other questions we can give only a very scrappy answer, for the earth has had a long history, and there is much to find out; and it is only quite a short time since man has seriously studied these things.

In trying to give a short account of what has so far been found out, the uncertainty about many of the statements that we have to make is a great nuisance, for we ought to keep on saying, "It is probable that . . ." or "There is some evidence that . . ." Instead, however, we will take as our story the best that we can make out of the facts that have so far been found out. It is the only theory so far put forward that fits the facts. But new facts may force us to alter it, and one day somebody may suggest quite a different story.

Now, we might write all sorts of beautiful stories about how the world began, something like the Indian story that the earth is carried on the back of an elephant, which stumbles every now and then, and so causes earthquakes. The trouble would be that, as more and more facts were found out, it would get harder and harder to write the stories, for they would begin to contradict one another.

On the other hand, the scientist finds that quite a small number of simple "laws" will describe a very large number of facts, even when these facts refer to very different kinds of happenings. For instance, the laws of chemistry hold whether the changes go on in a plant, an animal, or in a glass tube. These laws he calls "the laws of nature," and our experience leads us to expect that all the bodies in the universe, whether they are stars or grains of sand, will

obey these laws (see *What Science Can Do*, p. 23, and *History of Ideas*, p. 457). For instance, if a hot body and a cold body are placed in contact, it is always found that the hot body grows cooler and the cold body hotter, provided, of course, that we keep these two bodies from gaining or losing heat in other ways. (We can do this more or less by putting the two bodies in a vacuum flask.) The physicist therefore lays it down as a law that heat always tends to flow from a hot body to a colder one. Now, when we are trying to work out what happens in the stars, we take it for granted that the heat-changes that go on there follow the same laws that hold on the earth, even if those stars are so far away that their light takes millions of years to reach us.

All sorts of people have put forward explanations of how the earth and the other planets came to be moving round the sun, but, when we apply the laws of physics to these theories, we soon see that the trouble is to get even one theory that does not contradict itself. There *is* one main theory that seems satisfactory, but that does not, so far as anyone has seen, explain all the facts that are observed.

When we have traced the whole universe back to one vast expanse of matter without any shape or form—that is, everywhere the same—we are still completely puzzled about how the matter came there in the first place, and perhaps all our long story of the universe is only a little bit of the complete history. Instead of tracing the history backwards from to-day, we will jump right to the earliest stage that scientists have worked back to, and follow as far as we can the course of events that led to the formation of the earth.

Before we attempt to describe how the earth came into being, we must first say something about the objects that can be seen in the sky, either by the naked eye or by the aid of a telescope.

On a fairly clear night, when there is no moon, we can see perhaps, 2,000 stars, and even a small telescope, like the one Richard Hughes used (p. 329), will show us many more. The larger the telescope (and this means “the wider

the large lens or reflecting mirror”), the greater is the number of stars that can be seen. Yet the number of extra stars that the giant telescopes of to-day reveal shows a falling-off as more and more powerful telescopes are brought into use; this fact alone shows that the stars are not scattered at more or less equal distances throughout space, but that there is some sign of a boundary to the enormous group of stars that can be seen through telescopes.

Before we can get a proper picture of the heavens, we must have a “shorthand” way of speaking of the vast distances between the stars, for we are not all in the habit of thinking in millions like the great financiers. One useful way of measuring distances is by the time that light takes to make the journey. Light can travel over seven times round the earth in one second, or 10,000,000 miles in under a minute (see *Physics and Astronomy*, p. 335). On this scale the moon is just over a second’s journey away, and the sun about 500 seconds. The distances of the planets from the sun, then, come out as :

<i>Planet</i>	<i>Light-time from Sun</i>
Mercury	3 minutes
Venus	6 minutes
Earth	8½ minutes
Mars	13 minutes
Jupiter	43 minutes
Saturn	1 hour 20 minutes
Uranus	2 hours 40 minutes
Neptune	4 hours 10 minutes
Pluto	6 hours.

It is a long journey to the nearest star—about four years; you can see how lonely is the sun, which is just an ordinary sort of star, when you realise that at present only eight stars have been found to be less than ten ‘years’ journey (or “light-years,” as they are called,) from the sun.

Leaving out certain special kinds of objects with which we shall deal presently, the greater number of the stars

that can be seen, even with the largest telescopes, form a huge flat collection, shaped something like a thin bun or tea-cake, at least 60,000 light-years across, and perhaps much more. The sun, with its family of planets, is well inside this "bun," and it is in this way that we explain the "Milky Way," or "Galaxy" (see *Physics and Astronomy*, p. 336).

Within this gigantic flattened group, which contains, according to one estimate, some 30,000,000,000 stars, are to be found all sorts of interesting objects. One of the most important is the "star-cluster," which is sometimes a very neat-looking cluster of perhaps 50,000 stars closely packed together, and sometimes more "open" in appearance, like the Pleiades ("The Seven Sisters" or "Butcher's Cleaver") or Præsepe ("The Beehive"). Large as these clusters are—perhaps 100 light-years for the "globular" clusters and much more for the open clusters—they are no more than tiny currants in the tea-cake that we have chosen to represent the Milky Way system. Our sun is just one star of a large open star cluster in this system.

The Milky Way system, enormous though it is, may be regarded as a little colony on its own. Right outside it, space is dotted with the numerous objects known as "spiral nebulae," which Richard Hughes has already described (p. 337) (see Fig. 64). They are at enormous distances; the nearest, the Andromeda nebula, is nearly a million light-years away. They are much larger than the star clusters, and are nearly as big as the Milky Way system, although this system, if it is a spiral nebula, is easily the largest known. On account of the size of these spiral nebulae, and their great distances apart, they are often called "island universes," and the Milky Way system may be called the "local universe." Of course, at one time the word "universe" meant "everything that exists," but now we know of distances that were not dreamed of thirty years ago, so perhaps it is not so very ridiculous to use the word in its new sense.

Very many of the spiral nebulae show a pair of curved arms—hence their name. The spectroscope shows that



Fig. 64. SPIRAL NEBULA

This is one of about two million spiral nebulae that could be photographed by the largest telescope in existence—the Hooker telescope at Mount Wilson, California, which has a mirror 100 inches across.

the light of the nebulae is the same sort of light as that given out by stars (see *Physics and Astronomy*, p. 334), so that we are fairly safe in stating that the spiral nebulae are made up of an enormous number of stars. One day perhaps some very powerful telescopes will show up these stars, but all we can say at present is that photographs taken with the largest telescopes in the world show bright points in the arms of the Andromeda nebula. These, we expect, correspond, not to *single* stars, but to *clusters* of stars. The spiral nebulae are moving away from us at great speeds, and the more distant they are, the more rapidly are they receding. Thus the whole known universe seems to be expanding,—as indeed theory predicts.

We have, then, the following objects, each enormously greater than the one that follows :

Spiral nebula
Star cluster
Star (sun)
Planet (earth).

This brings us to the main problem, how all these are related to one another, and incidentally why these different kinds of matter occur at all. For it is strange that, although stars differ very much among themselves in size and brightness, yet the amount of matter in each is roughly the same : it is very rarely that a star has ten times as much matter as the sun or as little as one-tenth as much. Then, again, there is a big drop in size from spiral nebulae to star clusters. About the sizes of the planets we cannot say much, for the sun is the only star that we know to have planets.

Now, to guide us we have one rule to which there seem to be no exceptions, namely, the "Second Law of Thermodynamics," explained in detail by Richard Hughes on p. 343. This at least makes it certain that some things *cannot* have happened. We *think* that certain things did happen. We think that the planets were formed from the sun. The stars were most likely arranged in star clusters

at one time, and it seems as if these star clusters were formed from spiral nebulæ.

What came *before* the spiral nebulæ? Since we do not know of anything, except perhaps traces of gas spread out through vast tracts of space, from which the spiral nebulæ can have been formed, it has been supposed that at one time, countless millions of years ago, the whole of space was full of gas, or perhaps a fine dust. It would not have been so heavy as the air we breathe—we must think of the slight trace of air that is left in an electric light bulb after practically all the air has been pumped out. What happened before this stage (if it really was a stage) is a problem that nobody has thrown much light on.

Now this gas would not have remained equally spread out through space. The law of gravity, according to which every particle of matter pulls every other particle, shows that the matter would collect into separate lumps, dotted about through space, each getting hotter as it contracted. These were the early stages of the spiral nebulæ, and a small number of the very distant nebulæ do look different from a spiral; in fact, they look like a mass of glowing gas, and are very likely spiral nebulæ in their infancy.

Because the spiral nebulæ which we can see now are spinning, we can reasonably suppose that the original gas that filled space was spinning round slowly. As each of these first nebulæ span through immense lengths of time, and shrank more and more under the action of gravity, it would spin faster and faster; at last it would reach a stage where it would cease getting hotter and start to cool. In shrinking, it would throw out two arms on opposite sides, just as the spiral nebulæ that we know do. The matter in these arms would collect into "knots," in much the same way as the original gas did in forming the nebulæ, and these knots (which we can see in some of the latest photographs of spiral nebulæ) would be of about the right size to form star clusters, as already stated.

As far as stars are concerned, we do know why they cannot be much larger or much smaller than the sun. Light exerts a pressure, just as a jet of water from a

garden-hose does when it hits a plant. It is this pressure that drives some of the dusty matter which comets are made of *away* from the sun to form a tail. In the stars the light from the intensely hot interior pushes the outer parts further outward, so that the star will swell slightly. If the stars were much larger, light pressure would burst them, something like the bursting of a balloon; if the stars were very much smaller, they would cool down and cease to shine, just as a small cinder that falls out of the fire cools more quickly than a large one. It is likely indeed that there are many dark stars that we do not see, and Sir James Jeans once calculated that there are three times as many "dark" stars as shining stars. A mass containing as much matter as a star cluster should form, not one huge star, but a lot of smaller stars, and the only ones we see are those of about the same weight as the sun; any that are very much smaller than the sun are dark and therefore invisible.

HOW THE EARTH SPLIT OFF FROM THE SUN

Now comes the difficult problem of how the planets were formed from the sun. For a long time people thought—and you may have heard—that the sun was at one time much more swollen in size, and that in cooling it threw off rings which condensed to form planets. We now know that for several reasons this scheme would not work, and the only theory that fits the facts seems to be the following.

At one time the sun had no planets. As we have already seen, the stars on the whole are very far apart, so that a star moving at the rate of twenty miles a second—quite a usual sort of speed for a star—would have a long journey before it got close to any other star. But now and then it does happen that stars pass very close to one another, and it was through an "encounter" like this that the planets began. It is quite likely that the star, which must have been heavier than the sun, actually grazed it. At any rate, when the star was very near the sun it would have pulled out a stream of matter from it—something like the arm

of a spiral nebula: and there would also have been a smaller arm shot out on the other side of the sun.

As the star went away from the sun, a lot of the matter fell back on to the sun, but, owing to the pull of the star, part of the arm between the sun and the star was pulled far enough from the sun to escape being pulled back again into the sun. The arm would break up into portions, and it is these portions that must have condensed to form planets moving round the sun. Most of the spin of the planets was caused by the pull of the star on the arm of matter. Further, some of the planets must have had a stream of matter pulled out of them, and it was in this way that the moons of Jupiter and Saturn and some of the other planets were probably formed (see Fig. 65).

This theory explains why the planets all spin on their axes in the same direction as the sun, and travel round the sun in the same direction; also why *most* of the satellites (i.e. moons) of the planets go round in the same direction.

At first the paths of the planets were long ovals round the sun, but gradually the friction of the trace of gas through which the planets moved made their paths into the nearly circular ones that the planets (and their moons) have to-day.

If this theory is true, it is quite likely that some of the stars have families of planets. However, it will be a long time before telescopes can be constructed that are powerful enough to see such small things as planets going round the stars.

HOW THE EARTH GOT SOLID

So now the earth had just split off from the sun. It was so much smaller than the sun that it cooled quite quickly, first forming a liquid with a lot of gas surrounding it. Later on a thin crust formed on the top of the liquid. In the meantime the heavier materials, such as drops of molten iron, sank right down and collected as a "core" at the centre.

Much more of the liquid became solid rock in the end.

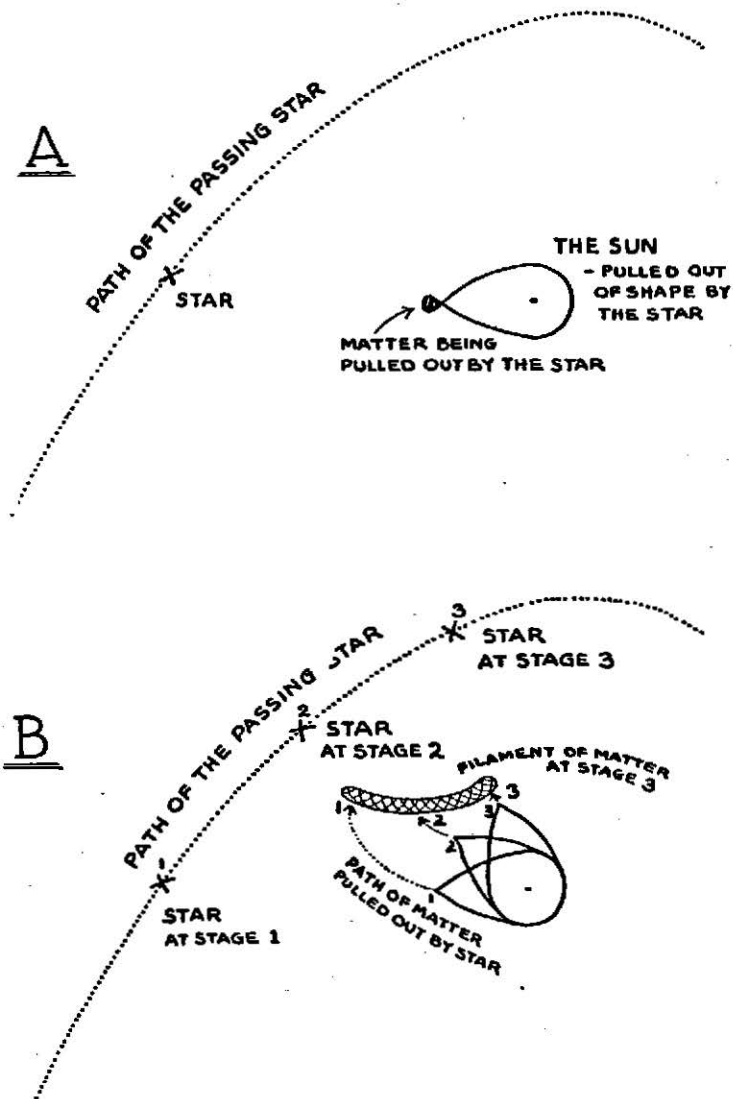


Fig. 65. HOW THE PLANETS WERE FORMED BY THE SUN

- A.** The star gets near enough to pull out matter from the sun, and drags the matter after it as it passes.
- B.** Three stages in one picture. The matter pulled out in the first stage has followed the path 1. The matter that came out in two later stages has followed paths 2 and 3, and all the matter forms a "filament" that afterwards broke up to form the planets. (After Jeffreys.)

Pieces of the thin crust, which would be heavier than the liquid that it was floating on, would sink; some would melt again, and so help to cool the liquid below, and some would sink right down until it reached the heavy core. In this way the earth, except probably for the core, became solid in a few thousand years—a very short time in its history.

At the time the earth was liquid it was so hot that nearly all the gases at the surface escaped into space. (This is because the tiny particles that make up a gas—"molecules" as they are called (see *Chemistry and Physics*, pp. 285 and 322)—move faster when hot than when cold, and so have a better chance of getting clear of the earth's pull.) Where did the air and the ocean come from, then? Any water would have formed water vapour (steam), which is lighter than air. Now it is a queer fact that under high pressure water and molten rock mix together quite easily, just like water and treacle. So all the ocean and all the atmosphere must at one time have been inside the earth! As the rock became solid, the water was set free as steam and rose to the surface, becoming water as soon as it was cool enough.

The story of the air is more difficult to find out. Some of it cannot have got away into space at the time that the earth was very hot. We must remember that air is made up of several gases, with traces of a number of others (see *Chemistry*, p. 252-254). It is likely that the nitrogen and carbon dioxide came from inside the earth: they are still being sent out from volcanoes. Plants take up carbon dioxide to make their food; they keep the carbon and set free most of the oxygen, and it is quite likely that this was the manner in which the atmosphere got most of its oxygen.

THE MOON

We have left out one important question; where did the moon come from? This is difficult to answer. The trouble is that the earth is rather a small planet, and our moon is

a large moon for such a small planet. It is, indeed, about one-eightieth of the weight of the earth, whereas Jupiter is 12,000 times as heavy as his largest satellite. It could not very well have been formed like the moons of Jupiter and Saturn, which, as we have seen, were made from their planets in much the same way as the planets were made from the sun. We can only suppose that one little planet happened to be very near the earth when they were both formed, and that they have kept company ever since. One thing we do know is that the moon was much nearer the earth when the earth became solid than it is now ; in fact, less than half its present distance.

HOW LONG AGO ?

All this took place a long time ago, and we naturally ask, How long ago ? It so happens that in the earth there are a few substances that act as clocks. Radium (*Chemistry*, p. 271) is one of them, and two others, uranium and thorium, are the ones that give us the information we need. Radium is a chemical element whose atoms break up of their own accord into helium and radon. The radon itself breaks up and passes through a series of changes of the same kind which end with lead. Now we cannot make radium break up faster or slower, whether we heat it to a white heat or cool it to the extremely low temperature of liquid air ; in 1,580 years half the radium in a given specimen would have broken up. There would be no radium left in the world but for the fact that it is being formed all the time from uranium, which splits up of its own accord in the same sort of way as radium, and is therefore slowly turning into lead. It takes, however, 5,000,000,000 years for uranium to be half changed. The more lead there is in a piece of uranium ore, the older it must be. It is fortunate that the change of uranium into radium takes place much more slowly than the change of radium into radon, otherwise practically all the uranium would have turned to lead—our clock would have run down long ago !

Uranium ores are found in all sorts of rocks, in some which we know to be very old, and in some that are fairly new (as rocks go), and the amounts of lead show that the oldest known rocks are at least thirteen hundred million (1,300,000,000) years old. Thorium ores tell the same story. Entirely different sets of facts confirm this result, and it is fairly certain that the age of the earth is between 1,500,000,000 years and 3,000,000,000 years.

HOW THE EARTH COOLED DOWN

Many changes took place before the earth was in its present form. It would not take very long for the surface to cool down to about its present temperature. The inside would cool more slowly than the outside, just as a cake does when taken out of the oven, so that after a firm crust had formed all over the surface the inside went on cooling and shrinking. In this way the inside became too small for the crust to fit it; accordingly, the crust, which is all the time being pulled towards the middle of the earth by the force of gravity, had to crumple into ridges, and these are the mountains. The cooling has gone on ever since, and from time to time mountain ranges are being formed. As the shell settles down, one part slides past another: these cracks in the earth are called "faults," and in railway cuttings we can sometimes see how on the two sides of a fault two different kinds of rock have been brought next to one another.

Each time there is a sudden slip of this kind, or whenever the crust of the earth drops down a little way to keep pace with the shrinking of the inside, the shock causes waves to travel through the earth, like the rumbling of a lorry, only much more violent. When these waves reach the place where we are living we feel a shaking which we call an "earthquake." Often these are only slight tremblings of the earth, but sometimes whole cities are shaken down, as in the Japanese earthquake, which, with the fires that followed, destroyed Tokyo on September 1st, 1923.

Earthquake shocks are being recorded all over the world at more than 300 places by means of very delicate instruments called "seismographs" (see Fig. 66). The records of artificial explosions, for instance, have shown how long a wave takes to travel through the ice of the Greenland ice-cap down to the land underneath and up again to the surface and in this way the thickness of the ice-sheet has been measured. The speed at which earthquake waves travel along the surface of the earth tells us something about the composition of the outer layers, that is to say, the rocks down to about 30 miles deep. The times taken for waves to travel deep into the earth and out again so as to reach observatories thousands of miles away from the place where the earthquake occurred indicate that no very important change in the earth's composition occurs below about 30 miles down until about half-way to the centre, where the material changes quite suddenly from rock to a core of much heavier material, which seems to be iron. It is so hot down there that the iron is liquid: at least, all we can say is that it behaves like a liquid, for nobody has examined a liquid under such a great pressure as there is at the centre of the earth. The energy of the waves sent out in earthquake shocks shows that the earth is shrinking at just about the rate we should expect.

CHANGES IN THE EARTH.

The face of the earth is always changing, and the sun, which is continually sending light and heat to the earth, does more than anything else to make this happen. In some parts of the world, such as Ceylon and Central Africa, the sun shines very fiercely, and at midday is practically overhead. But near the North and South Poles there is a large area always covered with ice. At the poles the sun's rays strike the earth at a small angle, and the light and heat received from the sun are spread over a larger area than they are at places half-way between the poles (i.e. at the equator), where the sun shines directly down on to the earth.

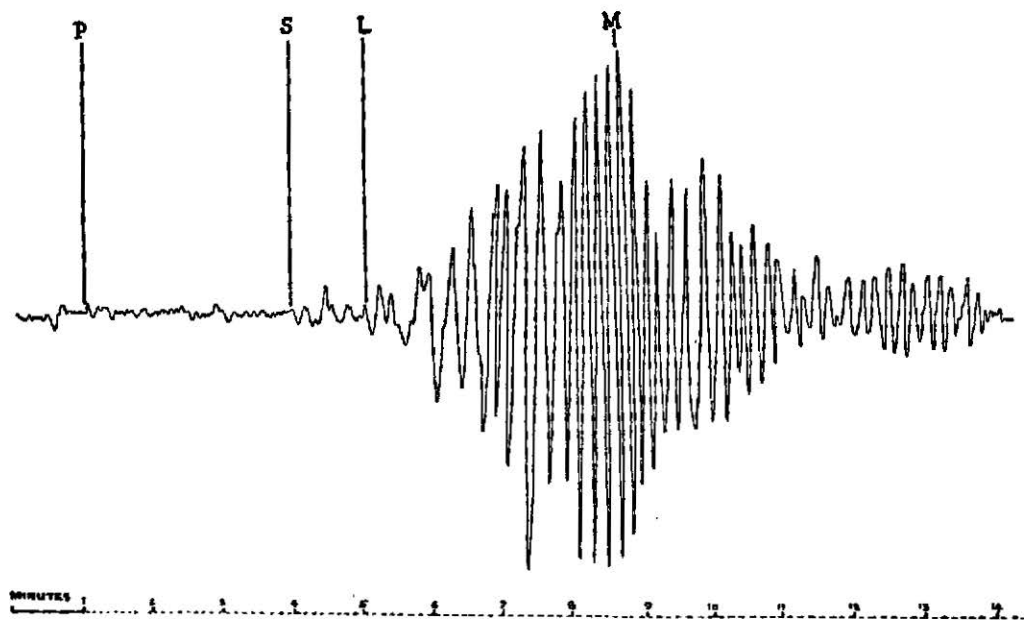


Fig. 66. SEISMOGRAPH RECORD OF AN EARTHQUAKE

Note: The great Italian earthquake of the 23rd July 1930 as recorded at Kew Observatory. The waves P, S, etc., have travelled through the earth and the L, M part over the surface.

The light of the sun comes straight through the air without warming it very much. When it reaches the earth it heats up the ground, and this in turn warms up the air. In this way, especially near the equator, the air gets hot and expands, becoming lighter. This hot, light air rises as the air rises over a fire, and colder air comes in to take its place. In this way winds are caused. The directions of the winds are affected by the spin of the earth on its axis, and in this fashion we account for the constant "trade winds."

There is always some water vapour in the atmosphere, usually a fair amount; there is a pint of water in any ordinary room. When winds blow across the oceans, the air takes up as much water as it can hold, and it is then said to be "saturated." When this very wet air reaches a mountain range, it has to rise in order to get across. Now the higher up a mountain we go, the less is the pressure, because there is less air above to do the "pressing" than there is at sea-level. The moist air expands as it rises, and in doing so it cools and gives up much of its water as rain. That is why it is so rainy on the windward side of mountains. When the air comes down on the other side of the mountain, it is rather dry. For example, rain-laden winds reach Great Britain from the west, after crossing the Atlantic. They give up much of their water on the mountains of Ireland, Wales, Cumberland, and the West of Scotland, and are fairly dry when they reach the eastern side of Great Britain. Most parts of the Lake District have over eighty inches of rain a year, while in much of the Fen District the rainfall is less than twenty-five inches a year.

This rain collects into streams, and these join up to form rivers; the water carries down fine particles of rock to form sand or mud, and, in time of flood, stones and large boulders are swept along the river-beds. In this way the mountains and hills are being worn away. Water gets into the cracks of the rocks also, and expands with great force when it freezes: great pieces of rock get broken off and fall down the mountain-sides, and in the end get ground away by bumping against other boulders in the mountain torrents. Substances like salt, that dissolve in water, are

likewise carried down to the sea, which thus gets more and more salty.

We have to picture all this going on after the original crust of the earth was formed. The mountains were gradually lowered, and the broken-up rocks raised the level of the lower-lying land. Some of the sand and mud was carried out into the sea and laid down on the sea-floor. Some made new land, just as the Mississippi, the Nile, and the Ganges are doing to-day. Layer after layer was deposited in the sea, and one day, perhaps after many millions of years, some great movement of the crust of the earth raised part of the floor of the ocean above the level of the water, so that it became dry land. In some seas the shells of very tiny animals collected for millions of years, and these in due course became the great deposits of chalk that you have probably seen.

Most of the rocks now found in the world were formed as "sediments" under the sea, and are accordingly known as "sedimentary rocks"; the sedimentary rocks seem to have covered up all the original crust of the earth. In many parts of the world molten rocks have from time to time flowed up from underneath the crust, and the same thing is going on at the present time in the active volcanoes. Sometimes the molten rock flowed over large areas, and the rocks of the Giant's Causeway in Antrim are part of a great outpouring. The great rock of Dumbarton is the remains of the hard plug of granite that fills up the neck of an extinct volcano of bygone ages. We may regard such rocks as granite and basalt, which have come right up through the sedimentary rocks, as samples of the material of the true crust of the earth.

L I F E

The oldest of the sedimentary rocks that we know of do not contain any traces of life; many of these rocks have been much changed by heat and by pressure. Life seems to have started a long way back, however, for rocks which

must be about 500,000,000 years old contain a number of different kinds of animal remains, preserved as "fossils." We are able to trace the changes in the fossils from the earliest times up to the present day because the surface of the earth has got very much twisted and wrinkled, and rocks containing fossils have in this way been brought up from great depths (see *Biology*, p. 190).

A study of fossils shows how more and more complicated forms of life appeared as time went on, and the nature of the rocks shows that every part of what is now dry land has had its "ups and downs"; sometimes the land has been beneath the sea, where sand, clay, or chalk has settled down on to it, and sometimes it has been raised high above the sea, so that it was quickly worn down by frost, rain, and other causes. It is very interesting to trace the changes that have gone on in the British Isles; these changes are, of course, the same kind of changes that have happened in the rest of Europe. Great Britain and Ireland are really a part of Europe that has happened to be separated off by a river that grew very big and became the Channel.

Some 500,000,000 years ago there were some large movements of this part of the world, and much of the land that had been high and dry sank beneath the waves. This sea is the first that fossils tell us anything about, and in the rocks that were formed under that sea we find plenty of fossil remains of the creatures that lived in it; some of them are related to the shrimps and lobsters of to-day (see Fig. 67, trilobite). After perhaps 100,000,000 years the land was raised again, and in some places became a desert; the beautiful red rocks of South Devon are made of the sands of this desert. There were fish in the sea, and on land there were ferns and some plants rather like them.

Then came another drop in the land, and in the sea that covered England were formed the limestone rocks that are seen in Cheddar Gorge, the Peak, and in the Yorkshire mountains Ingleborough, Wharfedale, Penyghent, and others. As the water grew shallow later on, coal was formed from the refuse of forests of giant tree-ferns. Insects and spiders now existed, and it is interesting to remember that

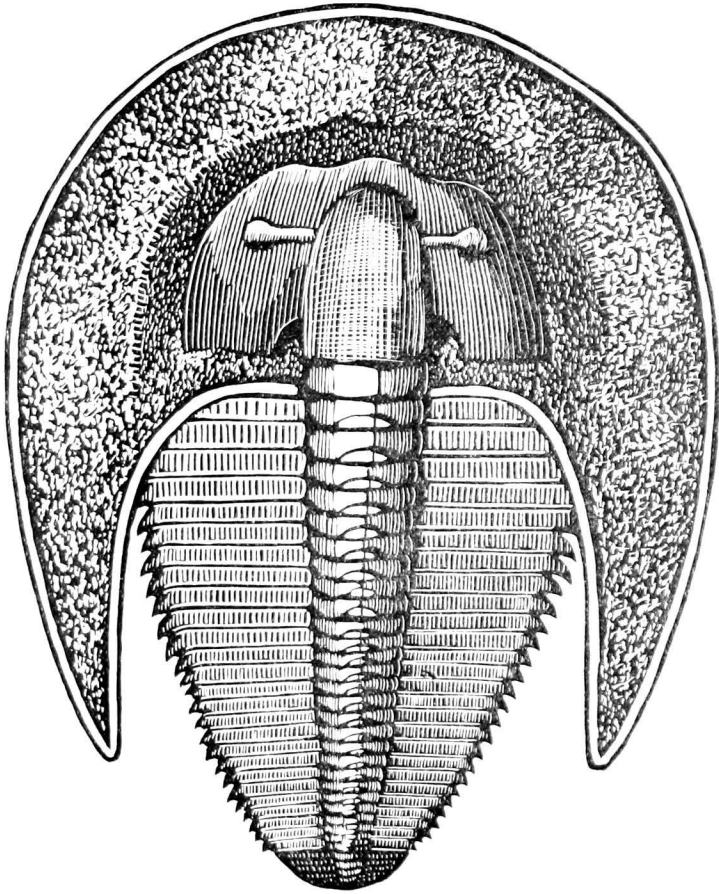


Fig. 67. TRILOBITE

Trilobites occur in very old rocks, and are the remains of creatures, the forerunners of our crabs and lobsters, that swam in the sea 600,000,000 years ago.

the coalfields to which Great Britain owes so much of her trade were formed about 200,000,000 years ago. After this, a continued rise in the land allowed a large amount of wearing-down of the newly formed rocks.

A large amount of crumpling of the surface took place at this time, and the mountain ranges that were formed

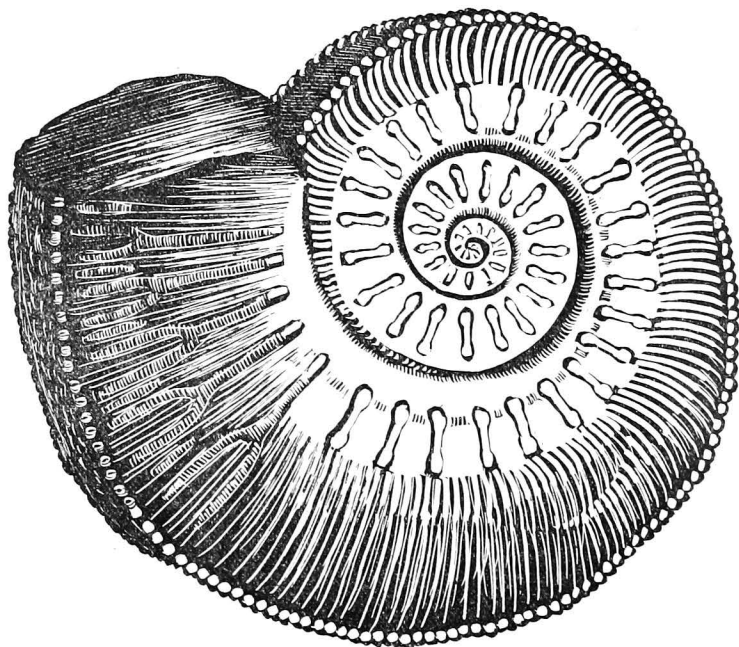


Fig. 68. AMMONITE

Ammonites existed in large numbers during the time that the oolite rocks (seen in the Cotswolds and the Yorkshire Wolds) were being formed, about 100,000,000 years ago. They have a flat spiral shell.

cut off arms of the sea, forming lakes, and at the same time the mountains kept these lakes from getting a proper amount of water in the form of rain ; the result was that northern Europe became a desert, with salt-lakes, and the salt-beds of Cheshire are the result of the drying-up of these lakes.

Then there was a new fall in the level of the land, and nearly all of England and Scotland were under the sea,

In this sea was formed the limestone which is now seen in the hills that stretch across England from Dorset to north-east Yorkshire (where they form the Yorkshire Moors) (see Fig. 68, ammonite). On the land were found trees closely related to our modern cone-bearing trees (such as our pine, fir, larch), while giant reptiles swam in the sea, roamed the land, and even flew in the air. After another rise above the water, during which there existed on land some of the earliest mammals, ancestors of such animals as the kangaroo, there came the last great sinking of England below the sea.

During this time the sea covered the south-east of England, and the chalk, which we find in Salisbury Plain, the North and South Downs, the Chilterns, and the Yorkshire Wolds, was formed from the tiny shells of little creatures living in the sea. At this time, about 60,000,000 years ago, although ferns filled the place that flowering plants occupy nowadays, a few flowering plants were beginning to appear, and fishes and reptiles became common. Birds began to appear, but they still showed likeness to reptiles, and often had teeth (see Fig. 69).

When the land was raised again, a large amount of folding took place, and at this time the Alps and most of the mountains of southern Europe were formed. However, England had its ups and downs on a smaller scale, and the London Clay, on which the city of London is built, was laid down almost directly on top of the chalk in a "basin" formed by a fold. In the London Clay they have found fossils of birds, turtles, and snakes, and the remains of palm-trees show that for part of this time, at any rate, the climate was much warmer than it is now.

During the time from then to the present day the larger animals have developed, and so have the kind of plants and trees that inhabit the world to-day (the conifers and ferns, however, belong to much older families). In some deposits laid down not very long ago (as geologists and astronomers count time) there have been found the remains of primitive man.



Fig. 69. PTERODACTYL

This was a winged lizard whose outstretched wings measured as much as 16 feet across. Their remains have been found in the chalk in Kent.

M A N

Just about that time there was a great Ice Age, and the northern part of the British Isles was covered with ice, just as Greenland is to-day. Possibly man existed before this Ice Age, and advanced northward as the ice melted: perhaps he came afterwards. But here we leave geology and begin to study geography, history, and anthropology. *The History of Ideas* chapter fits on next.

One word in conclusion. The earth has by no means settled down to a quiet old age. Land is still rising in some places and sinking in others: climates are changing—that of England is getting drier (grown-ups won't believe this!): large earthquakes occur quite often, and volcanoes are pouring out molten rock and hot ashes, just as they did in the Lake District and in Scotland in past ages. There has been a great volcanic eruption in South America since this chapter was first written. These changes are nothing for us to get frightened about. Most of the changes of level referred to take place very slowly, and during the comparatively short time that man has been on the globe the changes in the map of the world have been small. It would be more profitable to try and imagine what race of creatures will rule the world in a million years' time!

PART II
CIVILISATION

EDITOR'S INTRODUCTION TO PART II

Now, IF you have read most of the Science part of this book, you will have got an idea of the kind of animal you are, and of the kind of place that you live in. And the next thing to think about will be how you live. Of course, by place I don't mean London or Oxford or Auchtermuchty, but the whole thing. You can't separate, even in your minds, the solar system from the universe, or the earth from the solar system, or one county, or town, from the earth; the same scientific ideas hold good through them all, and, if you try to consider them as something entirely on their own, the way they exist doesn't make sense. And equally you can't separate your body from the air you are breathing, the food you are eating, the book you are reading and which is having some effect on your mind, or the laws of gravity that allow you to sit comfortably in a chair reading, instead of whizzing off into space. And still less can you separate your mind from your body, or any other "you" from any other part of the universe.

Of course, if you are thinking in terms of art or of science, you can and must to some extent think—and think well—of things and people all divided up and separate, but, even if you do, you must keep in the back of your mind the certainty that they aren't really separate, but that you are thinking of them in this special way just because you want to focus your mind and your imagination very intensely on one single kind of reality. You are making yourself into an instrument of precision, a sort of mental microscope. Equally in this book, and in the part you have just read, we have had, for the sake of clearness and precision, to write of things separately and in compartments. And, on the whole, you have been reading and thinking of people as single, separate bits of life. But in the next part you are going to look at people not separately, but in groups, considering not only themselves, but one another.

In the last chapter you read, on *The Structure of the Earth*, you saw the kind of place where mankind started, and in which it is likely to go on living for an indefinitely long time. Because we live in this kind of a world and not some other kind—for one can easily imagine other kinds of world with, for instance, a different atmosphere and different chemical make-up—we are the sort of animal that we have become. Biologically, perhaps, the most interesting thing about us men and women are our heads and hands. But we have also developed self-consciousness, and all that this implies. This has only just been touched upon in the Science part, but now we shall get down to it. It is part of what civilisation is about.

You will also, after having read even quite a little of the Science part, have seen the kind of thing which scientific knowledge is; you will have seen what a great body of knowledge it is, although most of it has been found out so lately. People are trying to apply this knowledge. But sometimes they make mistakes, and there are always a lot of other people who hinder them. Sometimes this is because one group of people think that it will be bad for everyone if the knowledge is applied, and sometimes because they think it will be bad for themselves: they will lose power or honour or something like that. And quite often people try to make practical use of a scientific discovery just so as to make money for themselves, which seems a pity. A great deal of the history of civilisation is really showing how people have tried to apply their knowledge, and it also shows one of the difficulties of a lot of knowledge: that life gets more and more complicated and difficult to live quite easily and simply.

One thing I hope you have noticed is how many different points of view the writers have had. Try and see, for instance, how differently Professor Cullis, Dr. Baker, John Pilley, and Richard Hughes look at things which aren't essentially different from one another. Perhaps things have got to be looked at from a good many different points of view before we can see all round them. The people in the next part have even more different points of view, as you

will see for yourselves, and it will be rather exciting to find out the places where all or most of these people do actually agree with one another. I always think it is rather dull reading books where the author's own ideas don't come through at all.

I have explained about the plan of the Civilisation part of this book in my Introduction at the beginning. I hope you didn't skip that, because, unlike so many introductions, it was really meant to be read.

AN OUTLINE OF WORLD HISTORY

by

N. NIEMEYER AND E. ASHCROFT



NANNIE NIEMEYER (who is now Mrs. Macfarlane) has written a good deal of history before, so you may have come across her books already. She has lectured at two colleges, and now lectures for the W.E.A. She has a little girl, whose questions about history are very hard to answer. Edward Ashcroft used to live in Paris, but now he edits a paper about electrical engineering and lives in London. They have had a real puzzle to get the history of mankind into so few pages, and they have not been able to put in the details, but you will see the main outline, and you will perhaps also see that the history of England, which is what you chiefly learn at school, is only a tiny part of the whole. After all, most of the history of mankind happened before people started writing or making any kind of record. It was not until men had leisure and curiosity enough to stand aside from work and magic and food-getting, that they could look at themselves and their fathers and

ask, what happened before us? Just as the things which geometrical figures prove were true before Euclid, so there was history before Herodotus; but just as scientists make science, so historians make history.



AN OUTLINE OF WORLD HISTORY

THE FIRST GREAT DISCOVERIES OF MANKIND

YOU MAY often hear it said that the world is becoming a unity. As far as this is true it is so because, first, communications are world-wide, and, secondly, because many people have interests, and are affected by events, in very distant countries. World history should explain how this has come about.

We are living in a stage of history which only began with the Industrial Revolution, some 150 years ago (see *Organisation of Society in the Past*, p. 531). Man actually began to write down his doings some 5,000 years ago, and beyond that date the vast unwritten history runs back perhaps to earliest ancestors, more than 250,000 years ago.

The earliest men of whom we really know anything we call Palæolithic (Old Stone) men, because they chipped their few tools out of stone. Remains of them have been found in Europe from Spain and the south of England to southern Russia, throughout Asia, and in Africa; (not in Scandinavia, northern England, Scotland, or Ireland, where the climate was probably too cold.) Few and slight remains have been found in South America. Nothing very much is known as yet about Australia; perhaps the ancestors of the native Australians drifted over the seas at a time when Palæolithic days were over in Europe and Asia. For at some time, perhaps some 10,000 years B.C. in Europe and Asia, men discovered how to grind stone tools to an edge, thus enabling themselves to cut harder materials. In this vast Neolithic (New Stone) Age the first stone constructions were made, such as the dolmens of Brittany. Three other mighty discoveries or inventions were made. One was the invention of pottery, first worked perhaps in south-east Asia, probably even before 5000 B.C. The art passed from hand to hand exceedingly slowly: in Europe,

potsherds are first found in Danish shell-mounds of about 4000 B.C. Secondly, at some equally remote time animals were tamed; sheep, cows, and goats in the mountains of Asia, dogs perhaps earlier, and horses somewhat later, and in cooler lands. (The tamed horse probably came into Mesopotamia from the north about 2000 B.C.) The third great Neolithic achievement was agriculture. Wheat was grown, perhaps first in north-east Syria, or Transcaucasia, probably before 5000 B.C. Either there or in Egypt, men first grew barley (see *Applied Biology*, p. 215). Knowledge of agriculture travelled slowly; in England, Neolithic men made pots, but it is still a little doubtful whether they grew crops. Beside all this, Neolithic people learnt to weave fibres into fabrics.

METAL

Some people probably had tamed animals, but no crops; this went on for a long time on the steppe lands. We know, indeed, that at this point in development a great migration took place. Men who used stone tools, and had tamed dogs, but no other animals, crossed the Behring Straits into America, and wandered slowly south, eventually to people the continent. Other people grew crops, but had few if any animals, as far as we know now. In one area, crops and stock, weaving and pottery, all added to the riches of life. This was in the plain of the Lower Euphrates, and here, among the Sumerians, arose the earliest known civilisation. Some historians believe that the Sumerians actually taught the Egyptians how to grow wheat, and perhaps other things as well. Some archaeologists even think that the next vital discovery was made in north-east Syria, and not in or near Sinai, as others believe. This discovery (before 4000 B.C.) was of the smelting of metal. The Copper Age is becoming better known to us year by year by excavation in the Near East, but we cannot yet tell whether Sumeria developed a high civilisation before Egypt, though it seems possible. In Sumeria long before

3000 B.C. men lived in brick houses, in cities, owned fields and flocks, built tower temples, made lovely things in metal and stone, and wrote with wedge-shaped letters. They traded with Egypt, with the Indus valley, with Persia and the Pamirs. Sumeria's greatness may go far back beyond this; Egypt's first greatness dates from about 3000 B.C., when the Pyramid Age began (see *Organisation of Society in the Past*, p. 503).

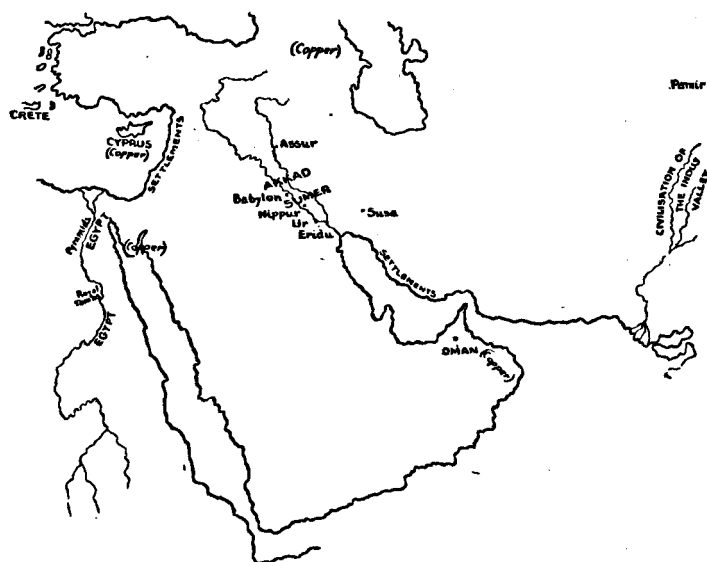


Fig. 70. Map A. Sketch Map of Part of the Early World, soon after 3,000 B.C.

N.B.—We know of many other settlements beside those marked here; the places shown are those of most importance.

The Copper Age merged into the Bronze Age, which lasted until about 1800–1200 B.C. in the Near East, and much later in western Europe and the extreme East. Map A shows some of the important places early in this time. England probably had no Copper Age at all, for, before its scanty population had learnt the use of metal at all, men who came from the Continent brought with them knowledge of bronze.

TRADE AND CONQUEST

On the wall of an Egyptian pyramid temple at Gizeh, built about 2800 B.C., is carved a beautiful sea-going ship, with sails and oars. Such ships had been elaborated from simple Nile boats. They went to Syria, to Persia and India, to Crete and Asia Minor. Egypt became a conquering power, and ruled Syria, with its harbours and its caravan routes (about 1500–1100 B.C.). The Egyptian ships frequented these harbours, and brought back strange goods to Egypt. Moreover, the ships were copied. Cretans and Trojans became traders. Cretan goods have been excavated on Russian sites. So sea-borne trade began.

Where traffic went, Egyptian and Sumerian traders took writing with them. Sumerians took their wedge-script to India, where there seems to have been, in the Bronze Age, a great civilisation among the Dravidian people. Archæologists are only now beginning to uncover the remains of these cities, and we do not yet know how great or how old their civilisation was. The Egyptians were cleverer than the Sumerians at writing, for, starting long before 3000 B.C. with picture-writing, they now used a proper A B C, representing sounds, and could write it quickly. Along the coasts of Syria and Asia Minor men learnt to use this writing; later they even used it for the sounds of their own tongues. Egyptian is the mother alphabet of Europe (see *Writing*, p. 859). But in China, before the Bronze Age ended, the Chinese had invented a writing of their own.

The Egyptian Empire broke up about 1100 B.C. North Syria was conquered by the Hittites, a people who dwelt among the Armenian Mountains. In these mountains lay iron. Historians think that it was because the Hittites were armed with iron that they conquered. Certainly the Assyrians, who gradually won Syria (about 1100 B.C. to 606 B.C.) used iron spears and arrow-heads. The use spread probably along the old trade routes, through the East and southern Europe. It had reached China by 1000 B.C. China then, when we first get a clear picture of it, was a remarkable land: small states formed and fell violently,

but in the villages the agricultural life went on, and the villagers tenaciously believed in the sacred order of life that brought men and divine things together.

The use of iron was learned, too, by people on the outskirts of the civilised world. In the steppes of Turkestan and Siberia, descendants of Neolithic nomads roamed on their countless horses. Toward the end of the Bronze Age, among one great folk-group began a very slow movement south and west. We call these people Indo-Europeans; they all spoke kindred languages, and they are very remote ancestors of our own and of most races of modern Europe. Through centuries they spread through central Europe. Some settled under the Alps and along the Danube valley, where we shall hear of them much later as "Celts." Others entered Spain; others Italy. We do not know why they moved. The steppes harboured many other folk, some of whom we shall see as Hiung-nu (see p. 404), later as Huns, and later still as Turks.

About 1800 B.C., Indo-Europeans came down into northern India, learning the use of metal and of writing as they came. They set up their own communities as masters among the Dravidians. Somewhere about the same time, another horde wandered into Persia; they spread through the mountains, and remained for centuries rough, illiterate farmers, taught by their seer, Zoroaster, the religion of "good thoughts, good deeds." It was they who finally made the greatest empire of the ancient world. The Persian Empire was founded by Cyrus the Great. For 200 years (about 550-330 B.C.) it extended from the Nile and the Dardanelles to the Indus. It has left us no great discoveries, no literature, and not much history. Yet it was of the utmost importance, because never before had vast lands been ruled, and ruled on the whole well, by a supreme master. Even after its fall, it was Persia and not Greece that influenced the way in which Chandragupta governed India. Even Roman emperors are believed to have fallen back finally on ideas borrowed from the Persian Darius the Great.

One group of Indo-Europeans came down through the

Balkans into Greece about 2000 B.C. They spent a thousand years in conquering Greece, the coasts of Asia Minor, Troy, and Crete ; in learning to farm and to smelt and to write, and eventually to sail the sea and to trade. Finally, between 1000 and 500 B.C. they formed city-states on the mainland, merchant cities and states in Asia Minor, and trading colonies on the Adriatic, in Sicily, and on the Black Sea.

The Greeks everywhere were workers and traders. Athens was a city of craftsmen, especially potters. In Asia Minor, Greek merchant kings introduced a new convenience for trade, a coinage. Hitherto exchange had been carried on either by barter, or with weights of gold, silver, or iron (see *Organisation of Society in the Past*, p. 517). The earliest coins are thought to have been coined by Gyges, King of Lydia, in the seventh century B.C.

THE GREEKS

It was in the Greek cities of Asia Minor that the scientific point of view, the search for the causes of things among natural laws, first becomes known to us, in the work of Thales and of Heraclitus (see *History of Science*, p. 40). These Asian cities fell to the Persians in the sixth century, and the mainland Greeks, led by Athens, provoked frontier expeditions by the Persians against them. The struggle was fought out at Marathon and at Salamis. These battles left the power of Persia much where they found it, but to the Greeks they stood for an overwhelming victory for the free educated Greek over the "barbarian." This was something new ; the West was now claiming to be the home of civilisation. On the grounds of her free Government, and the complete and worthy life possible to her citizens, Athens thought herself the leader of all men. In a sense she has indeed been so ; the poetry and philosophy of Athenians of the fifth century have been read at all times since, when men's minds have been at all fruitful. The free Athenian Government was a failure, but yet, standing out sharply as it did against the Oriental idea of one-man power, it

remained in men's minds as the idea of democracy (see *Organisation of Society in the Past*, p. 519).

The Greek States were too small to carry their ways of thought and life abroad as conquerors. That fell to the Kings of Macedon, who possessed both genius in themselves, flourishing gold-mines, and a fighting machine in the Macedonian army. Philip (360–336 B.C.) mastered the little Greek States. His son, Alexander, sprang across the Hellespont, shattered the Persian armies, and in eleven years (334–323 B.C.) conquered and organised lands stretching from the Adriatic to the Indus.

When Alexander died (323 B.C.), this amazing empire fell to pieces at once. Yet the history of the next 200 years depends upon Alexander's work. Had his work been lasting, East and West would not have fallen apart as they did, and the Near East might have remained the centre of the world. In fact, for nearly two centuries there was a considerable chance that this might happen.

Alexander made a Greek kingdom out of the land saddle which joins East and West, from the Hellespont to Cabul. He filled this land and Syria with Greek communities and Greek fashions and notions. Thus he brought Greek culture out of its small homes. After Alexander's death, his general, Seleucus, kept this kingdom together, and his descendants followed him. The Græco-Asiatic world still extended into the Afghan mountains in the second century B.C.

INDIA AND CHINA

Its advance into India was, however, blocked. Just after Alexander's death, the great Chandragupta built up a strong kingdom on the Indus. He drove the Greeks decisively back in 305 B.C. After his days, Asoka completed his work of conquest in India, and was turning to works of peace when he was captured by the teaching of Gautama, a man who had taught his disciples beside the Ganges some 800 years before. Asoka taught the Buddha's Law of Duty wherever he went. He made Buddhism the religion of

immense numbers of men, and thus unawares created a new bond of union for the East; but in the Hellenistic cities of Syria his missionaries failed (see *History of Ideas*, p. 454).

Beyond India, in the time of Asoka, a greater power than his was rising. At about 220 B.C. a single ruler of extreme ability drastically moulded China into one State. Under the Han emperors China was for nearly 400 years the strongest and most civilising power of the East. She protected the trade routes; she taught the barbarians. Japan was now populated by invaders, users of iron, who had probably been driven from the mainland by Chinese; and all the arts and crafts of life seem to have been sought by the early Japanese from China. Beyond the Great Wall, the nomads whom the Chinese called Hiung-Nu were driven back and finally broken up by the emperors. Hiung-Nu in turn pressed on the Saka nomads, and these latter flooded the Greek Asian kingdoms, and overwhelmed them by about 120 B.C. Some tribes set up kingdoms of their own, like that of Yue Chi (see Map B). Only the Parthian King of Persia held out. The nomads were destroyers, terrible as the plague, blind and deaf to Greek influence. Thus there was now a cut between civilised East and civilised West. Perhaps we should date the real separation of East and West from here.

For 200 years the eastern end of the Mediterranean remained much as Alexander had left it, and its life became in many ways Greek. It was an age when people read and wrote, traded and built and carved, worked at practical science, and stored up and studied and added to the knowledge handed down to them. Perhaps to live in, it was an age somewhat like our own.

AUSTRALIA AND AMERICA

Of the history of Australia throughout all this time we know nothing. Within living memory, the natives were living as Old Stone man must have done, with stone tools, without homes, crops, tamed beasts, and quite without any record of their past.

Of the history of North America we know very little. But the people of South America, quite isolated as they were from other Continents, made their independent discoveries. In Peru, in the valleys of the Andes, by about the time of Christ, men were practising an agriculture of their own. They used hoes instead of ploughs, and grew millet and maize and sweet potatoes. The llama was tame, and had been for a long time. So was the guinea-pig. Men made pots and wove cloth; they were most skilful gold- and copper-smiths. They built immense stone buildings. They used knotted strings for reminders and for calculations. But, as they did not write, we cannot discover much of their history. We only know that their life went on in much the same way until the coming of the Spaniards in the sixteenth century.

Farther north, in Guatemala and northwards, were people whom we call "Maya." They could build and farm and weave and make pots; they had knowledge of the skies and seasons, and of their own history. They had a writing, and a calendar of their own. We are not yet quite sure how to place the dates in their calendar. But it is believed that the Maya had achieved all this by about the beginning of the Christian era. Soon after that time probably they went northwards towards Mexico, and in that country, one of the richest in gold and silver, they became users of metals. The Maya are one of the peoples whose history is being literally dug up at the present time.

ROME

For more than 1,000 years the Indo-European tribes called Celts had shifted and spread in central Europe. There must have been a great western movement somewhere about 600-500 B.C. It is thought that Celtic tribes first invaded Britain then, bringing with them the knowledge of ironwork. By this time the whole mass of Celtic tribes in Europe were in movement, entering or trying to make their way into Spain, France, Italy—"from the

Atlantic to Asia Minor." From Asia Minor to Greece and northern Italy the old half-Greek world needed protection, and it was ultimately Rome that gave it.

When the Celts descended on Italy in 382 B.C., Rome was a small town struggling for the leadership of small local Latin tribes. The Celts sacked Rome, and settled in the plain of the Po. But when, about 230 B.C., the Romans almost destroyed these Celts in battle, Rome was practically the ruler of Italy, including the Greek towns

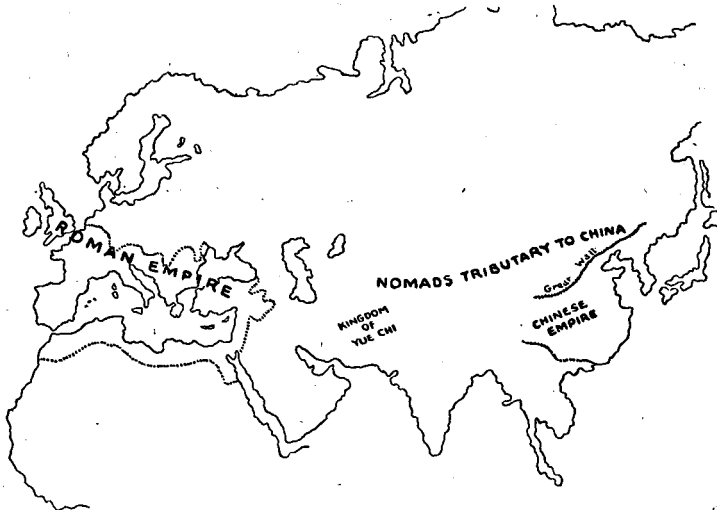


Fig. 71. Map B. Sketch Map to show the Roman and Chinese Empires about A.D. 150.

of the south. She was also in the middle of the tremendous Carthaginian War (264 B.C. to about 146 B.C.). This war had two results ; Carthage, the largest Semite city in the West, a sea-power only, was destroyed, and Rome took her place. Secondly, by the time the war ended, Rome had conquered the greater part of the Hellenistic world.

The Roman military genius was still fresh. In the next century it threw back from northern Italy the Celts, and, more terrible still, the first comers of the Teuton tribes (102 B.C.). Its further conquests are shown on Map B.

The Roman political genius, which had worked out a republic under the rule of the Senate for the government of a small State, could find no way in which to govern all the provinces in anything like a reputable way. It was not until Julius Cæsar became absolute that he was able to create a provincial system which was as good as that of the Persians of old. Augustus Cæsar carried out Cæsar's work, as far as great talent can imitate genius, and combined the provinces and Rome and the Italian home country into an empire. From 80 B.C. to about A.D. 170. Rome gave to the West a peace and order greater than that which existed in the Chinese Empire at the same time (see *Organisation of Society in the Past*, p. 523).

The effect of these two centuries on western Europe decided the future. The provincials were taught something of the Roman way of life. Even in a British country town, labourers scratched their jokes on tiles in Latin. Town-planning, engineering and construction, road-making, were at least seen by the provincials. The provincials entered into world-trade. Besides, the Romans taught everywhere the use of their magnificent law, that tough, still-living part of their spirit, the belief in the sanctity of contract, in the necessity of scrupulous fairness. But, as a sort of unity spread over the West, the city of Rome herself grew actually less important, magically great as she still seemed. For now the emperors, and not the city-fathers, governed, and the emperors were always on the road. Rome had never been an important town for world-trade.

BREAKING UP ROME

From A.D. 180 to A.D. 284 is only a hundred years. In it the empire was transformed. The barbarian attacks and the attacks by the new power of Persia mattered far less than the shattering and collapse of the old civic and civilised Roman life, while Roman troops incessantly proclaimed this man emperor, or that, and fought for him

or betrayed him. There were eighty nominal emperors in ninety years.

Diocletian put an end to this. The empire which took the full force of the barbarian attacks was Diocletian's work. In it the tax-gatherer was supreme. It was neither strong nor civilising. It renewed the old cleft between East and West, for Diocletian himself undertook the government of the East from Asia Minor, while his partner ruled the West. Thus the West again began to fall back, to be again only on the outskirts of the real, interesting part of the world. Two factors alone saved the West. One was that the Goths, when they came, were not wholly destroyers. The other was that the humble communities of Christians, under their bishops, in Italy at any rate, were strong enough to carry on some form of organised life.

Ever since the Han emperors, between 210 B.C. and A.D. 220, had made China a strong kingdom, there had taken place a slow drift of the nomadic peoples westward across the grasslands of central Asia. Immediately to the west of China were various large tribes of Mongolian nomads, often called Tartars. The Chinese historians called their country "the back of a horse," for even the children learnt to ride, on sheep or pigs, almost before they could stand. They lived in hordes consisting of numbers of families, had no writing nor towns, lived on milk and flesh, and drove their cattle wherever they went. Later on, these people threatened to overrun Europe (p. 412). At this time, between the first and the fifth centuries of our era, it was their movement which caused the Gothic and Vandalic tribes, of the same Indo-European stock as the Greeks and Romans, to invade the empire. These Tartars formed a part of the army of Attila, called the Huns, who came into Europe on the heels of the invading Goths.

The break-up of the Roman Empire was gradual. The Goths first became serious enemies of the Roman Empire when they crossed the Danube in A.D. 247. At the same time the Franks and the Alemanni began to raid Gaul. In 410 the Visigoths captured Rome. At first the barbarians liked to consider themselves part of the Roman Empire ;

when the battle of Troyes was fought against the Huns, victory was won by Franks and Alemanni fighting side by side with Romans (A.D. 451). In A.D. 455 the Vandals sacked Rome, and from this time we may say the Roman Empire ceased to exist.

The eastern part of the Roman Empire continued under the rule of emperors from Byzantium (or Constantinople), which remained for hundreds of years the richest city of the world. Under the Emperor Justinian (527-565) it seemed that a part of the Western empire might be reconquered; but, after 565, new tribes came into the West—the Lombards and the ancestors of the Hungarians and the Slavonic tribes who live to-day in the Balkans. The Empire of Byzantium ruled most securely over the Eastern provinces, though it was engaged in a long series of wars with the Empire of Persia under the Sassanid kings. The people of Byzantium spoke Greek and were Christians, under the Patriarch of Byzantium. There were large and prosperous towns in both the empires; trade flourished in spite of the wars. It was not a period of vigour in art or science. Though Greek was the language of the empire, the Greek feeling for individual freedom had died out. The people were poor in spirit.

BREAKING UP CHINA

At the end of the third century, the Tartars or Huns did in China very much what the Goths and Vandals did in Europe. China was split into a number of little States for 400 years; the most powerful and largest of them was the Hunnish kingdom of Shen-shi, whose northernmost boundaries reached the Arctic. But the break-up of China was not complete, for Chinese civilisation was a part of the life of a peasant population, whose habits did not change (see *Organisation of Society in the Past*, p. 501). The Hunnish conquerors became very like the conquered. The kingdoms drew together. At the beginning of the seventh century, the dynasty of Tang ruled over an empire stretching southward into Assam, west almost to the Caspian. The greatest of

the Tang kings was Tai-tsung, who reigned during the seventh century.

ISLAM

From the beginning of the seventh century until the beginning of the thirteenth century the most important single power in the world was the Islamic or Moslem Empire. Its career of victory was begun by the Semitic tribes of the Arabian desert, nomads except for the little mud-walled towns in the Yemen (south Arabia), where are the cities Mecca and Medina. In A.D. 632 they were united by Mohammed, who preached a belief in the One True God, Allah, and the necessity to fight for this God against unbelievers. These Arabs were fine people, and they treated all who joined them as brothers. The great empire they won was due to their simple religion, which inspired their leaders and soldiers, and, during the first hundred years of their conquests, to their understanding and good treatment of all people they came across. In A.D. 634, after Mohammed had died, the Byzantine Emperor Heraclius left all his empire but his capital and a strip of land around it in their hands after the Moslem victory of Yarmuk. The Persian armies were shattered at Kadassia in A.D. 637. By the middle of the eighth century the Moslems had control of the Mediterranean, and were marching into Gaul from Spain, whilst eastwards their armies had gone beyond the Indus to the borders of China. They were checked by an army of the Franks under Charles Martel at Tours in 732, however, and they never took Byzantium.

From the eighth century until the eleventh century the Islamic Empire was peaceful and in political decay. It was ruled over by the Abassid Caliphs from Bagdad (Haroun al Raschid, A.D. 800) as an Oriental monarchy. During these years, when there was peace in most parts of the huge empire, the Moslem universities grew up at Cordova (Spain), at Cairo, at Bagdad, and Basra. The Greek knowledge of natural science was revived, and, since the Empire was large, men from all over the Mediterranean and

Asiatic world collaborated together for the first time. Mathematics and medicine were the two great Arabian sciences: the Arabian doctors used anæsthetics and did some of the most difficult operations. They built observatories, discovered many new substances in chemistry; from China they learnt how to make paper. Their knowledge spread into Europe and fertilised the European mind (see *History of Science*, p. 59, and Fig. 11).

THE DIVISION OF EUROPE

The only real unity in Europe was given by the Christian religion and the Latin language, which was spoken by the Church and, until the end of the sixteenth century, was the language of the learned men of Europe. In the eighth and ninth centuries the sea-going Scandinavians continued the restless movements of the European tribes who had broken the Roman Empire. They invaded England, where the Angles and Saxons had settled. They moved eastwards into Russia, travelling along the great rivers of the plains. They went as far as the Caspian Sea, and even threatened Byzantium from the Black Sea. The Moslems called them Russians. A second wave of these people settled in Normandy and from that invaded England in the middle of the eleventh century. In A.D. 800, seventy years after the Franks had defeated the Moslems at Tours, Charlemagne was crowned Holy Roman Emperor. He ruled over what is now France and Germany, and over most of Italy. But at his death his kingdom split up, and, although the idea of a Europe under a Holy Roman Emperor still lasted as a dream, the people of Europe have always shown a tendency to split up into smaller communities. In Map C you will see how Europe was divided in A.D. 1200. The Holy Roman Emperor was not really as powerful as the Kings of France and England, because the people in England and France were beginning to think of themselves as English or French, and to make the laws that best suited them.

THE MONGOLS

But from A.D. 1200 into the middle of the fifteenth century the Mongols are the most important people (see Map C). About A.D. 900 the Tang dynasty in China was over and its empire split into separate States. These States were conquered by Jenghis Khan, the Mongol King of Karakorum. The Mongol armies, composed of these Tartar hordes, appeared on the Black Sea, and in 1241 defeated an army



Fig. 72. Map C. Europe and Asia by 1200 and 1250

of Poles and Germans at Leignitz. They did not go farther west. In 1258 they took Bagdad. The empire of Jenghis Khan and of his successor was rather a union of States under the rule of the warlike hordes. Jenghis Khan's influence was, on the whole, a civilising one. His empire broke the barrier between East and West. Islam and Christian Europe drew closer. Between 1369 and 1405, however, Timurlane became Great Khan. His object was destruction, and he destroyed all the cities and trade of central and southern Asia. But China remained intact under the Yuan dynasty, founded at the end of the thirteenth century.

After Timurlane, the Mongolian hordes seem to have

lost all military ardour. About the middle of the fourteenth century, hundreds of thousands of them died in a great plague, which also came to Europe where people called it the Black Death. The Grand Duke of Moscow threw off his allegiance to them in 1480, and, in 1547, Ivan the Terrible became the first Tsar of Russia. In the seventeenth century the Russians, with the nomadic Cossacks as their advance guard, swept across Asia from west to east. The Tartar tribes, once the terror of Europe and China, could put up no resistance. Early in the sixteenth century, however, a Mongolian chief went to India and founded a dynasty which, under Akbar Khan, united almost all of the huge peninsula. This dynasty lasted until the beginning of the eighteenth century.

One of the results of the Mongol activity was the arrival in Europe of the Ottoman Turks in the fourteenth and fifteenth centuries. Much as the Seljuks had done, they revived the fighting spirit of Islam. In 1453 they captured Constantinople under Muhammed II. In 1560, under Suleiman the Magnificent, their territory stretched from the borders of Hungary and Roumania in the north, to Greece and the Adriatic coast in the west, to Egypt in the south. They held Bagdad. One of the great enemies of the Ottomans was the great trading town of Venice. In 1571 the Turkish fleet was defeated by the Spaniards and Venetians under Don John of Austria at Lepanto.

THE BEGINNING OF MODERN EUROPE

It was only at this time that it appeared probable that Christian Europe would develop into a world power. From the beginning of the sixteenth century the historical centre of the world is no longer the eastern end of the Mediterranean, but western Europe and the Atlantic seaboard: and now, for the first time in history, when we say world we mean the whole world.

By the end of the sixteenth century, England, France and Spain were independent and strongly rooted nations.

Germany did not become a nation until 1870, and Italy not until 1861 (see *Peoples of the World*, p. 587).

If you look at a map of Europe to-day, you will see that the Ottoman Turks have been almost driven out of Europe. This brought about the formation of the Balkan nations. The effect of all the wars between the European nations since the sixteenth century has been to fix national boundaries and to defeat the idea of a united Europe.

But, in spite of this, the European people have made a civilisation which is European, and not French or Italian or English. In Europe began the study of the world of nature with an ardour and an exactitude which, built on the work of the Greeks and Arabs, has been carried farther than was ever imagined by people before (see *History of Science*, p. 62).

THE WORLD OPENS OUT

The Europeans began to discover the world at the end of the fifteenth century. In 1492, Columbus, and those who followed him, discovered the American continent. Vasco da Gama in 1497 opened up the route round Africa to India and to the Far East. Magellan sailed round the world in 1519. During the seventeenth century, Europeans began to trade with all the world; England, Holland, and France were the most active traders. By the middle of the eighteenth century, England had won North America from the French, who had settled there, and had also driven the French out of India. In 1776 the American colonies broke away from England, and during the nineteenth century the independent nations in South America were formed. So, in the American continent, the European race has founded, not European empires, but new, independent nations made out of people from Europe. The history of the U.S.A., of Canada, and of Peru and Chile in South America, is more likely to be bound up in the future with the other nations on the Pacific than with Europe. Australia, colonised mainly by the British in the nineteenth

century, is another country whose history is only beginning, but is bound to be closely connected with Japan, China, the U.S.A., and the other nations in the Pacific.

In India, and in other parts of Asia and in Africa, the European nations have built up empires, and people have gone to these places, not so much as colonists, but as soldiers and civil servants. Africa, where the Dutch, English, and Portuguese had trading settlements along the coasts, was divided up among the European nations between 1850 and 1900. South Africa, where there have been British and Dutch colonists for over a hundred years, is a part of the British Empire, but, like Australia and Canada, is really a new and independent community.

THE MODERN WORLD

England had not only gained the largest share of the world outside Europe by the end of the eighteenth century, but she had begun to make herself the first manufacturing country. The use of steam power to drive machinery, and hence the ability to make all kinds of necessities quickly and cheaply, is one of the most important happenings in the history of man. It has meant that the population in manufacturing countries has increased very rapidly: that trade with other parts of the world, instead of being a luxury, has become a necessity (see *The Last Thirty Years*, p. 541). Railways and steamships began early in the nineteenth century. The first railway ran from Stockton to Darlington in 1825; by 1840 the railways were spreading over Europe and the U.S.A. Later in the century, the Russians built a railway to the Pacific coast of Asia. From the time of Sumeria until the railways, an emperor or an emperor's messenger could not travel much faster than five miles an hour at an average speed over a long journey; so you see what a huge difference the railways have made. At the end of the nineteenth century, as a part of the development of the science of physics, came the telegram and the telephone and the last and the most important of all means of

communication—the power to transmit the human voice to all intents instantaneously across the world.

So here are the dry bones of human history—a very short space of time in the history of the earth; too short for people to have been able to alter much. Men and women take about thirty years between generations. Rats take a year or less. So rats have more chance of altering, by mutations and natural selection (see *Biology* and *Applied Biology*), during a century, than people have between Homer's time and our own! But the conditions in which people live have altered, as you see, enormously, whereas the conditions in which rats live have altered little (though more than those of some wild animals, because they are partly dependent on man). In the next chapters you will see how people, not so very different from their forefathers in Sumeria or central Asia, have dealt with the new conditions which new knowledge has made possible, and how they are likely to deal with them in the future.

BOOKS TO READ

On the earliest times and down to the Fall of the Roman Empire :

H. G. WELLS : *Outline of History*.

J. BREASTED : *Ancient Times*.

H. B. HALE : *Unwritten History* (2 books).

C. L. WOOLLEY : *Ur of the Chaldees*.

WARD FOWLER : *Rome*.

T. G. TUCKER : *Life in Ancient Athens*.

G. GORDON : *The Minoans*.

PLUTARCH : *Lives*.

R. MACALISTER : *Civilisation in Palestine*.

GERALD HEARD : *The Emergence of Man*.

F. HAVERFIELD : *Romanisation of Britain*.

S. J. C. HEARNSHAW : *Main Currents of European History*.

HAKLUYT : *Voyages*.

PRESCOTT : *Conquest of Mexico*.

THE HISTORY OF IDEAS

OR

HOW WE GOT SEPARATE

by

GERALD HEARD



GERALD HEARD is very nearly my best friend, so I find him very hard to describe. He is the sort of person to whom emergencies are rather apt to happen (he even wrote a book called *The Emergence of Man*, which you might try if you find his chapter exciting). For instance, he was alone at Fox Rock, Sir Horace Plunkett's house, during the troubles in Ireland ; the house was burnt down and he was very nearly burnt with it ; that kind of thing gives one a philosophical outlook. I think he is probably the only philosopher who is writing in this book, except Olaf Stapledon. A philosopher is someone who loves knowledge, and so does everyone who is writing—or they wouldn't be—but all the others want to do things as well. Some of them want to do scientific research or teaching, and some want to write or paint or dance, and some want to alter the way things are run. But Gerald Heard doesn't want to *do* things very much ; he wants to understand things and then to explain them. Only, once things are fully understood and explained, they usually get altered as well ; so perhaps he

is as likely to be really helping to make a better world, as some of the other writers here, who want to alter the things which are wrong with civilisation, even more immediately and actively. He is amazingly well aware of what is happening and being discovered and being written in the world all round him, and he puts these things and these ideas together. He does the staff work. He is half Scotch and half Irish, rather older than me; he has blue eyes, and he broadcasts a great deal, so you have perhaps heard him yourself. When Richard Hughes (who wrote the chapter on *Physics*) was a boy, Gerald Heard went for walks with him and was the first person to talk to him about the Fourth Dimension and things like that. He has a Siamese cat which he teases—he is extremely kind to everyone else—but it likes him all the same.

THE HISTORY OF IDEAS

WHAT IDEAS ARE

PEOPLE have always differed about ideas in a way they couldn't differ about objects that could be produced, turned over, and handed round. When they discussed ideas, they really couldn't be quite certain that they meant the same thing when they were using the same word. This, of course, must lead to a lot of confusion, and, unfortunately, it has.

The first thing, then, we must do is to try and understand what ideas really are. Ideas are general notions which are made up from noticing many separate facts. They are generalisations. We notice that men have legs, and, from noticing this constantly, we come to the general idea of man as a legged being. Of course, there might be people without legs, and then our general idea about people would be wrong. But we should still find that we thought of men as beings who *ought* to have legs, and we should find that we looked on the legless men with disgust, so firmly had we got in our heads the idea that men shouldn't be legless. We should look on the legless men as unnatural. Now that illustrates another great difficulty about dealing with ideas. Ideas are partly abstractions, or generalisations, which we make deliberately from numbers of actual cases, and partly abstractions which we make almost without knowing we are making them. Most ideas are of this second sort. When an idea forms in our mind, it is hardly ever made by carefully comparing hundreds and thousands of examples and then finding what they have in common and so making a generalisation from them all. We don't make the idea as we might design an engine : it forms itself unconsciously in our mind.

Now this way that ideas grow has two great disadvantages. In the first place, the idea may be made up from far

too few actual examples. For instance, we may have got into our heads that the swan must be a large white bird. A great philosopher actually said that one of the things that there could not be was a black swan. And then, when Australia was explored, the beautiful pure black swan was discovered. The generalisation, the idea of what a swan is, had been made from far too few examples. So we see that ideas, though they are formed out of many actual examples, are not formed deliberately and consciously added to bit by bit, but they settle and form at the back of our minds without our knowing they are forming, just as sediment settles down at the bottom of a pond until all the fragments pack together into a cake which becomes too hard to be taken to pieces.

This fact that ideas form without our knowing it, and set hard at the back of our minds, so that we find it hard to take in new facts and work them in with the ideas we already have—this is bound to be rather a nuisance. But we also find, when we try to change our ideas, that we don't want to do so, that we feel very strongly about them, and that we are apt to get very frightened and angry, and even cruel, when people point out that we ought to change them.

Now why is that so? If we can answer that question, we shall know a good deal more about ideas, and we shall understand why they have played such a large part in our past history and why they are still so important to-day.

HOW IDEAS STARTED

The reason why we feel so strongly about our ideas, and resent so keenly anyone interfering with them, is probably the main reason why ideas have been so important. It may seem silly to get angry when someone points out that your ideas are not quite right, and when they show you facts which your ideas have left out and which prove that your ideas are incomplete. But men really have had a very good reason for being frightened, and so getting angry, when anyone wanted to upset their ideas. We have seen that

ideas are unconscious generalisations, or, if you like the word better, unconscious principles, or laws, that men have made up from their continual observations of the world around them and themselves. These ideas were not made for amusement, or even for truth's sake. We can make it clearer by saying that the first ideas men had were not so much reflective thoughts as practical rules about how to behave; they were generalisations which told everyone how, up till then, it had generally paid men to act (or react) when they were faced with certain facts, with certain conditions.

You see, ideas at this stage were not "bright" or "original," but, first and foremost, practical, well-worn, traditional. Indeed they are, at this level, much more like those impulses which we call instincts. A bee, for instance, as soon as it comes out of the cell in which it was hatched, finds itself faced with a mass of things, and itself a very complicated little person. But at once it sets to work at its elaborate business. For it has in it an inborn idea, an instinct, as to what it is to pay attention to and what it is to do, and what it is to disregard and leave alone. We human beings have no such perfect instincts, but we have born in us certain dispositions and tendencies, and all these dispositions are not so much to help us to think and to question, but to help us to live. Now our ancestors, when they were struggling to survive, on much the same level as the other animals, had to combine all their dispositions, their handiness, their general curiosity, their power to notice all sorts of out-of-the-way things, so as to help them the better in their struggle to survive. The bee, when it faces up to a flower, knows exactly what to do with it. It is not distracted by thinking whether that particular flower is beautiful or rare. It sees it as simply so much possible honey. But we men have big brains, and those brains don't only tell us exactly what we should do on every occasion; instead, those brains can notice many things which don't seem to mean anything, which have no particular message for us. The bee simply can't be taught. Given a flower, it knows exactly what to do with it, but

given a piece of bread, it is completely at a loss. Instinct is all right, is perfect if you find exactly the conditions which your race has found up to the present. But when you are faced with something quite new you simply don't know what to do, and you have no wits to find out. You are not merely angry, you are simply done.

Now it is clear that man has a better chance of surviving than a bee has, because when he meets a new problem he can sit down and think it out, he can have ideas about it. But the power to think things out is not wholly an advantage, for new ideas may simply keep men wondering and guessing, when the real problem has always been what they were going to do. That is what Shakespeare means when he makes Hamlet say that the native hue of resolution (the healthy feeling that you know at once what to do about it) is sicklied o'er with the pale cast of thought. You may notice so many things, and see the problem from so many sides, that you end by doing nothing, and so you are done in. This is the very practical disadvantage that goes with the power of being able to think things out and to change one's mind too easily. The bee only attends to its business. Of course, if the business changes, the bee may be done in. It could not find another. But our strange minds run a risk from the other direction: we notice so many things which are not our business. That, obviously, is very dangerous. And the farther we go back into the past, the simpler and weaker human life was, the more dangerous it was to keep on noticing and wondering about facts which had nothing to do with getting a living and keeping loyally together. For those things have been for hundreds of thousands of years, for hundreds of times longer than men have had any science, the two supremely important things, and beside them everything else has been mere fancy.

So now we can say why we feel so strongly about our ideas, especially those ideas which have to do with the way we behave, and why we resent people when they try to change them and "widen our minds." For our ideas are in origin very like instincts; they shaped our wandering minds so that we might have some of the readiness and

resolution which animals with instincts have, the power to face up to the world and tackle it so that the race could survive. Our first ideas are general rules for reacting to things. They are not summaries of all the facts made by perfectly detached onlookers. They are selections of those facts which needed most to be noted, or that forced themselves on your notice, and these selections are so interpreted that men and women may behave toward the facts, face up and handle them in ways which, on the whole, have proved most helpful to our race.

You will see from all this that ideas have obviously gone through a long development. They have a history of growth, just as a tree or animal has its history and stages of growth. And the first ideas were as different from what we now today call ideas as an egg is from a chicken. Yet as the egg turns into the chicken, so the earliest, vaguest, almost unconscious notions that the first groups of men had, have grown into the bright and original ideas we enjoy having to-day.

That history of the growth of ideas is therefore a history full of remarkable changes, and it is also a very dramatic history, because it is the history of great struggles. On the one side we have the order-making, pattern-making side of man's mind, trying to sum up and decide the practical sense and meaning of what it is up against. This side is always saying, "What is the use of this?" It tries to make all our experiences useful, moral. It tries to say, "All experience shows you must behave in this particular way." On the other side we have the exploring, speculating side of our minds. This is always hunting after facts, and collecting them just for the sake of doing so and quite regardless of the use or possible consequences. It is always noting and pointing out facts that the other side of our minds, the order-making side, has left out, because they were inconvenient facts and didn't fit into the practical ideas.

Let us try to trace this struggle without taking sides. Both sides were necessary to a single growth—the growth of man's mind in its power to understand the world and its power to carry on while learning to understand.

IDEAS OF THE FIRST MEN

First let us remind ourselves again that the first ideas that men had must undoubtedly have been not what we should call ideas, but what we should call reactions. However vague many of our ideas are to-day, the ideas of the first men must have been far vaguer. What, then, can we know about them? The earliest evidence we have is undoubtedly the wonderful animal pictures made by the men of the Old Stone Age probably some twenty thousand years ago, when those men were living in caves during the Ice Age. But when we look at these pictures we find nothing vague about them. We are amazed to see how well they could draw. The great beasts that they hunted, mammoth, bison, and boar, are drawn and painted and modelled on the rock as well as any artist to-day could paint an animal. These people, living twenty thousand years ago as savages, were nevertheless perfect artists, and could draw whatever caught their eye. Surely they had quite clear ideas? But when we study their pictures carefully we find out another even stranger thing about them. Though these cave-men could draw and paint so well, they treated their pictures in what we should call a very inartistic way. They do not seem to have had any sense of arrangement, any eye for order or design. Though the animals are so well drawn, they are drawn all over the place, as children will scrawl pictures anywhere over a whitewashed wall. And, more than that, we find they drew the same picture over and over again on the same spot, making it very confused and spoiling it as a picture. And there is a third remarkable thing about these first pictures that men made. Very often the beast has a mark made in its side just above where we know the heart lies. And in some cases there are drawn arrows and darts sticking in the mark. We can't help feeling, when we study these pictures, that they tell us something very strange about our early ancestors.

We see that they were naturally artists, but they really didn't care for art as we do; they had, in fact, quite a

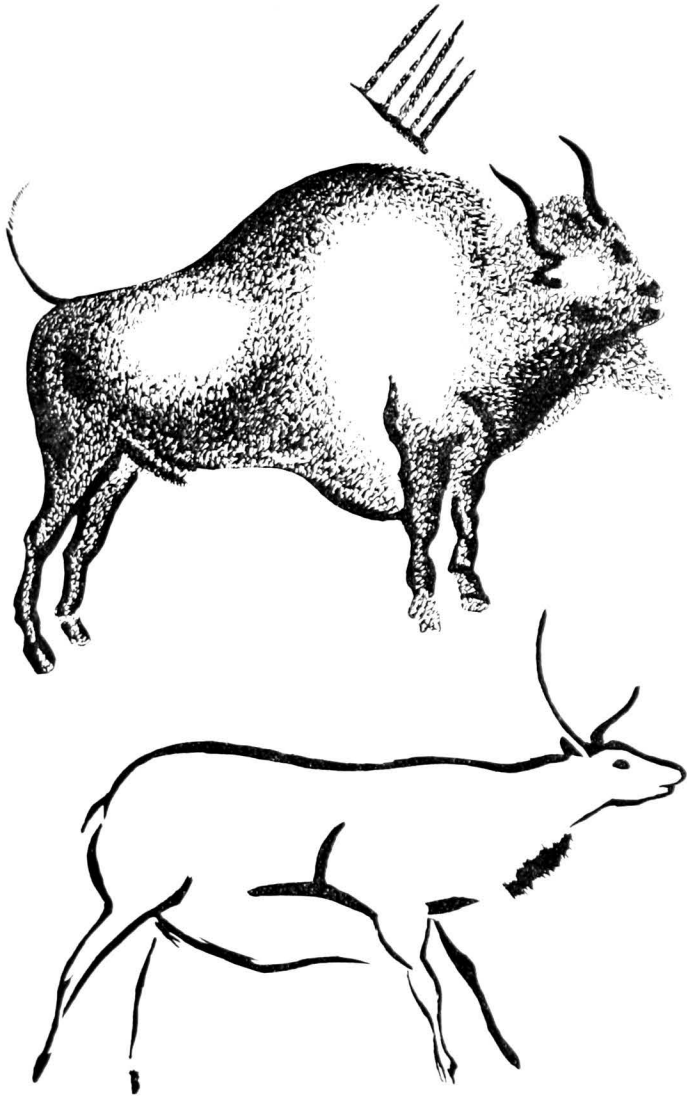


Fig. 73. HOW WELL THE FIRST MAGICIANS DREW

Pictures in coloured earth, drawn by the light of little lamps in the back of a cave: look how the deer is reaching out his nose to catch smells that are coming on the wind.

different idea about it. They could make these wonderful life-like pictures, but they did not do so for the delight in making a pattern and studying nature. They didn't mind spoiling the picture and scrawling bull's-eyes and arrows on it. There are no pictures of landscapes or even of trees. And the animals which are drawn, we soon realise, are nearly always animals which man had to hunt. The pictures are not pure art at all. They are as practical as a doctor's prescription. In short, these pictures are not works of art, but works of magic. They are not studies of animals done for the sake of drawing ; they are spells done to make the animal easier to catch and kill. That is why the heart is shown pierced and that is why the animal is drawn over and over again on the same spot. What these wonderful draughtsmen valued was the power to be able to create afresh, every time it was needed before hunting, the appearance of the animal they wished to slay.

So we see these earliest drawings illustrate very clearly one of the first ideas men had. It is a mistaken idea, from our point of view, but it is one which has influenced men throughout the world, and one in which many backward people even to-day still believe. That idea is called sympathetic magic. It is the idea that if I make a model or picture exactly like something I want, because I can do whatever I like with the model or picture, I can do what I like with the object it imitates. This sounds absurd to us, but it is important that we should try and understand this point of view, because it tells us a great deal, not only about the ideas of our ancestors and the kind of mind they had, but it also tells us about the fancies that still go on at the back of our minds and which influence us more than we know. The idea is obviously absurd to us because we distinguish clearly between ourselves and the outside world, and we distinguish, though not quite so clearly—not nearly so clearly as we think we do—between what we wish to happen and what actually happens. Our Early Stone Age ancestors were not able to make these distinctions as we can make them—they could not define things exactly, as we can define them ; they could not analyse

them—that is, break them up into their separate pieces, and so realise how they were put together.

Now why did our ancestors do this absurd thing for thousands of years? Surely a very little experience would have shown them how utterly mistaken they were, and that when they drew over the picture of a bison or a boar charging, that did not make it at all more likely that they would be able to kill an actual bison or boar when they ran into it! I think we can now say that men did not find out their mistake until there was a very good reason that they should, and that all the time that they went on making those drawings there was a very good reason why they should think that this making of drawings of big game was immensely important. Remember, we have to try and think back into their minds, and that those minds were not full of definite, sharp-cut distinctions as our minds are. So when we use such an old-sounding word as magic to describe these paintings we must not think that the magic of these Stone Age artists was a sort of mistaken science; that when they drew an animal they definitely thought that they were making a sort of artificial animal, or that they thought out the way that making the model really helped to snare the real animal. Their ideas were far vaguer than that, and were far more emotional.

When, for example, an Australian native (a type of man who is still living a life as simple as that of our own Stone Age ancestors) is faced by a drought, he will spit at the sky. When asked why he does so, he will generally say that he does so to make the sky rain. But what we should note is that the explanation comes after the act. He spits, not because he knows that it brings rain, but because he feels that he must do something against the dry sky and he feels it to be not much larger than his parched mouth. He feels that the world is emotionally tied up with him. And so, undoubtedly, felt our early ancestors.

So we can understand these first pictures and they can help us to see into the minds of those first artists. They tell us a good deal about the growth of ideas. They show that men at this stage had not the clear idea of being quite

separate from the world around them. They felt that they were part of it all, and quite an important part. And I think we can see how important it was that they should think this. For if they had felt quite different and separate from the world, if they, with their small powers, had felt themselves up against it and not part of it, then they would have been frightened. They had to imagine that they could affect and order it if they were to stand up to it.

I think we can understand another very strange thing about them and their ideas. Just as they drew these wonderful animal pictures because they saw them "in their mind's eye," and felt the animal's presence so vividly that, without knowledge of anatomy or without a model to draw from, they could set down the animal exactly as it was, so they felt the curious sense of kinship with the animals, so that they thought of the animals almost as though they were men. In the earliest stories, animals are always talking to men, and animals are always becoming close relations. So we get the rise of that curious custom which all people seem to have had in the long past—the custom called totemism. That points to a time when men did not clearly define between themselves and the things around them which interested them, and when they felt a strong tie between themselves and the animals they hunted. Their ideas of their own aliveness and the aliveness of the animals were not divided. Indeed, I think we must go farther back into vagueness and we must say that the first men did not think of themselves as self-conscious, separate individuals as we do. They were so completely taken up with living, and had so little time or taste for reflection, that it did not occur to them to ask how they themselves were alive, and what distinguished them from the rest of the world. They felt themselves alive, and they assumed that not only were all the animals alive in the same way—however different they might look—but that as the other animals were all alive, so, too, was everything else that moved—the trees, the rivers, a rock that rolled down the hill, the wind, the sun, and the moon.

This, then, is the first notion that men seem to have had.

When they looked round them they felt the animals to be kin, and the whole world to be alive.

THE NEXT STEP

The taking of the next step is also illustrated for us by the pictures made by the men who took it. We have seen that the men of the Old Stone Age had this wonderful power of drawing animals exactly as they saw them. That is odd enough; but what is even odder is that when we come to the next age, when men had discovered not only how to make far better stone tools, but how to make pottery and to grow crops, this wonderful power of drawing, instead of developing, as we would have supposed, disappears. For at this stage, instead of those perfectly life-like pictures of animals we get little scrawls very much like the pictures we made ourselves when we began to try and draw. How can we explain this decline in art when men were advancing in everything else? I think that there is only one explanation, and that it throws a most interesting light on how ideas have grown up.

If it is true that our first ancestors did not have very clear ideas, and so did not distinguish definitely between different things, we should expect that power of separating up things to grow. As it grew, men would make more and more words to distinguish the many different things they were noticing.

We can trace that development even in some of the languages that have lasted until to-day. In Arabic, for instance, there are some forty words for different sorts of camels. If these words are translated into English, which is a younger tongue than Arabic, we have to say a black camel, or a three-year-old camel or a female camel, etc. We keep in English the general word camel, and add an adjective to it to show the type of camel we mean. In short, we analyse and classify the actual camel we see. In Arabic that is done less, and the earlier the language the less there is this power of making general classes and groups of things.

So we can say that when men were beginning to make

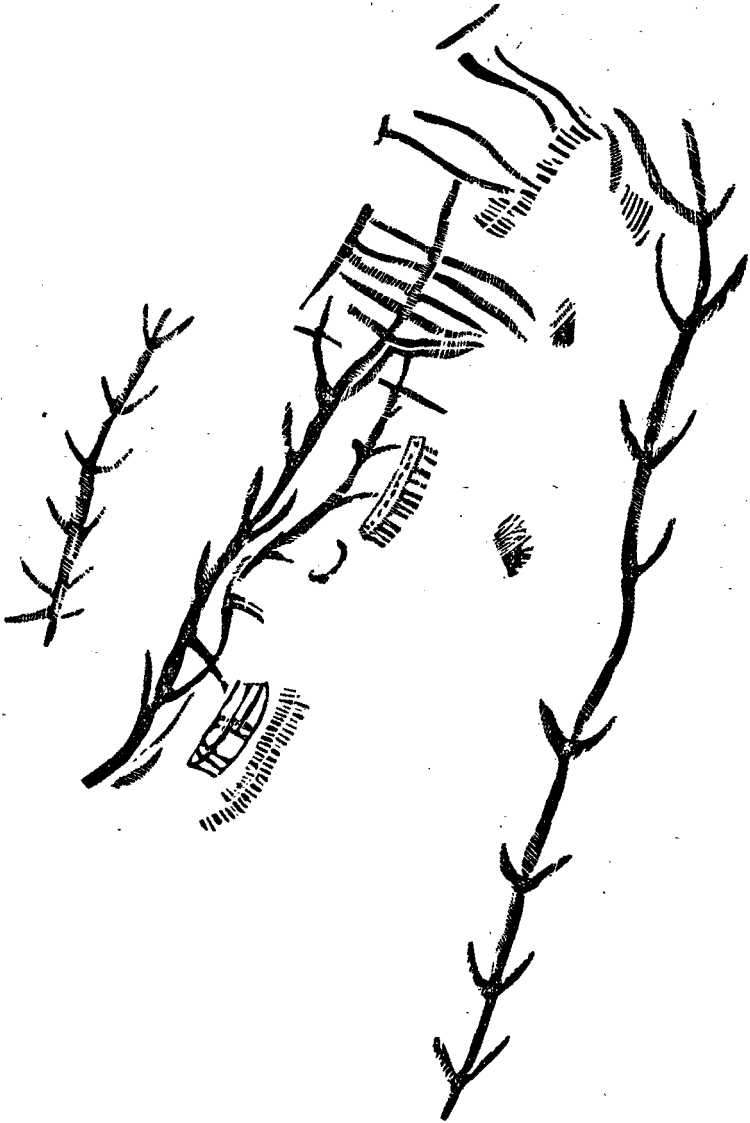


Fig. 74. DRAWING IN SHORT CUTS AND SIGNS

The next men trying to explain their huts and hunting routes : they are not drawing things they see suddenly with their eyes, without thinking, but ideas of things that they are imagining with difficulty in their minds.

their language clearer, and were beginning to try and write down their words and ideas, the first thing they would have had to do was to make general signs and types for what they wanted to show. First they would draw complete pictures, as the Old Stone Age men drew, but gradually they would have to hurry up, they would have so much to say, and the drawing would become a simple sign. So the picture of an ox becomes \times . This does not explain why they lost the old power of drawing so life-likely, but I think we can explain that too. The Old Stone Age artist saw what he was drawing, like a waking dream in front of him. But that power had to go if men began to think how they saw and drew. If you do a thing without thinking, and in the middle suddenly try to think how you are doing it, you will fail. So this early power of picture-making had to desert men as soon as they began to think how they recollected things, and so no longer saw them as a dream but recollected them by putting them together bit by bit until they had a general idea of the whole. Those little pictures that the New Stone Age men made, and which have no beauty like the pictures their predecessors drew, show that men's ideas have become so clear, and have broken up what they see into such distinct parts, that the old vague sense of unity has gone, and instead of it men have a new power of taking things to pieces and of feeling themselves detached.

And we have lots of other facts that show that ideas must have been getting clearer and sharper in men's minds. Men began to make all sorts of inventions quite quickly, and the power to make inventions shows a new clear way of thinking about things. We know at this stage men not only invented new ways of making tools, but they also found out how to bake pottery and how to grow crops. Till then men had drifted about, save when, near the ice, the cold made them seek shelter in the caves. We know how widely they wandered, because types of the Old Stone Age tools, flaked in precisely the same way, are found in places as far apart as South India, Mongolia, central Africa, and England.

But when men had found out how to grow crops they didn't have to wander about trailing and tracking their food, the wild game. And as they could stay in the same place they could study things more thoroughly. A rolling stone gathers no moss, and a hunter, always on the trek, has far smaller opportunity of making inventions and of thinking things out than a man who is kept with the same problem turning up again and again in front of him. One of the most remarkable things in history is that we only begin to go ahead in our minds when our bodies more or less come to a standstill. All the time, during the tens of thousands of years of the Old Stone Age, while man was a roaming hunter, the stone weapons he used are so regular in their shapes, and these shapes change so gradually, that you feel that no one was making inventions. The weapons were changing their shapes and becoming better so slowly that no one can have been aware that they were actually improving. But when, with the New Stone Age, men settled down, then discovery began to go ahead. Inventions were made and improvements added. It is clear that people could now think why they made a tool—not merely that it had always been made that way and that it was right that it should be made that way. They could think clearly of the end and purpose for which the tool was being shaped, and so they consciously improved it, and even dared invent a better sort of tool.

Now they couldn't have done this unless they were able to think about their intentions and aims in a way that the earlier people were not able to think. In short, they had far clearer and more definite ideas.

There were great advantages in this power of making these distinctions, this ability for clear ideas and not muddling things up. It was very useful and practical, and led to a great increase in power. So these men of the New Stone Age, who had these clearer ideas, definitely began civilisation. Yet this power of having these very much clearer ideas was not wholly gain. It led to men being far more powerful, but it also led to their being far less happy. However hard up they were, the men of the Old Stone Age,

whenever they did anything, whether it was chipping a stone arrow-point or painting a picture, they did it as their people had always done it. They did it according to tradition ; they did it in the way that they felt was so right that we should say it was the lucky way. To try and do it in some original way, however brilliant, that would have been wrong—unlucky.

But with the clearer ideas that came to the men of the New Stone Age that word "right" began to change its meaning, or, rather, to split up into several meanings. It had meant that a thing was right when everyone could approve of it. An arrow-head not only had to be sharp, so that it could pierce an animal's body ; it had to be of the traditional lucky shape, and chipped with the strokes that made it certain that it would kill the animal. So we see the word "right" is a far more embracing and comfortable word before people have come to think too clearly about it and to define clearly what they mean by it. When the man of the Old Stone Age made things according to the rules, he felt he was doing something noble and good, and that helped everyone to be happy, as well as that he was making a particular weapon or tool to get food in a particular way. When a man of the New Stone Age made things rightly, he meant more and more that these things were right simply and solely if they were efficient, if they did their particular job well.

So one of the effects of having more definite ideas was that all work lost some of its worth and value. Its rightness was less and less mixed up with what we call morality, with the way things ought to be and with the rules of your group.

PROPERTY

Another way that clearer ideas made men more unhappy, though they made them more powerful, was through the beginning of property. We human beings come from a stock of animals which undoubtedly always went about in packs. We won through best when we were together, and we liked

being together, and being together and liking it, we naturally shared most things. A kill was broken up among all the pack. But, when men began to till the fields, the idea of property began to form in their minds (see *The Family*, p. 473). They put up boundaries and warned off trespassers, and cursed those who dared remove their landmarks. And so, soon after the idea of property formed in men's minds—this idea of getting as much for yourself as you can—another, even more disturbing idea came in with it—the idea of deliberate war. Till then undoubtedly men had quarrelled often, snarled, bit, and even occasionally killed each other in sudden flares of temper. That is natural enough. But solemn, organised war is not natural. As far as we know, no species of animal organises itself into separate parties that attack and destroy each other. This queer idea was evidently left for our species, for man, and it evidently arose because we wanted to protect or seize that other strange new thing, property. So men's clearer ideas led to two great unhappinesses. In the first place, men lost the sense that their work was right in the widest and most comforting sense of the word, and, in the second place, as they won private property, and grew suspicious about other people wanting to take it from them, they lost the sense of all sharing a life in common, and they even started to attack and destroy each other wholesale.

But, though the growing clearness of men's ideas had made them much more powerful, these ideas were really not much more *true* than the ideas the men of the Old Stone Age had had. Though people thought much more clearly, they still fell into very serious mistakes in their thinking, and couldn't yet distinguish clearly between their ideas and the objects which those ideas were meant to represent.

WRITING

We have a very good example of that when we trace how men began to have a written language. As we have seen, many backward peoples still don't have any definite

general ideas; their language lacks adjectives, and the nouns are all names of things and not of ideas. We saw that the early Arab, when he was making his language, must have seen each camel as different from any other camel (as of course it is). Early languages show that early people try to have a separate word for each separate thing. The attempt, however, breaks down, for not only are there far too many things in the world for you ever to be able to name and remember them, but because one thing is always running into something else: you can't keep them all distinct.

So written language starts with pictures of things men want. Then these pictures become more and more symbols, shorthand pictures. The Old Stone Age man drew animals as completely as though they had been photographed on his mind. But his successors drew them with half a dozen strokes, and probably in half a dozen seconds. It was a far quicker way of making another person see what you meant, but it was not nearly as clear—it was an abstraction of the thing, not a representation. You could see what the Old Stone Age artist meant, but unless you understood first what the New Stone Age man was driving at you might fail to get his meaning from his scrawl. So, though what most of the pictures of the Old Stone Age men stand for is still as clear as daylight, we can't understand many of the scribblings of their successors. And this making the pictures more and more a symbol goes on until we have writing which clearly must have been made up from pictures of actual things, but, unless we already know the language, we can't make out in the least what the signs stand for.

But, though these signs have changed so far from pictures that they have become symbols in which it is hard to recognise a line of the original sketch, the men who made these symbols couldn't get their ideas clear about what they were, for a long while. They fell into the queerest confusion over them. We have seen that those first artists, when they made their perfect pictures of animals, certainly thought that the perfect picture was in some way a real animal;



Fig. 75. WRITING WE NOW CAN'T READ

A message written spirally round a bronze disc from Phaistos in Crete. What does that head mean that they repeat so often, sometimes with a helmet, sometimes bare? And what is that thing like a plant in a pot—is it a vine?

and, indeed, so well are they drawn that it is not hard to understand their mistake. The perfect picture of a particular animal is there. But the queer thing is that when men began to make scribbles that were no longer recognisable pictures, but were simply signs for an animal, they could not give up the notion that this scribble, because it had once been a picture of an animal, was still in some way the animal. Now this mistake has led to very great confusion in our ideas, a confusion from which we are even now not quite clear, and so, though it is hard to get the thing straight in our heads, we must try.

The Old Stone Age artist when he drew, was drawing a particular animal which he had in his mind's eye. So if he thought of his picture as somehow making present, a *representation* of, the animal he wanted, though he was mistaken about the picture being real, he was right about the object: the animal was real. But when people began to make, instead of particular pictures of particular animals, general symbols, signs, and, in the end, written words that would do to describe whole groups and species of animals, then they began to think that the symbol, say, for a cat, as it referred to all cats, to cats in general, was somehow itself the cat-in-general. They began to get ready to think that somewhere there must be a perfect cat, a typical cat, of which all the other actual cats you see are only rough copies.

And of course, if they fell into this mistake about cats and other perfectly plain things, they fell into it even more easily when they came to deal, not with things, but with qualities such as good and bad, with what we call abstract ideas.

We know, again, from the study of early languages and backward peoples, that all these abstract ideas are made out of actual things to which people can point. For example, when men first started digging they were disagreeably surprised when they came up against the strength of rock. So a rock became the symbol of strength. But when they had made the symbol they began to think of it, of the word "strength," as something that existed somewhere by itself,

and of which the strength of rock and bronze and iron were only poor examples. And so, too, with Beauty and Goodness and Truth. Beautiful things, good things, and true things all came to be thought of as objects into which so much of the Perfect Ideas of Beauty, Goodness, and Truth had been put.

We can trace this unhappy confusion all through our attempts to think clearly about the world we live in and to have ideas that describe it accurately. It is for this reason that most backward people will not let you know their real name. Their name is themselves, their "soul," and so, if you know that and can say it over in an unfriendly or even a careless way, you can damage them. They can't help thinking the description, the label, is the person himself. And for the same reason the Hebrews would not say or write the word for their God, and still when a Jew is copying out the Old Testament, every time he comes to the word God he only writes a short sign, not all the letters, and even to do that he must wash his hands first and use a new pen.

So it is from these mistaken ideas that there grew up the fancy that spells could be made—that is, that if I write some words, or even only say them, the words themselves have power to injure or help.

NUMBERS AND PATTERNS

What had happened with words also happened with numbers; those other symbols with which we try to have clear and separate ideas. Numbers we can see are only notions. They are the plainest labels we can put on things. They help us to arrange things in the simplest sort of order. But, unfortunately, people got into almost as great a muddle over these very plain and convenient little counters as they did over the lovely and varied symbols we call words. Part of the muddle was due to that very plentiful source of muddles; the fact that we have only come bit by bit, and very slowly and uncertainly, to our present knowledge.

Long periods pass without anything new being added, and then people tend to think that their knowledge must be complete. They feel that there is no need to know anything more, because, with the facts they have already in hand, they have made a good enough way of living. Then new facts and further finds force themselves on people's attention. But though at last the new facts are accepted, they are accepted grudgingly. They seem at best pointless and out of place, because they are not needed to make life have meaning, for a complete meaning of life has already been made out of the older known facts. And the new facts may not be merely pointless and unnecessary: they may seem actually wicked, because they may seem to contradict some of the old facts, which were used, and made sacred by being used, to show the meaning of life.

So the old facts, all caked together in a sacred crust of custom and all meaning something, have an importance, as part of tradition, which new facts can never have. Even to-day there are backward peoples in out-of-the-way parts of the world who cannot count up very far. Some have no words for any number above thirty or forty; anything that is more than that they say is numberless. Yet some of these people, when tending a flock of fifty or sixty animals, can say if one animal is missing. We see from this that they haven't the power to "abstract" the flock into its separate numbers and to add them up, but instead they have that amazing power of taking in the flock as a single picture, in much the same manner as the Stone Age artist took in at a glance the bison without knowing anything about how many muscles and sinews and bones it had, and in much the same manner as we still notice—as we say "instinctively"—when something, however small, is wrong with a person's face before we can say exactly what it is (see *Physics and Astronomy*, p. 350).

So it seems we were able to get on for a long time without being able to number things very far. We took things in, but in the lump; we didn't analyse them. So, as we were able to get on for a very long time with a very few numbers, this first group of numbers quite naturally became sacred.

People at various times have thought there must be something sacred about nearly all the smaller numbers. Three has certainly been sacred, and from there on to twelve. And it is pretty certain why all these small numbers have been sacred and lucky, while hundreds of thousands and millions have not been thought to have any luck about them. It is because these early numbers were all the numbers we knew for long ages, and so they had to become sacred. They gathered round themselves a sense of mysterious importance because they were part of the traditional, sacred, moral knowledge, while all the later, higher numbers, because they were discovered later, could have nothing to do with tradition and morality. By the time we became able to reach up to them we had got our minds clear of this muddle, and could see that all numbers are simply and solely little ticks to help us reckon more clearly and more quickly.

But there was also another and more difficult reason why men got into a muddle with their figures and thought that numbers must have something magical about them. They thought they must be magical because of the beautiful way numbers often seem to "work out." For instance, they found they could make "magic squares" filled with numbers which, whatever way you added them up—right to left, up or down or slopingly—always gave you the same sum. This is one of them. Now that seemed very wonderful,

1	14	15	4
12	7	6	9
8	11	10	5
13	2	3	16

Up and down or across or corner to corner, they all add up to 34.

as though there must be some power in the numbers themselves which made them arrange themselves naturally

into patterns. This idea of pattern, design, and purpose is perhaps the deepest and most difficult idea we can have. Man is a pattern-making animal. We like making designs that "mean" nothing, quite as much as we like making pictures that mean to be exact copies of things. This love of pure pattern goes so deep that it is the cause of nearly all music. Even with a picture which we like, because it is what we call a good likeness, we only get lasting pleasure out of it if the objects shown in it are shown so that they make a certain pattern.

Just as we like arranging objects so that they make a pattern, so we are always trying to see patterns, design, and order in the world around us. Numbers, naturally, help us to do this, and this is another reason why men thought numbers, instead of being convenient ideas to help us to think about things, were themselves super-things, and had something divine about them (see *Physics*, p. 356).

While we are tracing this difficulty we must go a little farther. We have seen that when men got definite words and numbers for things and groups of things, they began to think that the words and numbers referred to mysterious "ideal" things, because the numbers were not themselves the actual things they referred to. The same mistake was made when men began to develop geometry. They found that, though they could make perfect circles, straight lines, and squares, actually in nature they very seldom came across such perfect things. Nature seems to "draw free-hand" from perfect geometrical models, but not herself to make such models. So men began to think there was something divine about geometry, and that circles, especially, were heavenly. The idea, of course, seemed to gain great support from the early study of the stars. It seemed to the first astronomers that, though down here every pattern was muddled and every design incomplete, in the sky there was perfect order. So firmly did this idea fix itself in men's minds that when, only four centuries ago, it was pointed out that the planets were not going in perfect circles round the sun, but in irregular circles called ellipses, the idea was attacked as impious, because to say that a heavenly body

did not move in the heavenly way—a perfect circle—was to throw doubt on the circle being a divine shape.

WHAT HAPPENED TO IDEAS: PROJECTION

Now we must go back to our history and see how the gradual defining of ideas made other difficulties as well.

We have seen that the growth of language and writing made difficulties, because people began to think that the words they used and the ideas they had were not merely labels, but had a life of their own, and, as they could not see these ideas, they thought they must be perfect and "laid up in heaven." And we have seen that the same thing took place as arithmetic and geometry developed. The whole difficulty was due to the fact that men didn't understand that they themselves were growing, and that the new things they noticed in the world around them, and the new ideas they had about them, were not new things turning up, but signs and symptoms of new powers in themselves. When men make a new discovery about the world, when they have a fresh idea, it is almost impossible for them to realise it is they that have moved, they that have grown. They can't believe that they have a new power of noticing things, and understanding. They can hardly avoid being sure that something quite new has turned up outside them. When we make that mistake, it is called "projection." For it is as though we threw the shadow of ourselves and our ideas on the world outside us, and then thought the shadow real. Ideas are absolutely necessary if we are to tackle life, but this confusion between our ideas and what is actually there, outside us, has made such confusion, and caused such pain and suffering in the past (and, indeed, is still causing them), that it is immensely important that we should grasp this trick of our minds and learn to look out for this serious mistake.

Let me give an illustration of projection to make it quite clear. In Germany, in some wild country, people used to be very frightened when they climbed a certain hill, for, as the lonely traveller breasted the summit, he often saw

striding toward him through the mist an immense giant. Yet when he had gone a little farther the monster had vanished completely. It was therefore called the Spectre of the Brocken, the hill country where it appeared. Not till the modern age was it explained. Then it was realised that this towering creature that strode through the mist toward the frightened traveller was only the shadow of the traveller himself cast by the light behind him on the fog in front. Precisely the same thing has taken place in our history. We actually thought that the words, the numbers, and the geometrical figures that we coined to help us to make classes and orders out of the innumerable actual examples around us were themselves somehow real ; indeed, more real than the examples. We " projected " our ideas on the world. But we did an even more serious and more mistaken piece of projection than that.

Our first ideas about the world and the way it worked must have been very vague, as vague as our notions about ourselves. We could not think clearly and definitely who we were and how we thought, and how we distinguished between ourselves and the others, and between what we thought and noticed for ourselves and what the others had thought and told us. At that stage we took things very much for granted, and assumed that everyone and everything was very like oneself. We felt alive, but in a very general way. We did not ask, " How do I know I am alive, and how do I recognise that I am alive, and that my friends are alive and that the animals are alive ? " As we have seen, this lack of definite ideas made men feel a very great kinship with the animals, and, indeed, with everything that moved. The whole world seemed alive, just as they were alive.

But when men became more sure of themselves, and more inclined to separate between themselves and each other and the animals and the world itself, then very soon they got into trouble with these new ideas. The early men had the vaguest ideas about their own aliveness, and so could have the vaguest ideas about the aliveness of everything else. But the men who came after, who were quite

clear about their own separate aliveness—their individuality—had to make up their minds about the way their friends were alive, and the animals were alive, and whether the world was alive.

And naturally they “projected” this new clear notion about themselves on to everything around them. The men who had come before them had taken for granted that everything was as vaguely alive as themselves. These late men in their turn had to take for granted that everything was as definitely and individually alive in the way that they had come to think themselves to be alive.

Now this was of course a great mistake. As long as you said, “Everything is alive in a sort of way,” you couldn’t be proved wrong, for what proves aliveness is a very difficult question. But when you said, “Everything is alive in the definite way I am alive,” then you were in for trouble. Yet the trouble was one that probably could not have been avoided. The way our ideas grow is part of the way we ourselves grow.

So when men came to this stage of awareness of themselves as separate individuals they had to give up the idea that the world was very vaguely alive, and they had instead to imagine that it was filled with beings and moved by beings exactly like themselves. This very important and very unpleasant stage in the growth of our ideas is called *Anthropomorphism*. That means the stage when men believe that the whole world is really made and moved by men like themselves. People at this stage believe that, though you may not be able to see it, yet every tree conceals a tree-spirit just like a human being, and the same is true of every brook, field, mountain, lake, and star.

Now this idea has had, perhaps, more effect on us than any other idea, and most of the effect has been bad. For as long as you thought of the world as only vaguely alive you were really not very much concerned about it. You did not know much about your own vague self, and so you did not know much about the world. It was enough for you to carry on as people had always felt right in carrying on, and you felt right yourself. You were not concerned with

fresh problems of how to behave differently, whether you ought to behave differently, and what would happen if you did behave differently. But, once you thought of the world as made up of a jumble of individuals all like your own now jumbled selves, you were faced with a very difficult and painful problem. For, as we have seen, men at this time had become very individualised, very conscious that they had to strike out for themselves and break with the past. They were heaping up property each for himself, and they were organising quarrelling and stealing so thoroughly that they were splitting up into bands which were always at war with each other. Now this unhappy frame of mind was, of course, through "projection," thrown by these men on to the world outside them. They read their own characters and passions into the forces of nature. Their gods were only "men writ large," and as men were becoming more selfish, cantankerous, and treacherous to each other, so they imagined their gods to be. Your work was therefore cut out if you were to placate such gods. Men imagined the gods always tricking each other and brawling with each other, just as they themselves tricked and brawled.

THE POWERS OF DARKNESS

And not only did men begin to think that every movement in the world outside them, and everything that happened to them, whether it was an accident or a disease, was due to the will of tricky, ill-tempered spirits. That was bad enough. But there was something worse. Men have always been rather uneasy in the dark. This is probably due to the fact that our ancestors spent several millions of years, like the chimpanzees, living up in the trees, and only really safe up there. When night came, the floor of the forest, on to which you might occasionally jump down during the day, became deadly dangerous. Then our ancestors huddled together high up in the trees, and the coming of daylight must always have been some relief. For even up in the trees you weren't quite safe. Tree-climbing snakes and cats could get at you, and that may be



Fig. 76. ANIMAL GODS TURNING INTO MEN GODS

The earliest Egyptian gods were totem animals with men's minds. Horus started as a hawk. Bast as a cat, but here only the animal mask is left; the anthropomorphic idea has come through everywhere else.

the reason why some people still have an unreasonable horror of cats and snakes, a peculiar horror they don't feel for far more dangerous animals (see *Psychology*, p. 152).

So at the back of our minds we all still have an unreasonable uneasiness in the dark. Now, when men began to think that, because they felt themselves to be separate individuals, outer nature must also be alive with separate individuals, they began to think that in the dark, when they could see nothing, but felt all the more frightened, there must be beings, spirits which were frightful. So, as well as believing that the outer world was alive with spirits as quarrelsome, cruel, and tricky as themselves, men started another even worse idea—that the dark, and, indeed, all strange places, like deserts and dim forests, were full of spirits as terrifying as the fear these men felt when alone in the desert or the dark. And this idea led to even more serious consequences. For if the dark and lonely places were the homes of dark and dreadful spirits, then under the earth, where the reassuring sunlight never came, must be the chief home of all these, the worst sort of spirits. So they began to think caves were the entrances into this dark and most dangerous underground spirit world.

Before men got this dismal idea into their heads, they had begun to think vaguely about what might be under their feet. They had begun to wonder why all the plants as they grew started under ground, and they had therefore begun to look upon the soil as somehow sacred and holy, in the dark of which the food they needed was mysteriously created. So they tended to worship the earth, and as, for example, the early Egyptians, perhaps the first people to have an organised religion, buried their dead in the fertile earth, they began to feel that their dead and the growing crops were somehow mysteriously in touch. So when people began to wonder what the dead were doing, they found it quite natural to think that they were somehow now living underground and helping the crops to grow, by which the men on the earth were kept alive. Ideas about what the main mass of the dead do did not trouble men for quite a long time. In early Egypt, the only person about

whose business in the other life you were quite certain was the King, the sacred Pharaoh, and he was helping the crops to grow. So the other world was not a distant, lonely place, but just under your feet, as near as the roots of the corn and the barley went. You couldn't see the dead, but they were not far separate from you ; they were co-operating with you just the other side of a quite thin floor.

But as men became more and more self-conscious, more sure that they were each separate, lonely individuals, the more they each wanted a separate life after death. They began to doubt whether it was enough proof of that life that the crops grew and that religion had said that it was Pharaoh underground who was making them grow. We have seen that men had begun to think that every object they saw contained a separate individual spirit like that they felt themselves to be. The clearer they thought, the more they felt that each tree and river had a separate being attached to it, haunting it, and that being was just like themselves. In fact, they had begun to make that same mistake they had made with words and numbers. As they had thought that the words and numbers, which are only labels, were themselves additional things, so they began to think that the moving of the stream and the growing of the tree were not mere moving and aliveness, but were signs of river and tree being moved by a separate man like themselves. They were being stirred and shaped as a soup is stirred by a cook or a pot is shaped by a potter.

This separating off from every living, moving thing of the power that moved it, and this turning of the separated-off power into a definite spirit, affected men's ideas about their own future. They began to think that the life they felt in themselves was something quite separate from their bodies. They came to think of a separate soul within their bodies, just like their bodies but able to get out and live on its own, just as they believed the spirit, or genius, of the tree or the river might occasionally be seen sitting outside the tree or river in which it generally lived. What, then, was going to happen to this precious self when the body it lived in, the house it had occupied, fell to pieces ?

When men began to have these doubts they got frightened, for doubt and fright nearly always go together in uneducated people. They had always been frightened of the dark, and, now that they had begun to think the world full of individual spirits, they had to think the dark full of wicked spirits. The next step was to think the dark underground, because it was the great place where the sunlight never came, was the home of all dark spirits. So men fell into the unhappy idea that the underground was not the fertile place of the kindly dead, but a huge, empty, barren, dark place, so vast that everyone was lost there, so sunless that no one had any real vitality there, and so full of dark spirits that it was a far more dangerous and frightening place than anywhere here on earth.

Once men had got that set of ideas into their heads there was nothing that they would not do to set their minds at rest. They got their personal safety on the brain, and, like most frightened people, they became cowardly and cruel. If, when a ship is in danger, everyone on board thinks, "I must save myself," the chance of the ship being saved is very small.

So with the ideas that men have had about the future life. The place you were going to was, they reasoned falsely, an enormous place, which had room for everyone who had ever been born. You would probably be there for ever, because it was your body that fell to pieces, not your soul. So, as you could hardly escape going to this place, and you might never get out, in comparison with that this little life here didn't matter at all. All that mattered was that you should somehow make yourself as comfortable as possible in eternity.

RELIGION

So the vast system of religion grew up. For there was a hope that you might make yourself comfortable hereafter—perhaps supremely comfortable. We have seen that before people got these gloomy ideas about the other life they had had far vaguer but far more pleasant notions about

it. It was a sort of blessed state where the holy King reigned, and sent good things up to the earth. Gradually, as the King's Court increased, he was thought of as having with him all his attendants. From very early times men had always buried a dead man's things with him, because they were thought to be part of him. Later, when rulers became powerful and had slaves and attendants, these too were buried with him, simply because it was thought dangerous to use a great man's things. But as the King's state grew so great that his priests and his officers themselves became great men, they also were thought of as joining in the blessed fertile life that the King continued under the earth. So there grew up an idea of a society of blessed people living after death, and more and more people were allowed to be able to be elected to that life. The King went on living underground because he had, during his life here, men believed, kept the people prosperous and happy. He was their luck, and the source of the happiness and power that came from their holding together, of their plenty and power as well as of their peace of mind. And so gradually it began to be felt that everyone who had done well by his fellows in this life, who had kept the laws and done things which were of benefit to all, might hope to deserve to share with the King in the blessed future life.

Then, when the underworld became more and more a place of dark spirits, instead of the secret place of growth, the meeting-place of all good people after death was changed. It could no longer be underground. For a little while people fancied it might be somewhere on the earth : very distant : the other side of the farthest river, or out in the ocean. So we get the idea of the Islands of the Blest somewhere far away in the sea near where the sun seems to touch the water. But that idea did not bear looking into. And so people began to think that, as no place on earth was the home of the blessed dead and no place underneath could be, it must be in the sky, in the heaven, near the sun, who is the friend of the good and the enemy of the dark and evil. The Greeks thought that the gods lived on the snow-tops of the high mountains where the clouds

hide them from the earth and where the summits above the clouds are in the clear sunlight, and, they thought, quite near the sky.

It was thus from quite simple ideas that men made a theory about another world above and below the world, and another life beyond this life. And that theory, though it was mistaken, was not a foolish and senseless mistake. For we have seen, as long as men felt themselves to be separate, lonely individuals, they had to have a crude and definite answer to their question, "What is going to happen to me?" Slowly men framed the answer—all religion is an attempt to frame that answer—"If you behave well, and care for other people as much as you care for yourself, and make yourself intensely interested in your society going on and prospering, it will be all right with you; you will come to no harm." Of course, the way many men in the past have put that answer has often been as muddled and crude as the way in which men asked the question. Lonely, individual men are apt to be very selfish, and there is a very great temptation for practical people who have to keep things going to play on the selfishness of such men, to frighten them, through threats of personal pain after death, into being good, and to bribe them to think of others here by promises of private pleasures hereafter. But the truth behind all these ideas—however they may have been perverted and however much harm that perversion has done—is that if you live for others and for great causes, you will find that you get away from the fear of what will happen to you personally, and that you have a large and free and hopeful life that accident cannot touch. That is the truth behind all these stories, and it is because of this truth in them that these stories and these parables can still be taught.

Gradually more and more men came to see that this was the truth behind these parables, the underlying idea in these stories, and when they saw this they were able to develop and enlarge the idea. All the traditional teaching had said you must serve your community if you would be happy. But men began to see that, though that was true,

it was too narrow. It was right for you to serve your community, but what if your community did wrong? So men like Socrates began to say that they were citizens of the world—that is, that they owed loyalty to every man and woman. The Stoics after this began to teach that all men are brothers, that only by treating everyone well can a really happy life be lived by us. And, in Asia, Buddha had gone still farther. He said that unless you treated all animals with gentleness and understanding you could not understand life and really reach that serene happiness that awaits the wise. That shows that men were gradually coming back to the sense they had once long before had (see Totemism, p. 430) that their life and all life are somehow bound together. The Stoics felt that every human being is akin. They had got away from the narrow, unhappy notion of our being completely cut off from each other, of every stranger being probably an enemy; and Buddha had gone still farther, for he felt that we are all parts of life, a fact that science has since shown to be true.

SCIENCE

So, in conclusion, we must see how this last great idea, the idea of science, has grown out of the earlier ideas men had about themselves and the world. We have seen that in the first dim ideas that men had they confused themselves and their tribe with the animals around them and the world they all lived in. And we have seen that this confusion, or perhaps it would be better to say this blending of themselves and everything else, was a very useful idea, because it made them feel that they were all part of life and part of the world. So they couldn't feel lonely and lost, and they could feel everything they did, all the tribal rules they kept, were immensely important, for if you broke these rules you were breaking the rules of the universe, and if you kept them you were not only keeping the tribe from wrong, you were keeping the world from breaking down. So their rules of conduct, their morality, gave

them a very great sense of importance and worth. It was immensely interesting to keep the rules and to see that they were kept. But as men's ideas grew clearer they saw that the rules they kept didn't apply to the animals or to the outer world. They were rules which only applied and were useful to the tribe itself. All the rest of their belief about their importance had been "projection." Man had seen his shadow falling on the outer world, and so he had imagined that in that outer world there was a man like himself.

This discovery led at first to a great upset in people's minds. They began to think that because the animals and the outer world didn't keep any of the rules the tribe laid down, therefore these rules were nonsense, and there was no reason to keep them, because if you broke them, and none of your fellow-men saw you break them, then nothing happened, no power outside the tribe interfered and told on you or punished you itself. I think that men made this discovery, about the great difference between the tribe and the world, at much the same time as they made the discovery about the difference between the tribe and themselves. They began to feel themselves independent individuals, and they wanted to know what would happen if they didn't obey the tribe's rules. They soon found that if you broke a rule the weather did not necessarily get bad; if you failed to carry out a rule, the crops or the hunting did not necessarily fail. In fact, it seemed for a little while that if the tribe did not notice you had acted wrongly nothing at all happened. We shall see in a moment that that was going too far, but first we must see what were the immediate results of these new ideas. One result we have already noted. That, of course, was that men began to break rules right and left, and the world became a far more difficult and unpleasant place to live in, with everyone struggling to get the utmost for himself. (For a description of a society in this state, written at the time, read the Book of Judges.) For, as we are creatures that work naturally in groups, if we suddenly lose the power of doing this we lose most of our power of protecting ourselves

against other creatures, and of getting ourselves enough food and clothing.

But this loss was not wholly without gain. For another consequence of men being able to see that the outer world did not run exactly as the tribe ran, and didn't have laws like the tribe's laws, was that they began to be able to discover by what laws the outer world did actually work—that is to say, men began to have their first purely scientific ideas. So the Greeks came to the first ideas of the laws of nature, laws which showed how regular and orderly the world is. And this was a great gain, because, we have seen, men had come to the notion that the world was full of beings like themselves, crafty, cruel, and violent. So it was a great advance when they realised that, however badly men might behave, the fancy that there were gods behaving just as badly was untrue. Science destroyed anthropomorphism—the belief that the world was run by characters just like men's characters. And science has proved that it is right, that the world is not haunted and run by moody spirits you must bribe, but by laws you can learn. For science *works*, and where it has been used to the full its ideas have given men powers and freedom which they never had before and could never have as long as they thought the world was run by quarrelling spirits and not by regular laws.

But though this great idea of science has not only given us tremendous powers, but also has freed us from being frightened by fancies, it has not been altogether a gain; we want even more ideas if we are to be really happy. We have seen that the idea of the world being full of spirits grew up in men's minds because their minds were changing; they were becoming self-centred. It was a false idea, and, what is more important, it was a sign of an unhappy and wrong state of mind. Science brushed away the false idea, but for some time it did not succeed in changing the bad state of mind. Indeed, science seemed to many people only to have swept away the last reason that men might have for fearing to behave as selfishly and as cruelly as they liked. For the ideas about the gods, though often bad, because

they were reflections of men's own moods, also sometimes were good, because they were recollections of the old rules that the tribe had once had when it lived in peace. So it was not enough for science just to say there were no gods. It had also, if it was to give men complete peace of mind, to tell them why they had made the gods. It had to explain to them, not only the outer world and its laws, but themselves and the laws of their own nature.

For men had found that they did not understand themselves. They found that when they broke the rules and no one found out, though nothing happened in the outer world, they weren't happy. They couldn't steal and murder and yet have peace of mind. It was not merely that you were in constant fear that someone else would steal from you and murder you. It was that the sense of life being worth living, that very deep and necessary feeling in oneself that one is right, was somehow hurt and killed by knowing oneself to be a thief and a murderer. This idea, and the problem it raises, runs through many of the greatest stories in the world, and especially interested Shakespeare in his greatest plays. If you are an individual, why can't you enjoy yourself the more you take from others for yourself?

Now at last science is beginning to deal with these facts about ourselves, and is giving us very important ideas on them. Science to-day is making out the laws that rule us and our lives as before it made out the laws that rule the outer world. And the results are going to be even more wonderful. For science is finding that our ideas about ourselves have been as mistaken as have been the ideas of our ancestors about the outer world. We have been mistaken in thinking we are isolated individuals, just as mistaken as we were in thinking that the outer world is a jumble of isolated individual spirits. That is the reason why we are unhappy when we try to act on our own and to have no rules. We have our own natural laws. And the latest and brightest idea of science is, through that branch of science that studies our minds and how we behave—psychology—to find out those rules and laws, and so teach us how to be

as healthy and happy in our minds as medicine and physical health rules teach us to be healthy and happy in our bodies.

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So we have seen how men's ideas have grown. The growth has been rather like a great spiral staircase. Men's first ideas began by being simple and vague, but did answer the questions which the first men needed to have answered ; they did make men sure they were part of life, and that in serving the group in which they found themselves they were serving life and also gaining their own happiness. Then those ideas had to become sharper and clearer. Men had to see the world more distinctly, and to understand more definitely how it ran. That led to an upset, because for a little while men could not see where they themselves came in. They tried for a time to be happy on their own, and to imagine that whatever they did didn't matter so long as their fellows didn't find them out. It was necessary that they should try this, because not only had they to learn that they couldn't be happy in this way, but they had also to learn that the idea that the world was run by spirits was false, that it was really run by regular laws. There was no spiritual policeman to catch them, and whom, because he was like themselves, they might bribe to let them go. Once they had got rid of that idea they were free to see whether they could really live for themselves alone. And then they discovered that they hadn't till then understood themselves, and that they were far more complicated and tied up with each other than they had thought.

That is the stage we have reached to-day. The latest ideas of science are bringing us back to the idea that we are linked up with each other, with life, and with the world, quite as firmly as our first ancestors knew by their feelings they were.

So we see ideas are very important things, not so much because of the new power they give us and the new discoveries they lead to, but because their growth shows us, perhaps better than the growth of any other thing about us,

how we ourselves in our minds are growing. There is no idea that we can have that does not mean something very important. To-day, when the world is fuller than it has ever been of new ideas, we know by that fact that our minds must be growing faster than they have ever grown before, and, knowing that, we shall not be afraid to keep our minds open to these new ideas ; for we know that every new idea is a sign of our being more and more alive, and that the new ideas of others help our own minds to grow.

THE FAMILY
OR
ONE WAY OF KEEPING TOGETHER
by
CHARLES SKEPPER



CHARLES SKEPPER is quite young, and has not done anything very exciting yet except trying to think for himself, which is always rather a painful and dangerous thing to do. He is a kind of scientist, too, a social scientist and sociologist (which means someone who is finding out about people), and you will see from his chapter that he is trying to look at established ideas and established patterns of life, in various countries and times, from a detached and scientific point of view. His way of looking at things is very different from Gerald Heard's; he looks from the outside, dividing societies and groups up into individuals, and Gerald Heard starts from the inside, pulling individuals together into groups. This is a rough way of putting it, but you will see what I mean. All of us who are writing in this book have our own special points of view—things we love and hate and criticise. The more one knows about anything, the more different from other people's one's point of view becomes.

You will probably see more or less what Charles Skepper

thinks of the family—the obvious group to which almost all of us belong. He criticises it, because he feels that an individual person—you or me or him—can easily be destroyed, be eaten up, by any kind of violent loyalty to a group; any problem ought ultimately to be decided by the individual person's own sense of right and wrong, and that may be swamped by the sense of loyalty, whether it is to a school, country, religion, or family. And family loyalty is especially dangerous, because a family is apt to think only of itself, and stick together whether it is right or wrong, and be proud of it! He sees that women have been treated very unfairly in the past, and are still being treated unfairly; he sees, too, that it is very bad for children when their mothers (or their sisters) are looked on as inferior kind of people. He hopes, as I do, that by the time those of you who are girls are grown up, you will feel and know that you are the equals and friends of men; different perhaps in some ways, but not inferior.

Charles Skepper also knows that children are often made to feel that the only thing that matters is success, and that they've got to be successful for the sake of the family. That isn't always the family's fault, for all sorts of other things—newspapers and books and movies, for instance—keep on saying the same thing. But not everyone can be successful (as success is counted just now), and those in a family who aren't successful are very often made to feel miserable. By the time you are old enough to have children of your own, the pattern of the family will probably not be quite what it is now; perhaps there will be something better, which will let individual people be freer and happier. At any rate, Charles Skepper hopes so!

THE FAMILY

FAMILIES of parents and children living together in family life exist in all human societies; and, in all human societies except Soviet Russia, family life doesn't begin until after a marriage ceremony. We have two kinds of marriage ceremony—a religious ceremony in church, in front of all our invited friends, and a civil ceremony, which takes place before a registrar in a register office. Among uncivilised peoples (it is convenient to refer to peoples who have no writing as “uncivilised”), sometimes the whole ceremony is just a meal taken together in public. But others insist on elaborate festivities, including dancing and feasting in which everybody takes part. Often there is a sham fight between the relatives of the bride and bridegroom. The natives of the Philippine Islands send the bride into the forest with an hour's start. If her suitor finds her and returns to the camp before sunset, the couple are considered married. Sometimes also the ceremony is a long-drawn-out exchange of gifts between the families of the bride and bridegroom.

However fantastic some of these marriage ceremonies may appear to us, they all have the same effect. In every case, until a man and a woman have become husband and wife by going through a marriage ceremony they are not allowed to live together. After the ceremony, a husband and wife are not allowed to live with anybody else until they have gone through another ceremony called divorce. These restrictions can only be understood if we realise that marriage is the beginning of family life.

Human children are born in a helpless state, and so have to be looked after by some grown-up person. Their mother is the best person to do this. But it is a great help to a child if a man as well as a woman is responsible for it. The child's father is the most suitable man. The link between a child and its mother is easily seen, because of pregnancy and childbirth, but there is no obvious link

between a child and its father. The sexual act, which is the only physical connection between father and child, is private. Nine months go by between the sexual act and birth. So the simplest thing is not to make a child's father responsible for it, but the child's mother's husband, who is of course usually the same man. It would not be possible to do this unless the mother and father had gone through a public marriage ceremony. The responsibility of a mother to her child is easy to show. Marriage makes it possible to establish the responsibility of a father to his child. Moreover, a child's mother and father cannot both look after it unless they live together, and this is the chief reason why married people have to live with one another and are not allowed to live with anybody else.

The one exception to the rule that married life only begins after a marriage ceremony is Soviet Russia. In Soviet Russia most people register their marriages at a marriage office, but the law does not oblige them to do so. How, then, can they fix the responsibility for a child on its father? They do so by insisting that every child must be registered within a few days of its birth, and that its father's name must appear on its birth certificate. This makes it possible to make one man responsible for a child. That one man can be made to pay whatever is necessary to bring up the child. He cannot be made to help look after the child, for he and the child's mother need not go on living with one another unless they both want to. Just as a man and a woman can live together without going through a marriage ceremony, so they can stop living together without going through a divorce ceremony. It looks as though the Russian child were not so well off as other children, because, although he is sure to have what one might call a "financial father," he may not have a father who looks after him in everyday life. But in Soviet Russia there are crèches and kindergartens and children's organisations, and these take the place of a father. It is their existence which makes it possible to remove the rule that a father and mother must go on living together.

Easy divorce has much the same effect as the removal of

this rule. And so the Russian example helps us to understand how it is that in some societies there is very little divorce allowed, while in others divorce is easy. In societies where divorce is strict, there are no organisations to look after children except the family. Where divorce is easy, there are always other ways of looking after children.

The necessity that a man as well as a woman should be responsible for looking after children is thus the reason for marriage. The care of children is also one part of family life. Our parents feed and clothe and protect us from the time we are born to the time when we begin to earn our own livings. Most of us learn special subjects at school, but the ordinary and more important knowledge—knowledge of the dangers of disease, knowledge of the use of money, knowledge of the laws and customs of our country—we pick up at home from our parents. We also learn at home the best way to behave on various occasions. Without this knowledge we should not be able to fit into the world.

The other important part of family life is the security that it gives. None of us can stand quite alone in the world. We need the companionship of other men and women, and we need their help when we are in trouble. Some of us get this companionship from friends that we have met at school, in youth movements or sports clubs or in the factory or office where we earn our living, but most of us turn to our families for help when we need it. The help that we need has nearly always something to do with money. When we need help, we therefore become dependent upon our family. And so family life, while it gives us security, also lessens our independence.

Although the family of parents and children is found everywhere, the extent to which parents are responsible for bringing up their children varies in different societies and at different times, and so does the extent to which men and women are dependent on their family or are influenced by family life. That is to say, the family is sometimes important and sometimes not so important. We have to find out why. There seem to be two main reasons that make it important. The first is when there are

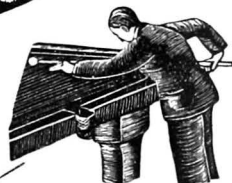
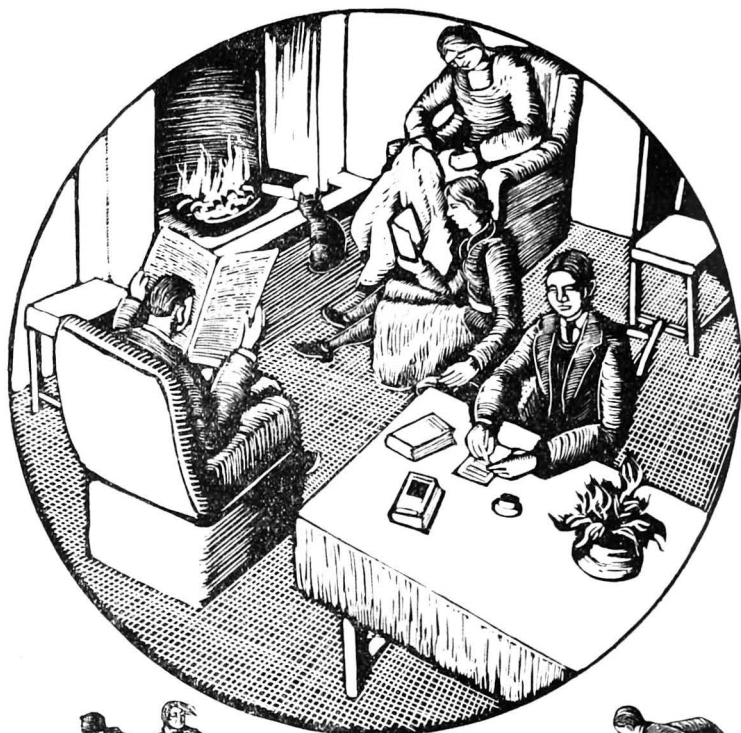


Fig. 77. THE FAMILY AT LEISURE THEN AND NOW

no groups except the family which can give companionship and protection to a man or woman. The second is when things like land and capital, without which it is impossible to earn a living, are privately owned. If a man or woman cannot get companionship and protection anywhere else, they get it from their families. If the means of earning a living are privately owned, men and women become dependent upon their families because they cannot earn their livings without the help of their families. Usually this means that they are dependent upon their fathers, for they are the persons who own the means of earning a living. We will see more in detail by examining several different kinds of societies (see also *Organisation of Society in the Past* on different kinds of societies).

THE SIMPLEST SOCIETIES

The Andamanese, of the Andaman Islands, in the Indian Ocean, are a good example of the simplest kind of un-civilised society. Small groups of twenty to forty live together in the forests. The men hunt, and the women gather fruits and berries and grubs—a great delicacy. Honey from wild bees' nests is another delicacy. There are no governments, because everybody knows everybody else, and so any problems which may occur can easily be settled by remembering what was done on a similar occasion before or by finding a commonsense way out. If a more important question has to be decided, such as whether a group should shift its hunting-ground or whether it should join with another group in a dance and feast, the older men and women discuss the matter together. Fighting between groups sometimes goes on, but it doesn't amount to anything like warfare. The enemies lie in ambush for each other and make raids on each other's huts, but as the weaker party always runs away there are rarely more than a few wounds after an encounter.

Children live with their parents in a separate hut, or in a section of a hut which has been built by the group as

a whole. The fruits and berries and honey are eaten by each separate family, but the animals killed by the hunters are divided up equally among all the members of the group. So, even though a father has not been lucky in killing anything, his family will get enough to eat.

As children grow up, they are often exchanged from family to family by adoption. We do not know why this happens, but its effect is that all the members of the group feel that they may at some time become responsible for looking after any particular child. When children reach the age of nine or ten, they begin to go through a long series of trials and ordeals. A child does not become a full member of the group until he has gone through these trials and ordeals, and so we call them initiation ceremonies. They initiate the child into the responsibilities of grown-up life.

Initiation ceremonies exist among nearly all uncivilised peoples. Sometimes they are endurance tests, like walking through fire and tattooing. Often initiates are supposed to die and be born again. In these cases they are numbed by starvation or by drugs and smoke, and then, with loud yells or douches of cold water, they are resuscitated and told that the great god has brought them back to life again. In one society, the initiates are sewn up in a sack full of large and fierce ants. Although suffering acute pain, they do their best not to show it, so as to prove that they are worthy members of the group.

The initiation ceremonies of the Andamanese begin by several days of fasting and seclusion, during which the initiates are not allowed to fall asleep. After that there are long periods when certain foods may not be eaten.

After the first ceremony, the Andamanese boy or girl no longer lives with his or her parents, but moves into the bachelors' or spinsters' hut (spinsters' huts do not always exist), and remains there until he or she gets married and occupies a separate hut. From this time on, the children—or men and women, as they are now—have very little to do with their parents. Their success in life depends upon their own skill and character and upon the fortunes of the group. Their friends and companions are just as likely to be any

other men and women in the group as they are to be members of their own family. They are not dependent upon their families, because everybody is free to gather the fruits and berries that they can, and everybody gets a share of the animals killed by the hunters. As the Andamanese live so simply, there is little private property, because there is nothing of value that can be stored up. Food is the most valuable thing, and that can't be accumulated because it goes bad. That also is why the animals killed by the hunters are evenly divided up, for otherwise each separate family would probably have nothing to eat on some days and far too much on others. As the ways of earning a living are so simple, and are available to everybody, children do not need the help of their parents, and parents cannot demand anything of their children in return for the help that they give. Men and women are not dependent upon their families, either for companionship, protection, or for the means of earning a living.

CLAN SOCIETIES

These societies are larger. They may have anything from a hundred to five hundred members. The North American Indians before the white people went to America were Clan Societies. Many of the peoples who live on the muddy mass of islands which lie between Asia and Australia have clans. Clan Societies usually live by cultivating crops in a very simple way—more like gardening than like farming as we know it. Within each society there are two or more clans. Hence the name. A clan is a group of people who feel obliged to help each other, and usually believe that they are all descended from a common ancestor. Each clan has a name, often that of an animal or plant, such as the Cockatoo Clan, the Elk Clan, the Wolf Clan, and so on (see *History of Ideas* on Totemism, p. 430. Totem Clans are one kind of clan. Also Fig. 76: hawk-god and cat-goddess).

Men and women never marry a member of their own clan. A child's father and mother therefore belong to

different clans, and, as it cannot be a member of two clans at the same time, it becomes either a member of its mother's clan or of its father's clan. The result of this is that family ties and clan ties may conflict. A member of such a society, for example, who belongs to the Porcupine Clan because his mother belonged to the Porcupine Clan, and whose father belongs to the Mango Clan, will think of his mother's mother (who is a Porcupine) as a relative, but not of his father's mother (who is a Mango). He may hardly recognise his own father as a relative, because his father is a Mango, whereas he himself is a Porcupine. This does not mean that there are not families of parents and children. It does mean that the clan as well as the family is to some extent responsible for a child. After initiation, which is carried out by members of their clan, men and women have very little to do with their families. Their clans help them in time of need, and protect them if they are threatened by anyone outside the clan. Their first duty is towards the members of their clan.

Just as in the Simplest Societies, the means of earning a living are there for anyone to use. There is plenty of land for growing crops, so nobody bothers much about its ownership. Food is the only other valuable thing, and that, we have seen, cannot be important as property, because it goes bad. There are no central Governments to which men and women might turn for protection, but the clan gives this protection. The clan also gives companionship to its members. Men and women are not dependent upon their families either for protection, for companionship, or for the means of earning a living, and so the family is not important.

LARGER UNCIVILISED SOCIETIES

These are more like nations as we know them, but not nearly so big. The best examples are in Africa—Dahomey, for instance. One of the things that distinguishes these societies from Clan Societies and from the Simplest Societies

is that they are warlike. They not only fight a lot, but they have armies and military organisation. They also have central Governments. The head of the Government is usually a king, but the real rulers are nearly always a group of wealthy people or a set of priests who use the king as a puppet.

Property is important. There are more people, so there is less land for farming. Those that possess it stick to it. Slavery often exists, and this means that slaves can be owned as property. And then there is a money system, so that only those who have money are able to get control of the means of earning a living. There are no clans. Men and women spend their everyday life in the family circle. Their duties towards other people and other people's duties towards them are determined by membership of a family. The bringing up and education of children is entirely carried out by the family. Men and women are very dependent on their families. They cannot earn their livings without the help of their families, because without land, or the money to buy land, they have nothing to work on. Moreover, cultivating the land is not a simple kind of gardening, as in the Clan Societies. It means owning ploughs and other tools, and cattle to draw the ploughs, and also slaves to do the work. These again cannot be got without money.

Only a family can give companionship and protection. One might suppose that the central Government would protect its subjects by enforcing laws. It doesn't. All it worries about is taxes and getting men for its army. The private lives and needs of its subjects are not its concern. It only interferes by supporting the authority of the head of the family, because he can be made to act as its agent in collecting taxes and in providing it with young men for its army.

Under these conditions, where family life is often hard, one would expect men and women to form groups, both for the sake of companionship and to protect their interests. Perhaps they do so, but the Government very soon suppresses them, because it is afraid that they might become

rivals to it. In England in the tenth century, when conditions were very much like these, this happened.

So, in this kind of society, the family is important, because men and women are dependent upon it for the means of earning their living, and because there are no other groups which can give them companionship and protection.

PASTORAL SOCIETIES

Pastoral Societies, like those of many Arabs, keep flocks and herds of cattle and horses, or sometimes camels and sheep. They seldom have fixed homes, since they have to follow their flocks to find new pasturage. Families are big because they include, not only the father and his wife, or more often wives, but also married sons and daughters, with their children, and often a few slaves too. A large family like this lives by itself, looking after its herds. A number of families make up a tribe under the leadership of a chief, but the chief has very little power to interfere in the lives of the separate families except when the tribe goes to war with another tribe. Even then his authority is not much greater than that of any of the heads of the families.

Property is important, because all the flocks are owned by the heads of the families, and it is impossible to live unless one possesses at least a horse and a few cattle or sheep. Here again, then, family ties are very strong, because there is no one else that a man or woman can turn to for protection, and because the means of earning a living are owned by the heads of the families. Men and women are, in fact, so dependent on their fathers that we call this kind of family by a special name—the Patriarchal Family.

THE PATRIARCHAL FAMILY

The Patriarchal Family, then, is a family where the authority of the father over his children and over his wife or wives is extreme. The Patriarchal Family does not only

happen in Pastoral Societies. Many Larger Uncivilised Societies also have it. The uncivilised Teutons of early Europe had it. The Hebrews of the Old Testament in the Bible had it.

Children are not very well off in most Patriarchal Families. They are harshly and even savagely treated. Often they are not allowed to talk or to sit down in their father's presence. They must obey their fathers without murmur or hesitation, and it makes no difference whether their father's command is sensible or not. In the Simplest Societies and in the Clan Societies children are not treated in this way. Earnest travellers who visit the Simplest Societies and the Clan Societies report that they are shocked by the impudent and disrespectful behaviour of children towards their parents. We can state it as a general rule that where the family is not important, parents are indulgent to their children.

The slave-like treatment of children in the Patriarchal Family does not end when they grow up. Children live with their father as long as he is alive, and even when they are men and women of forty and fifty they go on obeying the commands of their father, without the slightest hope of escaping from this subjection. The father can force his children to marry as he pleases. He often is allowed to sell his children and his wife as slaves if he so wishes. In the Fiji Islands, at one time, a musket was a good price for a wife. The uncivilised Teutons sold their children as slaves. The uncivilised Romans could even kill their wives or children on very little provocation.

The Patriarchal Family is therefore the most extreme example of the importance of the family. The conditions that produce it are the same as those that lead to the importance of the family generally: (1) the absence in a society of any other group than the family from which men and women could get companionship and protection; and (2) the private ownership of the means of earning a living. But something must be added, namely, the tendency of all those who have power to exploit those who haven't power, to use their power to their own advantage at the

expense of others. The patriarchal father controls the family wealth and the means of earning a living. This control gives him power, and, as always happens, power leads to the abuse of that power—that is to say, “exploitation” of the family by the father. Once this starts happening, it is very difficult to stop it, because the people who would want to are just the people who can't, because they have no power or independence of their own.

Many Patriarchal Families are also polygamous, so this is a good place to say something about polygamy.

POLYGAMY

In polygamous societies, instead of one man marrying one woman, one man marries several women. In a few societies (Thibet is one of them), one woman marries several men. This is called polyandry. Polygamy does not alter the effects of the marriage ceremony or change married life. Married people still have to live together, and the marriage ceremony still makes it possible to point to one man and hold him responsible for a child. The most extreme form of polygamy was that of King Mtessa of Uganda, who is said to have had 7,000 wives. The King of Ashanti was allowed a maximum of 3,333. Polygamy is most frequent in the Larger Uncivilised Societies and in the Pastoral Societies, but it is often allowed in the Simplest Societies and in the Clan Societies. Usually most of the population cannot afford more than one wife, and only the rich have more. Chiefs very often are polygamous when the rest of the population is not. Their polygamy is a way of showing their privileged position, and of proving the power and wealth that they possess. This is the cause of most polygamy. Where, for one reason or another, there are more women than men, polygamy is necessary, for otherwise many of the women would never have any sex life or any children. Sometimes, where constant fighting kills off more men than women, nearly every man has several wives. But where there are about as many men as there are women,

the polygamy of some men makes others into unwilling bachelors. The men who are able to obtain many wives thereby show that they have been successful. The possession of a large harem is a sign of riches and power.

Where polygamy is the result of the unequal numbers of the sexes it is quite natural, and only seems strange to us because we have been monogamous for so long. Where it is a result of the unequal division of wealth, it is a kind of ostentation by those men who possess property and privileges.

Women's position is usually worse in polygamous societies than in monogamous societies, but it would be a mistake to say that polygamy is the cause of the bad position of women. They are often just as badly treated in monogamous societies. We must dig down farther to find the reason why women are not treated equally with men.

POSITION OF WOMEN

The patriarchal father could sell his wife into slavery. Even in the Simplest Societies and in the Clan Societies, women are not usually in such a good position as men. When we think of it, this inferior position of women is a very extraordinary fact. It becomes still more extraordinary when we think further and realise that we ourselves do not consider women to be as good as men, and that we do not give girls and women the same advantages as we give to boys and men. The unequal treatment of women cannot be due to their natural inferiority. They are obviously not inferior. Many women are more intelligent than men, in the same way as some men are more intelligent than others. Many women are physically stronger than the majority of men. And if we should still doubt what is so easy to see, we cannot doubt that in some societies women are in a better position than men, and men are badly treated, for that is a fact. In a few Clan Societies, women treat their husbands as slaves or servant-boys. Women manage the affairs of the society. Women do the most important work. Women have privileges which men don't have.

A supposed natural inferiority of women is therefore no explanation of their inferior position. It has an element of truth in it, though, for if women are deprived of the advantages which men enjoy, they cannot develop the skill or the intelligence which men are able to develop. They begin to look inferior and to feel inferior, and if for this reason they are deprived of still more advantages, they will appear still more unintelligent. In the end they will be reduced to a state when they are incapable of managing anything, and so can be trusted with nothing. Probably this has often happened in societies.

But what is the explanation? It must lie in social conditions. A careful study of the social conditions where women are well treated and where they are badly treated shows that they are badly treated in warlike societies. The Andamanese have nothing approaching to war, and Andamanese women enjoy nearly equal rights with men. They take part in the discussions which are held to decide the policy of the group. Clan Societies are peaceful, and the position of women in Clan Societies is nearly always as good as that of men, and sometimes better. The Larger Uncivilised Societies and the Pastoral Societies are warlike. Here the position of women is bad.

Why should war influence the position of women unfavourably? Not because they can't fight as well as men. That women are perfectly able to fight is shown by the lusty way in which some uncivilised women do fight. The King of Dahomey, in Africa, had an army corps of women who were so bloodthirsty and so disciplined that they won him many battles. The reason seems to be that fighting and army life interfere with pregnancy and the care of children. Children have got to be born and children have got to be looked after if society is to go on. Only women can bear children, and, where there is no organised system of looking after them, women must do that too. Women therefore must not take part in fighting, but since they are well able, and in many cases anxious, to do so, they must be excluded from the military organisation, and the way to do this is to deprive them of the right of taking

part in government. For it is the Government that controls the army. Moreover, in larger societies, government is a full-time job. Taking part in government would also interfere with pregnancy and suckling and the care of children. The Andamanese women discuss the important affairs of the group with the men. Often, indeed, it is they who settle whether a feud shall go on or peace be made. Women manage the affairs of Clan Societies. But in larger societies women are excluded from government.

Thus women are in a bad position in warlike societies, and the reason is that they are excluded from the Government and from the army because government or military life would prevent them from looking after children.

Then, again, women are badly treated in the societies where they do not produce so much as men. In the Simplest Societies, the women gather fruits and berries but they do not hunt. Men therefore contribute more than women. In Clan Societies, the gardening work is not strenuous and women contribute as much as men. They are in a better position than in the Simplest Societies. In the Larger Uncivilised Societies, the farming work is very heavy. Women do not take part in it to any great extent, and their position is bad. The work in Pastoral Societies involves being in the saddle from morning to evening. Only men do this work, and women are in a very bad position. And so women's position is better when they do important and useful work. The reason is the same as in the case of military life. Where the work, such as gathering or gardening, does not interfere with pregnancy, suckling, and looking after children, women take part in it. Where the work is heavy and arduous, they do not. Not because they can't do so, but because, if they did, children would be neglected and probably fewer children would be born. The way of preventing them from doing so is to keep the ownership of the lands and the flocks in the men's hands. Ownership means control, and so not only are women excluded from the control, and therefore from the work, but the control gives the men power over the women and this power is bound to be misused.

The third condition unfavourable to women is the importance of the family. The reason is clear. Where the family is important, there is nobody else to look after children, and it becomes all the more necessary that women should be deprived of rights in order to make them specialise in this task. The inferior position of women is therefore due to the fact that they alone can bear and suckle children, and is closely connected with family life.

SUMMARY

This is a good place to make a summary of the conclusions that we have got from looking at uncivilised societies. The first is that marriage, whether polygamous or monogamous, is a way of making men as well as women responsible for looking after children. The second is that the bad position of women is due to the necessity that children should be born and cared for. Where the family is important, marriage is likely to be stricter and the position of women worse, because there is no other way of bringing up children. This leads to the fourth conclusion, that the family is important when private property means a lot to men and women and when there are no other groups of people in a society which could give companionship and protection or which could look after children. A fifth conclusion is that, when no groups of this kind exist, and where private property is very important, the family often becomes a Patriarchal Family, because those who have power nearly always abuse their power.

THE EARLY CIVILISATIONS

In the civilisations of the past, the civilisations of Egypt, Babylonia, India, China, Greece, the family was nearly always important, and very often it was patriarchal.

In Babylonia at one time a father could sell his sons or daughters into slavery for a maximum of three years to pay off his debts. Children had to obtain their father's consent before marrying. Women were very much under the

authority of their husbands and fathers, but they had considerable freedom when dealing with other people. A woman could conduct a business and she could own property. On the whole, Babylonia was probably not a bad kind of society for women to live in.

In Egypt, also, women had a better position than might be expected. They too could own property, and bequeath it as they liked. Egyptian queens often had a great influence in the affairs of the country.

For one short time in India, women enjoyed equality with men. That was under the influence of the first Buddhist religion. It did not last long. Most of the time a woman passed from the absolute control of her father into the absolute control of her husband. However vicious and worthless a husband might be, yet he must be constantly worshipped as a god by a faithful wife. A wife was believed to be so much part and parcel of her husband that when he died she became of no account. If she did not voluntarily kill herself at his grave, she was expected to devote the whole of the rest of her life to his memory. She was not allowed even to mention the name of another man after her husband had died. Manu, an Indian lawgiver, said, "In childhood a female must be subject to her father, in youth to her husband, and when her lord is dead to her sons; a woman must never be independent."

The Chinese father had great power over his children. Children had nothing to do with getting married. They waited for the orders of their father, and often bridal couples met for the first time on their wedding day. Children felt it their duty to serve their fathers hand and foot. There was a great religious worship of ancestors, and this became a worship of the head of the family. Sons were not allowed to leave home without their father's permission. A father could sell his children in case of necessity. Chinese women were in a very inferior position. When young they had to obey their fathers, when married their husbands, and when widowed their sons. A Chinese husband could beat his wife, but if she raised her hand against him she received a hundred strokes.

In the early days of Greece a father might sell his daughter, but as time went by the position of women improved. They never became anything like the equals of men. They were confined to their homes. They did not, except in Sparta, and very occasionally in some of the aristocratic states, play any part in public affairs. They received very little education, and so could not become companions for cultured men. The wonderful Greek civilisation is a civilisation of men, to which women contributed very little, because they did not get the same education.

The reason why the position of women was bad and the family important in the early civilisations is much the same as in the case of the Larger Uncivilised Societies. Private property and money were the chief ways by which people's behaviour to one another was settled. The Governments could not protect individual men or women very effectively. And so men and women were dependent on their families. Men had power because they controlled property and because these societies were very warlike, and they abused this power.

ROMAN TIMES

From the beginning of Rome up to now things happen in one continuous stream. Each event is linked to the one that went before. Rome is part of our own history. In its beginnings, Rome was much like one of the early civilisations. The family was patriarchal. Roman fathers were allowed to kill their children for very small offences. Marriage was monogamous, and no divorce was allowed. As we should expect, the position of women was bad. As time went by the authority of the father weakened. The main reason for this was that gradually the central Government invented better and better ways of managing the affairs of the empire, and was able to interfere with, and influence, the private lives of Roman citizens to a much greater extent. It interfered to lessen the brutal authority of the patriarchal father, and its increasing

influence made it a body to which men and women could turn for protection and security. In this way the growth of the State or Government lessened the importance of the family. And as the authority of the father weakened, so did the position of Roman women improve. The way this came about is curious. In early Roman marriage, women passed out of the power of their fathers into the power of their husbands. As the family grew less important, a kind of marriage began by which the wife remained in the power of her father and did not pass into the power of her husband. The result, since the power of the father had declined, was that the later Roman matrons enjoyed a great deal of freedom. At the same time divorce appeared, and gradually became more and more frequent. By the end of the Roman Empire, men and women depended much more upon the State than they did upon their families. Marriage was not strict, because divorce was easy and women were in a very favourable position.

THE MIDDLE AGES

As the Roman Empire broke up, all this was altered. Deprived of the protection of the central Government, people turned to their families, and family life was strengthened. The Teuton patriarchal family, which was decaying under the influence of Rome, revived. Women sank into subjection again, and children again trembled before their terrible fathers. But, in the troubled times of robbery and plunder which we call the Dark Ages, many families were not strong enough to defend themselves. They were obliged to become serfs on a feudal manor in return for the protection that the feudal lord could give them. Feudalism weakened family bonds. Serfs were sold by their masters to other masters. Sometimes care was taken not to separate parents and children, but not often. Serf families might be divided between his heirs when a feudal lord died. In many cases the lord had the right to marry his serfs to whomever he chose. When serfs belonging to different manors married,

their masters usually agreed to share the children, and so broke up the family. To sum up, a serf was much more dependent upon the manor to which he belonged than he was upon his family.

Apart from feudalism, the chief influence in Europe during the Middle Ages was that of the Roman Catholic Church. The Church took on a lot of ideas from Rome. It protested against the sale of wives and against the sale of children into slavery. Moreover, the Church was more interested in saving people's souls than in family life. It did not attack the family, but it made loyalty to religion more important than loyalty to one's family.

The Church believed that men and women should love God, and that if they loved one another, it interfered with that. So it was said by those in authority in the Church that it was sinful for men and women to be lovers, and celibacy (not marrying) was better than marriage. There was supposed to be something wrong about *sex* (being an adult, functioning man or woman), and especially about being a woman; women were made to feel ashamed of themselves just because they were women. There are remains of this still in various ideas and customs, even in "civilised" countries.

According to the Church, men and women who did not marry, but went out of the hard world and became priests or monks and nuns, were supposed to be better than those who married and had children. This was bound to make people think less well of family life, although the Church never actually attacked the family as a system. It also had an important effect on marriage. It was impossible to stop ordinary men and women from falling in love with one another and wanting their full sex satisfaction, so this was allowed between married people. "It is better to marry than to burn," was one of the well-known sayings of the Middle Ages. But the Church wanted to control even marriage, and declared that it was a sacred thing: when it felt that its influence was sufficiently strong, it insisted on a religious ceremony for marriage. And, because it wanted to be as strict as possible about human—"profane"—love,

the Church set its face resolutely against polygamy, and enforced monogamy. It also refused to allow divorce, with permission to remarry.

The position of women was curiously affected by this belief in the sinfulness of sex. Women were regarded as the root of all evil. This outcome can only be understood when we realise that men, and not women, were the thinkers, the rulers, and the lawgivers of Middle Age Europe. The idea that women were evil, hard though it is to believe it, was strengthened by pointing to the story of the creation of the world in the Book of Genesis, in which Eve introduces sin into the world by eating an apple. When women carried such a burden of sin, we are not surprised to read that "A good woman is like one eel put in a bag amongst five hundred snakes, and if a man should have the luck to grope out that one eel from all the snakes, yet he hath at best but a wet eel by the tail."

The Catholic Church influenced the position of women in another way, and this time favourably. The Church started numerous convents. A woman of gifts might rise to be the head of a convent, or several convents. She would be respected and consulted. Women had a better chance of a career this way than they have had since until the twentieth century. And, besides, if a girl was badly treated at home, she could threaten to go away to a convent. The same applied to men with monasteries. And so convents and monasteries weakened the family. Entering a monastery or a convent was a way in which sons and daughters could escape from the authority of their fathers and free themselves from dependence upon family wealth.

In spite of the combined influence of feudalism and the Church, family authority nevertheless remained strong. There was a husband whose wife had disobeyed him. He rode into town and commissioned a surgeon to heal two broken legs, rode home again, and broke both his wife's legs. The serf family, we have seen, was not important. The upper-class family was more important. Children, it is true, were sent away from their parents and parked out as pages and ladies-in-waiting. About the year 1200, laws were

passed which forced a father to leave all his land (the most important kind of wealth) to his eldest son. Where the younger sons could find a profession in military adventure or enter a monastery, this weakened the family. But the control of parents over their children was very great. Child marriages were the rule, the age of consent (that is to say, the age at which you are supposed to be able to know whether you want to marry another person or not) being fixed at seven, "at which time infancy endeth for both sexes." This meant that parents arranged marriages for their children when they were very young, and children therefore had no choice as to the person they married. Sir William Plumpton arranged marriages for his granddaughters when the elder was only four! There was very little praise of family life, however, and no emphasis on the value of the family.

THE PROTESTANT FAMILY

When we come to the sixteenth and seventeenth centuries, family life is strongly influenced by the Protestant Churches. The Protestant Churches drew many of their ideals from the Old Testament. As some of the Hebrews were polygamous, a few Protestant sects allowed and practised polygamy. The advanced sects also argued that marriage was not a religious affair. In many of the American States, religious marriage was prohibited by law. Some of the sects went further, and said that marriage was a purely private matter for the two people concerned. They encouraged marriage by consent, without a ceremony of any kind. They also argued that divorce should be easy. Probably many of these ideas were held chiefly because they were the exact opposite of what the Catholic Church had taught. However that may be, the main body of the Protestant Churches, both in England and in America, soon fell back into line with the teachings of the Catholic Church. Polygamy was gradually stamped out, although it persisted among the Mormons in America until 1890. Divorce was made more difficult, and in England it became

unobtainable. Because marriage by consent led to so many confusions, since it was impossible to fix the responsibility of a father, the Governments in England and America made civil marriage compulsory. In England the first Civil Marriage Act did not work, but the Churches were strong enough to make nearly everybody go through a religious marriage. It was only much later in the eighteenth century that an effective civil marriage law was passed. In America, because religious marriage had been prohibited, more attention was paid to civil marriage, and, as the views of the Churches became less extreme, little by little religious marriage was allowed. The final result was the same in the two countries. Both civil and religious marriages were allowed, but marriage by consent was prohibited. Scotland and some American States are exceptions. Even now marriage by consent is allowed in these places.

In one matter the Protestant Churches never adopted the Catholic viewpoint. They never believed that celibacy was better than marriage. There were no more monks and nuns in Protestant countries. Marriage became an "honourable" state, and people began to stop thinking of women as evil and full of sin. But if in this respect the influence of the Protestant Churches was favourable to women, the general effect of Protestant teachings was to rivet women to the family to serve their fathers and husbands in subjection. The reason for this is that the Protestant attempted to shape family life according to the model of the patriarchal Old Testament family.

Protestant writers paid a great deal of attention to the family. Luther spoke of the family as "the first regiment out of which all regiments have their being." Bunyan believed that "the fruits of true Christianity flow from a proper fulfilment of duties between husband and wife, parents and children." Calvin argued that "those who violate the parental authority by contempt or rebellion are not men, but monsters. Therefore the Lord commands all those who are disobedient to their parents to be put to death." In one of the American States, where there were many followers of Calvin, a law was passed to this effect,

but there is no known case when the death-penalty was exacted!

The life of a middle-class Protestant was passed within his family circle. In England the way he earned his living was entirely settled by his family. This is not so true of America, because there was plenty of free land available for those who wanted to farm it. The whole upbringing and education of children was carried out by the family. Protestants did send their children to schools, but reluctantly, and they preferred day-schools to boarding-schools. The family became a religious centre. Protestants transformed daily family life into a prolonged Church service, with morning, midday, and evening prayers. Whenever an occasion could be found that did not interfere with work, Protestant families sang psalms. On Sundays, the whole family went to church and the afternoon was spent in family discussion of the sermon. The first words that children were taught were God, faith, love. As soon as they could put sentences together, they learnt, "All men are brothers," "God alone can save me," and so on. Great stress was laid on the authority of the father as the representative of God, and the duty of wives and children to serve the father in subjection.

Parents were told to choose husbands and wives for their children, for, if the children chose themselves, they would be guided by their senses, and that was the same as being guided by the devil. If children did choose themselves, their choice had to be approved by their parents. They were never allowed to marry without their parents' consent, or against their parents' wishes.

Providing their religious beliefs were satisfied, the early Protestants were kindly people, but their treatment of small children was unbelievably harsh. Punishment was thought to be as necessary for children as eating and drinking. This was due to an unfortunate belief in original sin (the idea that babies were born wicked, and that parents had to get it out of them somehow). Bunyan, although he himself was a kind and indulgent father, bids parents remember that children are cursed creatures.

The reasons that led to this extreme importance of the Protestant middle class family are not difficult to find. Feudalism had dissolved, leaving in its place a very weak central State, which could not do much to interfere in the private lives of men and women or to protect them. The middle class were merchants and traders, and so money, the middle class way of earning a living, was controlled by the family. The ground was therefore favourable for the growth of the Protestant ideal of a strong family.

In England the upper and lower classes were not affected by Protestantism. The upper classes became more and more absorbed in "society life." The people they met daily were not so much members of their families as members of the wider circle of their own class. Class loyalty made an individual independent of his family. He could obtain help and protection because he was a member of the upper classes. The upper classes did not look after, or bring up, their children themselves. Children were sent away to wet nurses as soon as they were born, and when they were six or seven they went to boarding-schools. The general upper class attitude towards family life was one of disdain, only slightly lessened by pride of birth.

We unfortunately know very little of the daily lives of the poor. The apprenticeship system was widespread, and this means that children moved from their families, sometimes as young as three or four, into the circle of a workshop. Probably many apprentices forgot their families, and carved their way into life without any help from them. When we read how completely domestic servants in Protestant families were taken into the family circle, how the head of the family was exhorted to look after them and to rule them for their good, we realise that they can have had very little to do with their own families. Moreover, the State was growing in importance, and the poor were the first to feel the effect of the State on their daily lives, both when it meant oppression and when it meant protection (see *Organisation of Society in the Past*, p. 532).

During the nineteenth and twentieth centuries the family has declined in importance both in England and in

America. Divorce has become easier, and the position of women has improved very greatly. In the realm of ideas the main cause of this change has been a wide sweep of thought called individualism. The central idea of individualism is that a country, a school, a family, or any other group of people consists of individual men and women. Put this way, it is hard to believe that anybody ever held a contrary view. But even now we commonly talk of the "good of the country," the "good of the school," or the "good of the family," and ask ourselves only whether suggested changes are or are not good for the school, or for the country, or for the family, without troubling to ask whether they are good for the individuals who make up the school, the country, or the family. When we grasp the principle of individualism, we realise that its growth led to a tremendous change in people's ways of looking at things. It meant that right and wrong came to be judged according to how they affected individuals, and not according to whether they fitted into accepted ideas of what a Government, a Church, or a family ought to be. Individualism was therefore a strong weapon with which to attack the absolute authority of kings and Churches. It was bound to weaken the authority of the family also. An eighteenth-century writer argued that it was absurd for men "to contend for and practise that arbitrary dominion in their families that they abhor and exclaim against in the State," and added that "if absolute sovereignty be not necessary in a State, how comes it to be so in a family?" Individualism improved the position of women because, once people accepted the view that the goal of their efforts should be the good of individuals, it was impossible not to agree that women were individuals as well as men, or to deny that they had a right to equal treatment. In fact, during the nineteenth and twentieth centuries women have obtained equality with men in the two most vital rights of our society, the right to have property of their own and the right to take part in government.

The idea that people should marry for love is connected with individualism. Before the nineteenth century, people

had married for money or for family reasons. A bride and a bridegroom were only in love with each other if by a lucky chance they happened to fall in love with the person whom they were going to marry for other reasons. Parents usually arranged these business marriages. Parents cannot arrange who their children shall fall in love with, and so the idea that people should marry for love weakened the influence of parents and the importance of the family, because it meant that men and women chose their own wives and husbands.

We cannot, however, explain either the improvement in the position of women or the decline in the importance of the family solely by individualism. Social conditions changed rapidly during the nineteenth century. Mass production in factories took the place of home industries. Children were no longer dependent upon their families, because they could get jobs in large businesses or factories. As division of labour increased there were many more jobs for women that did not interfere at all seriously with the care of children. War and military organisation played a smaller part in everyday life, and for this reason also the position of women improved. The State grew stronger and stronger. Its laws were enforced in the remotest parts of the country. Men and women could count on the protection of the law, and found the protection of their families less necessary. The State provided free education, and so took one of its most important tasks away from the family. And, as the State grew, so did patriotism, which holds up a loyalty which is different from family loyalty and may be opposed to it. Other groups, like trade unions, clubs, youth movements, gave men and women companionship outside the family circle. Various charities, such as free hospitals or children's holiday funds, had the same effect of making the individual less dependent upon his family. The starting of crèches, nursery schools, child guidance clinics, hastened the decline of family life, and made it possible for married as well as unmarried women to take their full share in the wider life of society.

THE FAMILY

CONCLUSION

Thus we see the family as one among many various ways in which men and women are grouped in social life. Where private property leads to the control of the means of earning a living, the family group is stronger because men and women are dependent upon their families. Where there are no other groups from which men and women can get protection, the family is also stronger. Marriage and the inferior position of women are due to the choice of the family group as the means of caring for children. Marriage laws and the unequal treatment of women are therefore only likely to disappear if and when we devise other means of bringing up children which will do the job as well as the family does. Even if marriage laws disappeared and the responsibility of parents for their children became unnecessary, and if children were no longer dependent on their parents, family life would probably continue. But it would continue because parents and children liked to live together, not because laws, or their dependence upon one another, obliged them to live together.

BOOKS TO READ

F. MÜLLER-LYER : *The Family*.

E. WESTERMARCK : *Marriage*.

RUTH REED : *The Modern Family*.

L. T. HOBHOUSE : *Morals in Evolution*. Chapters IV. and V. on "Marriage" and "The Position of Women."

**THE ORGANISATION OF SOCIETY
IN THE PAST**

OR

BIGGER GROUPS AND HOW THEY WORKED

by

MARGARET COLE



MARGARET COLE was Margaret Postgate, a classical scholar. She married an historian and writer on economics, G. D. H. Cole, and when they are doing nothing else (which is rare, because they are both extremely busy people) they write detective stories and sometimes put in their friends. I am hoping that some day they will put me in. They have also got three children, Jane, Anne, and Humphrey. She has the historian's mind—that is to say, she gets excited about the way things have happened, and how the present state of the world has come about because of what our ancestors thought and did. She likes thinking about people, not only individual people, but whole classes of people, and she sees how these classes and groups of people hold together and have held together in the past. She sees how one group of people have oppressed others in the old days, and how different groups oppress one another and hate one another still. She gets very angry about this, but, because she is a real historian, she tries to be absolutely fair.

THE ORGANISATION OF SOCIETY IN THE PAST

THE TITLE of this chapter may sound difficult, but all that it means is that in it we are going to study the way in which communities of people lived together in past ages, in particular how they worked together, what their laws were like, and what arrangements they made for getting jobs done which are necessary but which everybody does not want to do for himself. In our own society of England, and in societies which are like England, such as Germany and the United States of America, there are a great many such jobs. We want the streets cleaned, for example ; but it would be a great waste of time if every householder cleaned his bit of street for himself. So we arrange for a body called the town council or the county council to send dust-carts and street-cleaners to do it for us. Or we want some goods, say coal or boots or strawberries, which are made or grown in a different part of England. We do not want to waste time each fetching our own, so we use the railways, or the post office, to fetch the goods for us and for anybody else who may happen to want them. Bodies of this kind are called " social institutions " by those who write about society.

Our English society leads a very complicated life, and has a great many social institutions. One of the reasons for learning history is to understand how our own society has grown up, how men used to live in England in the past, and how they have come to live so differently now. It will also help us to understand how other people than ourselves live at the present time, which is enormously important if we are to play our part in running the world aright. We are, all of us, much too ready to think that the way in which we live, at the moment, is all that matters, and to forget that there are millions of people, not only in Europe, but in

places like India, China, and Africa, who do not live in at all the same way—who live, in fact, much more like many people lived in ancient times than like modern Englishmen. Reading history intelligently will help us to understand what they are like and how we can get on with them.

KINDS OF SOCIETY

In all communities—whether they are as tiny as a city-state of ancient Greece (which might have ten thousand people) or as huge as the Roman Empire or the United States of America (which has over a hundred million)—the most important thing is the way in which the people in the community, as a whole, get their living. The people of this country, for example, get their living—that is, their food—not mainly by growing it themselves, but by manufacturing a great many things—machinery, railway engines, cotton shirts, boots, etc. We make many more of these things than we can use ourselves, and we sell them, or try to sell them, to other countries whose people do not manufacture much for themselves but either grow more food than they eat, such as Australia or Brazil, or produce quantities of some stuff or substance which we need but cannot grow ourselves or find in England, like the rubber which comes from Malaya or the cotton of Egypt or the South American States.

Since this is the way in which we get our food, we find ourselves living, perforce, a certain kind of life. We build factories to make the railway engines or the shirts, and in them we put machinery and men and women to run it, who must stick steadily to their work and cannot break off and have a rest when they feel like it, because the machinery must be kept going. We have built large (and generally very ugly) towns for these workers to live in, near the factories, and we have drains and hospitals and public health services to prevent the crowded towns from becoming hotbeds of disease. We have railways and main roads along which the goods which are going to be exported can

travel to London, Glasgow, Bristol, and other ports, ships to take them to Australia or wherever they are wanted; we have shops in which those who do not grow their own food or make their own clothes can buy what they want; we have armies of clerks, city men, and so on, to see that the goods are dispatched to the proper places, that bills for them are sent in and the money collected; and we have schools and universities to train men and women for all sorts of different jobs (see *Economics*, p. 665). In most of the countries which we know best and call most "civilised"—such as France, Germany, or the United States—we find that life is lived in much the same way. There are, of course, important differences between life in France and life in England; but French society is much more like English society than, for example, Chinese society.

But these "industrial countries," as they are called, however important they may seem to us, cover a comparatively small part of the world and are only recent arrivals in history. Three hundred years ago there was no such thing as an industrial country; and to-day in the world many fewer people live in industrial societies than live in quite other ways. What were, and what are, these other ways? How else can peoples live than by making things in factories and selling them?—and what is the life of those peoples like?

Broadly speaking, there are four possible ways in which men may live other than by manufacture. They may live by catching their food, i.e. they may be hunters or fishermen, as many of our ancestors in northern Europe were, and as the Eskimos are to-day. Hunters and fishermen, however, lead a hard and poor life; they often live by themselves or in families, and not in societies at all; and, where they do have societies, these societies are small and simple and not very important for the history of the world. So we shall not consider them further here, but pass on to the other ways of getting a living (but see *The Family*, p. 469).

Much the commonest way of getting a living, both in the past and the present, is by *agriculture*—that is to say, by growing corn and other food stuffs, or such plants as

cotton and flax, of which clothing is made. Before the sixteenth century an enormous part of the world lived by agriculture ; and to-day almost the whole of Asia (except Japan), practically all Africa, a great part of America (particularly South America), and some of Europe lives so too.

Then there are the *herdsmen* peoples ; peoples, that is to say, who live mainly by keeping animals—sheep, cattle, goats, horses (sometimes even camels)—eating the flesh and drinking the milk of these animals, and clothing themselves in their skins or their wool. We do not find so many of these pastoral peoples, as they are sometimes called, in the world to-day, though there are some in the deserts of Arabia and northern Africa, and in central Asia ; but in earlier times they were very much more common and played a large part in history.

Finally, there are people who live mainly by *trading*, who take merchandise from one place to sell it in another, and live by the profits they make. The pedlar who goes through country villages with a pack of ribbons and buttons and shoelaces on his back is a trader ; but he is not a society of traders, he is only one man. A caravan of merchants going from Bagdad to Damascus laden with silks and spices is a small society of traders ; and in the past there have been whole cities, such as Tyre and Venice, which lived almost entirely by trade. These traders, in the history of the world, have been few in numbers compared with the agriculturists ; but they have been enormously important. For one thing, trade is exciting. The trader, particularly the trader who crosses the sea, brings back new and extraordinary things—monkeys, ivory, amber, pepper—to show to those who have stayed at home ; and he has tales to tell of people and countries quite unlike anything he has seen before. He has seen elephants, maybe, or talking apes, or trees so wide that a coach can be driven through a hole in the trunk, or men who smear themselves all over with butter ; and his friends become interested and anxious to see for themselves, so he adds to the sum of knowledge. For another thing, trade makes people and societies rich, so that they

can spend more money on things which are not immediately useful, like food or clothes or houses. They can afford to build roads and bridges and temples, to print books and to paint pictures, to write poetry, study science, run theatres—to do, in fact, all the things which make up what we call “civilisation”: so, few as they are by comparison, it is the trading peoples which have done most to alter the life of the world.

We must now consider in more detail what life has been like in each of these types of society. But, of course, the types are not sharply separated from one another. Agricultural societies often do some trading, and pastoral societies and merchant cities some growing of food. Nor is every agricultural society, say, exactly like every other. Life in ancient Egypt was in many ways different from life in an English village at the time of the Norman Conquest. These differences belong to history proper, and in some ways are the most exciting and interesting part of history. But those who want to read this part must look in the history books for themselves. All we can do here is to look at the organisation of society in a few of the most typical places at the most interesting times.

AGRICULTURAL SOCIETIES

Let us begin, as it is so much the largest, with agricultural society. If people are to spend their lives cultivating the land, year in and year out, in the same place, certain things are necessary. The land must be reasonably fertile, not too cold or too hot, not too unprotected from the wind, not too heavily overshadowed with forest trees, not too swampy, so that the grain is drowned, but, above all, not too dry. Water is the first necessity for growing food. There must be some sort of tools to do the field-work, spades and hoes and mattocks and ploughs, and oxen or horses to draw any but the smallest kind of plough. It will often be more economical and more convenient if everybody does not make his own tools, but one man or men does the

blacksmiths' work for the whole community, not growing any food himself, but being kept by those who do in return for making their tools. There must be granaries and barns built to store the food for the winter, and some sort of a guard or defence to keep the settlement from being attacked by wild beasts or possibly by neighbouring peoples who are short of food themselves. There must be arrangements for seeing that the ploughing and sowing and reaping are done at the proper times ; there must be people who know the weather and the calendar and can tell when the god of the harvest likes the harvest to begin, and how to prevent the god of the river from getting angry and drowning the crops ; and, if the community trades part of its spare food for iron or stone or salt or anything else, there must be roads or tracks made along which the goods can travel ; there must be a market at which they can be sold or exchanged, and probably some people in charge of the market to see that the weights and measures are true, that there is no cheating, and no quarrelling between those who come to market. But a real agricultural community does not need large towns, or main drains, or stock exchanges, or a post office, or the other things which our industrial society needs. It does not even need schools, because you do not learn to grow food out of books, but mainly by actually growing it.

One thing further about agricultural life : it changes very little year by year. The land produces much the same sort of crop, and the same things have to be done to make the crop grow. Plough-time, seed-time, harvest, and winter follow one another year in and year out, and everybody's work is much the same as it was last year and as it will be next year. So that agricultural societies are generally conservative, and slow to change their ways or their minds. On the other hand, life in an agricultural society is safe, safer, at any rate, than the life of a merchant trading over dangerous seas into strange, perhaps savage, countries ; and so, whatever people engaged in agriculture may have gained or learned, they can generally keep, unless, indeed, they are conquered or plundered by some stronger and more violent people from outside, as Sennacherib conquered the

Ten Tribes of Israel, or the British the Indians of North America.

One of the earliest agricultural civilisations we know was Mohenjo Daro in north-west India. Here archæologists have found tools, ornaments, playthings, and religious symbols six thousand years old, but so far not one single weapon for people to kill one another with!

EGYPT

There are agricultural societies in all parts of the world and in all ages of history. We cannot possibly look at all of them, but we can choose a specimen to study; one of the most interesting is the very ancient civilisation which we find in two great river-valleys, those of the Nile, which is Egypt, and the valley which is called Mesopotamia, because it lies between the rivers Tigris and Euphrates.

Egypt—please look for it on the map (p. 399)—is an extraordinary country. It is very long and very narrow; except in the northern part, the Delta, it is really no more than the bed of the Nile, with a mile or two of flat land on either side and beyond it rocks and desert. It has one of the most beautiful climates in the world, and is also one of the most fertile countries in the world; but its fertility depends entirely upon the flood of the Nile. There is no rain in Egypt to water the crops; but in the lakes and mountains in which the Nile rises there is abundance of rain at certain times; and this water, filling the bed of the Nile and flooding all over the surrounding fields, will, if it is wisely directed, make them so fertile that they will grow far more food than the people who cultivate them can eat. But this will not happen unless the flood-water is properly distributed about the fields. If it is not, some part of the land will be drowned, while some will get no water at all. The picture on the following page shows you one of the ways in which the distribution of water (which is called *irrigation*) was done in ancient Egypt; and you can easily see that, if the whole of the soil of Egypt is to be satisfactorily irrigated, the work must be properly organised.



Fig. 78. AGRICULTURAL LIFE—SPREADING THE NILE FLOOD

The first and most important job, then, of the Government of ancient Egypt was to organise the water-supply. As the Nile is only one river, it was more convenient, as soon as it became possible, to organise the water-supply as a whole, and that is why Egypt, odd shape though it is, very early in its history became a single State with a single Government. (In Mesopotamia, where the water-supply was not so simple, we find from the beginning a great number of small States and kingdoms.) This Government was headed by a king called "the Pharaoh" and believed by the Egyptians to be a god, and by the officials and chiefs under him, who were often priests. These men organised the water-supply and the other jobs necessary for Egyptian society, and as payment took for themselves part of what every peasant produced and forced every peasant to do some work for them for nothing. They explained this by saying that the Pharaoh provided the water for the people, and that in return the people owed him food and services. Of course, as a matter of fact, the Pharaoh and his officials did not provide the water; they did not cause the Nile to flood. But they settled who should get the water, and how much he should have; and that, to an ignorant peasant, appeared much the same thing.

We may also notice that those who did this organising took from the peasants enough to make them very much richer than the people who grew the food. In almost all agricultural societies (and in most other kinds of society) there is a large lower class which does the main work of producing the food, and a small upper class which organises and governs; and the upper class takes from the lower class a great deal more than it leaves the lower class to live on. Sometimes the upper class keeps the lower class as slaves, as the planters in Virginia kept the African negroes. Sometimes the lower class become *serfs*—that is, half free and half slave; sometimes they remain free men, who hire or may even own a little patch of ground, but have to pay heavy rents and taxes to the upper class. But always, when there is an upper or governing class, we shall find that its members are much better off than the lower or working

class, and almost always think that they have a right to be much better off. They do not always call themselves gods, as the Pharaohs did ; but they frequently say that it is God's will that they should be much better off. What they mean, in either case, is that the governing or organising which they do is so much more important than the work of growing food, making clothes, digging coal, and what not, that they ought to be paid very much more for it. In some countries this upper class were people of a different race from the lower class, who were the original inhabitants of the country and were conquered and made into slaves or serfs by the foreigners. This happened, for instance, in Sparta, where the original inhabitants were made into a particularly oppressed kind of slave called a helot ; in other cases the upper class were of the same race as the lower class, and merely succeeded, by one means or another, in raising themselves into a superior position.

In Egypt, then, there was a large lower class of peasants, some free, some serf, some with small and some with larger plots of land, cultivating the soil and keeping, by means chiefly of contributions of food and labour, the Pharaoh and a number of priests and officials of various kinds who formed the upper or governing class. But the soil of Egypt is so astonishingly fertile that if the work of irrigation is properly done and the country is reasonably at peace, it will almost immediately grow far more than the people of Egypt need for themselves, even allowing for the large share of the Pharaoh and his governors. Some of this spare or surplus corn the Egyptians used in trade with other countries—particularly the seafarers who came to the Delta from the Mediterranean, and the caravan merchants who came by land from the Red Sea or through Palestine from the Euphrates valley—and in paying for craftsmen, such as potters, masons, jewellers, and the like. Some, particularly in times when the rest of the world was in famine, was carried off by invaders from other lands. (You may remember how Joseph and his brethren, a small, poor tribe which lived on the rough Palestine hillsides, in one specially bad season heard that there was “corn in Egypt,” and

hurried there to get it.) Most, however, was spent in a way which makes Egyptian civilisation different from that of any other country—on religion and the care of the dead.

All societies, of course, spend a certain amount upon religion and burial ; but no society has ever spent so much as ancient Egypt. This may be partly because the dry air of Egypt preserves dead bodies intact for far longer than our damps and fogs, so that it was natural for the Egyptian, seeing a dead body, to think that the man's soul had only left it for a time and would return again. And it was very important, when the soul did return, that it should find a body to return to, that the body should not have been thrown away, or eaten by jackals. Otherwise the soul would be a homeless, angry ghost, and an angry ghost is a terrifying thing. So the Egyptians mummified the bodies of their dead to preserve them, and buried them in tombs of brick or stone, the strongest that they could afford, always with a hole or passage by which the soul could return. The richer the dead man, the more sumptuous his tomb ; and the huge Pyramids which every traveller in Egypt goes to see are no more than the giant tombs of the Pharaohs of the Fourth Dynasty, furnished inside with as many as possible of the things which the Pharaoh had used while he was alive and which his soul would expect to find when it returned. Enormous quantities of labour were expended in Egypt upon these and other matters of religion, and thousands of people maintained in order to do nothing but attend to temples, tombs, etc. ; so that it is almost true to say that the ancient Egyptians spent more on the dead than they did on the living (see *History of Ideas*, p. 449).

OTHER AGRICULTURAL SOCIETIES—MESOPOTAMIA, ETC.

Ancient Egypt is the first great agricultural civilisation about which we really know a great deal—much more, of course, than is set down here. In Mesopotamia, life was rather different in some ways, mainly because Mesopotamia is what we call a "highway of traffic." People are always

coming and going through Mesopotamia from India, China, and central Asia to the Mediterranean, and this made the Mesopotamian peoples take to trade, and mixing with other races, much earlier in their history than the Egyptians. (Nobody to speak of travelled up the Nile ; it is like a corridor leading nowhere in particular.) The story of the Tower of Babel shows how many languages were spoken in Mesopotamia in quite early times, and among the ruins which have been dug up at Babylon and other dead cities are thousands and thousands of clay bricks on which are written wills, leases, accounts, deeds of partnership, and all the other things that merchants use. Also, Mesopotamia was much easier to attack from outside than Egypt, and was always being conquered by people from the poor and barren mountains who were hungry for the food of the plains. The best known of these conquerors were the Assyrians, whose fierce faces and heavy armour you can see on the sculptures in the British Museum.

People are discovering more and more every day about the Mesopotamian civilisation. You must read about it in the fascinating books by Mr. C. L. Woolley on the Sumerians. And you must also get books to find out about the old Hindu civilisation of India, where the classes are still so sharply separated that the lowest class (or "caste") is not allowed even to touch the higher ones ; and the even older civilisation of China, where only the other day thirty or forty *million* people starved to death because the water-supply went wrong and the crops failed. There is, however, one bit of agricultural civilisation which we must look at, since it is part of our own past history ; this is what historians call the feudal system, under which the great part of northern and western Europe lived from about the tenth century to the fifteenth century after Christ.

FEUDAL EUROPE

Before the rise of the feudal system, most of Europe was part of the Roman Empire, about which we shall read in a later part of this chapter ; and, under the Roman Empire,

people—at least the upper classes—were comparatively rich and safe. But, when the Roman Empire decayed, when strange half-civilised people called Franks and Huns and Goths invaded it from the north-east, and still more when Mohammedans from Arabia conquered the south side of the Mediterranean, as well as Sardinia, Corsica, South Italy, and Spain, and stopped all trade with the rich countries of the East, then the Europe that was left unconquered became again very poor and unsettled. Men lived by agriculture, rather skimpily, because they had forgotten the best methods of cultivating the land, which their fathers or grandfathers knew in more settled times; and they lived in perpetual danger of being attacked by invaders, as our ancestors in England were attacked by the Danes.

It was difficult to defend the country or to collect taxes; and the kings of the different parts of Europe tried to get over the difficulty in this way; they would grant, to each of their most important followers, a piece of land which might be as small as a village or as large as the whole of Belgium, and let him use it as he pleased, on condition that he paid taxes to the king and sent troops to help him when he went to war, and did certain other less important things, such as entertaining the king and his Court in his castle at certain times of the year free of charge. These pieces of land were called *fiefs*, and the people to whom they were granted, king's vassals—sometimes also counts, or dukes or earls or barons, or simply lords. They did not, however, own their fiefs and keep them, no matter what they did, as dukes and earls can keep their estates to-day. It does not matter to-day what the Duke of Anywhere does; he may be a lunatic or a criminal, but until he dies he does not cease to be a duke; but the holder of a fief in the Middle Ages was liable to lose it if he did not keep faith—that is, fulfil the duties which he had promised the king to perform.

Sometimes these feudal lords would in their turn grant part of their lands as a fief to a lesser lord upon the same conditions. Thus, when William of Normandy conquered England in 1066, he might have granted, we will say, the county of Sussex as a fief to his follower John Fitzgerald.

John Fitzgerald would then have to pay taxes to William and to provide troops to help him if he wanted to raid the north of England or to put down a revolt in his own country of Normandy. But John Fitzgerald might grant the district of Pevensey (which is in Sussex) to *his* follower Hugh de Vere, and Hugh de Vere would then have to provide taxes and troops for John Fitzgerald. And so it might go on ; and it sometimes happened that a man was granted two or three fiefs by two or three different lords, which made it very difficult if his overlords quarrelled and all demanded troops of him at once.

All these lords, barons, counts, dukes, etc., whether they had large fiefs or small fiefs, were counted members of the upper class, which was then called the "gentle" class—whence we get our word "gentleman," though they were by no means always gentle. But they did not till the land themselves. If they had to pay their overlord, as they often did, so many loaves a year, so many fat sheep, so many sucking pigs, so many casks of wine, and so many fresh eggs, they did not grow the corn or the wine themselves, any more than the present Duke of Norfolk ploughs the fields on his estates. These things were produced, and given to the lord, by the lower classes of peasants, whom the writers of the Middle Ages call the "simple" class. On every lord's fief there lived, in villages, peasants who were sometimes free, but more often serfs—that is to say, half-free men who cultivated a piece of land, and might keep for themselves and their families what was left after the lord had had what he wanted ; but who could not leave it and go somewhere else without his permission, and often could not marry without his permission either.

Such a serf—we will call him John Postgate ; John because it is his name, and Postgate because one of his jobs is to keep the watch at the postern gate of my lord's castle—has a holding of perhaps thirty acres, which may be all in one piece or made up of a number of scattered bits. He also has the right to turn some sheep or cattle to graze on the village meadows, and to send his pigs to grub acorns in the woodland, and to cut fuel from it for his fire (but not to

shoot game in it, for the lord reserves that right for himself). If enemies attack him, he hopes that the lord's troops will protect him, for he is not allowed to bear arms himself, since he is not of gentle blood. In return for this, he must give to the lord some portion of all the crops he raises and sometimes pay him a money rent as well. And he must also work for the lord without pay, for so many weeks or days in the year, either ploughing and reaping the lord's own private crops for him, or acting as a servant in his castle, or cleaning out the moat, or building him a new barn, or a host of other things.

In addition he will have other dues to pay. Very likely he will not be allowed to grind his own corn, or bake his own bread, but must take his corn to the lord's mills to be ground and his bread to the lord's bakehouses to be baked; and some of the corn and some loaves will have to be left behind in payment. (He will also have to make some payment and do some work for the priest of his parish church; but that is too long to explain here.) At all events, you will see that the peasant of the Middle Ages was not likely to have much left for himself; indeed, he was almost always very poor. This system died out in England after Elizabeth's time; but it continued much longer in other parts of Europe, and in Russia was only finally ended in the 1917 Revolution.

PASTORAL SOCIETIES

We have dealt at some length with life in agricultural communities, because so much of the world lives and has lived by agriculture. We must now turn to pastoral life, which will not keep us so long, because the life of pastoral communities, on the whole, is simple, and because there are not so many of them.

In early times, particularly, the most noticeable thing about a pastoral society is that it is always moving. The sheep, cattle, horses, or whatever kind of animal it is by which the community lives, are always eating up the grass and having to be driven on to new pastures.

Now a society which is always liable to be "moving on" will be rather different from a society which stays in the same place and does the same things year in and year out. For one thing, it must "travel light." It cannot accumulate a great many possessions, or build magnificent houses and temples; for, if it does, when it moves on it will have to leave them all behind. The gods of the Egyptians, for example, lived in magnificent temples built of stone and ornamented by the work of generations of craftsmen; but the God of the Hebrews, who were originally a pastoral people, lived in a box called the Ark of the Covenant—you can read all about it in the Book of Joshua—which was easily carried about and never had a temple of his own till the Hebrews settled in an agricultural country, the land of Canaan, and took to living an agricultural life. Then King Solomon built a temple, which was so new an idea that whole chapters of the Bible do nothing else but describe how magnificent it was.

Secondly a pastoral people on the move is generally much more inclined to fight than a people settled in a quiet agricultural valley. Peasants living on their tiny farms do not ordinarily make war on one another; they may squabble about boundaries, about where my field ends and your field begins, or about your pig getting into my potato garden and rooting it all up, and things of that sort; but, though they may get very angry in their squabbles, peasants generally argue, and go to law, rather than fight. It would be very foolish for Farmer Jones to go to war with Farmer Smith, to arm his farm-servants and attack Farmer Smith's fields. Farmer Smith would probably attack in return, and, at any rate, Farmer Jones and his men could not be attending to their own crops while they were at war; and the final result would probably be that the crops of both sides would be destroyed, and nobody would get anything to eat. But the pastoral tribe or community, when it moves on to fresh pastures, often finds that there is another tribe trying to use that new pasture as well; and it fights, until it has either driven the rival tribe away or been driven away itself. Also, while it is actually

moving, it needs to keep a good look-out and be ready to defend itself, in case wandering brigands (or possibly another tribe) try to carry off its sheep or cattle ; for sheep and cattle wander about, and sometimes get mixed with sheep and cattle belonging to somebody else, and it is not always easy to prove which is which. It is a long time now since shepherds in England had to carry arms to protect the sheep against wolves and brigands ; but in the wilder parts of Europe they do so still. In ancient times all pastoral peoples were ready for war at any moment.

The pastoral peoples, then, were on the whole warlike, and inclined to organise for war. This meant that those who governed them, their upper class, consisted mainly of the sort of people who could fight and organise fighting—that is to say, of the men who were strongest. And we may notice here that in a pastoral society the men are considered much more important than the women (see *The Family*, p. 479).

But the essential thing to notice about pastoral people is that they are much less conservative as a whole than agriculturists. This is partly because the care of sheep and cattle does not mean such an exact day-in, day-out routine as does the care of crops, and so the people who do it do not acquire the habit of mind which wants to go on doing the same thing in the same way, just because it has always done it. But it is also because the moving shepherd is always coming into contact with different kinds of land, different people with different habits, and having to adapt himself a little accordingly. This is even more true of merchants, of whom we shall soon be speaking ; but in history, particularly in ancient history, we find that the pastoral peoples are more ready to take up new ideas, and that they tend to bring new vigour and energy to the communities of peasants and farmers—to wake them up, in fact.

For the pastoral man is always coming into contact with the peasant. His life is generally hard and poor ; it is not lived in the rich valleys which, like Egypt, produce so much surplus wealth ; and the pastoral man, particularly in times of drought, is always casting hungry eyes on the rich cornlands. Here his warlike organisation helps him ; he descends,



Fig. 79. PASTORAL SOCIETY—A DESERT ENCAMPMENT

strong and armed, often with better and more useful weapons—hard iron pikes, for example, instead of soft bronze ones (see *Outline of World History*, p. 400)—upon the peasants' fields. Perhaps he just carries off what he wants for the moment and then goes again, as the early Northmen raiders plundered the coasts of England; perhaps he finds the new country so pleasant that he decides to settle down in it, either making a settlement and taking to agriculture himself or, perhaps, conquering the country and making the original inhabitants work for him as slaves or serfs.

There are many pastoral peoples in history. Central Europe and central Asia, in early days, were full of them, wandering about with their flocks and herds and their fighting men; and ever and again pouring down in floods into the fertile fields of India or China, or the countries round the Mediterranean. The Assyrians who came down "like a wolf on the fold" were pastoral conquerors; the Hebrews were a small pastoral people until they settled in Canaan. Then there were the Franks and Huns and Goths and all the other tribes which settled in the Roman Empire in the time of its decline. The most interesting example, however, of a pastoral people is that of the Arabs, not for their organisation, which is not very important, but because of their intelligence and the way in which they spread knowledge as well as their religion through the world.

You must read in other books about Mahomet, the great prophet of the Arabs, and the religion he taught, and about the way in which Mahomet's Arabs, a pastoral people brought up as warriors, raiders, and camel-drivers, conquered for their faith so rapidly that, in just over a hundred years, Mohammedanism and the Mohammedan Empire had spread from a tiny corner of Arabia right across Persia and Syria, and through Egypt, Africa, and Spain to the Pyrenees. But the thing to remember, which too many histories forget, is that the Arabs did not destroy the peoples whom they conquered; they woke them up. They did not force them, in many cases, to become Mohammedans; they made those who were not converted pay heavier taxes,

and treated them as inferior to the Mohammedans, but they did not generally kill them, as Christians in the Middle Ages killed Christians of a different way of thinking. What they did was to take up and support the civilisation, or what was left of the civilisation, of the Roman Empire, and add to it new knowledge, either of their own or learned from the East. Our numerals, our algebra, and most of the beginnings of science in Europe come from the Arabs, and would have spread to us more quickly had they not been continuously at war with the Christians of northern Europe (see *History of Science*, p. 59).

MERCHANT SOCIETIES

Next we come to the merchant communities—the people, that is, who make their living, not mainly by growing things themselves or by herding animals, but by travelling about with goods and selling them to other people. They may, of course, travel either by land or water; but in Europe, at any rate, water-travel is much the easier and cheaper, and so we find that the great merchant cities of Europe are either on the sea-coast, or a little way up the great rivers, at ports, such as the port of London, which ships can easily reach, and where they may lie safe from winds and tides. The part of Europe which first developed trade and commerce was the Mediterranean, particularly the eastern side of it, which is now called the Levant; and if you look carefully at a map of the eastern Mediterranean you will easily see why (and see *Outline of World History*, p. 400).

The Mediterranean is a nearly tideless sea and, moreover, a sea full of islands which are really the tops of submerged mountains. If we, in England, set off in a boat, land at another part of the coast, and go exploring inland for some hours, we are pretty likely to find, when we come back to our boat, either that the tide has taken it out to sea or, on the other hand, that the tide has gone out, leaving it high and dry so that it cannot be launched.

But in the Mediterranean you can beach your ship almost anywhere where there is a beach, and, provided that you

have a guard to see that it is not attacked, it will come to no harm unless there is a violent storm, and it will be there when you want it again. Again, seafaring adventure is much easier where there are islands. You set off on a journey to the island, twenty miles away, which you can just see from your own shore, and find, when you have reached it, that there is another island in sight, twenty miles further on. And beyond that is another that people can describe to you ; and beyond that again, they will tell you, if you dare sail straight for a whole day out of sight of land, you will come to the coast of Asia, where there are rich cities, like Smyrna, and where you will find dates from Syria, pale gold from Sardis, Persian carpets, and many remarkable things which you can buy and take back, to sell again, to the place you came from. In some such way as this the early dwellers by the sea first took to trade, though they did not always buy the goods they took to sell again—at least, they did not always pay for them ! It is tempting, if you are well armed and greedy, to take property by force without paying for it ; and in early times (and sometimes in later times also), if you saw a ship approaching, you were not at all sure whether she would turn out to be a trader or a pirate. Gradually, however, most of the merchant peoples found out that, if you wanted to go on trading, it paid to be trusted.

A community of merchants lives differently in many ways from a community of farmers or herdsmen. In the first place, merchants live in *towns* ; or, rather, towns—sometimes quite small towns—are built by merchants. For they do not want to live scattered about the countryside ; they want to be close together, near the port where the ship will come in. Then they want shops, or at least a market with stalls, where they can sell the goods they have bought and buy others from strangers, and where provisions from the countryside, eggs and chickens and butter, can be exposed for sale. Anyone who has seen a market-day in a tiny English country town will know what this means.

Another very important need of the merchant is money.

Agricultural peoples, when they wish to exchange some of their spare produce for something else, often do it by simple barter or swapping ; one cow is exchanged for three large copper saucepans, and so on. But if you are a merchant of Crete sailing to Tyre to buy scarlet cloth you cannot take several cows with you. It would not be convenient ; besides, the cows might die on the voyage, or the clothmakers of Tyre might not want any cows. It is much more practical to take money, gold or silver at all events, because gold and silver will buy things in most parts of the world. So our merchant needs money, and his town or city will very soon find that it needs money-changers and bankers, to exchange the money of foreign cities with the home money, and special laws, to deal with foreign merchants who have come from elsewhere trading, to say where they may live and what they may do, and what is to happen if they have a dispute with one another or with the citizens.

Also there will be craftsmen needed for the city : masons and bricklayers to build the houses, shipwrights and carpenters to build the ships, potters to make household goods, weavers to make cloth, stampers and die-makers to coin money. And if the city decides itself to make goods which its merchants can sell abroad, there may be a whole host of craftsmen making them, and generally living altogether in a special quarter of the city, such as the tanners' quarters (which must have smelt rather unpleasant) or the armourers' quarter (which must have been very noisy). Of course these craftsmen could not grow their own food as well as follow their crafts. The earliest merchant cities had agriculturists enough, either among their citizens or as slaves, to grow food for the craftsmen and merchants as well as for themselves ; but gradually, as their trade grew and more and more people became merchants and craftsmen, they found they had to buy corn from overseas with the money they made by trade. Which worked quite well when the world was reasonably at peace.

We have noticed already that trade and city life encourage new ideas and discussion. We should also notice that

the business of being traders tends to make men quick-witted and self-reliant and impatient of being ruled; the ideas which we call "democracy" and "self-government" were invented by city-states. And, lastly, we should notice that merchants generally want to make some sort of settlement of their own in the places with which they do most trade. Sometimes this will be just a trading-station, a sort of house where the Germans from Hamburg can live when they are in London; sometimes it will be a colony occupying a large piece of land, like the early English colonies in America; sometimes the merchants will go on and conquer a whole vast country, as the British East India Company (with the aid of the British Government) conquered India.

The first great trading peoples were the Cretans and the Phœnicians, both of whom, interesting as they are, we must pass over. There were two other periods in European history when merchant cities were very much in the forefront, one the time of the city-states of the ancient Greek world and the other the end of the Middle Ages; these we shall now look at.

ANCIENT GREEK CITIES

The ancient Greek cities and the great mediæval cities, such as Venice, Florence, Paris, and Hamburg, were alike in many ways. But they were not alike altogether. The cities which we call Greek—which were not only to be found in Greece, but in Asia Minor, on the shores of the Black Sea, in southern Italy, North Africa, and even in Spain—were founded by conquerors from the north, who had dispossessed the original inhabitants and either driven them out or made them into slaves or serfs. Then the Greeks settled down, and, from being the warriors about whom you can read in the poems of Homer, the *Iliad* and the *Odyssey*, turned into farmers and fishermen, and eventually, most of them, into sea-traders. (Sparta, however—which, next to Athens, is perhaps the most famous of the Greek States—kept her citizens as warriors and forbade them to engage in trade or even to possess gold or silver.)

Greece and the Greek islands are poor, with high and rough mountains, a climate cold in winter, and soil that, except in small patches, will grow little. This meant that the Greeks lived what we should call a hard life ; they did not eat nearly as much as we do, they dressed very simply, and their houses were cold and uncomfortable. As a matter of fact, they lived very little in their houses, but more in the open air, in fields and streets, watching plays out-of-doors even in midwinter. Even so, their food-supply was always liable to run short—that is to say, they were always in danger of finding out that there were more people living in the city than there was bread enough to feed. If they were not rich enough, as Athens was in her greatest days, to buy corn from abroad, from Egypt or the Black Sea, they had to find other ways of solving this problem. They might refuse to bring up all their children, putting the weaker babies (which means girls rather than boys) out on the hillside and leaving them to die of exposure ; this seems a cruel method to us, but is perhaps not more cruel than bringing them up to live in slums, as other civilisations have done. Or they sent the superfluous people out of the city, to find land and to found cities far from home, or to take service as mercenary soldiers in the army of some monarch, such as the great King of Persia, who was able and willing to pay for them. This was how the Greek cities, Greek civilisation, and Greek ideas spread all over the Mediterranean lands, for wherever the Greek went he thought of himself as a Greek and a superior person, talked of the other races as “barbarians”—as some Englishmen talk of all foreigners as “dagoes”—and taught his own Greek language all over the civilised world.

This hard life made the Greeks tough and resourceful, each man used to thinking for himself and working out his own problems, instead of just doing what somebody else had told him to do or what his fathers and grandfathers had done before him. It also helped to make him passionately devoted to his own city, which he had helped to make, and which was always in danger of destruction or starvation if every citizen did not pull his weight. Greek

patriotism was something very much more than the sort of flag-wagging which we do on Empire Day ; it was a real and continuous belief that the city in which a man was born a citizen gave him all that made life worth living, and that he ought to spend himself to the utmost in the city's service. But, though the life which the Greeks led may explain some of their qualities, it does not really explain what we call "the Greek spirit," of which the two most important signs, perhaps, were their idea of equality, which they called *isonomia*, and freedom of speech and thought, which they called *parrhesia*.

The Greek civilisation was the first, so far as we know, which was not ruled by gods and priests. In all previous civilisations, men asked what the gods wished them to do or say, before they did it ; and the priests were there to tell them. But in Greece, for the first time, men began to do what it seemed right or sensible to *themselves* to do, and to discuss among themselves why some things seem right and others wrong, how the world had come to be what it was, and how it could be altered. The consequence is that the people who lived in Greek cities—particularly in Athens, where this sort of free discussion reached its height—seem to us much more like the modern people than any who lived before. If you were to meet an ancient-Egyptian boy, you would not be able to talk to him, because his mind would be so different from yours and he would have been so differently brought up. But, if you met a young Athenian, though you might not agree with him, you would be able to talk to him ; he would be able to tell you how he had just been having a discussion with Socrates (the greatest of the Athenians) on whether children ought to obey their parents, and, if so, why ; and how he had told his father all about it, and his father had grumbled and said he didn't know what the world was coming to when they allowed children to discuss things like that, and it wasn't like that in his young days—just as a modern father might. That is *parrhesia*.

Isonomia means equality of rights. It means a belief that people who are in full possession of health and wits

can rule themselves and their city ; that they do not need any king or governor from above to do it for them ; that there shall not be one law for the rich and another law for the poor ; that each man is as fitted to decide what is right and wrong as his neighbour, and every *free* man of equal importance to the city. We have to say “ every *free* man ” ; for the Greek cities, like every other ancient civilisation, kept slaves, who were not free, had nothing to do with governing the city, and had no rights. It was not until generations after the Athenian Empire perished that it occurred to the world that slavery was wrong and that equality, if it was a good thing, ought to mean equality for everyone, not just for a few. Nor had women, in Athens, equal rights with men. But in itself the idea was a great one ; it was the start of all that we now call democracy : and it came from Athens in the fifth century before Christ.

Unfortunately, the Greeks did not push their idea far enough. Equality is a difficult thing to manage ; it is much simpler to order people to do something than to discuss with them until you are all agreed what to do. It means knowing how to keep your temper and to see other people’s point of view, and a host of other things. The citizens of Greek cities learned to do this with one another within their own cities, but never outside. The several Greek cities quarrelled with each other as fiercely as, and more frequently than, modern nations do, and only once in their whole history did they succeed in uniting against a common foe (see *Outline of World History*, p. 402). Furthermore, the very freedom and patriotism of the Greeks roused in them desires which their poor homelands could not satisfy. They wanted leisure to talk and discuss, to hear poems, to run races, and to see plays ; they wanted beautiful buildings and gold and ivory statues to adorn their cities ; they wanted a great deal of what we call culture and civilisation. And they got it—at least, Athens and a few other States did ; and the sculpture and architecture and literature of the great Athenians has delighted hundreds of generations since they died. But the civilisation of Athens was paid for by other cities, just as the Athenian citizens were

largely fed by the labour of slaves. The gold and marble and ivory which adorned the Athenian temples was paid for by tribute which Athens drew from cities which she held in subjection by her navy; and, when those cities grew tired of their subjection and rebelled with outside aid, the Athenian Empire and the great days of Athens came to an end. Not that anybody was much the better off for that, for the cities could not agree, and fought continually. The seas became unsafe for trade; life became dearer and poorer, until the disorder was stopped by the conquest of Alexander (see *Outline of World History*, p. 403) and, after him, of the Roman Empire.

THE ROMAN EMPIRE

We can only, here, speak briefly of the Roman Empire, though it was, perhaps, the greatest experiment in organisation which the world has ever known. The Romans, originally a small community of farmers who took, for safety, to living in a small fortified city built upon seven hills, discovered within themselves a gift for organisation which no other people has ever had. They were good fighters, and understood (which all good fighters do not) how, by means of proper food-supplies, good roads, and fortified stations, to win a war and hold a conquered territory. But, far more than that, they were impressed with the importance of law and order, the making and keeping of certain rules of civilised life which everyone must obey, or peaceful citizens will not know where they are or be able to get on with their jobs. These two gifts, the gift for military organisation and the gift for law-making, caused the Romans, not merely to conquer Italy, but to extend their conquests right over the Mediterranean, including the shattered bits of the Greek world, as well as to Spain, France, Britain, and western Germany, and to make of the whole a single unit—the Roman Empire (see *Outline of World History*, p. 405).

The Romans did a great deal for the peoples and the cities they conquered. They brought, on the whole, peace

to the Mediterranean world, and a uniform law, so that trade would revive and prosperity increase. They taught barbarian tribes to live in cities (if that is a good thing, as most people believe); they gave them good roads and a good water-supply, and spread a knowledge of Greek and Greek culture among many who would never have found it. Most important of all, by making the leading persons in the conquered nations citizens of Rome, with all the Roman citizen's rights and privileges, they succeeded, for the first and only time in history, in making a world-state to which people of all nationalities were proud to belong. A Jew of Tarsus in Asia Minor, such as St. Paul, was as much a Roman as a Briton from Colchester or a Roman in Rome, and felt that the likeness was more important than the difference; whereas an Indian from British India feels himself the subject, not the equal, of an Englishman born in London.

But, unfortunately, the organisation of the Roman Empire proved too expensive in the end. It had continually to be defending itself against barbarian invaders from outside, and armies cost a great deal to keep and train. Baths and roads and aqueducts cost money to build; and to get the money for all these things and the other necessities of city life one must levy taxes and employ a great many tax-collectors, who also have to be paid for. There were other reasons (see *Outline of World History*, p. 407), for the decline of the Roman Empire in the west; but the main reason was that there was not enough surplus in the lands it ruled to pay for the expenses of government and city life.

Eventually, then—though not for four hundred years—the Empire in the West collapsed; the barbarians broke it up, though for a long time they preserved much of the way of life which the Romans had taught them. But in eastern Europe, which was richer because there was more trade in it, the Empire endured for another thousand years, centred upon the great Roman city of Constantinople, which for generations was the defence of civilisation against attack from the east, and by far the richest and most magnificent city in Europe.



Fig. 80. A STREET IN A MEDIEVAL CITY

MEDIÆVAL CITIES

The cities of the Middle Ages were merchant cities, like those of the Greeks ; but they grew, not by conquest, but out of the feudal life that we described on p. 509. It would happen, perhaps, that in a bad year some of the peasants could not make a living off the land, or, having a spark of adventure in them, wanted to see something of the world, and would wander off from their village, begging their bread or picking up a job of work, or even turning highwaymen, as best they could, until they fell in with, say, some Jewish or Syrian merchants peddling silk and spices and other rare goods which the richer lords or bishops could afford to buy. Such a caravan would go from place to place buying and selling, holding fairs for all the countryside, whenever they had enough merchandise ; and at certain convenient places, possibly at the mouth of a river, at a ford, or at a junction of two important roads, they would build themselves a permanent market or trading-town. These little companies of traders, forming themselves into a kind of brotherhood for mutual protection, for defence against robbers, and for borrowing money with which to start their enterprises, are known as *merchant guilds* ; and merchant guilds were the origin of most of the cities of the Middle Ages.

These cities did not become great without, as you might expect, some bitter struggles with the feudal lords. The count or baron on whose land the merchants built their city was very unwilling to give up his rights over them. Sometimes the merchants fought their lord, as the great cities of the Netherlands, such as Bruges and Ghent, fought the counts of Flanders ; sometimes, having grown rich by trade, they bought him off ; sometimes they managed to secure their freedom by playing off one great man against another. London, for example, gained its freedom by siding with the kings of England in their wars against the barons, and receiving special privileges as a reward. At all events, by one means and another, merchant cities all over western and northern Europe—the most important

being those of Flanders and northern Italy—sprang up, secured their freedom, re-opened the trade with the rich East which the Mohammedan invasions had closed, and advanced rapidly towards wealth and power. Many of them became much richer than the Greek cities had ever been: the Queen of France complained bitterly that the wives of the burghers of Bruges were much better dressed than she could afford to be! Like the Greek cities, they developed a passionate patriotism among their citizens; and most of the beautiful old houses, churches, halls, and works of art which people travel to see in France and Italy and some parts of Germany are the products of mediæval gilds.

For the gilds of merchants were not the only gilds to be found in mediæval towns. As the cities grew, and craft and manufacture developed among them, we find craftsmen of all kinds joining together in gilds or brotherhoods. There were gilds of tailors, of weavers, of dyers, of fullers (who bleached cloths), of farriers (who shod horses), of armourers, of spurriers, of bakers, of sweetmeat makers, of tilers, of goldsmiths, of barbers, of apothecaries; in fact, of almost every craft. These gilds, as well as taking part in the government of their towns, were charged with the duty of protecting their craft, keeping up the quality of the goods they made, and looking after the interests of the members of the craft, in sickness and in health. Originally, they were all organised in much the same way. First, there were the masters, who were, as one might say, the grown-up members of the craft. They had all learned their trade thoroughly as apprentices, had shown their knowledge by producing a piece of work—called a “masterpiece”—for the approval of the other masters, and had paid a fee for the privilege of becoming masters and setting up in business for themselves. Then there were the apprentices, who were learning the trade. They were “bound apprentices” when they were boys, generally for five or seven years, but sometimes for longer; they lived in the master’s house—like Dick Whittington—and worked in his workshop, and he promised to teach them the trade and to provide them

with food and clothes and sometimes with a little pocket-money. And, like boys at other times of history, sometimes they worked hard and sometimes they did not. A good many mediæval writers have a great deal to say about "idle apprentices," how they waste their time, spoil good material, play football in the streets, and annoy the passers-by; but these writers were mostly themselves masters, and we need not think that the apprentices were really as bad as all that. Finally, there were the journeymen—that is, apprentices who had served their time, but had not yet become masters, and so worked for wages in the master's workshops, but did not generally live in his house.

The ideal mediæval gild, then, was a group of family parties working at a trade, keeping searchers to see that no bad work was done, fixing prices so that everyone received a fair rate and the purchaser was not charged too much for his goods, watching to see that the work was not done under bad conditions and that nobody practised the trade who was not properly qualified; and many of the great works of mediæval life were made by this kind of co-operative effort. But the gild system did not last in this happy condition. For one thing, as riches increased, the gild masters became greedier. They tried to keep down the pay of journeymen and apprentices, and also to prevent new men from setting up as masters and so getting a share in the trade. Again, the mediæval cities quarrelled with one another, like the Greek cities, though not to the same extent. In northern Italy, particularly, the wars of great cities such as Venice, Florence, Milan, and Genoa were terribly hard upon the common people. And thirdly, and most important, the great discoveries of the sixteenth century, particularly the discovery of America and the way round the Cape of Good Hope, showed people that there was most money to be made by employing a very large number of workmen as wage-earners, who had no chance of ever becoming masters or employers themselves, and paying them as little as possible to produce quantities of goods for sale, not in their own cities or in nearby cities, but all over the world.

Consequently we find the power and independence of the mediæval cities gradually decaying, and in their place rising the national States—England, France, Germany etc.—which we know to-day. And in place of the mediæval gild, with its equal company of masters and its groups of craftsmen working in the master's house, we find the great employer, with hundreds and thousands of men working under him for wages, manufacturing far more goods than can ever be used at home, which he tries desperately to sell to distant lands. This leads us on to the industrial, capitalist, power-using society of our own day.

CAPITALISM AND THE INDUSTRIAL REVOLUTION

The system under which the organising or upper class in society, instead of keeping the lower class as slaves or serfs or training it through apprenticeship to rise to mastery, *employs* it to do the work for wages, is called capitalism. It is the system under which we are now living. The employer or capitalist may be a small capitalist, or a large one, like Henry Ford, or a company, like the Great Western Railway; he may collect his wage-earners in a single place, like a factory or dock, or he may give them work to do in their homes, as the London tailors do. But in either case the wage-earner, with very few exceptions, remains a wage-earner all his life; he has no interest in, or control of, the things he makes, except through being paid wages for them; and if his work is not wanted he gets no wages, and is fed—if he is fed at all—either by charity or by some sort of State help such as poor-law relief or unemployment pay (see *Economics*, p. 670). When the big employers are private persons or companies, as in western countries to-day, the system is called "private capitalism"; where the wage-earners are employed by the State, as in Russia, it is called "State capitalism." (For other differences between Russia and the western countries see the next chapter.)

Capitalism is not a new system. There were great capitalists in ancient Rome, who disappeared in the west with the break-up of the Roman Empire; and during

mediæval times capitalism was slowly reappearing. It grew much faster, however, after the discovery of America and the Cape route to India, partly because in America and India there were found many more people to buy the goods which the wage-earners produced, and partly because there was a good deal more money in the world (mostly stolen by the Spanish and Portuguese from Peru and other parts of South America), so that people all round could buy more things. In England, the most important of the early capitalists were the big clothiers, who exported English cloth and clothes (made by hand, of course), and bought large pieces of agricultural land which they turned into sheep-farms. The peasants and labourers who had previously lived off this land were set adrift; some found work in the factories, and some became sailors in the navy of Elizabeth.

All through the sixteenth, seventeenth, and eighteenth centuries, capitalism went on growing. Manufactures became more plentiful; sea-going ships became larger and safer; new customers, both at home and in distant parts, were found to buy the goods; and more trades began to be run on capitalist lines, i.e. by wage-labour. It is important to notice that under the new system the mediæval idea, that there was a fair price at which goods ought to be sold, slowly died away. When you were selling glass beads and guns to North-American Indians in exchange for furs, there was no question of a fair price; you just took as much as you could get. And similarly, when you were hiring wage-earners—"hands," as big employers call them—you hired them as cheaply as you could get them. In the new capitalism, then, the great thing was to make as much *profit* as possible, by buying what you wanted, whether it was wool or "hands," as cheap as you could, and selling what you made as dear; and the man who made most profit was most highly thought of, even if he made it, as he sometimes did, by what a mediæval guild would have called cheating. This is very important for the period which follows—the time of the great inventions—which we call the Industrial Revolution.

In the seventeenth and eighteenth centuries a good many experimenters were at work, in England and elsewhere, trying to find out ways in which goods could be manufactured more cheaply, and eventually they succeeded, as everybody knows. They made machines, driven by coal-fires, do the work which hands had done before. Everyone has heard of James Watt and his engine; but not everybody knows that Watt was only one of an innumerable band of inventors who were inventing from the middle of the eighteenth century down to the present day, each trying his hardest to make goods be produced faster and cheaper, and carried faster and cheaper to those who might buy them, with results that are almost incredible when we read them.

This great movement started in England towards the end of the eighteenth century and advanced very rapidly. It meant a big change in the habits of the people. Quantities of "hands" were needed to work the new machines, and new towns of "hands" sprang up around the factories. At the same time, capitalism—though not machinery—was being applied to agriculture; small farms and cottage plots were being turned into parts of large farms; commons were being enclosed and destroyed; and the labourers and yeomen were either left to live without land or driven into the new towns.

It was very unfortunate, in many ways, that the discovery of machinery occurred in a capitalist society whose main idea was to make profits. For the new factories and towns were built by people determined to do the thing as cheaply as possible, to work the wage-earner as long for as little money as he would stand, and not to spend a penny until he was obliged. So we find that the hours in the new factories were intolerably long, that children, even children of four and five and six, were set to work all day tending machinery, in dark, dirty, dangerous, and poisonous places (because cleaning and lighting and fencing machinery costs money), and that the houses in the new towns were as ugly, cheap, and insanitary as you could imagine. The coming of machine production, which might

have made everybody happier by giving them more of this world's goods, in the beginning brought misery and disease to thousands of wage-earners and their wives and children.

The worst conditions did not last very long. The danger of disease breaking out in the filthy towns and spreading beyond them forced the State to take some steps to clean them: the wage-earners themselves, when they were collected together in towns, formed themselves into trade unions which forced slightly better treatment out of the employers; and very slowly people began to grasp again the fact that a society where everybody is trying to make as much as possible is not the most admirable or pleasant kind of society. Town and factory life, also, made it necessary for the wage-earners to be better educated, and eventually gave them some share in the government of their cities and country; and, as British manufactures increased enormously and were exchanged for cheap foodstuffs from America and Australia, the workers became, in the end, a good deal more comfortably off, though it was a long time before their working hours were made reasonably short, and the towns of the North and Midlands are still full of disgraceful houses which were built in the early factory days.

The Industrial Revolution eventually made all British people better off, mainly because we were able to *export* (i.e. sell abroad) vast quantities of manufactured things from railway engines to soap, in exchange for cheap foods. The Industrial Revolution in England was, however, followed by industrial revolutions in other western countries, notably Germany, France, and the United States. What the results are—when more and more countries are becoming “industrial societies,” and all trying desperately to manufacture goods, to get the materials to make them (which are mostly found in tropical countries such as Africa), and to sell the goods when made, without attempting to reach any agreement—you must read in the next chapter on *The Last Thirty Years*.



Fig. 81. MODERN INDUSTRIAL LIFE—THE PORT OF LONDON

BOOKS TO READ

Some very much enjoy :

WINWOOD READE : *The Martyrdom of Man*. But it is not everybody's book.

J. H. BREASTED : *Ancient Egypt*. Big, with plenty of pictures.

SIR W. FLINDERS PETRIE : *Social Life in Ancient Egypt*.

C. L. WOOLLEY : *The Sumerians*. Or others of Woolley's books.

A. E. ZIMMERN : *The Greek Commonwealth*. A great book. Read some of it, at any rate.

For pastoral peoples, read the early books of the Old Testament, or :

M. PICKTHALL : *Knights of Araby*.

EILEEN POWER : *Mediæval People*. Easy reading.

HELEN WADDELL : *The Wandering Scholars*.

C. and B. QUENNELL : *History of Everyday Things in England* (illustrated fully).

CHARLES READE : *The Cloister and the Hearth*. For late mediæval and Renaissance times. Excellent.

J. L. and B. HAMMOND : *The Village Labourer* and *The Town Labourer*. For early industrial society.

C. R. FAY : *Life and Labour in the Nineteenth Century*.

And try early chapters of :

H. G. WELLS : *Work, Wealth, and Happiness*.

THE LAST THIRTY YEARS

OR

WAR AND REVOLUTION: WHY?

by

LANCE BEALES



LANCE BEALES is kind, public-spirited, a good sort of person to be friends with ; he laughs and helps. He is rather older than me, has a wife called Taffy, two sons and a daughter, and an immense dog. He took history at Manchester University, and played in the University Rugger XV. He has done a great deal of teaching all his life, and also the organising of teaching. In 1915 he went out to France as a corporal in the Royal Garrison Artillery. His work was to do the mathematics of the shooting of the heavy guns. He was in the fighting on Vimy Ridge, at Messines, and then in Flanders ; more than three-quarters of the men in his battery were knocked out, but he got back to England late in 1917 and took a commission. After the war he went back to lecturing, first in Sheffield and then at the London School of Economics. He has always been interested in politics, and you will see from this chapter where his sympathies lie.

THE LAST THIRTY YEARS

A THIRD of the twentieth century has already slipped away. We have the habit of saying that our own century is the most wonderful of all. In one respect that is true. We have more wonderful things to use and to enjoy than people ever had before, and we know more about the world we live in, and about the whole universe, than people have ever known before. But we must be careful not to exaggerate the wonders of our wonderful age, and we must be careful not to be ignorant about it. For most of the millions of people who have lived, or still live, in the world of the twentieth century, things have been far from easy. There has been so much quarrelling, so much fighting, so much poverty and anxiety and strain, that we cannot think the age in which we live is a very wise or very successful one. If we want things to get better, if we want more people to live happy lives, we must get to know what the world of to-day is really like. We must find out how people spend their lives, and why their lives are so full of troubles. One way of doing that is to look at the twentieth century rather closely.

THE SCRAMBLE FOR PROSPERITY

Grown-up people in a country like England are very much interested in politics and business. As they grow older they think rather less about games and rather more about government. They get nearly as excited over a General Election as their juniors over the boat-race. These public affairs must be important, and when we ask questions about them we find that they really are: they are important, because they have to do with the big things that matter in the lives of all of us—how we get our food, shelter, clothing, and amusements; how we get our education; what arrangements are made to keep us healthy

whether we are to be safe as we go about the streets; whether we are going to travel about comfortably in our own country and in other countries; if we have to fight in army, navy, or air force against people like ourselves with whom quarrels have arisen that statesmen have failed to smooth out; whether our pounds, shillings, and pence are going to exchange for as many things as they used to when we spend them (see *Economics*, p. 643). As the world has grown older, the numbers of people that live in it have increased. Some countries are very crowded—they are the poorest of all, like China and India, and the richest, like England and parts of the United States (see *Peoples of the World*, p. 580). The more crowded together people are, the more the affairs of government matter, and the more important it is that they should be well managed. When the history of the last thirty years is looked at closely, it is very hard to believe that they have been well managed.

If you look at the picture which shows the world's populations (Fig. 87) you will find that the countries with most people are in the Far East, where war is a present evil, and in Europe, which was at war a dozen years ago. If you were to look at a map which shows the chief occupations, you would discover that in the Far East most people are cultivators of the soil, and in western Europe most people live by making things and selling them—that is, by industry and commerce. The Chinese peasants, for example, have to struggle to make a living: they have large families, all of whom have to work very hard, and many of whom die in the famines that occur from time to time. The same happened in Russia until the last few years. People in Great Britain or the United States, in contrast, do not suffer famine any longer. Though they do not produce all the food they need from their own soil, they have no difficulty in buying all they want from other countries.

Not only do different peoples in different parts of the world live different kinds of lives (see *Peoples of the World*, p. 579); there are differences in prosperity as well, and differences in the rates at which their numbers increase.

The nations that have taken to industry and commerce—the industrial nations, as they are called—are the wealthiest and in the last hundred and fifty years they have been the readiest to leave the places in which they were born and to settle in other countries. Scores of millions of European people have settled in the United States, for example, and several nations have, through war or by agreement among themselves, made colonies in Africa and elsewhere. The population of Japan increases by three-quarters of a million every year, that of Russia by about four millions, but the population of Great Britain and France has nearly stopped increasing. In the Far East, the Chinese can live more cheaply and poorly than the Japanese, but the Japanese have developed their industry more than the Chinese. Differences of this kind in a world which is not controlled by one single power cause difficulties between the different peoples. And as railways, steamships, and all the other means of communication have been improved, and as the wealthier nations increasingly require goods, like rubber, tin, palm-oil, tea, and a host of others, which are produced by the poorer nations, there is a sort of scramble always going on. It is difficult to prevent that scramble from becoming actual war—so difficult that it has often become war during the last thirty years.

All men and women, save those who have been left large "fortunes" by their parents or relations, have to work to get the things that are necessary to them. Some have to work very hard and get very little: others have pleasanter work to do and get much more. There is a good deal of jealousy between individual human beings on this account. The same is true of nations—that is, of the citizens that compose them. The world is divided up between nations, each of which has a different history, and each of which is very jealous of its fellow-nations and very anxious to increase its power, so that it may cut a fine figure in the world and protect itself from attack by other nations.

THE "GREATNESS" OF NATIONS

Different nations can offer different claims to be considered great. The British have been clever at building bridges and harbours and ships, at making iron and steel and cotton and woollen goods : they have been successful in avoiding revolutions by allowing more and more people to take part in government without ever letting ordinary common people take charge : they have built up an empire which is spread in all parts of the world, and they have allowed the parts of it in which British people are the most numerous to govern themselves. In other ways, too, the British have been very successful. The Chinese, on the other hand, have never been interested in questions of government, or not until quite recently. But they have produced marvellous pottery, and they managed to delude everybody into thinking they were a powerful military nation until 1894, and they have believed in their religions so firmly that they have even been content to carry out the rules of conduct which they sanction. The Americans of the United States, too, have done remarkable things. They have produced in their midst the most wonderful industrial advances, flooding their homes with motor-cars, wireless, gramophones, typewriters, refrigerators ; they have made almost a new language out of the English they speak ; they have sent their cinema films all over the world and filled every dancing-hall in Europe with their jazz-music ; they are the richest people in the world, and some day may be the wisest.

It is easy enough to see the differences between the nations of the world. But it is not so easy to explain why some nations regard themselves as superior to others just because they have achieved a different kind of strength—the strength, say, of big industries and big battleships instead of the strength of a belief in peace (as among the Swiss or the Scandinavian peoples), or in religion and art and good citizenship (as among the ancient Greeks). All the same, the actual facts are simple. The world is divided up between nations, some of which are stronger than

others and able to subdue others, even to make them work for them as slaves ; so clashes between them have been very frequent. There is no very clear sign that they are likely to be less frequent in the next thirty years than they have been in the past.

There are other causes which render peaceful living difficult. If all the nations had the same kind of civilisation, if all nations had the same degree of wealth, if all nations had the same ideals of behaviour, good government would be only a matter of making agreements. But there are more differences than there are resemblances—differences of religion, of liberty, of laws and customs, of education and the rest. To avoid selfishness, especially in pursuit of wealth at some other's expense, is the hardest of all duties. Nations, like the individual human beings which compose them, have not managed to avoid selfishness. The recent history of the world is, in consequence, a history of strife.

AN AGE OF VIOLENCE

It is rather disturbing to study the history of the last thirty years. The makers of history-books have a way of describing past periods of human life by short descriptive terms. They talk about the break-up of loyalty to the Roman Catholic Church in some countries as "The Reformation": they describe the time when the steam-engine and cotton-spinning machinery and railways came into common use as "The Industrial Revolution." What will the historian call our age? Unless things alter, and alter quickly, he will have to call it "*The Age of Violence.*" There have been so many wars and so many revolutions in the last thirty years that some such description will be unavoidable. That is why many people wonder whether civilisation has made progress, and are even asking whether, in anything like the forms in which we have known it, it can possibly survive. Instead of a regular advance towards peace and prosperity and happiness, in the last thirty years there have only been intervals of quiet between sharp and destructive conflicts.

There has never been a period of thirty years in the historical past during which the whole world has been free from wars, but it is doubtful whether, save in the rather similar period between 1815 and 1850, there was ever a time when wars and revolutions were so frequent as in our day. At bottom the same forces were at work a century ago as now. Wars and revolutions were not accidents then, and they are not accidents now. There are causes for these things. They are not just outbursts of bad temper, or freak events. Ours is an age of violence because people are so moved by ambition, or so oppressed by what they feel to be tyranny or injustice, or so determined to control the things which spoil their lives, that they will defy the forces of law and order, face discomfort and even death, for causes they feel sacred. This applies to wars and to revolutions alike. In fact, if we are to understand the events of the last thirty years, we shall be wise to regard wars and revolutions as linked together. Not only do they come together, but they spring from the same causes. Neither war nor revolution would be necessary in a well-run world ; but ours is not, for most people that live in it, by any manner of means a well-run world. The wars and the revolutions spring from the bad working arrangements under which we live. They are signs that civilisation is defective, that its machinery is out of order.

1900-1912

Let us briefly recall some of the outstanding events on account of which we call the last thirty years an age of violence. When the century opened, Great Britain was engaged in a war in South Africa. That war was regarded by most people as a highly patriotic enterprise. Boer farmers had defied us. They had refused to British people, who had settled in their territory to work gold-mines, the full rights of citizenship, and they handicapped them in their work. Further, they had disturbed the neighbouring British states by withdrawing traffic from railways which

had been constructed to the gold-fields and directing it to another and non-British railway. To the Boers, the British gold-miners and business men were unwelcome and disturbing guests. Their presence was threatening; they might induce the British to claim the right to rule over them; their whole way of life was different. Four years before the war broke out British people had tried to bring about a revolution in the Boer territory. The kind of events which were allowed to take place made war inescapable. Yet when it was over, a settlement was made which inside ten years, removed the differences that divided the two peoples. The principles of that settlement had been suggested more than fifty years earlier, and rejected. The forces which were bound to make Boers and Britons unite existed all along, but the way to the Union of South Africa (1910) was the way of violence.

No sooner was that war over than Russia and Japan took to arms in the Far East (1904). Ten years earlier, Japan had been at war with China and had strengthened her power at China's expense. Few people expected that the Japanese would be successful against enormous Russia, yet they were, and their victory was taken as justifying their action. But what exactly had happened? The East had awakened, we say. That means that Japan had decided to increase her strength by developing industries and opening up neighbouring territories. She had a desperately poor and rapidly growing population. She could not get much more out of her own soil, but she could do a great deal if she could get the chance of working the coal and minerals of Korea and Manchuria (see *Peoples of the World*, p. 598). Russia had the same sort of aim. Without ports on the open seas except those which were frozen up in winter, barred from Constantinople, Russia had restlessly advanced towards the Pacific. Railways had been built, and towns had sprung up in their track like mushrooms. The other Powers of the world had not made up their minds what to do about the East. They formed alliances, but put off the making of definite decisions. They must be blamed, with Japan and Russia, for the war that broke out.

To

The Russian defeat in this war was followed immediately by the first Russian revolution. The Russian people had not only seen how feeble their government was in war, but they had grown tired of waiting for the setting right of very old grievances. The educated and business classes wanted a share in the work of ruling the country ; the country people were burdened by the hardest poverty and quite unable to pay the taxes, increased now by the expenses of the war. They had been serfs, the property of the landowners, until Tsar Alexander II had set them free forty years before, but they had never been satisfied with the arrangements then made, and their condition had got steadily worse rather than better. After the war with Japan was over, revolutionary movements broke out. Thousands of men and women were killed, both during the risings and in the hangings and shootings which followed. Then an attempt was made to establish a Russian parliament, and to carry out reforms which would benefit the farmers and other classes in Russia. These and other improvements were long overdue, but they came too late.

TROUBLE IN THE BALKANS

In 1912 war flared up again, this time in the Balkan States, in which Russia and the other Great Powers of Europe felt themselves deeply interested. Two years after that, the Great War followed. In 1917 revolution broke out again in Russia. Of the events of 1917 we will speak later on.

Trouble in the Balkan States was not a new thing. There had been a crisis in 1909, but an agreement had been patched up. Nobody expected that it would last, though on the surface the appearance of peace was maintained. The Balkan peoples themselves wanted to escape from the misrule of Turkey. (They had some hope of this when the " Young Turks " made a revolution in 1908, as a result of which more up-to-date and less violent methods of government might be expected.) But what the Balkan peoples

themselves wanted mattered little. Austria, Russia, and Italy thought simply of their own interests in the Balkan States, and all arrangements in the Balkan States were really determined by these three countries. The Great Powers of Europe had allowed Prince Ferdinand of Bulgaria to call himself Tsar in 1908, and to make his kingdom independent of Turkey. They had allowed an exiled prince to gather the fruits of a revolution in Serbia and become King Peter I in 1903. In 1908 they had allowed Austria to annex Bosnia and Herzegovina, small territories which were Serbian in loyalty but Turkish by legal right; this was the time Germany showed her readiness, as the Kaiser put it, to don "shining armour" in support of Austria if Russia should protest. They had been unwilling to allow Greece to acquire Crete in the same year, but they allowed Italy to make war in Tripoli and extend her territory at the expense of Turkey, and stood aside while the Albanians broke into open rebellion against their Turkish masters in 1911. Turkish massacres in Macedonia inflamed the Balkan peoples, now in alliance, but the Great Powers warned them that they would not permit any alteration of Turkish territories in Europe. Despite that, the Balkan kingdoms declared war on Turkey in 1912 and quickly won a series of victories. No sooner had they got to the task of re-arranging the map of south-eastern Europe than they fell to quarrelling among themselves. A second Balkan War broke out in 1913. The war for freedom from the Turk became a war over the division of Turkish territories. And it was as savage a war as any that had ever taken place. After it had lasted a few months, the Balkan States were given new boundaries, and Turkish territory in Europe was limited to Constantinople and the hinterland of the Straits.

The surprising part of all this tangled history was that the Balkan Wars did not widen out immediately into a general European war. All the same, that could not long be delayed. Europe was already divided into two armed camps. Germany and Austria, exerting a growing influence upon Turkey, had hoped to get power in the Near East,

and had a scheme for a railway to Bagdad. Now the Balkan kingdoms of Serbia and Bulgaria, hostile to each other and also to Turkey, stood across their track and looked to Russia for support. Italy, their ally, was plainly unfriendly to Austria, because Austria controlled the Adriatic Sea. France, allied to Russia, openly rejoiced at the discomfiture of Germany, which had robbed her of Alsace-Lorraine in 1870. England, allied to Russia and France, was determined to keep the Turks in Constantinople, lest Russia, with Eastern ambitions, should acquire it, but equally determined to prevent German expansion in the Near East. England, also, was afraid of Germany competing successfully against her in the world's markets. What a welter of conflicting rivalries! Is it any wonder that, armed to the teeth as they were, these Great Powers should plunge into war? In 1909, again in 1911, war had only just been avoided. In 1913 everyone outside England knew it was coming, and coming soon. Monsieur Poincaré, the French Premier, declared at the beginning of 1914, "In two years the war will take place. All my efforts will be devoted to preparing for it." It came even earlier. The storm burst in the summer of 1914.

THE BURSTING OF THE STORM

That pitiful tragedy ended by casting its blight upon every part of the world in some degree. After it ended, millions more men and women perished in the typhus and influenza epidemics which followed it.

We pass on to the world's revolutions. Some have already been mentioned, but the greatest of all was the Russian Revolution of 1917. We may well think of these revolutions as collapses of civilisation in the national fields in which they happen, as wars are collapses of civilisation in the international field. What has been the record of revolutions in our age of violence?

In Russia, the War which broke out in 1914 called forth, as in other fighting countries, all the patriotism, all the heroism, all the sacrifices which a people can make. Russia



Fig. 82. MUD AND DESOLATION
Ducking past a traverse : modern trench warfare.

was never a wealthy manufacturing country, and the sufferings of the Russian people were enormous. They were borne with the utmost courage and goodwill till it became clear that sheer bad management had made and was making them far more grievous than was necessary. At last it became impossible to hide the wretched weaknesses of the Russian Government any longer. Ordinary people, both middle-class and working-class, began to feel that the War was against their interests—something thrust upon them from above and not of their own making, something which could not end in their good. People began to recall the fierce stamping out of their pre-War revolutionary movement, and to make new, strong demands for change.

Suddenly the Russian will to go on with the War broke down. Sailors in the navy mutinied. Soldiers began to stream away from the firing-line. Workers in munition factories went on strike. Politicians had to tell the Tsar what was happening. Incapable of taking charge of events, or even of understanding them, he gave up his throne. For a short period a new Government was able to pump up again the war-energies of the Russian armies, but, after a few troubled months, a second revolution took place. The Bolsheviks seized power in the name and the interests of the working-classes. Abandoning the War, they tried to rescue Russia from the chaos into which she had been plunged, and to make out of the old Russia a new and better country. The transport system had broken down. There were wretchedness and starvation everywhere. The cry for peace and bread was made with overwhelming force, and it was this demand which Lenin and the Soviets, or Councils, of Workers and Soldiers first set themselves to satisfy. Their further aim was to bring about complete Socialism in Russia. But so hopeless was the confusion in Russia that the Bolsheviks had to begin almost from the beginning the rebuilding of Russian life. They seized the property of rich people. They took over the banks, the factories, foreign trade, grain supplies in the peasants' barns—everything that would enable them to satisfy the



Fig. 83. MEN AND WOMEN FROM ALL RUSSIA FILING PAST LENIN'S TOMB
IN MOSCOW

demand for bread and peace and enable them to establish a new way of life in Russia. They made peace with Germany, at a high price in gold and territory. Then Russia's former allies turned upon her. Anti-revolutionary forces were collected: the British sent an army, the Japanese attacked at the other extreme of Russia, European Russia was blockaded, Polish troops invaded the neighbouring Russian territories. This nightmare of violence was over by the end of 1920, and Russia was at last able to set her hand to the urgent tasks of peace. War and revolution, counter-revolution, foreign invasion, blockade—in the wake of these came famine and pestilence. No people's leader ever faced a harder task than that which confronted Lenin when at last he was able to tackle the problems of the new Russia. Disloyalty, greed, incompetence, bitter hatred, faced him on every side. He had to build up a new system of life and government, and drive people, by whatever force he could command, to accept it.

So world-shaking an event was the Russian Revolution which took place during the War itself that we are inclined to forget the others. But they make a very imposing list, and they have happened in the Far East as well as in Europe. In China a revolution took place in 1911, and the rule of the emperors was replaced by a republic. Dynasties had disappeared in China before, but this time there were new forces at work. China had begun to learn from the West. Though no one can pretend that China has yet mastered the secrets of firm government, the Chinese revolution clearly showed that old ideas had passed away and new ambitions had been born. The greatest of the Chinese revolutionaries, Dr. Sun-Yat-Sen, led a body of followers whose outlook was modern and Socialistic. As China is reproducing all the evils of early Western industrialism—child labour, long hours of toil for the lowest wages, vile housing—and adding them to the crude poverty and unhealthiness of the old order, it is not surprising that a labour movement is springing up, and that many among the students and workers are inspired by Bolshevik Russia to hope for further revolutionary changes.

REVOLUTIONS IN EUROPE

In Europe a whole crop of revolutions was harvested immediately upon the ending of the War. The Governments which existed in most European countries before 1914 were not organised to make the lives of ordinary people happy : they were instruments of military power. They were old-fashioned tyrannies, and they lived in fear of each other. In days to come historians will take pains to show how these Governments were out of touch with what people were feeling and thinking, unable to understand why people were increasingly coming to resent the existence side by side of great wealth and great poverty. Where these Governments showed themselves unable to achieve success even in war, in which they had made their greatest efforts, there seemed to be no particular reason why they should be allowed to continue to exist. In fact, they were just kicked out.

What happened in Germany in 1918? The German defeat could no longer be hidden ; the Allied blockade had been successful and the German people were starving and hating the rulers who had brought it on them. As a last desperate gambler's throw, the German fleet was ordered to attack the British. It mutinied. From the military front the armies began to melt away. There were strikes in munition works. With the Russian Revolution as inspiration, the people demanded the Kaiser's surrender of the throne. He scuttled away to exile in Holland. A republic was established, challenged for a time by those who wished to build up a new Germany on the Russian model, and then by those who wished to supplant the workers by representatives of the old order of army officers and civil officials, but able to hold its own through the loyalty of the organised trade union workers. A brief effort to establish Communism was brutally smashed, and the new republic was strongly entrenched in power.

What happened in Austria-Hungary? As early as October 1916 the Austrian Premier was murdered. The same round of events followed : strikes, mutinies, the

hoisting of the red flag. Soon Austria was split up into a series of warring groups. The Treaty of Versailles confirmed most of them. The Poles set up a new independent State, with their old capital, Warsaw : the Czechs broke away, and other nationalities followed. Soldiers' and Workers' Councils were rapidly set up, and Austria-Hungary, in its various parts, began to look very like Russia. Vienna was starving. A Communist Government was set up in Hungary, and then thrown down. White terror succeeded to Red terror, until, weary of torturings and slaughters, a group of separate "Succession States" replaced the old military empire of Austria-Hungary.

And in Italy? Alone among the victors of the Great War, Italy carried through a revolution. For Italy, a great victory in 1918 wiped out the disgrace of a heavy defeat the year before. Gaining considerably by the peace treaty, Italy was suffering all the same from the distresses of the War. Civil war threatened between Government supporters and those who resented the shortage of food and other necessaries. Prices were high, and mounting higher. Strikes were organised : workers seized factories : peasants rebelled against their landlords. A new armed force, called Fascists, was organised by Mussolini to check the aims of Communists, and conflicts were frequent. Finally the Fascists marched on Rome, and the King of Italy accepted Mussolini as Premier. The Fascists were established as the rulers of Italy, and they set to work to reorganise Italy. They have established there a strong Government, refusing to allow any influence to different views, and just as much a tyranny as that of the Bolsheviks in Russia.

And in Spain? Here the oppressors were mainly King and Church. Various generals had nearly got absolute power, but none were as competent as Mussolini, though they tried to imitate him. The revolution was essentially made by the young and intelligent against the old and prejudiced ; those who carried it out were largely undergraduates ; they turned out the Court and the monasteries with hardly any bloodshed, gave women the vote, and are putting through all kinds of reforms, especially in the

schools, which had been particularly bad before the revolution.

REVOLUTIONS IN ASIA

Not alone in Europe have these violent changes taken place. Asia has been as full of trouble as the West, and in Turkey, Persia, and Afghanistan startling changes have been brought about. A new Turkey was established under Mustapha Kemal, with its headquarters at Angora, again a republic. The oldest habits were abolished: women ceased to veil their faces, men to accumulate wives. The slumber of centuries was over, and a new era of Western efficiency was opened. In Persia the same process of shaking off foreign power took place, and the old weakness and corruption began to disappear. In Afghanistan the escape from foreign influence was begun, but the introduction of the Western ways of life was pushed on so rapidly that a revolution broke out to check it.

Meanwhile Palestine had been restored to the Jews as a national home, and they began to develop new self-governing communities there. In India, movements which aimed at complete independence of Britain had gained in strength, and others had taken shape which asked for self-government, with or without the same kind of independence as the British Dominions enjoy (see *Peoples of the World*, p. 591). Riots, boycotts—the way of violence is found there too. Again, in these latest months, war storms have broken over Japan and China. The area of conflict at first was Manchuria. The struggle was then transferred to Shanghai, where bitter and destructive fighting has shown the East divided as deeply as the West, and seeking a solution in violence on the best Western model.

NEW KINDS OF GOVERNMENT

No series of changes has been more striking in the last thirty years than this destruction, in Europe and outside, of old systems of government. France and her Emperor

Napoleon III had suffered the bitterness of defeat in the war with Germany in 1870 : it was not surprising that the republican form of government was adopted again in consequence. But between 1870 and 1917 the only new republic established in Europe was that of Portugal in 1910. Until 1917 the Governments of Europe kept their authority ; since then monarchies have been overthrown in Europe and in Asia in a way that has known no parallel in history. In Russia, Germany, and Austria-Hungary the monarchs were driven from their thrones. In Italy the King retained his throne, but the real ruler was Mussolini. In Czecho-Slovakia—a new State, carved with half a dozen others out of the old Austria-Hungary—a republic was established under the enlightened guidance of one of the great personalities of our day, President Mazaryk. Yugo-Slavia, which faces Italy across the Adriatic, is an exception, ruled by a King who is sovereign in fact as well as name. Greece parted with her royal family, and Venizelos, for a whole generation her strong leader, was the architect of the Greek Republic. Poland, divided up a century and a half ago between Russia, Germany, and Austria, the defeated Powers in the Great War, has been reconstructed as one independent State, and under her ex-Socialist dictator, General Pilsudski, has become a new storm-centre for Europe. Ireland has been divided into two parts, Northern Ireland and the Irish Free State, the latter of which has passed into the control of its republican party this spring. The old systems of government have disappeared in Asia, too, as we have seen. So the story goes on. Let us sum it up by saying that in the greater part of Europe and Asia monarchies have been overthrown, peoples have been delivered from rulers whom they hated, and an altogether new kind of State has been established in the Union of Socialist Soviet Republics in Russia. All over the world, though least of all in the case of the victorious Powers in the Great War, new experiments in government have been made, usually attempts to achieve the sovereignty of the people (see Fig. 86).

This catalogue is far from complete, yet it serves to

prove that ours is an age of violence ; that the twentieth century, so far as it has gone, has been a dark age of strife. And in all this catalogue scarcely a mention has been made of the conflicts of peace-time. When war is not afoot, there is almost unceasing industrial war. Labourers demand more wages : employers refuse. Employers demand that wages be lowered : labourers refuse. In all countries this happens. In England these industrial disputes are conducted peacefully ; even the General Strike of 1926 was very orderly. In the United States and some other countries, strikes and lock-outs have sometimes led to fighting. But that sort of violence is occasional in disputes between employers and workpeople. What matters is that there is constant friction in industry in every part of the world. That friction causes suffering and waste. It shows that industry is badly run, whether employers or workpeople are to blame.

WAR : WHY ?

But it is necessary to try to discover the meaning of these things. Let us start with the wars.

What is the explanation of all these wars ? Have they a common cause ? If we read the speeches made by the leaders of the nations which took part in them, we shall not get very near to understanding why they took place. All of them assure us that their cause is right and that God is on their side ; all with one voice claim that the enemy was the attacker. Clearly we must get below what people said and find out what they intended, and by what forces they were moved. No one enters upon a war lightly, and people do not always know the reasons for less serious actions than war. It is safe to say that none of these wars was due to the wickedness of any individual—German Kaiser, or Russian Tsar, or Boer President, or Balkan King, or French Foreign Minister, or English Prime Minister. When English politicians in 1918 invited the English electors in the General Election to hang the Kaiser, they were proposing an action no more sensible than some

old tyrant's execution of a messenger because he brought bad news. The leaders of the nations that went to war in these last thirty years were expressing in their actions the forces that brought war about. Those forces are best described as nationalism and the quest for power.

When we were soldiers in the so-called Great War, some of us asked ourselves what we were fighting for. Working-men had bluntly asked lots of people, who tried to explain to them what the War was about, what difference it would make to them if the Germans won. They brushed aside the easy answer that they would have to pay more taxes, and all that sort of thing, as being quite unreal. There is a passage in a book which has helped a great many people to see these things clearly : ask your father if he thinks it true : " When a man dies for his country, what does he die for ? The reader in his chair thinks of the size and climate, the history and population, of some region in the atlas, and explains the action of the patriot by his relation to all these things. But what seems to happen in the crisis of battle is not the logical building up or analysing of the idea of one's country. . . . What comes to him [the soldier] in his final charge ? Perhaps the row of pollard-elms behind his birthplace. . . . If he is an Italian, it may be the name, the musical syllables, of Italia. If he is a Frenchman, it may be the marble figure of France with her broken sword, as he saw it in the market-square of his native town, or the maddening pulse of the 'Marseillaise.' Romans have died for a bronze eagle on a wreathed staff, Englishmen for a flag, Scotchmen for the sound of the pipes " (Graham Wallas, *Human Nature in Politics*, p. 72). And there are plenty of real examples to confirm these imaginary ones. " Last of the Cardigans ! " shouted a leader of the Light Brigade as he charged to his death in the Crimean War. " Here's for Sheffield Wednesday ! " was an English Tommy's cry as he went over the top in the cold dawn of a French morning in 1917. One writes of England, France, Germany. . . . But what *do* those words mean ? They mean areas on the map, certainly. They mean units of Government, equally certainly. They mean bunches of people,

pretty much alike in behaviour and beliefs. But the term England and the term English people are not quite the same thing. By England we mean the place, so marked on the world's map : we mean the behaving or living of English people in an English way. So, when we say that England made war upon Germany, we mean that the English Government, backed by the English people, made war upon the German Government, backed by the German people. All sorts of people in all sorts of ways tried to make English men and women hate German men and women, and they had a certain amount of success. There were folk who called German soldiers "Huns," but there were few of them to be found in the trenches, where German soldiers were usually called "Fritz" or "Jerry," because human feelings were more usual than these artificial pumped-up feelings. The armies in the War fought each other, not because individuals in them hated each other, but because of the strength of nationalism. Nationalism is an idea which is capable of being so used that it leads Governments to make war upon neighbouring Governments.

If we ask, then, What is nationalism? we get a funny sort of answer. To an Englishman it is being English; to a Welshman being Welsh; to a Frenchman being French. All peoples, sooner or later, develop this feeling, though they do not all express it in the same way. Some day it may be as little capable of being made an impulse towards war as it is now between the countries called England and Wales. It seems reasonable that there should be football contests between the chosen English and Welsh experts, but not that there should be wars of nationalism (see *Peoples of the World*, p. 585, *Problems and Solutions*, p. 719).

Nationalism as a war-making force has been alive for a long period (see *Peoples of the World*, p. 586). Especially in more recent history it has led to the division of Europe into a series of armed camps. When Germany was being moulded into a single empire through the "blood and iron" policy of Bismarck, it had trampled on Austria and France in the process. Austria had been won back to friendship, but

France had become an undying enemy. French pride had been wounded: French people longed for revenge: the power of Germany seemed to threaten French security. So she made alliances with other countries. Germany did the same. The two sets of allies added armaments to armaments. Peace was kept between the two opposing groups with the greatest difficulty. Actually it lasted between 1870 and 1914, but it was surprising that it did.

It is hard to believe that nationalism alone would have produced war, all the same. But behind the force of nationalism went another force, the quest for power. This took two forms. One was imperialism, the ambition to master other areas and other peoples so that they may be made to yield up their wealth. The other was the use of all the powers of the State to strengthen industry, to secure markets, and shut foreign competitors out of the home and colonial trade. Nations followed a policy of protection or economic nationalism, as it is called.

The best example of imperialism is what is called "the scramble for Africa." Before 1870, most of the interior of Africa was undiscovered land: now it is all parcelled out between the European Powers. England, France, Belgium, Germany, Portugal, Spain, Italy, have all secured colonies in Africa. They have done this for all sorts of reasons—to gain prestige, to add to their wealth, to enlarge their armies by adding to them trained native soldiers, to break up the slave trade. But the strongest motive has been to get more wealth. They have sought areas rich in minerals, or areas where necessary tropical products grow, such as rubber. They have valued these areas, with their teeming native populations, as markets for their manufacturers as well. Having got their colonies in Africa, they have often been guilty of almost unbelievable cruelties in the development of them. Gradually these cruelties have been reduced, and better treatment of the native peoples has resulted. In the same way as European nations built up empires in Africa, Japan absorbed Korea and is now getting a grip on Manchuria.

Economic nationalism is the ambition to make a nation as completely self-sufficient and independent of other

nations as possible. In the years after 1870, Germany, France, and the United States developed their industries very rapidly. At the same time steamships displaced the old sailing-vessels, and great transcontinental railways were opened in North America. It became possible to move anything to anywhere, and among the things which were moved were the wheat and meat (in refrigerator vessels) of America and Australasia. These were brought to Europe and sold more cheaply than European farmers could produce them. At the same time American and still more German manufacturers began to compete successfully with the British. At once people began to demand protection, both for agriculture and industry, against this competition. Except in Great Britain, this demand was at once successful, and Great Britain has followed the other nations this year (see *Economics*, p. 688). Protection has been given by fixing large duties on things which are brought into a country from abroad, so that these things will cost more than similar things produced at home. There are many other ways, too, in which the powers of the State have been used to preserve and enlarge a nation's trade. Both economic nationalism and imperialism make the rivalry of the nations of the world more intense, and so render it more difficult for peace to be preserved. Economic progress has been more rapid than political progress : it is time for the latter to catch up.

REVOLUTION : WHY ?

Let us turn now to the revolutions of the last thirty years. What can we say of them ? Always, when one talks about revolution, passions are excited. That is because in every revolution those who have power are stripped of their authority, and often killed as well. Revolution, that is, is a violent way of getting change brought about. People do not make revolutions for fun, or because they are wicked. They make them because they think there is no other way open to them to secure what they want. Feeling desperate, they face even the risk of death to end the thing they hate

and get control over the ways in which they live and work. Revolutions mean destruction, but not purposeless destruction. To understand them we must find out their purpose, and that purpose is to substitute a new Government, a new way of managing public affairs, for an old one that has grown unbearable.

It will help us to keep our tempers as we examine the revolutions of the last thirty years, if we remember that revolutions in the past have contributed a good deal to human progress. Quite conservative people, for example, can approve the career of Oliver Cromwell, the leader of the Puritan Revolution of the seventeenth century. One of the greatest nations of the world, the United States of America, was born of a successful revolution against British rule. There were people in the British Isles just before the War ready to encourage and take part in civil war in Ireland—to make a revolution, that is—in order to prevent new arrangements for the government of Ireland being carried into effect.

The revolutions that have been so frequent in the last thirty years have shown all sorts of differences of detail, but their general character has been pretty much the same. They all aim at simplifying life; they are an attempt to make behaviour square with knowledge. There is a big gap between the discovery of new truth, the acquiring of new knowledge, and the applying of it to the way we live our lives. For example, many old beliefs, religious or social, have decayed, but the practice which these beliefs forced upon people remains. To do away with the old practices in government and in economic and social life has been the purpose of these revolutions of the last thirty years. The sufferings of the War made people so impatient with the way things were run, and with the sort of lives they were compelled to lead, that they determined to make a break with the past and start again on new lines.

If we wish to see clearly the underlying meaning of the revolutions of the last thirty years, we must go back a hundred and forty years to the French Revolution. The aims of the French Revolutionaries were: "Liberty,

Equality, Fraternity." People wanted liberty from tyranny and misrule, and freedom to carry on their activities in the ways their common sense demanded. They were held in bondage by the privileges of the aristocracy and the Church and the gild and the family: they felt that they were not free to use their powers and opportunities to enrich their lives and to behave in worthy ways, because all kinds of old-established restrictions held them in check. They wanted equality before the law, the destruction of burdensome privileges which made life easy for some and desperately hard for others. They wanted fraternity, brotherliness in citizenship and social life. They did a great deal for liberty and equality by their revolution, and even something for fraternity—by ending slavery for a time, for example, in the French West Indian islands. That great revolutionary movement was a healthy and necessary movement. By means of it the French people not only destroyed worn-out and burdensome forms of government, but helped other peoples to do the same. During the nineteenth century they repeated their revolution; in 1830, 1848, and 1870 they overthrew Governments because they had become oppressive again, or inefficient, or unable to satisfy people's needs. At bottom these revolutions in France aimed at making the French people, at first the middle, and later the working-classes, masters of the French State. They made it clear to all whose eyes were open that the old ways of governing France were no longer acceptable. The people had knowledge, and they sought power. They wanted to sweep away the old worn-out habits of life and put new and better ways of living in their place. Those who held power would not give it up. They could not believe their day of power was over; they clung to it; they were swept aside, good people as well as bad, by the mastering force of the revolution. So we say that the French Revolution was brought about to make the French people masters of France.

Behind the revolutions of the present century there is the same purpose. In the case of Russia that purpose has been declared more fully than ever before. The Russian

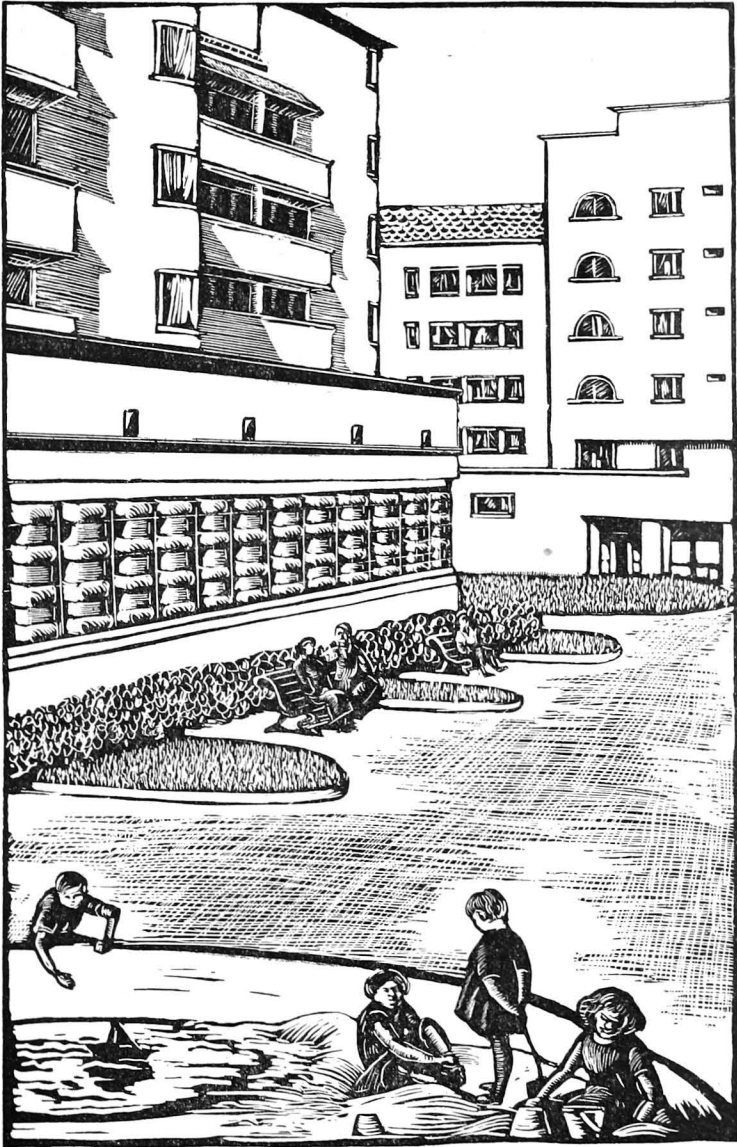


Fig. 84. NEW HOMES FOR THE WORKERS BUILT SINCE THE WAR BY THE CITY OF VIENNA

Communists, who really rule Russia, do not think it possible that any society can provide happy lives for its members unless all share, and share equally, in the means of living. There must be no poverty, no great riches, no oppression of the poor by the rich, no schools for the rich which the poor cannot attend, no ill-health which can be prevented, no idleness among rich or poor, no industries or trades save those which are owned by the people themselves, and worked for the people's advantage. The Communists, it is true, are a minority in the State. But as a governing party they have used their power to establish a working-class community (see *Problems and Solutions*, p. 713). They have, of course, made mistakes and committed cruelties. But the Russian people, for the first time in their history, are in charge, through the Communist Party, of their own lives, and they are showing great powers of will and great skill in organisation. They are re-making their old industries and building new ones. They are using the latest machinery and up-to-date methods in their agriculture. They have created a new kind of society, and they believe in it. More than any country in the world, they have reduced the gap between the discovery of new knowledge and its employment in new ways of living. And as they have got rid of rich people, using all their resources to make life bearable for humble folk, given women equality with men, abolished the privileges of great wealth and the power of great possessions, their example provides a living inspiration to the working classes of other countries and an unmistakable challenge to the defenders of the existing order in the rest of the world. To establish Socialism, as Russia has done, and to plan the whole country's economic life instead of leaving it to individuals to do as they will, is the road to happiness in some people's eyes : in others' it is the road to ruin. That is why the Russian Revolution is the most exciting adventure in the recent history of the world.

The Russian Revolution is different from the other revolutions which have been described because it has established a Socialist State. But the same forces were at work in Germany, Austria-Hungary, and Italy. The revolutions

that took place in these countries are a protest against war : they express the intention of people so to control affairs that they will not suffer again as they had to suffer during the War. Many revolutionaries in all these countries believed that the way to prevent the breakdown of the machinery of government was the Russian way, but up to the present (1932), at any rate, the example of the Bolsheviks has not been followed. Great changes have been effected all the same, and these changes have the purpose of destroying old evils and establishing new ways of living. It is important to notice that there have been revolutions in agricultural countries, where most people live by working on the land, as well as in industrial countries, where most people live by making things with machinery.

For centuries there has been a life-and-death struggle between the great and the humble in the world's countryside. You can find it in ancient Greece and Rome as well as in England and Germany in the Middle Ages. You can trace its history in Ireland, in Denmark and Norway, in Russia and Roumania. So, since the Great War, in eastern Europe the ancient landed estates of the aristocracy have been broken up by force and small peasant farms have been established in their place. The same kind of causes produced the Labourers' Revolts in England in 1830, the formation of farm labourers' trade unions in 1872, the Irish Land Acts of 1881 and 1885, the redistribution of land during the French Revolution in 1792, the nationalisation of the land in Hungary and Russia after the Great War, and a host of similar events in different ages and different countries. The great estates of the past have been breaking up in England as well as in other countries. It was a Conservative Minister of Agriculture, afterwards Viceroy of India, who described that post-War process as "a silent revolution." It sprang from Acts of Parliament and estate duties, which between them rendered the landlord's function on the land first unimportant, and then unprofitable. From slavery to the half-free state of serfdom ; from serfdom to freedom ; from freedom to control—that has been the progress of this unceasing struggle in the countryside.

But in our country, eighty out of every hundred people now live in towns, so the farmers and landowners are no longer a very influential class. In most other countries there are fewer towns, and more food is grown on the land, so things are different. We are inclined in England to undervalue the importance of the world's "Green Risings"—that is to say, peasant revolutions. But we are probably wrong.

What does this attempt to explain all these revolutions amount to? That in town and countryside alike men are inspired by a determination to control their own lives. All the revolutions of the last thirty years are links in a long chain of struggle. That struggle has been manifest in all sorts of times and places, but it has assumed a new importance in our century. In part that is the consequence of the War, and in part it is due to the new knowledge people have got. Education is spreading, and people communicate with each other much more than they used to. The steamships, motor-cars, and railways of the world, the wireless and the newspaper, the cable and the telegraph, have made the world into one big whole. People everywhere are striving to use their new knowledge and their new strength to improve their lives. They are handicapped in all sorts of ways, for example by the way they are governed, and above all by the wars in which their Governments force them to take part. Many of them believe that things could be improved, and revolutions are no more and no less than their attempt to secure that improvement. In the different countries of the world people have never thought alike so much as nowadays. The Indian student reads the writings of Edmund Burke: there are Chinese translations of Huxley's *Essays on Evolution* and Mill's *On Liberty*: there are French and English versions of the writings of Karl Marx and Lenin. There are always individuals from whom "dangerous thoughts" about the emancipation of men and women can radiate. Anyone can see, as well as read about, the contrast between the rich, with their resources of property, and the poor, who, whether labourers or clerks, have only their labour to sell.

So the yearning for another kind of social and political system becomes irresistible, and leads to revolution when improvement is stubbornly refused, when times are specially bad, and when failure in war throws discredit on those who govern and suffering on those who are governed.

INDUSTRIAL STRIFE

Wars and revolutions have been examined. There remains to be explained the industrial strife which is so conspicuous a feature of the age in which we live. In several countries general strikes have taken place such as that which occurred in this country in 1926, and strikes and lock-outs in particular industries go on unceasingly. These show that there are defects in the system by which we get the goods and services we require (see *Economics*, p. 663). Industry, like the political system of the world, presents all too often the appearance of two armed camps, employers on the one side and workers on the other. Let us try to get some idea of what industrialism is, and why it should lead to this sort of thing.

Industrial strife is especially marked in the countries in which big industries and wide foreign trade have been built up. In these countries, the sort of civilisation that exists is described as industrialism. Industrialism means that power-driven machinery is very extensively employed in making the things people require. This machinery is used in factories, which are manned by wage-earners who are employed through their managers by the factory-owners (see *Economics*, p. 651). In this sort of system few people make complete things or work alone; most people make parts of things, or do particular jobs which are organised so as to render the whole series a complete whole. There have been vast gains in wealth and power as the result of this increased use of machinery and the more intricate organisation, and people work shorter hours, live better and longer and healthier lives, and have far more enjoyments. But there are disadvantages as well as gains

which come from industrialism. The making of things is carried through in expectation that the things will be bought. But that calculation may go wrong. If it does, there will have been waste, and the further making of these things will be stopped. The workers who would have earned wages for their work in making them will then be unemployed. One of the outstanding consequences of industrialism is that the insecurity of the worker's life has been increased by it. As the cost of labour is, usually, the heaviest of the manufacturer's costs, he tries to reduce it. This he does by substituting machinery for labour, or by reducing wages, or by closing his factory, when it seems advisable in the interests of his business. Working men resent the loss of employment and the reduction of wages. They resist them. By trade union action and in other ways they try to increase their control of the industrial system so that their lives will be more secure. Many of them believe that the system of industry which prevails, where employers work for their own profit and their workpeople have to accept the consequences of their failure or success, is an unwise as well as an unjust system. Whether they are right or wrong, there is a great deal of friction in industry, and the more so as industrialism spreads over the world.

Industrialism rests upon the competition of employers for markets in which to sell their products. The employers of the different countries of the world are ceaselessly struggling for them one with another. While they have sometimes made agreements by which markets are assigned to particular business firms, as in shipping, usually there are no such agreements. Trade being world-wide, disturbance in any part of the world affects it. At the present time, for all sorts of reasons trade is in a thoroughly bad way. In consequence, employers and workers alike are suffering. Increasingly they call upon their Governments to give them help, and the Governments have responded in the ways they have thought fit. To employers they have given such help as subsidies and tariffs; to workpeople, social services, such as old age pensions and insurance against loss of health and employment, which amount to



Fig. 85. STARVING UNEMPLOYED QUEUE UP OUTSIDE THE SOUP KITCHEN RUN BY AL CAPONE, THE GANGSTER, IN CHICAGO

a *social* wage additional to the wage they receive, when employed, in their weekly wage-packet (see *Economics*, p. 668). In all sorts of ways, Governments are called upon to take a big part in economic life to-day under industrialism. They do much for both employers and employed, for example, in Germany and England, but in the United States unemployed workpeople have to depend on charity, because there is no system of unemployment insurance there. At present industrialism seems to have reached a sort of half-way house between the unplanned system, the system of individual enterprise which used to prevail, and the planned system which has been established in Russia. But capitalism at the present time is working badly. This is because it does not permit easily the making of international agreements about such things as money, and the improvement of the laws of property so that people can share more equally in the great advances in wealth which science has made possible. Hence the friction of industrialism and its poor record, both among individuals and among nations, in distributing wealth are making people dissatisfied with it.

WHAT WE CAN HOPE

So, as we look over our age of violence, we find all kinds of forces at work. We cannot foresee the future, but we know that change, the working out of these forces, is bound to come. It may be that the old supremacy of Europe is coming to an end. It may be that in the coming years Japan or Russia or the United States will be the world's leader. No one can be certain. Yet in the last thirty years man's power over nature has been vastly enlarged; man's hatred of war has been strengthened; many nations have raised themselves in efficiency and in the esteem of their fellows. If the poor nations are being enriched, if the strong nations are deepening their wisdom, if the real unity of the world is being realised and is about to be more fully organised, there can be no room for gloomy thoughts about the future. And, as civilisation itself is still very

young, there is a big field for hope. That hope will be turned to achievement if people everywhere are enabled to make their full contribution to man's common life. From new knowledge to new behaviour—that is the motto of the next thirty years, born in the throes of the violence of the first third of the twentieth century.

BOOKS TO READ

The best explanation of economic and social change is H. G. Wells's new book *The Work, Wealth, and Happiness of Mankind*. A useful survey of post-War history is C. Delisle Burns' *Short History of the World, 1918–1928*, and of pre-War history G. Lowes Dickinson's *The International Anarchy*. P. T. Moon's *Imperialism and World Politics*, and H. Kohn's *History of Nationalism in the East*, deal with necessary subjects in a clear-headed way. But these are all long, grown-up books. Good short books are hard to find.

The best thing to do to get to know more about the subjects dealt with in this chapter is to read something about each of the leading countries. Most books are written for adults, of course, but you would find the following interesting, or at any rate parts of them :

- R. H. GRETTON : *A Modern History of the English People* (Vol. III., 1910–1922).
- F. L. ALLEN : *Only Yesterday* (about U.S.A.).
- M. HINDUS : *Red Bread*.
- M. ILIN : *Moscow has a Plan*. } (about Russia).
- A. NEVEROV : *Tashkent*. }
- C. DELISLE BURNS : *Modern Civilisation on Trial*.
- P. COHEN PORTHEIM : *England the Unknown Isle* (a foreigner's view).
- PEARL S. BUCK : *The Good Earth* (about China ; a novel).
- E. M. FORSTER : *The Passage to India* (a novel).
- RUDYARD KIPLING : *Kim*.
- JOSEPH CONRAD : *Heart of Darkness* (a short story about imperialism, in *Youth*).

Working Days, edited by MARGARET POLLOCK (how people live).

You would find some of the pamphlets issued by the B.B.C. in connection with their recent series of talks on *The Changing World* useful, if you could get them explained to you. These only cost 4d. each. The weekly issues of *The Listener*, too, are very helpful. There are interesting articles about all parts of the world, amply illustrated, in the *National Geographic Magazine* (American). But the best advice I can give is to look over the numbers of the *Graphic* and the *Illustrated London News* of past years.

It is possible to learn a lot from films, if you can get the opportunity of seeing the right ones. Among the best are these: *Kameradschaft* (for industrialism and nationalism), *White Shadows of the South Seas*, *Tabu*, and *Trader Horn* (for imperialism), *War is Hell* (for the Great War), *The Fall of St. Petersburg* (for the Russian Revolution), *Turksib* (the Turkestan-Siberian railway), and *The General Line* (for the reconstruction of Russia after the Revolution).

Lives of some of the world's leaders are useful, too. They are not written for boys and girls as a rule, and, if they are, they are so sloppy as to be positively misleading. Your father and mother might tell you the leading facts in the lives of such men as Mussolini, Mustapha Kemal, Lenin, Venizelos, Mazaryk, Pilsudski, and others.

THE PEOPLES OF THE WORLD
OR
NATIONALISM AND INTERNATIONALISM
by
C. DELISLE BURNS



C. DELISLE BURNS is half Scots and half French, and when he was a boy he lived in the West Indies, sailing a boat and running about on hot, sunny beaches. After that he went to Cambridge, and later to Italy, where he worked at history and archæology, and rode a one-eyed horse about the hills round Rome. He has travelled all about Europe, and has been to America six times. He has been all over England, too, lecturing. He was one of the people who helped to start the International Labour Office, which is one of the parts of the League of Nations which really works well, and which he will tell you something about here. He is on the Executive Committee of the League of Nations Union, and he broadcasts a lot, so you have very likely heard him. He has two sons.

THE PEOPLES OF THE WORLD

MANKIND ONE FAMILY

FOR BREAKFAST we use tea from India or China, or coffee from Brazil, Java, or East Africa. We eat fruit which comes from Spain or California : and the milk we drink, which comes from local cows, is provided in winter by feeding the cows with cow-cake made of beans from China or of seeds from Africa. Many of the peoples of the world contribute to supply us with breakfast : and the money we pay to them for it is used by them to buy gramophones and sewing-machines and motor-cars, which people in our country make. The other peoples of the world, then, who dwell far from us and would not understand our language if they met us, send us the things we eat and drink. But tea and coffee are only leaves and beans. The funny thing about them is the way we use them ; and we did not invent for ourselves the idea of using them with boiling water. The Chinese and the South Americans gave us the ideas as well as the leaves and the beans. Indeed, there are very few ideas about food and clothing which have come into use without being somehow affected by what foreigners think. Customs of civilised life, as well as food and clothing, are international : for as a Swedish poet has said, " Nothing is truly national, except barbarism."

The countries of the world should not be thought of as patches on a map, nor as bits of land, but as men and women and children with different languages, religions, and customs, but all alike in the way they are born and die, in the way they eat and sleep and work or play : for when we say, " England, arise ! " or " Scotland for ever," we do not think of land, but of people. We ourselves are " our country " ; and every other country consists of people like ourselves in most things. All of them spend most of their lives in getting food and clothing and shelter ; and more of

these things can be obtained if people of different countries exchange what they can spare for what they want to use.

The peoples of the world have arrived at their present ways of living after many thousand years of effort. The history of men in very early times shows them without our tools and food and clothing, and, above all, without any security from famine or disease from year to year. Different groups of men made experiments ; and discovery and invention, both in new tools and in new ways of treating one another, have made our lives what they now are. But the past was not of the same kind for all the different peoples of the world. Some have been continually worried by wars against their neighbours ; some have lived for centuries untroubled. So the customs and beliefs which are common to-day in any country or among any people are not fixed and eternal, but merely ways of living produced by past experiences, which are now changing into new ways. The ways of life and characters of the peoples of the world at present, then, are changed from day to day by harvests or storms or the changes of the seasons : but they can also be altered by the peoples themselves. We ourselves can make the world of men different from what it now is. The relations between the peoples can be directed by our will, if we know enough, as we can direct electricity to our uses ; and, for the purpose of making all people happier, we must know what sort of lives they now live.

In every country in the world there are a few rich and powerful people, and thousands of others who have little more than bare needs in food and shelter, who are dependent for that little upon the goodwill of the few rich. In India, for example, there are rich princes whose subjects have hardly enough to eat. In China there are a few rich merchants and millions of half-starved peasants. In Europe and America the contrasts are not so crude, because there are various levels of " middle class " between the rich and the poor : but in Europe and America too the great majority have only a very small share of the benefits of civilised life. This is nothing new. In Assyria and Egypt, before England was discovered by civilised traders, the majority lived upon

a little and the very few had much (see *Organisation of Society*, p. 505). In this matter the peoples of the world have made hardly any progress—if progress consists in more comradeship or more equal sharing of what is good. But in most countries the poor admire the rich and powerful, and anyone who is poor, and can manage to escape, does so as quickly as possible, and joins the rich, leaving the rest as they were. This makes every separate nation hold together—rich and poor and middling—against every other. The poor of one country generally dislike the poor of another—when they think of them at all—much more than they dislike anyone who speaks their language and wears a more expensive form of the dress they recognise. Some believe that the division of the peoples of the world into rich and poor—those who have most of the benefits of life in their country and those who have only enough to work with—is more important than the division into those who speak different languages and have different customs. But at present most people, rich or poor or middling, think the divisions by race and language more important. Let us look, then, first at these divisions.

RACES OF MANKIND

The most general division of mankind is made by contrasting the colours of their skins and the shapes of their features. If we do that, we divide the peoples into different “races”—such as the European, the Semitic, the Mongolian, the Malay, the Negroid. Pictures of people of these different races are given in many books, and so we need not describe them here. The importance of the distinction between races, for our purpose, is that people of one race seem generally to dislike people of another race, or at least to feel uncomfortable about them. Many white people look down on negroes because they have black skins; but why black should be worse than white it is difficult to see. Malays and some Mongolians are called “yellow” by some white people; and their slanting eyes are supposed to be

peculiar. Europeans call themselves "white" races, although their skins are of any shade from light pink to dark brown. Mixtures occur in some places, where a white person and a black or a yellow are the parents; but these children of mixed blood or mixed race are generally excluded from the companionship of both the races of the two parents. Half-castes, as they are called, are then supposed to have something wrong about them. Colour of skin and shape of features give rise to so many prejudices and so much fear of what is strange, that "race" differences sometimes lead to murder or riot or oppression or hate; and books are written to show that the hostility to what is strange is excellent, if it is felt by "us." A whole library of books has shown that people called "Nordics"—who are relatives of the authors of the books—are very fine fellows. There is hardly anyone in the world who does not believe that the people he "belongs to" consists of very fine fellows. Perhaps everyone is right: the trouble is that nobody thinks anyone else is right (see *Problems and Solutions*, p. 706).

DIFFERENT CIVILISATIONS

There is no denying that people in different countries differ very strikingly in dress and speech. To say "Yes" is much the same as saying "Ja" among the Germans and "Oui" among the French and "Si" among the Italians; and there are a thousand other ways of saying "Yes" which you can discover for yourselves. But the different ways of saying the same thing are important. Manners also differ. We shake hands for greeting or to say good-bye; but the Chinese gentleman shakes his own hand to show that he wishes you well. In European countries men wear trousers; in Asiatic countries women do; and it would be silly to suppose that what we do in our country all other peoples ought to do in other countries. It would be silly because, although countries are peoples and not patches of land, the land in which any people live makes a

very great difference to what they have to do to keep warm and to get food. So we may discuss the differences between peoples by thinking of the different ways in which people live in different parts of the world.

The different ways of living are partly due to climate, partly to the sort of land people live in, partly to the customs they have inherited or are working out for themselves. Climate makes a difference to the food and clothing which is common among any people. The sort of land one inhabits may be near the sea, or mountainous, or good for agriculture, or supplied with minerals under the surface : and so peoples take to trade overseas, or they rear sheep on mountains, or they grow cotton or wheat or rice, or they dig for coal, iron, or diamonds. And customs vary because among some peoples women are useful as field-workers and in others as domestic workers. Some peoples have learned priests to guide them ; and among some peoples it has very recently become common to read and write. But most people in every country neither know nor care how anyone else lives in other countries.

DIFFERENCES IN THE WAYS OF LIVING

The ways in which people live are dependent upon the amount and the security of their food-supplies and other needs : for our way of living, in order to have regular food of the kind we like, we have to be in contact with thousands of different peoples in many different parts of the world. We have therefore to use elaborate machinery for production and transport, and to maintain a very complex set of institutions, such as banks and Government offices. But for simpler ways of living, less is needed : and the very simplest ways of living are those from which all of us began (see *Organisation of Society in the Past*, p. 498).

Some peoples are living now in ways like those our ancestors followed two thousand or more years ago. In tropical Africa, in Polynesia, and in parts of India, people live upon very little, and even that supply is insecure. They are in

small groups in villages, hardly communicating with the rest of the world, practising old traditions and haunted by old fears. But some of these people have been influenced by traders and missionaries and administrators from Europe, because Europeans wanted the rubber or oil-seeds or other products from the lands where the simple peoples live.

Other peoples have a skilled agriculture and traditional crafts—pottery, smith's work, building, and so on. These are living as our ancestors did in Europe between about A.D. 800 and A.D. 1400. They have a cultured aristocracy, trained in a literary tradition : they practise inherited customs, and are unwilling to make changes in their social relationships or their methods of production. The chief examples of this sort of life are in China and India ; but the same sort of life is found in part of Asia and North Africa, and, until recently, it was the commonest kind of life in Russia.

The peoples who use power-machinery, or who are dependent upon those among them using such machinery, are regarded as " modern." These are all the European peoples, both in Europe itself and in America, South Africa, and Australasia. Power-machinery makes a very great difference in ways of living, because steam and oil and electricity replace the muscles of men and animals as motive forces, and these new motive forces can be used to work machinery much too large to be moved by muscle. The power-machine is to steam or oil or electricity what the hand-tool and the plough were to arms and legs. The aeroplane is only a tool, like a chisel ; but it is a tool for oil to use, not for a man's muscles to move.

DIFFERENCES OF RELIGION

But the way in which people live is only in part dependent upon their power to get supplies. It is also affected by traditional ways of looking at what happens to them—the changes of season and birth and death. And all peoples have ceremonies or ways of celebrating what seems important, such as marriages or funerals. Thus the peoples of the

world may be distinguished by their religious or traditional social customs. Most of the peoples in the world belong to one of the three great religions—Christianity, Mohammedanism, and Hinduism. In most European countries, in America, and in western Asia the Hebrew religion is maintained by the Jews, and there are also Confucianism in China, Shintoism in Japan, Buddhism in parts of China and in Burma, and various forms of fetichism in Africa. Hinduism is confined to parts of India: but Mohammedanism, or Islam, is spread in India, Persia, the Dutch Indies, throughout western Asia and northern Africa: and Christianity in its many, sometimes opposed, forms is to be found chiefly in Europe and America. The most powerful international form of Christianity is Roman Catholicism, which unites the peoples of southern and central Europe and South America, besides including the people of Ireland, most of France, and many in the United States and Canada. Distinctions of religion sometimes lead to violent struggles between people, as in India, in Ireland, and in Arabia. But even religion does not divide men nowadays so strongly as the belief that the “nation” is the most important fact about the relationship of any group of men to other men.

THE NATIONS OF THE WORLD

The races of the world are each divided into many “nations.” The word “nation” is used in many different senses in different books; but generally a “nation” means a group of men, women, and children with a distinct common language, common traditional customs in daily life, common ideas of what is the best sort of life and the finest sort of person, and, above all, a common tradition of past distress or past victories expressed in the local histories. Perhaps a “nation” also has a separate country or piece of land of its own, with mountains or sea-coast or plains for which its people feel affection. We agree that the English, the French, the Germans, the Italians, and the Japanese

are distinct "nations"; although it is disputed that the Indians are a "nation," and it is difficult to call the different distinct groups in tropical Africa "nations." The words "nation" and "nationality" must remain, therefore, a little ambiguous; but the most obvious distinction between peoples to-day is that they belong to different "nations."

This distinction, however, cannot be understood unless we know something about the way in which it came to be thought important. The fact that any group of people living together share a common language, and usually also common ideas about the sort of life best worth living—this fact was not felt to be important until the *differences* between two or more such groups, in language and in ideals, began to be noticed. Nationality thus became important when people with different languages were brought into contact, that is, in Europe about five hundred years ago. Before that time a few travellers and traders did, indeed, pass from one country to another; but the few who could read and write used one common language—Latin—in all the countries of Europe; and the majority of any "nation" did not then depend, as they now depend, upon people of other nations for food and clothing. But the kings of different districts or countries in Europe five hundred years ago, then first called "sovereigns," were opposed to one another; and each wanted support from the people he ruled. It "paid" the ruler to emphasise the distinction between his people and others. Also each people began at that time to value its own language, for literatures in the "vulgar tongues" had grown up; and foreigners were felt to be ignorant of the excellence of one's own language.

Then came a period, about a century ago, when the peoples began to claim control over the Governments under which they lived: and some peoples, as nations, took over the powers and the rivalries that the kings used to have. From the time of the French Revolution, in Europe first and now in all the world, more and more peoples have claimed to be "nations," with the right to have their own separate systems of government. Thus by a succession

of accidents the "nations" of the world have come to think that the distinctions between them are more important than the likenesses. The impulse or feeling which makes any group of people claiming to be a "nation" desire to have a separate Government of its own is called "nationalism." This nationalism is a result of European history; but it has now spread to Asia and Africa. This may lead to war and other evils, but nationalism is not altogether bad; for, by feeling the distinction between one's own way of living and that of others, one is led to see good features in one's own; and a "proper" pride is good. Again, it is good to feel one's fellowship with those whose language and ideas one shares. It is good also to share with others an affection for familiar things, such as the hills or the houses where one lives. This is the basis of patriotism; and anyone who has none of this, is like a plant uprooted. Upon "patriotism" and a common tradition nowadays most systems of government are based; and a system of government which is independent of all others is called a State, or a sovereign State.

The nations which based their systems of government upon this sense of patriotism, worked up into a belief in nationalism, were, first of all, England and France. Then, in the nineteenth century, Italy and Germany were made into separate States by the new nationalism. Then parts of the old Turkish Empire broke away and made themselves into national States; for example, Greece, Bulgaria, and Rumania: and since the Great War, in 1918, the same belief in nationalism has restored to Poland a separate government and has created new States, for example, Czechoslovakia and Esthonia (see *The Last Thirty Years*, p. 556 and the map of Europe, Fig. 86, p. 590).

The belief that every "nation" should have a separate government was, and perhaps still is, opposed to the belief that one nation, more advanced or more competent than others, should rule over some of these others. This second belief is modern imperialism. Nationalism in any nation easily becomes imperialism, because, when any nation wins its independence, some of its people feel that they are good

enough to rule other nations. But nowadays the great empires, in which people of one nation rule peoples not of that nation, are the results of past conquests. The two great empires of to-day are the British and the French. In each, the people of one European nation rule over millions of non-Europeans, most of whom perhaps do not yet feel themselves different enough from the nation that rules them to object to alien conquerors, so long as the alien rule is just and beneficial. Subject peoples under the great empires are, in general, living in the very simplest sort of way described above ; and the areas they inhabit are called "colonies." From the work of these peoples, in Asia and Africa, are drawn the raw materials—rubber, oil-seeds, oil—required for modern industry. The colonial areas are in the tropical and sub-tropical parts of the earth : and in most cases only a few Europeans, officials and traders, live there among great numbers of Africans or Asiatics.

Besides the British and the French Empires in Africa and Asia, there are colonial areas with subject peoples, in Africa, under the Portuguese and the Belgians, and, in the islands of the East Indies, under the Dutch. Colonial government in all cases is a sort of alien despotism, which may be better for the peoples living under it than the native despotisms which existed before. Many attempts have recently been made by all European peoples which control empires to improve the system of government in colonies. But the modern feeling against rule by people of a different race—a sort of nationalism—is spreading in all empires, especially where the subject races have an old native civilisation, as in British India, in the Dutch Indies, and in French Indo-China.

If we assume, however, that, in general, different independent systems of government or States roughly correspond to the differences between "nations," we may classify the peoples of the world by considering in order each of the chief States.

STATES OF THE WORLD

The States of the world at present are classed as (1) Great Powers and (2) Small States ; but there is also an intermediate group, including such countries as Poland and Brazil, which are neither " small " nor " great." The Great Powers are Great Britain, the United States, France, Germany, Italy, Russia, and Japan. Please look now at the picture showing the populations of the countries of the world (Fig. 87).

Great Britain is the official and international name for England, Scotland, Wales, and Northern Ireland. It is mainly industrial—that is to say, the greater part of the population is in towns and city areas, employed in manufacture. About a quarter of what was manufactured (reckoned in money value) used to be exported : that is to say, British people used to send to other people, engines and machinery, textiles and—what was not manufactured, coal. As the export trade was large and the British lived in islands, most shipping in the whole world was British. But now the whole situation is changing. Other nations manufacture for themselves, sometimes with the machinery sent from Great Britain—oil and electricity have replaced coal for some purposes, and the things which people use most in other countries are not the same as in the nineteenth century.

Great Britain is only a part of a sovereign State which is called either the British Commonwealth of Nations or the British Empire. The former phrase indicates that under the same king there are several British Governments, each equal to that of the Government of the United Kingdom of Great Britain and Northern Ireland. These parts of the Commonwealth are the Dominions—Canada, Australia, New Zealand, South Africa, and the Irish Free State. Most of these areas are agricultural : all except South Africa are inhabited chiefly by British and Irish, and each, except perhaps New Zealand, is now trying to set up industries for itself. In South Africa the majority of the inhabitants are Africans, mainly of the Bantu race : but

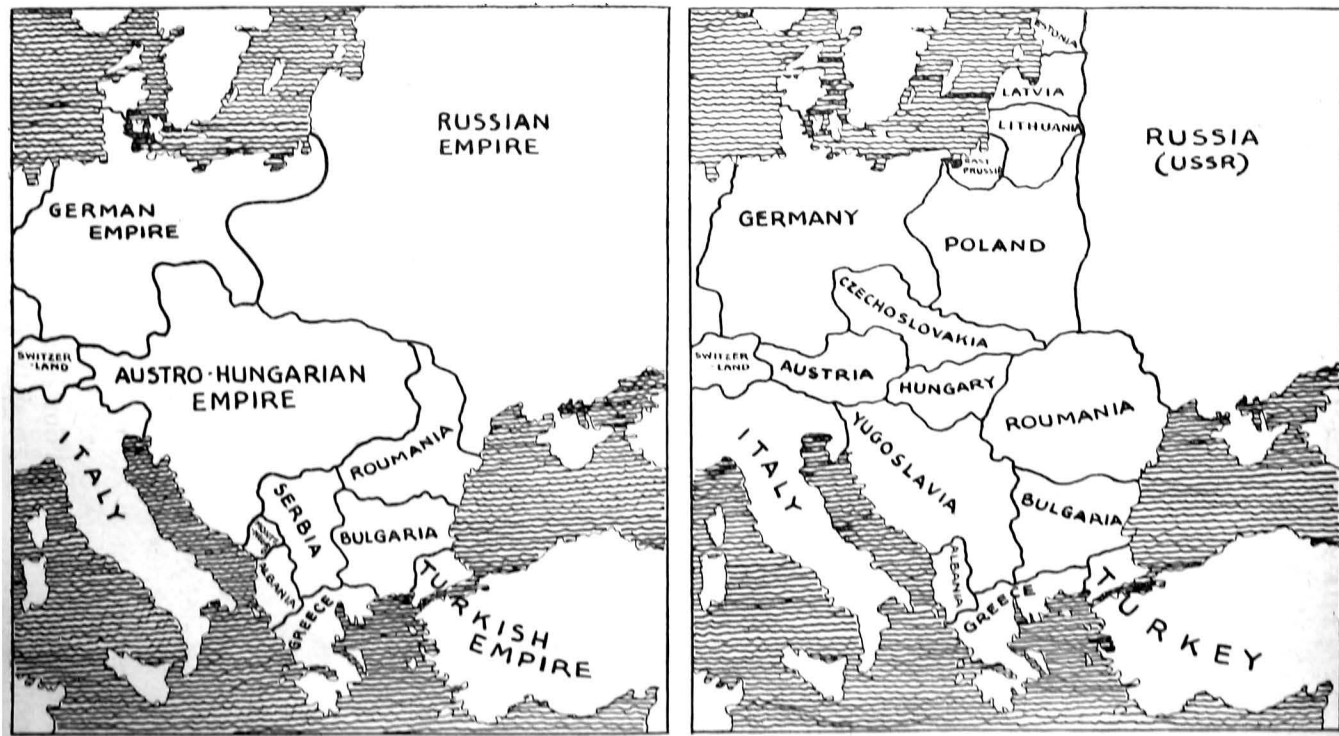


Fig. 80. Sketch map of Europe in 1914 and in 1925, showing how the great empires have broken up into smaller nationalities

the "white" population, half Dutch and half British, is trying hard to hold the Africans under them, because they want to keep for themselves the modern means of getting wealth in industry and the power over government.

The second phrase used above—the British Empire—refers to the fact that the British rule over large numbers of other races in India, tropical Africa, the West Indies, and Malaya. Altogether in the Empire there are about 470 million people, of whom only about 70 million are British, and 40 million of these in Great Britain. The other 400 million are "subjects," but in no sense "citizens." They are governed by the agents of the 40 million who live in Great Britain. Most of the 400 million are desperately poor and very simple in their customs and beliefs.

By far the greater part of the subjects of the British live in India; about 300 million of these ruled directly by British officials and about 60 million through Indian princes, some of whom are almost independent so far as the affairs of their own territories are concerned. In British India more than eighty out of every hundred are peasants, and the children of peasants: in the Indian States almost all are peasants. That is to say, these people, living in villages, depend for livelihood upon growing on very small patches only a little more than will just keep them alive. Hardly any can read or write; but that does not mean that they are ignorant of traditions or of the simpler public affairs. The religion of the majority is Hinduism, which includes many very old customs, such as the avoidance of eating beef and elaborate rituals for meals, marriages, and funerals. In Hinduism also the people are divided into "castes," some of which seem originally to have been based upon occupations but are now inherited divisions which prevent free intercourse between those of different castes, just as in Europe the distinction of social "classes," in manners and customs, prevents the so-called "lower" classes mixing freely with the "upper" (see *Organisation of Society*, p. 508). One large group of people outside all "castes" is called the "untouchables"; and those of the highest of all the

POPULATION OF THE CHIEF STATES (IN THOUSANDS)

GREAT POWERS

BRITISH EMPIRE 443.500 United Kingdom 44.500 Irish Free State 2.900 Other Dominions 25.000 African Colonies 31.000 India 318.000 UNITED STATES 129.000 U.S. alone 116.000	FRANCE 110.260 France alone 40.744 RUSSIA (U.S.S.R.) 148.950 Russia alone 114.430 ITALY 42.620 Italy alone 40.548 JAPAN 84.565 Japan alone 59.736 GERMANY 63.500
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OTHER EMPIRES

DUTCH 59.718
Holland 7.416
East Indies 51.200
BELGIAN 19.250
Belgium 7.812
PORTUGUESE .. 14.889
Portugal 5.600
African Colonies 7.500
CHINESE ... 445.175

OTHER STATES

SPAIN 21.960
POLAND 29.249
RUMANIA ... 16.900
YUGO-SLAV ... 13.100
CZECH-SLOV .. 14.250
BULGARIA ... 5.000
GREECE 6.400
SWEDEN 6.054
NORWAY 2.770
DENMARK ... 3.440
FINLAND ... 3.500
SWITZ'D ... 3.900
ESTHONIA ... 1.120
LATVIA 1.800
LITHUANIA ... 2.500
AUSTRIA ... 6.500

BRAZIL 36.870
ARGENTINE .. 9.500
CHILE 3.900
PERU 5.500
COLUMBIA ... 6.600

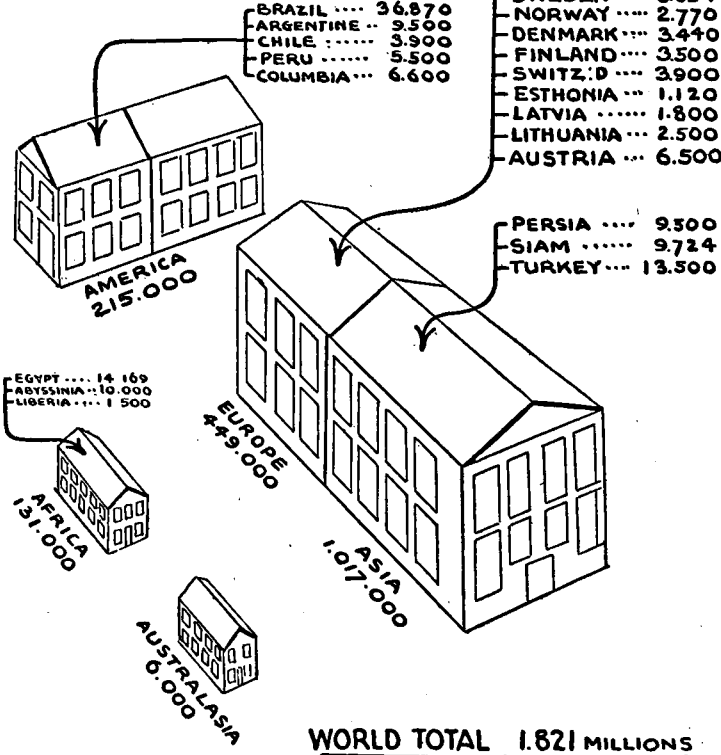


Fig. 87. "PEOPLE WHO LIVE IN GLASS HOUSES SHOULDN'T THROW STONES"

castes are called "brahmins." The brahmins were originally the learned and the priests, who claimed to guide all the people; and they have still a very great influence.

Into this sort of society modern industry has been introduced—iron and steel manufactures and textiles. But very few Indians, by comparison to the millions employed in agriculture, are employed in industry; although the great natural resources of India, and her numerous population, have already made India one of the chief industrial countries. The British have lent much money for the building of railways and the setting up of industries in India; but now most of the money invested in Indian industry is already Indian. There are rich and powerful Indians controlling industry, besides the princes who obtain their riches from taxing the peasantry or merchants. In India there is a very ancient tradition of culture; and, although the majority are poor and uneducated, there are many who are trained in modern knowledge. Those who have some modern knowledge make the claim that India should be ruled by Indians, and no longer be under the control of the British. Gandhi is one of the most influential representatives of this claim, and he is supported by the Indian National Congress. But many other groups of Indians also demand self-government: and India's right to it has been admitted by the British Parliament. The Indians are impatient of the delay in establishing the new form of government: but conferences between British and Indian representatives are planning this new form (see *Problems and Solutions*, p. 717).

The United States contain about 122 million people, of whom about 10 millions are negroes, descendants of slaves brought into the Southern States from West Africa between about 1700 and 1860. The great majority of the 112 million others are of different European races; but, as the States were established by British immigrants, the language of the whole is English, and the system of law also English. The great power and wealth of so large and united a population stretching across the North American continent, and, in fact, constituting a "new world," leads

to the name of America being given to the United States, its people therefore being the "Americans." In the United States, members of nearly all the European nations and races have found a refuge from the oppression, the poverty, and the interminable wars of Europe. Great modern industries have been built up there; and agriculture, for wheat first and then for fruits, has greatly expanded there, as the western part of the continent has been opened up. After nearly a century of borrowing money from Europe for building railways and factories and using immigrant labour from Europe, the Americans have established a new society where people are more equal than in Europe, and have developed resources upon which the rest of the world depends. The American people are conscious both of the evils in Europe from which their ancestors escaped and of their power to influence public affairs in the whole world. There is a higher general level of well-being and education in America than in most countries; and the evils which survive there—the illegal action of certain gangs and the unsolved problem of the negro's inferior position in the community—are not preventing the advance of civilised life in other aspects.

The American Government at Washington is concerned both with the difficulties left over from the Great War in Europe and with the development of Oriental civilisation in the Western Pacific. To Europe, America is tied by the debts owing to her Government from the Allied Governments since the War, and also by the investment of American money, chiefly in Germany. In the East, America is concerned both with her own trade in Japan and with the danger to her trade in China, if Japan dominates China. In South and Central America and the West Indies the American Government finds itself in the difficulty of desiring to maintain order and yet not wishing to limit the independence of her neighbours. A statement of policy made by President Monroe in 1823, now called the "Monroe Doctrine," is supposed to express the determination of the people of the United States to assist the other peoples

in South and Central America to develop their own institutions without interference from Europe.

Russia is the third of the Great Powers, with many different races under one rule and contacts in the two most populous continents—Asia and Europe—looking east and west. The Russian Government controls one continuous area across the whole of the largest land-mass on the earth. But what we call Russia is called by those who rule it “The Union of Socialist Soviet Republics”—the U.S.S.R.; as “America” is called the “United States”—U.S. The U.S.S.R. includes about 154 million people, of whom about 80 million are Russian, about 32 million Ukrainian, and the rest Tartars, Mongolians, and other races.

In 1917, during the Great War, a social revolution destroyed the power of the ruling class in this country; and after the war which lasted there till 1920 the Communist Party reorganised the Russian and other peoples in a society based upon the control by manual workers in the interest of manual workers (see *The Last Thirty Years*, p. 565). The people concerned were almost all peasants—ignorant, superstitious, and without any clear ideas of public policy. They were living in conditions rather like those of China and India. Although a small aristocracy of landowners had acquired European culture, they did not give any share of it to the vast majority whom they controlled. Perhaps they believed that people who were given no opportunities would not be able to use such opportunities. But the Soviet Government since 1918, having abolished the property-owning class, has extended education to immense numbers, has improved the organisation for production both in agriculture and in industry, and has now embarked upon the Five-Year Plan for making Russia a modern industrial nation without the use of private investments. The decision as to what shall be made, and how it shall be distributed, is in the hands of the leaders of the Communist Party, and is not left, as with us, to the interaction of separate groups of capital-owners. For the purpose of destroying control by the rich,

harsh measures and even imprisonment and executions are used to silence all opposition ; but the driving-force of the policy is in the enthusiasm of about a million members of the Communist Party, mostly quite young, who aim not merely at transforming Russia, but at destroying the power of the owners of property in all countries of the world.

France is another example of a Great Power, a very highly civilised people in Europe ruling millions of non-French peoples in Africa and in Asia. The French have been living under a Republic since 1871; but much of their way of living was formed immediately after the French Revolution of 1789, under the Emperor Napoleon. The great majority of the French peasants are living on their own land and growing wheat and grapes for wine. There are many very ancient small towns and a few centres of industry for textiles, iron, and steel machinery. The education, under central control of the Government in Paris, has made all the nation speak good French, and almost everyone in France has a feeling of fraternity and equality ; but, as France is by no means as full of people as England, the French do not rely upon their Government for common services as much as the English do, except under the stress of war. They fear war, because ever since the Middle Ages, when English kings laid France waste, they have suffered greatly from wars—even from those in which they thought themselves victorious. Many millions of foreign workers, Poles and Italians chiefly, work in the mines and factories in France, because the French population is not increasing.

Beyond the seas, the French rule over a few islands in the West Indies, over Algiers, Morocco, and tropical regions farther south in Africa, over Madagascar and over Indo-China, in sub-tropical Asia. But not many French go out as colonists ; so that most Frenchmen in their colonies are officials or agents of trading companies. They have so far generally tried to make a few of their native subjects French in language and sentiment : Frenchmen do not seem to have such violent feelings about people with

different coloured skins as British and Americans and Germans have ; and therefore the French in their colonies keep in close contact with the inhabitants.

Germany lies in the very centre of the European continent. Until 1871 its peoples were divided into many small States under princes, but at that date the German Empire was established under the leadership of Prussia. This Empire was transformed into a Republic in November 1918, after defeat in the Great War and the flight of the Emperor or Kaiser (see *The Last Thirty Years*, p. 553). The German people developed, during the nineteenth century, large, well-organised industries, chiefly for iron and steel, chemicals and electrical machinery ; but a great part of Germany is still agricultural, especially in the east. The level of education is high. The sciences are studied with great effect, as the name of Einstein reminds us ; and in many German towns you can see the best modern architecture and hear great music. The distinctions between different forms of Christianity is important in Germany, and these distinctions affect politics ; for in the south and the Rhine country most of the people are Catholics, and in the east and centre most of them are Protestants. There are also very strong Socialist and Communist groups which are opposed both to the Catholics and to the Protestants.

Since their defeat in the Great War in 1918, and after the Versailles Treaty, the Germans have been living under restrictions imposed by Great Britain, France, Italy, and other Allies in the war. In the first place, Germany is prevented from having certain kinds of armaments—naval ships of more than 10,000 tons, tanks, big guns, and bombing aeroplanes ; and the size of the German armed forces is restricted. Secondly, Germany has had to pay large sums of money and some commodities as “reparations” to France and other countries. For some years also a part of German territory on the Rhine was held by British and French troops. This last restriction has ceased ; the payment of reparations seems to have become no longer possible ; and the Germans are now claiming “equality of rights” in regard to defence forces—either to compel other

nations to reduce their armaments or to gain freedom for their own nation from alien control. A new party, the National Socialists (Nazis), has organised opposition to the terms of the Versailles Treaty; and the whole of Germany seems to feel that the situation in which the defeat of 1918 placed them must now end.

Italy is one of the Great Powers, and the Italian Government seems to aim at making their country a Great Power on the same lines as France. Italy has an increasing population, largely poor agriculturists, with some new industries in the north. Before 1914 many thousands of Italians used to emigrate to the United States; and every year thousands used to go, for the harvest only, to South America. Since the war more Italians are settling in South America and in France; but the great flow into the United States has been stopped by the Government of that country. Therefore the Italian Government aims at developing Italy and the area in North Africa, Libya, which is an Italian colony, more rapidly, in order that the increasing population of Italy may live more easily. Since October 1922 the Government of Italy has been controlled by the Fascists under Mussolini (see *The Last Thirty Years*, p. 554). As dictator he keeps control of the Government in the hands of members of the Fascist Party. The old Parliament has been replaced by an Assembly representing industries, trades, and occupations, but without any power: and the quarrel between the Italian Government and the Roman Catholic Church, which had lasted since 1871, has now been ended by an agreement that the Vatican Palace and its grounds in Rome shall be an independent State under the rule of the Pope.

Japan is reckoned one of the Great Powers, and has been so since about 1905, when the Japanese won a war against the Russians in Manchuria. The Japanese live in a group of islands off the eastern coast of Asia: and so much of the islands consists of rocks and mountains that the majority of the 60 million Japanese have a very hard life. Most of them are very poor farmers, growing rice, and fisher-folk; but for about fifty years modern industries have been

developed in certain great towns in Japan. Cotton-goods, made largely with cotton from America, are the chief products of the new industries ; but Japanese shipping also is important. The Government in Japan is a sort of dictatorship of a few old families, using the people's reverence for the Emperor or Mikado, as a basis for government ; but since 1925 all men have votes for the Diet, or Parliament, which is supposed to control policy. The Japanese Government has followed a policy of imitating European practices ; and, besides introducing Western industry among its people and adopting Western armaments, has taken control of Formosa as a colony and of Korea or Chosen, as another sort of dependency. The Japanese suppressed the independence of Korea by killing thousands of Koreans ; and many of those who were not killed left Korea and went into Manchuria ; but the Japanese control the chief railway there, and seem to intend to control the Government there too.

China is at present the name for about 400 million people, the greatest number in any "nation," crowded into a few river valleys and also scattered over a vast section of eastern Asia. These people are dominated by different groups or rulers in the different districts ; but they are united in the kind of life they lead and the sort of civilisation they admire. They have many different languages, but one common literature of great antiquity, which is known to the few who can read and write. The majority are very poor peasants, always in danger of flood, famine, or plague, because there are no roads and hardly any knowledge of how to control nature, so that people cannot help one another.

Until 1912 there was an Emperor of China who symbolised the unity of the people ; but central government has never been more than an indefinite distant power, for the majority in their villages lived easily enough by arranging their own family affairs. On the outer edge of the Chinese world a few Europeans settled in "Treaty Ports"—Shanghai, Tientsin, Hangchow, etc.—to trade with the Chinese ; and a few power-machine industries have recently

been introduced among the Chinese under European influence. A Republic was established in 1912 (see *The Last Thirty Years*, p. 552), but its authority has not yet been made effectual in most of China; and Europeans and Americans have seemed to the Chinese to be more inclined to make money out of them than to help them. The younger Chinese men and women, however, have set about modernising their country, by teaching the people to read and write, by improving agricultural methods, and by organising a new government.

Other States.—The other peoples of the world may be classified according to the part of the world they inhabit, dividing the world into the continents Europe, Asia, Africa, and America. In Europe there are several small States—Sweden, Norway, and Denmark, Holland and Switzerland—in which the people are more “democratic,” more equal in wealth and more friendly to one another, than in other parts of the world. The fine arts flourish especially in Scandinavia, where many people spend their money, not on themselves, but in beautifying the town in which they live. Of these small States, Holland is peculiar, because it contains a small population which controls the large populations of Java and the other islands of the Dutch East Indies: that is to say, Holland is democratic at home and “imperialist” outside, as some other larger nations are. Some other European States have been in existence for centuries—for example, Spain and Portugal—although both have changed their forms of government, from monarchy to republic, within recent years. The Spanish people abolished the monarchy in 1931, and are now organising a government free from the control of the Roman Catholic clergy and the great landowners. Other European States were made in the nineteenth century, such as Greece, Bulgaria, and Rumania; and others, again, have their present territory and population as a result of the form of peace which followed the war of 1914–1918—namely Poland, Czechoslovakia, Austria, and the Baltic States. Yugoslavia, although it includes the Serbia of 1914, is really a new State made up of bits of old States; and

Hungary is a remnant of what used to be called by that name before 1918 (see Fig. 86).

In several of the new European States—for example, in Poland and Czechoslovakia—groups of people are included who differ in race or religion from the people who control the government. These groups form Minorities, which were given certain rights, by Treaties, to preserve their religion or language ; and appeals from such Minorities are made to the Council of the League of Nations. But some of these Minorities have grievances which keep hate and violence alive in Europe ; and in most of the larger European States there are military groups which “ breathe fire ” against similar groups in neighbouring States. Thus oppression and warlike rivalry still make of Europe the most likely source of future wars. The great intelligence which produced in Europe modern science and its applications in industry, as well as modern social organisation, is still used partly to prepare new violence and to organise more savagely the rivalry between peoples.

In America, North, Central, and South, and in the islands, the West Indies, the languages, customs, and forms of government come from Europe. North America has been discussed above : its peoples come from northern Europe. The peoples of Central and South America come from southern Europe. The States of Central and South America were once colonies of Spain and Portugal, but became republics under military presidents during the nineteenth century. Their languages are : in Brazil, Portuguese ; and elsewhere, forms of Spanish. They have agricultural populations, partly American Indians and, in Brazil, partly African negroes. They grow coffee, rear cattle, and in the north have supplies of oil. They have all been developed by the use of money lent by European owners of capital ; and even the Governments of South and Central America are in debt to the lenders, who are called bondholders.

In Asia, besides China and Japan, there are three independent States—Siam, Persia, and Turkey. The latter two are under military dictatorship ; and Turkey at least is

being rapidly modernised by the spread of education, transport, and new forms of social organisation. In Africa there are three States, one—Egypt—partly under the control of Great Britain, the two others independent—Abyssinia or Ethiopia, and Liberia.

ARMAMENTS AND WAR

All the States of the world follow the ancient custom of giving to their Governments the use of armed forces, partly for each to suppress opposition among its citizens or subjects but mainly nowadays to “defend” each against the others. The armed forces of small States, however, are hardly more than police and frontier guards; and some of these States have deliberately reduced their armed forces so that they shall be only police. The Great Powers are the most heavily armed, with bombing aeroplanes as well as armies and navies; and, since the forces of small States are not dangers for other States, the danger to each Great Power, against which its armed forces are supposed to defend it, must arise from some other Great Power. The danger against which any national force—army, navy, and air force—is supposed to guard is not “the people” of other countries, but other similar armed forces. Thus every armed force in every nation seems to other nations not to be “defence,” but to be a danger. The British navy, for example, which seems to the British to be a “defence,” seems to the Americans, the French, and others to be a danger against which they must provide “defences.”

The more powerful the “defence” of any nation becomes, the more frightened its neighbours become; and, when any nation is frightened that its neighbours’ “defences” will be used against it, or when any nation thinks its “defences” can secure a victory to reduce its neighbours’ “defences,” war is begun. War is always made to seem a gallant sacrifice on the part of the soldiers; and the newspapers usually say that any war is for a noble purpose. But war is chiefly killing, in order to get your way, and deceit in order to kill more successfully.

Soldiers are trained and fight in war not to die for their country, but to kill for it. There are, however, in all countries some who are so primitive as to like that sort of job; and there are others who make money out of selling armaments, who do not at all mind other people using them.

Past wars have left such a large legacy of hate and fear and greed that new wars are possible; and all the Great Powers are preparing, in case of another war, in which bombing aircraft and poison gas will destroy children and babies as well as men and women in the great cities (see *Problems and Solutions*, p. 720). But, because greater numbers of people are directly hurt in modern wars, there has been a strong movement for the past ten years in favour of new efforts to prevent war. And, besides, some people in every nation are coming to see that difficulties, such as epidemic disease, which affect many nations, can be overcome only by co-operation between nations. For these reasons the League of Nations was established in 1920; and it has done much good work ever since.

THE LEAGUE OF NATIONS

The League of Nations is an association of more than fifty Governments, in which all the chief Governments are included except the United States, Russia, and Turkey. The League is not something above the British or the French Governments. It is simply these very Governments acting together for common purposes—to prevent war and to make progress in civilised life, through co-operation between peoples. But each Government in the League is represented by, or acts through, some responsible Minister: and so, when “Great Britain” and “France” are said to meet in the League, what really happens in that Mr. Arthur Henderson or Sir Austen Chamberlain and M. Tardieu have a discussion together. The League is therefore a means by which Foreign Secretaries or other Ministers of different States can act together.

Most of the meetings connected with the League take

place at Geneva, where the permanent Secretariat of the League has its office. The League works in this way. A Council consisting of fourteen people of different nations meets three or four times a year. This is the chief executive body of the League. Among the members are always representatives of the Great Powers in the League; and the other members are elected from time to time. The Council discusses and tries to suggest a way out, if there is any danger of war; and it agrees, wherever possible, to joint action by all Governments members of the League. The members of the Council who are not "permanent" are elected by the Assembly. This Assembly is a large body of representatives of all the Governments which are members of the League. It meets once a year early in September in Geneva. It has no power either as a legislature or as an executive body; but it can propose work to be done by the Council.

The League in the Council, Assembly, and Secretariat has prevented war between Bulgaria and Greece in 1927: it has organised the economic relief of Austria, Hungary, Bulgaria, and the Greek refugees. In its early days, soon after 1920, it restored war prisoners to their homes and warded off epidemic disease from western Europe. Certain colonial territories, called "Mandated," are governed by the British, French, or Belgian Government; and each has to report how it is done to the Council of the League; and so a new principle is being introduced in the government of colonies. The experiment of the League system is certainly an advance on anything there has been before for bringing the peoples into friendship. But sometimes, if the Government are undecided or their representatives in the Council or the Assembly are not good enough for the job, the League has failed to prevent violence or to establish co-operation between nations. The men who sit on the Council or in the Assembly of the League may be stupid or they may be so old-fashioned as not to understand any but the old methods of foreign policy. The Governments represented on the Council or Assembly may be unwilling to use other means than force and fraud; or they may have no

idea of their true interest in working with other Governments. The League is not an angelic choir : it is a body of old men, some of whom are not in sympathy with new ideas. The League system provides only a means of co-operation ; and men may either use it or misuse it.

A separate section of the same system of co-operation in the League is the International Labour Organisation—the I.L.O. This has a governing body and a General Conference, like the Council and Assembly of the League ; but in the I.L.O. not only the Governments are represented, but also the trade unions and the employers' associations of the countries which are members of the organisation. The purpose of the I.L.O. is to improve the conditions under which the productive services of industry and agriculture are carried on. The kind of work that has been done by the I.L.O. is the same as that done in different nations under factory laws, by Ministries of Labour and industrial organisations : and here, too, it is the men who are doing it that matter. The I.L.O. is a system, which may be used or may be left unused.

A third separate section of the League co-operation between Governments is the Permanent Court of International Justice at the Hague. This is a court of lawyers or jurists, for trying certain cases in dispute between Governments according to the recognised principles underlying international law. Most of the cases actually dealt with have been about the interpretation of Treaties between Governments which have brought the disputes before the Court. The Court has proved successful in preventing such disputes from becoming causes of war.

But the most dangerous disputes between Governments arise when the interests of two nations seem to be opposed. For example, the French may prevent Italians from settling in their territories in North Africa, or the ports of one country may be closed against the trade of another. In such cases, there is no law or rule to indicate what interests should prevail ; but *diplomacy*—the daily work of Foreign Secretaries in Governments and of Ambassadors—may arrive at a compromise between the two views. If

diplomacy does not succeed, the Council of the League has power to use conciliation, or any form of persuasion, in order to prevent such a dispute leading to war. If either side uses armed force, without delaying to negotiate, the Council may advise the Governments to use force against such violence.

Under the Kellogg or Paris Pact of 1928 the States of the world, including those not members of the League, have agreed not to use war "as an instrument of national policy," and also never to use any but peaceful means for the settlement of disputes. The Government of the United States has a special interest in the Kellogg Pact, which indeed was due to American ideas and American influence. But so far no new methods for settling all disputes have been generally agreed upon to take the place of the old method of war.

The League and the I.L.O. are parts of a social "machinery" for getting things done by means of cooperation between Governments. The other part of the same "machinery" is the system of diplomacy—Ambassadors and Foreign Offices; and nowadays there are many conferences held between those in control of power in industry and finance in the different nations. But what is it all *for*? If the "machinery" is for getting things done, what things ought to be done? In general it is believed that the machinery is for "peace" and for avoiding war; but what is peace *for*? Why should we in our country be friendly, or assist people in other countries? Why should we not neglect them for most of the time and fight them occasionally? The reason is, first, that fighting between nations has never been found successful for making men happier.

It is not enough, however, to avoid fighting and live apart, for life has been made more civilised by the use of more varied food and clothing, better transport, and greater security from famine and disease; and all this has come about owing to intercourse between different nations. Each nation, therefore, can make its own life more civilised by the use of goods and services supplied by the people of

other nations. The "nationalism," which was described above, which divides the nations, must be reconciled with an "internationalism" in which each nation, remaining true to its own tradition, assists the others to be more civilised. To make such intercourse between the nations prevail over their differences is the great problem of the world to-day : and, just as a person gains more in "individuality" or in "having a mind of his own" by talking to other people and not by avoiding them, so a nation becomes greater and finer by intercourse with other nations.

But there is another problem lying behind this one. It is the problem of the millions of men, women, and children, in many different countries, whose lives are still so far from civilised that they lack food and clothing, and die of preventable disease. The peace which is an intercourse between nations should be an opportunity for solving this most ancient problem, especially because we in this generation, for the first time in history, have immense and increasing power to produce all that is necessary, in agriculture and industry. This is the opportunity for raising "the standard of living"—that is to say, for giving people happier and healthier lives in every nation. But, because so many in every country cannot buy what they need, each nation tries to solve its own problem separately ; and each nation, using obsolete methods to meet a new situation, makes matters worse for its own poor and for other nations. Thus the standard of civilised life goes down, while goods that are needed are destroyed—coffee burnt in Brazil and rubber destroyed in Asia—and the machinery, whose products the poor need, stands idle. The bankers and traders and Governments of the world do not seem able to allow those who need goods even to work in order to pay for them. The problem is world-wide ; and therefore it is necessary for the nations to co-operate in order to solve it. In one country only—that is, Russia—a plan is adopted for the use of modern production in the supply of all needs. But, in a world of very slow-moving minds and many ancient privileges, those with modern ideas may fail to make life more civilised for common folk. The natural desires of all men

for healthier and happier lives may, however, overcome the prejudices which prevent those desires from being satisfied.

UNOFFICIAL INTERNATIONAL ASSOCIATIONS

People in each nation who wish to be so friendly as to work with people in other nations join societies or groups for these purposes. And this is just as important for preventing war and improving civilised life as the action of officials or representatives of Governments, especially if great numbers work in such international groups. For example, the Boy Scouts and the Girl Guides of many nations have international meetings, in which boys and girls of different nations get to know one another. The Red Cross League has its junior branches, and is international. League of Nations Societies exist in most countries, and hold international meetings: and there are some travel associations which aim, not merely at seeing "sights" abroad, but at meeting people of other nations. The growth of all this has been very recent and very rapid: it has not yet succeeded in overcoming national fears and prejudices. But a better way of living may be brought into existence, in which war, and the danger of war, will be forgotten; in which the people of one nation will not think it noble or wise to attack or to oppress the people of another. Such a new way of living, however, cannot come into existence without the use of brains and energy by those who believe that it would be better than the world of to-day. If it is to come into existence, those who believe in it must have quicker intelligence and deeper and more powerful feelings than those who do not. Those who believe in the co-operation of nations must see in it the only means for making life happier for those who now lack food and health and knowledge in all nations.

Thus the relation of the peoples of the world is not—and, in fact, has never been—a mere result of natural forces, such as storms or rain on the crops. We live as we do now because certain people in the past have, more or less deliberately, chosen to improve upon primitive ways of living.

They did not foresee all the consequences, any more than the slave-traders of earlier times foresaw the difficulties of the negro problem in America to-day. But their desires and their efforts to get what they desired, have left us the world as it is. It is still capable of being made better by those of us who think clearly and feel deeply about our fellow-men. In any case, the relations between the peoples of the world are changing : we have power to make them change in the direction which we think good. The world of the future is waiting to be given its shape by those who are the artists in the making of men's minds : and these are not only the statesmen and the business men, but also the poets and philosophers. Common folk, too, can make the future happier if they work together for a world in which all nations shall be at peace and everyone shall have a share of what is best.

BOOKS TO READ

- G. N. BARNES : *History of the International Labour Office.*
C. DELISLE BURNS : *A Short History of International Inter-
course.*
J. FAIRGRIEVE and G. YOUNG : *Human Geographies.*
H. FLEURE : *The Peoples of Europe.*
R. JONES and S. S. SHERMAN : *The League of Nations, from
Idea to Reality.*
F. S. MARVIN : *The Modern World.*
F. NANSEN : *Adventure.*
H. SPAULL' : *The Fight for Peace.*

LAW AND GOVERNMENT
OR
THE MACHINERY OF SOCIETY
by
G. R. MITCHISON



Most lawyers who have been at work for at all long get stuck and dull, and not interested in anything, except the workings of the law and which of the judges is going to die next and who is going to succeed him. But a few lawyers stay alive and able to change their minds, and are not so much interested in the law as in justice (which may be quite different). Dick Mitchison is that sort. He also tells stories very well—quite often a legal case is like the funniest kind of story, and the witnesses are the most unlikely people, and the Bar is the only profession where people still have to dress up. During the last part of the war he was liaison officer between a French division and the English in Italy ; he tried to persuade the French to like ginger and *Alice in Wonderland* ; he likes going to other countries and making friends with new kinds of people. He has five children, Denis Anthony, John Murdoch, Sonja Lois, Nicholas Avrion, and Valentine Dione. He plays various games

rather well ; he likes dogs and he likes making speeches, but he is rather untidy. By the way, he and I have been married for sixteen years, which sounds a ridiculously long time when one writes it down, but it is not really.

LAW AND GOVERNMENT

ONE NIGHT in February, Uncle William thought of visiting a friend of his. So he took his Ford car out of the garage and started off. On the way, he remembered that he had no tobacco, and stopped in the village of Titwillow to buy some. While he was in the tobacconist's shop, Police Constable Ramrod came along and noticed that there was no red light on the back of Uncle William's car. So when Uncle William came back to the car he found Police Constable Ramrod looking very official. The police constable asked him why he had not got a light at the back of his car, and Uncle William explained that he did not know the light was out. But, unfortunately for Uncle William, Police Constable Ramrod had been getting into trouble lately with his superiors and was feeling rather cross. So he fished out a note-book and told Uncle William that he would have to report him. Then he asked for his driving licence and his insurance certificate and looked at the licence on the front of the car, made a number of notes in his note-book, and walked away. Uncle William drove on to see his friend. A few days later, Uncle William received what he supposed was a SUMMONS—an official-looking document telling him that Police Constable Ramrod had laid an information about Uncle William's misdeeds and that (in official language) Uncle William had better appear at the police court and see what happened. So, on the day indicated in the summons, Uncle William went to the POLICE COURT and found the local magistrates sitting on the bench. When Uncle William's turn came, the clerk of the court called out his name and he was asked if he pleaded "Guilty" or "Not Guilty." Uncle William thought that he might get off more easily if he pleaded "Guilty"—though I doubt if it made any difference—and said, "Guilty." Thereupon Police Constable Ramrod, looking very official indeed, went into the witness-box and told the

magistrates when, where, and how he had found Uncle William with no red light shining on the back of his car. The presiding magistrate asked Uncle William whether he wanted to ask the police constable any questions, but Uncle William, who by this time was feeling very guilty indeed, didn't quite see what sort of question to ask, and said rather glumly, "No, sir." After that it seemed unkind of the magistrate to ask the police constable, "Any previous convictions?"—but happily the police constable also said, "No, sir." So the magistrate just remarked, "Twenty shillings," and Uncle William went out, paid a pound to a police sergeant and went away, feeling rather silly.

THE LAW

That is quite a common story—not very interesting—but it *is* interesting to see exactly what Uncle William had done and how and why and by whom he was made to pay a pound. Now obviously Uncle William had not done anything very wrong. He had not, for instance, hit Uncle James on the head with a chopper or even tried to burgle the tobacconist's shop. But, all the same, if there are going to be a number of motor-cars about on the road, some going fast and some going slow, the motor-cars which go fast are quite likely, on a dark night, to run into those which go slow, unless there is a red light—or something of that sort—on the back of them. It really comes from leading such a complicated life—with motor-cars and things. But, if you lead a complicated life, you have to have rather complicated rules for preventing your complicated self from interfering with your complicated neighbour in his complicated life. And those complicated rules are made in a rather complicated way. So let us just see exactly how Uncle William had broken the law—and "the law" is just the name for the rules under which people live together. Some of the rules are unwritten, because you do not need to put it down in writing that you must not murder Uncle James with the chopper—that seems quite clear, at least to Uncle James—but others are written, because they are not so clear. They

are really a rather elaborate way in which people have arranged to live together. People, as we shall see in a minute, elect a PARLIAMENT to make that sort of rule.

ACTS OF PARLIAMENT

And now I am going to look at a book, full of that sort of rule. The book is called *The Public General Acts Passed in the Seventeenth and Eighteenth Years of the Reign of His Majesty King George the Fifth*. Those are generally called "Acts of Parliament." One of them is called the Road Transport Lighting Act 1927—and it begins like this: "Be it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows . . ." Now who are all those people?

THE KING

"The King's most Excellent Majesty" is King George the Fifth—and you may be fairly certain that King George the Fifth had very little to do with the eight or nine pages of print, which he is said to have enacted, which he probably never read, and certainly does not know by heart. King George the Fifth, like every other king in this country for many years past, cannot make laws by himself, but only with the advice and consent of Parliament—and that means that Parliament makes them and King George the Fifth has to say "Yes." But, all the same, they are the laws of the King in Parliament—and that dates from a time when kings were more important than they are now—and Uncle William could not have been fined until the King had given his Royal Assent to the Act of Parliament.

THE HOUSE OF LORDS

Now let us see what is said about Parliament. The Act is to be enacted "by and with the advice and consent of the Lords Spiritual and Temporal . . ." Who are they? That

means the HOUSE OF LORDS, in which the archbishops and some of the bishops are the Lords Spiritual, and the hereditary peers are the Lords Temporal. The archbishops and bishops are there because they are the persons who for the time being have been appointed to hold their archbishoprics or bishoprics—to be, say, the Archbishop of York or the Bishop of London. They are archbishops or bishops in the Anglican Church, which is the official or “established” Church of the country. There is no particular reason why anyone should be a member of the Anglican Church or believe in the particular form of religion which the Anglican Church represents. But, since it is the official Church and the King is the “Defender of the Faith,” the King appoints its bishops and archbishops—and, here again, he cannot do it by himself, but must act on the advice of his Prime Minister. These archbishops and some bishops sit in the House of Lords, though the heads of other religious bodies have no right to do so—and no one has yet suggested that the irreligious ought to have a bishop or two there too. The Lords Temporal are people who have been made peers by the King—again on the advice of his Prime Minister—or the descendants of people who have been made peers, sometimes a very long time ago. Some people wonder very much why the descendants of someone who was made a peer two or three hundred years ago should still be entitled to sit in Parliament and take a hand in looking after Uncle William’s back light. I suppose they wonder whether their light, like Uncle William’s, may not have gone out in the course of centuries. But, after all, the Lords Spiritual and Temporal had not very much to do with the Road Transport Lighting Act 1927. It was passed, you remember, by and with the advice and consent, not only of the Lords Spiritual and Temporal, but also of the Commons, in this present Parliament assembled, and by the authority of the same.

THE HOUSE OF COMMONS

The Commons are the HOUSE OF COMMONS, and it was in that House that the Road Transport Lighting Act

started. The Commons are representatives of town areas and country districts all over England and Scotland. I have not mentioned Wales—but, for all practical purposes, Wales is a part of England, while Scotland, though she sends members of Parliament to the House of Commons, has different laws from England and is in many ways governed differently. There is also Northern Ireland, which not only sends members to the House of Commons, but also sends members to a Parliament of its own—a very Irish state of affairs. Altogether, 528 members come from England and Wales, 74 from Scotland and 13 from Northern Ireland. Those 615 members form the House of Commons for five years, or until the King dissolves it; and he can only do that on the advice of his Prime Minister. Most of them belong to one of the three principal political parties. But whether there really are three, or more, or less, or what they think, or whether they are right or wrong, are all questions about which you had better look somewhere else, or ask your father and then be quite certain to disagree with him. You may be sure that there will be some newspaper or another to suggest that you are right whatever you say. The largest party or combination of parties—that is to say, the one which has the most members in the House of Commons, for nobody counts the Lords Spiritual and Temporal in this connection—forms the Government. That means that the leading members of that party become **MINISTERS**. One of the Ministers is the Minister of Transport—and he looks after motor-cars (like Uncle William's) and roads and railways and things of that sort. He has a large office, in which there are numbers of **CIVIL SERVANTS**, public officials, who do the work of the office, whatever party may be in power in the House of Commons.

HOW AN ACT OF PARLIAMENT IS MADE

Probably the Road Transport Lighting Act began by one of the civil servants in the Ministry of Transport suggesting to the Minister that it was high time some new

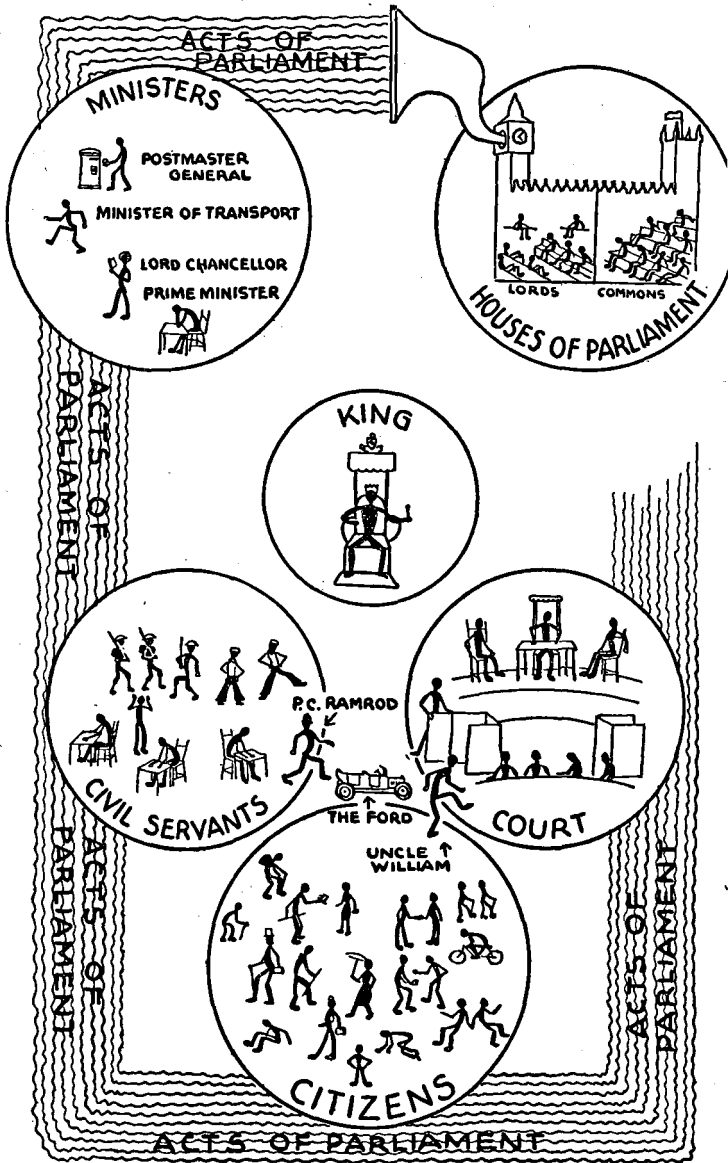


Fig. 88. THE BRITISH CONSTITUTION

rules should be made about lighting motor-cars and other vehicles on roads. I expect that some one or more of the civil servants in the Ministry suggested an Act of Parliament very much on the lines of the Act of Parliament which we are now considering, and when they had discussed it with the Minister their suggestions were sent to another civil servant, who is called the Parliamentary Counsel and whose business it is to put such suggestions into a proper form. The result was a **BILL**, and the Bill was introduced into the House of Commons by the Minister and some other members of his party, whose names were put on the back of the Bill to show that they approved of it. It was then given what is called a "first reading" by the House of Commons. That does not mean that anyone really read it or that there was any discussion about it. It only means that the Bill was printed, became available for every member to consider, and took its first step on its way to being "enacted." Some time afterwards the Bill came forward for a Second Reading and this time the Minister would make a speech explaining the Bill and giving his reasons for wanting it passed. Then there would be a debate about it, on general lines, the members of Parliament who opposed the Government putting forward their objections to the Bill, and the members of Parliament who agreed with the Government supporting it. The chairman of the debate would be the **SPEAKER** of the House of Commons. The Speaker is not called the Speaker because he speaks often. In fact, he hardly speaks at all in the House of Commons, but in old days, when the House of Commons wanted to make some protest or statement to the King, the Speaker spoke for it. Now he calls on members of Parliament to speak and keeps order in the House of Commons.

Well, the Bill was given a Second Reading—that is to say, a majority of the members of the House of Commons voted in favour of it—and it was then referred to Committee. The Committee may be the whole House of Commons, sitting in Committee, or it may be a smaller number of members, chosen from the different parties in the House of Commons in proportion to the strength of each

party in the House. The business of the Committee is to consider the Bill clause by clause. There may be amendments on each clause, and quite often an arrangement called the "guillotine," which limits the time to be taken in discussing any clause. So the Bill including the provisions about Uncle William's back light was considered in detail in Committee and the Committee reported to the House of Commons. There might have been some further discussion—some additions to the Bill—at this stage, but as it happened, in this particular case there were no alterations when the Bill was reported. After the report the Bill was given a Third Reading and then went on to the House of Lords.

The arrangements in the House of Lords are rather different, but the real point about what happened there is that the House of Lords would be reluctant to make many changes in the Bill. If they did make changes, they could send the Bill back in its changed form to the House of Commons, and the House of Commons might accept the changes; or, if the House of Commons did not like the changes, they might make some other suggestions and see if the House of Lords would accept those. Or, if the House of Commons and the House of Lords could not agree, the House of Commons might wait till the next Session—next term, as it were—and send the Bill again to the House of Lords. If, by sending up a Bill three times in that way, in three successive Sessions, the House of Commons keeps on asking for it, it will become law, even though the House of Lords rejects it every time. The result of that arrangement is that the House of Lords can delay a Bill becoming law, but that they cannot in the long run prevent it, if the House of Commons go on asking for it three times. But, as the time of the House of Commons is very fully occupied, the House of Lords by delaying a Bill may prevent its becoming law if the House of Commons are so busy that they have not time to go on asking. Many people think that the House of Lords, which is not elected and not responsible to anyone, ought not to be able to delay Bills in this way.

The last stage of the Road Transport Lighting Act 1927 was that on the 22nd of December, 1927, it and eighteen other Bills received the ROYAL ASSENT and became law.

The Royal Assent is quite formal, for the King has no right to refuse to agree with Parliament. It is usually given by the King signing a Commission, telling three members of the House of Lords to assent for him—and they send for the Commons, who attend in the House of Lords and are told that “*Le Roy le veult*” (which, as you know, is old French—dating from very early times—for “The King wills it”). On the 22nd of December, 1927, the King’s Commissioners assented like that to nineteen Acts of Parliament, one after the other.

MONEY BILLS

Before we go on again with Uncle William’s adventures it is interesting to look at one or two other of the Acts of Parliament in the same book as the Road Transport Lighting Act. One of them is called the Finance Act 1927, and it is rather long and complicated, all about taxes, beginning with a tax on tea. It is an Act by which people all over the country are going to be made to pay money for the purposes of the Government. It begins like this :

“ Most Gracious Sovereign—

“ We your Majesty’s most dutiful and loyal subjects the Commons of the United Kingdom of Great Britain and Northern Ireland in Parliament assembled, towards raising the necessary supplies to defray Your Majesty’s public expenses, and making an addition to the public revenue, have freely and voluntarily resolved to give and grant unto Your Majesty the several duties hereinafter mentioned ; and do therefore most humbly beseech Your Majesty that it may be enacted, and be it enacted by the King’s most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows . . . ”

The reason for the difference in this beginning is that the House of Commons alone is the body which passes Acts of Parliament for raising taxes. In this case the Bill would be certified by the Speaker as a Money Bill, and the House of Lords would not be able to alter it or delay it. The idea is that the ordinary people, who pay taxes, resolve by their representatives in the House of Commons to make a grant to the King, and the Royal Assent is still given in the words "Le Roy remercie ses bons sujets, accepte leur benevolence et ainsi le veult" ("The King thanks his good subjects, accepts their benevolence and wills it so"). That dates from the time when the King, through his secretaries, really did the spending of the money. Nowadays it is merely a formula, because the people who direct and arrange the spending are the secretaries, or, as we now call them, the Ministers. But, by their complete control over Money Bills, the House of Commons had, and still has, the last word—for, as you will remember, he who pays the piper calls the tune—and especially when he has to find the money for the piper out of his own pocket.

ARMY, NAVY, AND AIR FORCE

Another interesting Act of Parliament in the same book is called the Army and Air Force (Annual) Act 1927. And it begins with this: "Whereas the raising or keeping of a standing army within the United Kingdom in time of peace, unless it be with the consent of Parliament, is against law . . ." and, later: "And whereas no man can be fore-judged of life or limb, or subjected in time of peace to any kind of punishment within this realm, by martial law, or in any other manner than by the judgment of his peers and according to the known and established laws of this realm; yet, nevertheless, it being requisite, for the retaining all the beforementioned forces, and other persons subject to military law or to the Air Force Act, in their duty, that an exact discipline be observed . . ." Then the Act provides for the continuance for one year of the Army Act and the

Air Force Act. This is the way in which the Army and the Air Force are kept going. There is to be no standing army in the country, except by leave of Parliament; so each year Parliament passes an Act providing for the Army to continue for one year. If the Act were not passed, no soldier could be punished for disobeying orders and the War Office would have no power. This is because Parliament used to regard the King's Army with great suspicion and was determined to exercise this kind of control over it. The Navy is not dealt with in the same way. It goes on from year to year without annual Acts of Parliament to renew it. After all, as the Navy does not live on land, there was never the same danger of the King terrorising his subjects by the use of naval forces.

HOW AN ACT OF PARLIAMENT WORKS

We have been considering how the Road Transport Lighting Act 1927 became a law. Now let us see what parts of it mattered to Uncle William. First of all we find this :

“ 1.—(1) Subject to the provisions of this Act and of any regulations made thereunder by the Minister of Transport (in this Act, referred to as ‘ the Minister ’), every vehicle on any road shall during the hours of darkness carry—

- (a) two lamps, each showing to the front a white light visible from a reasonable distance ;
- (b) one lamp showing to the rear a red light visible from a reasonable distance ;

and every such lamp shall, while the vehicle is on any road during such hours as aforesaid, be kept properly trimmed, lighted, and in efficient condition, and shall be attached to the vehicle in such position and manner as the Minister may by regulations prescribe.”

That means, you see, that Uncle William's car had to have a red light showing at the back. But cars do not obey

Acts of Parliament, so the Act goes on to say who is to see that the red light is there.

“It shall be the duty of any person who causes or permits a vehicle to be on any road during the hours of darkness to provide the vehicle with lamps in accordance with the requirements of this Act and of any regulations made thereunder.”

Now, Uncle William caused his car to be on the road during the hours of darkness ; so it was his duty to provide it with a red light showing at the back. But we have not yet got to any provision for punishing him if he failed to carry out his duty. You will find that later on.

“If a person causes or permits any vehicle to be on any road in contravention of any of the provisions of this Act or of regulations made thereunder or otherwise fails to comply with any such provisions, he shall be guilty of an offence and shall be liable on conviction by a court of summary jurisdiction for each such offence to a fine not exceeding five pounds.”

So you see that, because the Bill became law, Uncle William, who had caused his vehicle to be on a road in contravention of one of the provisions of the Act, was guilty of an offence and liable, “on conviction by a court of summary jurisdiction,” to a fine. We shall have to see in time what is meant by “on conviction by a court of summary jurisdiction.”

REGULATIONS

Before we leave the Road Transport Lighting Act 1927, will you just notice that the Minister of Transport has power to make regulations—as a matter of fact, not only the sort of regulations we have just read about, but regulations under various other sections in the Act. The reason for that sort of provision is that Parliament is very busy

and has not time to arrange the details of all the Acts which it passes. So a practice has grown up, under which Parliament authorises the appropriate Minister to make regulations about details, especially those which may vary from time to time.

Another instance is that the Minister is authorised by Parliament to make regulations about parking-places for motor-cars. If anyone breaks those regulations he commits an offence just as though he broke the Act of Parliament itself.

EXECUTIVE: THE MINISTERS

The Minister is a member of the Government. He is a member of Parliament, who introduced the Road Lighting Act into Parliament and supported it through the stages we have been talking about in the House of Commons; also he is the Minister to the King, and, as the Minister with the help of the Civil servants in his office, he makes regulations and puts the Act of Parliament into execution. Parliament makes the laws and is therefore called the LEGISLATURE. The Minister, in putting the laws into execution, is part of the EXECUTIVE side of the Government.

The Minister of Transport happens to be a new kind of Minister. His office was set up by an Act of Parliament called the Ministry of Transport Act 1919—for Parliament can make laws setting up Ministries, just as it can make laws about what the Ministers are to do. Some Ministers are older—that is to say, they started by being secretaries of the King as soon as or before there were any Parliaments. For instance, the Lord Chancellor, who advises the King about the appointment of judges and the administration of the law, holds a very old office, dating from the time of Edward the Confessor. He presides over the House of Lords, just as the Speaker presides over the House of Commons.

The Ministers are a link between Parliament, which makes the laws, and the various people whose business it is to carry them out—the Executive. In the same way the

Lord Chancellor is a link between Parliament and the judges and magistrates, who interpret the laws and decide people's rights under them. The judges and magistrates are called the JUDICIARY. The Government of the country is therefore carried on, in the name of the King, by Parliament, which makes the laws, by the Executive, which administers them, and by the Judiciary, which decides people's rights under them.

THE PRIME MINISTER

The Prime Minister, like other Ministers, is a member of Parliament. He is the leader of the largest party in the House of Commons and the head of the Government. As the head of the Government he is the head of the Executive, but, generally speaking, though he is usually also the First Lord of the Treasury, he does not look after any particular Government office; his business is to keep all the Ministers working together. The most important Ministers form the CABINET, which is a committee that meets privately and decides the most important points of policy. The Prime Minister is the chairman of the Cabinet, and, in general, all the members of the Cabinet have to agree with its decisions or to resign.

The Prime Minister chooses the members of the Government—that is to say, the Ministers—from the principal members of Parliament in his own party. He is requested by the King to form a Government and submits the names to the King, who has to accept them. He is requested to do this because he is the leader of the largest party in the House of Commons. If he loses the confidence of the House of Commons, because of changes in the membership of the House or because some of his own supporters begin to disagree with him, he and the other Ministers have to resign, and to advise the King whether to dissolve Parliament or to ask someone else in the House of Commons to form a Government.

THE POSTMASTER-GENERAL

There is another rather interesting Minister, with whom most of us have dealings every day. The Postmaster-General carries our letters, sends telegrams for us, provides telephones, runs a Savings Bank, and, in his various offices all over the country—for every post office is just an office of the Postmaster-General—issues licences and pensions and postal orders and all the funny things you get over a post office counter. He began with letters in the seventeenth century; and rather expensive they were, travelling by postboys on horseback all over the country—and, the longer the distance, the more the letter cost. Then a London merchant, named Dockwra, started post offices and a penny post inside London. But the carrying of letters was, by Act of Parliament, a Government “monopoly.”—something which the Government refused to allow private persons to do. So Dockwra’s London penny post was taken over by the Government. But country letters were still very expensive; even after the Napoleonic Wars, when there were mail coaches instead of postboys, a letter to the north of Scotland cost 1s. 5d.—a great deal of money in those days. In 1840 a member of Parliament named Rowland Hill persuaded the Government to start a penny post all over the country, and the result was that a great many more letters were sent. As you know, letters cost 1½d. now (since the Great War), and the *average* number of letters for every person in the country every year is more than a hundred each.

Quite an interesting person, the Postmaster-General—a little old-fashioned in some ways—but he has taken over, not only Mr. Dockwra’s London penny post, but a number of other things since then. The telephones used to belong to private companies until he took them in hand. And all that business he runs quite successfully, as part of the Government of the country, and does all the business of banking and licensing and pensions too—a sort of Government errand-boy, responsible, like other Ministers, to Parliament.

One other thing before we leave the Postmaster-General.

Has it ever occurred to you that, though a water-fall is always there, there is never the same water in it? So there is always a Postmaster-General, though the person who fills that office is not always the same. I buy a postal order at a post office, when Mr. Liberal is the Postmaster-General, and a month later the man to whom I sent it can present it to be paid by the Postmaster-General, even if by that time Mr. Liberal has resigned and someone quite different, Mr. Labour, is the Postmaster-General. So, if the King dies to-morrow, the government of the country, which is carried on in his name, will not stop with a bump—as, to some extent, it used to at one time. The King may die, but his office is always there. The Crown, as it is sometimes called, survives.

LOCAL GOVERNMENT

We seem to be getting some way from Uncle William and his adventures. But, at any rate, it is clear that Uncle William broke the law and became liable to be fined, as he was fined. Now let us see how Uncle William was brought to book. The police constable, Ramrod, was walking about, you will remember, in the village of Titwillow. As Titwillow is in Loamshire, Police Constable Ramrod would be one of the Loamshire county police. Originally the county magistrates appointed the police, but by Acts of Parliament beginning in 1839, county police forces were formed, and their control transferred in 1889 to a committee, formed partly from the County Council and partly from the magistrates. The Home Secretary, who is one of the older Ministers, makes rules about the county police forces, including rules about their pay. In each county a Chief Constable, appointed by the Joint Committee, is in command of the police force. The Chief Constable of Loamshire appointed Police Constable Ramrod, and may dismiss him whenever he thinks fit.

Until 1888 each county was governed by the magistrates, but in that year County Councils were set up by Parliament.

They have to do with a great many things besides the police—things which have been delegated to them by Parliament, such as schools and education, relieving the poor, housing (see *Economics*, p. 669), public health (which includes a great deal of medical and sanitary work), various pensions, some work about agriculture, and so on.

County Councils, like Ministers, can make many regulations, but they are mainly an executive body. They carry out all sorts of laws, which have to be administered locally and according to local conditions. There is no room in this book to describe all the other kinds of Local Authorities, but it is worth mentioning that the larger towns, called "Boroughs" have Borough Councils which do all or most of what is done in counties by the County Councils and are more or less independent of the County Councils—the extent of their independence depending on the size of the borough. Some boroughs are County Boroughs, and, oddly enough, some boroughs are actually counties in themselves. London is a county, run by the London County Council, and the local government of London differs in a good many ways from that of other counties or cities. London, for instance, is divided into a number of boroughs. Birmingham—the next largest town in England—is one borough, a County Borough.

WHY IT HAS WORKED OUT LIKE THIS

All that, I am afraid, is rather confusing. You have to remember that, before there were good roads and quick journeys by road or by rail, the different groups of people living in England were more separated than they are now. I must not start writing the history part of this book—but remember that there was local government of some kind or other in parts of England before there was any central government for the whole of England, that the central government only got complete control gradually, and that, when Parliament established its rights against the Stuart kings, it did so with the help of country-folk, who learnt

how to govern by organising things in their own districts. So local government has always mattered in this country. The House of Commons is a body which has grown up to enable people representing different parts of the country to meet and govern themselves—not a body representing any one place which has succeeded in imposing government on other places. You find the same sort of thing in other countries, but often in a different form—not one Parliament and County Councils, but one central Parliament and local Parliaments, which have larger powers than a County Council would have. That system of local Parliaments (called “Federation”) applies, for instance, in the United States of America, in Germany, and in Russia (the Soviets). The only local Parliament here is that of Northern Ireland.

THE POLICE

Police Constable Ramrod, then, was for most purposes a servant of a local authority, subject to some control by the Home Secretary. Policemen are the successors of the old constables. Their powers and duties are partly the traditional powers and duties of a constable and partly given them specially by Parliament. One of their traditional duties is to bring criminals like our poor Uncle William to justice. They have limited powers of arresting people on their own—if, for instance, they suspect the commission of a serious crime (called a “felony”)—but in general they have to act mainly on warrants, or orders, issued by magistrates. They have the right to get help from passers-by in carrying out their duty, and anyone who prevents them from carrying it out can be punished for doing so. But it is one of the odder things about the police in England that they really have very little special power. Without the authorisation of a magistrate they can do very little more, especially in the country, than ordinary people. It requires no special authority to take a note in a book of Uncle William’s name and address and so on—though Uncle William was bound by Act of Parliament to show his

licence, for instance, to the police, while he need not produce it to you or me. But it was Police Constable Ramrod's duty to take those particulars, and, if Uncle William had prevented him from doing so, Uncle William would have been punished for obstructing the police in the execution of their duties.

Now, when Police Constable Ramrod went back to the police station and reported Uncle William, a Summons was procured. There are two things to notice about that summons. First of all, it was obtained from the magistrate, and Uncle William had to answer it and appear in court, not because the police told him to do so, but because the magistrate did. Secondly, though the person who informed the magistrate about Uncle William's back light was a policeman, there was no reason why anyone else should not have given the magistrate the information. The summons could have been issued just as well on information given by some private person. In fact, the policeman who informed the magistrate was a sort of public busybody—someone to do on behalf of the public a job which any member of the public could have done for himself, but which no one was likely to do. Roughly speaking, that is the traditional position of the policeman, and, in cases where he has special powers, they have usually been given him fairly recently by particular Acts of Parliament.

LEGISLATURE, EXECUTIVE, JUDICIARY

Police Constable Ramrod was a member of the EXECUTIVE. Most of the people concerned in governing are members of the Executive—the Minister of Transport, the civil servants under him, other civil servants, tax-collectors, postmen, policemen, and all soldiers, sailors, and airmen, whether they are Air marshals or Air craftsmen, Admirals or Able-bodied seamen, Generals or Privates.

But what about the magistrates who tried Uncle William? They were not members of the Executive, because they took their orders from no one—nor of the Legislature

because they didn't make the laws which they administered. They were members of the JUDICIARY. The Legislature, the Executive, and the Judiciary are the three principal bodies of people which govern the country. There is a traditional distinction between them. The Legislature is supposed to make the laws, the Executive to carry them out, the Judiciary to interpret and enforce them. But the distinction is apt to break down. When Parliament has not enough time to make the laws in detail it has given power to Ministers to make regulations. That means that the Executive, besides carrying out the law, has to take some hand in making it. In the same way the Executive has, under some rather complicated Acts of Parliament, the power and the duty to make decisions—often about the rights of private persons. That means that the Executive is to some extent doing the business of the Judiciary—perhaps because the costs of legal proceedings are so high. The general tendency is for the Executive to encroach on the business of the Legislature and the Judiciary. This is because modern civilisation has become too complicated to fit into the old scheme, under which Parliament made all the laws in detail and no one but the Judiciary made decisions under those laws.

JUDICIARY

The magistrates, before whom Uncle William was tried, were unpaid JUSTICES OF THE PEACE, sitting in PETTY SESSIONS—a small and a very old form of court. There have been unpaid justices of the peace in England for many centuries. They were first appointed by the King as “justices of the peace” in 1360. They are mainly a court for dealing “summarily” (without delay or formalities) with various small offences, like Uncle William's, and they can “commit” prisoners to be tried for more serious offences in other courts. To commit a prisoner does not mean to try him yourself. You do not decide whether he is guilty or not. You simply decide, on hearing the case against him,

that it is worth while keeping him to be tried by a more important court. When he is committed, he will either be kept in prison till the time comes for his trial by the more important court or he will be released "on bail," he and his friends promising that he will appear for his trial or that they will pay money if he does not. Of course, even if he does not appear and they have to pay the money, he will probably be caught and tried just the same.

A number of Justices of the Peace, sitting every quarter (of the year) in QUARTER SESSIONS, have larger powers than the justices in petty sessions, who tried Uncle William. They can deal with most criminal matters, leaving only the very serious offences to be dealt with by judges at ASSIZES. Assizes are the visits of the judges of the High Court to the important towns outside London, and the old names for their duties are interesting: "gaol delivery" and "oyer and terminer." "Oyer and terminer" is old French for "to hear and determine" (cases), just as "assizes" is itself an old French or Latin word. Those phrases, like the phrases for the Royal Assent in Parliament, remind one that the King's law was on the whole a Norman and Latin graft on the original Saxon stock—laws of the Saxons, administered by Norman kings and modernised in those days by the light of Roman law.

In the larger towns you have Stipendiary or POLICE COURT MAGISTRATES, who are paid officials and do the work done by the unpaid justices in the country. In the same way, in boroughs, RECORDERS take the place of quarter sessions. And in London, where there are no assizes, the judges try serious cases at the Old Bailey.

CRIME

That is a rough list of the principal criminal courts—courts in which you try cases about crime. Crime is "a wrong against the public welfare," or, as the old traditional language goes, "against the peace of our Lord the King." It may be more or less serious; and there are differences,

not only the old-fashioned distinction between **FELONIES** (such, for instance, as murder) and **MISDEMEANOURS** (which include such trifling offences as the affair of Uncle William's back light), but also as regards the punishment. You are hanged for murder, but Uncle William was only fined a pound. Besides, you cannot really classify crimes by labelling them. To steal something is theft. But you steal a penny by picking it up in the road and keeping it—and that is not really serious; or you may deliberately steal something valuable or steal from someone who is poor—and that is serious. So, except in a very few cases (of which murder is one), Parliament or traditional law—for some crimes are so old and obvious that they have always been recognised as crimes and punished—does not say what the punishment is to be. It simply says the most which the punishment may be—the maximum. The magistrates or the judge decide exactly what the punishment shall be—not above the maximum, but not necessarily up to it. They “sentence” the prisoner.

Now in Uncle William's case the magistrates first found him guilty—Uncle said he was guilty (“pleaded guilty”)—and then sentenced him to a fine of a pound. But in more serious cases—before the judge at assizes, for instance—the question of whether the accused man is guilty is decided, not by the judge, but by a jury.

TRIAL BY JURY

A jury is a very old institution in England. It consists of a number of persons, chosen more or less at random, to sit in a court and decide questions of fact.

Nowadays both men and women form a jury and usually the jury consists of twelve people. They decide in criminal cases whether the prisoner is guilty or not; and they also decide questions of fact in civil cases. In a criminal case you have to decide whether someone or other has or has not committed a crime—like Uncle William, though his was a small one. A “civil” case is just a dispute between

two private persons, not a question of crime at all. For instance, if Uncle William had driven his car into someone else's car, the other person might have said that it was Uncle William's fault, and that he had to pay for the damage caused by the collision. Uncle William might have said that it was not his fault, but the other person's. Then the other person—old Joe Smith, who was driving to deliver boxes of eggs at the station—might sue Uncle William. He would issue a WRIT, which would be a printed document—rather like the summons which Uncle William got about his back light—telling Uncle William to appear and answer for what he had done. Then there would be a good many preliminaries, lasting for some time—one of the troubles about justice in England is that it does take some time—and finally a TRIAL in which Uncle William, Joe Smith, and anyone who had seen what happened would give EVIDENCE—that is to say, tell the judge and the jury what they had seen and knew. The judge would then tell the jury what the law was, explaining to them that anyone driving a motor-car owes a duty to other people to drive it carefully, and telling them that they had to decide whether Uncle William or Joe Smith had been careless. The jury would then have to decide the question or questions of fact : whether Uncle William was careless, whether Joe Smith was careless, whether the carelessness of either of them caused the accident ; or whether, though one had been careless, it was really the combination of the carelessness of both of them which had caused the accident ; and, if either of them really was careless and so caused the accident, without the other one being at fault, how much damage the careless one had caused—how much damage to the other one's car or perhaps to the other one himself. The result might be that Joe Smith failed in his action, because Uncle William had not been careless or because Joe Smith had been just as much responsible as Uncle William. Or, if Uncle William had been careless and was the cause of the accident, Joe Smith might recover, in that civil action, the amount of damage (in money) which Uncle William had caused to

him or his car. The jury, you see, would decide, on the directions of the judge, who was at fault and how much he ought to pay.

CIVIL COURTS

Civil actions are not tried in the same courts as criminal cases. The smaller civil cases are tried in **COUNTY COURTS**, which are local courts, held in most towns of importance. There are only eight persons in a county court jury. There is a county court judge—numbers of them, for there are so many county courts. Cases in which the claim is for not more than £100 are tried in county courts. Cases in which there is a larger claim are tried before judges of the **HIGH COURT**, either in London or on assizes. The judge at assizes, therefore, has to take both civil and criminal cases. In London the judges of the High Court try civil cases in the Royal Courts of Justice—that extraordinarily ugly building in the Strand—and criminal cases at the Old Bailey (near St. Paul's). Then there are “appeals.” If the person who has lost the case thinks that the judge made a mistake about the law, he can appeal from the judge to the **COURT OF APPEAL**. There is also an appeal in criminal cases to the **COURT OF CRIMINAL APPEAL**, which consists of two or three High Court judges sitting together. The final court for law cases is the **HOUSE OF LORDS**. When the House of Lords is not doing business as part of the Legislature—you remember what it had to do about Acts of Parliament—it may sit to have the very last word about law cases. Those cases are heard in the same place in which the House of Lords sits for Acts of Parliament, but only a few of the lords sit; they are judges, who have been made lords for this purpose. The Lord Chancellor usually presides, and former Lord Chancellors who have retired from office also sit as judges there.

CIVIL LAW

The civil law—the law about disputes between people—is at least as important as criminal law, and actually it

takes up much more of the time of the courts. You hear rather less about it, because the newspapers are more full of criminal cases and people always talk about murders. But, you see, one of the main reasons for having a civilised society is to give people the opportunity of settling their disputes peaceably in a court instead of having to fight about it (see *Problems and Solutions*, p. 695). Most schools suffer from having no satisfactory arrangements for settling disputes except fighting about them!

The trouble about the way in which grown-ups settle disputes in law courts is that proceedings in law courts, especially in this country, are very expensive. You have to get advice from lawyers and help from lawyers. They usually argue the case in court for you, and they have to be paid. Also you have to produce all the papers about the dispute and have them copied for the judge. Also you have to prove what you say about the dispute by calling people to give evidence—Joe Smith, for instance, might call someone who saw the accident, to say that it was Uncle William's fault, and that person would have to be paid for the time he took to come to court and give his evidence. So some people say that when King John promised at Runnymede that he would sell justice to no one, he might have taken care to see that justice really would be cheap and would not become as expensive as it actually is.

Let us just see what are the principal disputes between people. There are really two main points. One is that people living in a community owe duties to their neighbours. In a sense, any crime is a breach of your duty to your neighbour, but we have gradually come to look at it as a breach of duty to the community, "against the peace of our Lord the King"—so that a crime is the subject of criminal proceedings brought in the name of the King on behalf of the community. But there are breaches of duty towards your neighbours which are not crimes. Uncle William, if he was careless with his motor-car and so collided with Joe Smith, did not necessarily—probably did not—commit a crime, but he did break his duty to take care when driving, and by that breach of duty he injured Joe Smith. That

breach of duty is called a **TORT**. Other instances are : if you leave some obstruction in the roads, where everyone has a right to go, so as to make it dangerous and hurt someone ; or if you make such a horrible noise or smell in your house as to be a **NUISANCE** to your neighbours ; or if you **TRESPASS** on your neighbour's property and do damage there, perhaps breaking the gate you have been swinging on. All those things are torts, and most of them depend upon the legal maxim : " *Sic utere tuo ut alienum non lædas* " (" Use your own property so as not to harm other people's "). Anyone who is injured by a tort can recover the amount of their injury—the money value of it—from the person who has committed the tort. You will notice that the law is mainly concerned (perhaps too much so) with money.

The second point is that you ought to keep your promises, and that, in general, if you do not, you will be made to pay what you have promised to pay, or what has been lost by your not keeping your promise. If you just promise out of kindness, you will not usually be held responsible in a law court. But, if you got anything for your promise, you will be made to carry it out or to compensate the person to whom you promised. There are far more promises in everyday life than you think. If you go into a shop and say, " I want a sixpenny tin of bull's-eyes," you are really promising to pay 6*d.* if the shopkeeper gives you the tin. If he gives you a tin and takes your 6*d.*, he is promising that the tin contains bull's-eyes—more or less eatable ones. There was a great case once about a man who asked for " two nice fresh crabs," and didn't get them—not fresh at least. But that is quite a long story, and perhaps you can guess the rest. If you get a railway-ticket at Paddington for Oxford and look at the time-table and the notices in the station and get into a train labelled Oxford, the railway-company is really promising, in return for the price of your railway-ticket, to take you to Oxford by that train—and more or less to time. I must leave you to think out any number of other instances for yourself.

Sometimes what you get for a promise is not an actual

benefit, but the promise of one. For instance, you may promise the shopkeeper that you will buy a tin of bull's-eyes in a fortnight's time, and he may promise to sell them. That is promise for promise. All those agreements, those mutual bargains or promises, are called by lawyers **CONTRACTS**; and the second main point of civil cases, besides torts, is this matter of "contract"—simply keeping people to their bargains or making them pay if they break them.

There are various other matters about which you can have a civil case, but in the long run almost all cases are about either torts or contracts—your duty to your neighbour because you live with him in a civilised society, or your duty to him because you have promised something. There is a good deal to be said for the view that even your duty, arising from living with people, really depends on a sort of promise, but it is rather hard to say exactly who made it and to whom.

LOOKING AHEAD

Well, this is the end of Uncle William's story. I have tried to tell you something about how the law is made—partly by tradition, in this country, and partly by Parliament—and roughly how Parliament works. Then we have had a look at Ministers and all the humbler fry who make up the Executive—the people who fill in the gaps and make the law work. Then we have had a look at the judges and juries and the other people, who have to decide whether the law has been kept or broken, and who is right and who is wrong, and what punishment or compensation for a wrong ought to be. It is all rather a complicated machinery. What is curious is that in some ways the machinery gets simpler as time goes on, in other ways more complicated. On the whole, the tendency of law, and, to some extent, of government, is to set up more rights and duties, but to make the enforcement of them rather less complicated. The law tends to get less formal, but there is

much more to make laws about. It becomes more and more necessary to regulate people's rights and duties towards one another—things like health in factories, unemployment insurance, taxation (see *The Last Thirty Years* and *Economics*). All of them in some form or another are the subject of law and government. The machinery is perhaps better oiled ; it runs with less creaks than it used to ; but it has much more to do.

I shall leave you to think out criticisms for yourself, but may I suggest one or two worth thinking about ? First of all, as I have suggested, are not some of the old lines of distinction breaking down ? The more complicated the duties of Parliament, the more it leaves to be made law by the Executive ; think of all the regulations about motor-cars which are made by the Executive under the general authority of Parliament. The more new rights and duties imposed, the more likely you are to find that they are enforced to some extent by the Executive—by Civil servants instead of in law courts. Perhaps we are living in a time when the State is taking on so many more duties that it is changing its character. Government is beginning to mean so much more. As we saw, the Post Office is really a trading concern. There are other instances. The Government, which both trades and governs, is beginning to spread itself over all the activities of the community. Whether we think it right or not, that is certainly the tendency. With it there is, I think, a growing tendency to enlarge responsibility—to recognise that people cannot be left merely to their own ideas of what is right and wrong even over things about which they used to be left to take their own line. That sort of question is, perhaps, the most important question which anyone concerned with the machinery of government and the law has to consider to-day. I shall leave you to think about it. I am sure that, when you are grown-up, you will be nearer the answer, if there is one, than I am.

ECONOMICS
OR
THE POWER OF MONEY
by
HUGH GAITSKELL



HUGH GAITSKELL is a young economist who lectures at London University. Economics is hardly ever taught in schools, and it is a rather difficult thing to explain, partly because it is still a very incomplete science, but I think you will understand this chapter. I have put one or two difficult bits into square brackets. The part about the Gold Standard looks difficult, but I don't think it really is, and it is rather important for you to understand about it, as it is influencing your and your parents' lives a great deal just now, and more nonsense is talked about it in books and newspapers than you would think possible! It seems a pity you should have to bother about economics at all; it is only a means to an end—making people able to lead the kind of good life they want to lead. But just now everybody is entangled in economics; people have to earn their livings and pay for things (including this book), and most people are constantly being worried about money.

That is because the economic part of life is in such a muddle. Hugh Gaitskell thinks that this ought to be made as easy and simple as traffic regulation, and as little bothering; but the only way for that to happen is for people to put it right; and the only way for them to put it right is by understanding it.

ECONOMICS

NATION WARS AND THE NATURE WAR

WHEN a country is at war, planning is necessary. The general who commands must plan his campaign and his battles. He has an army, so many infantry, so many guns, so many aeroplanes, so many tanks. His problem is to make the best use of these ; his object is to win the battle. He has to make decisions : how far to concentrate them, how far to scatter them, how many to keep in reserve, how to combine them. Behind him are other people, planning how to use a whole population and everything that they have, their fields and their factories, their machines and their mines. What do these other planners—the statesmen—have to decide ? They have to decide how large the army shall be, how many people and machines shall be used for making munitions, and how many for producing clothes. But other things are necessary too. There must be railways and merchant ships for transporting troops and the munitions and food that they need ; a navy to defend and attack by sea ; aeroplanes to make raids. The statesmen, too, have one object—to defeat the enemy. With this end to guide them, they have to decide how to use the people and the things they control.

Actually a war is going on all the time. Not a war between one nation and another, but a war between all nations and nature. A war which everybody is fighting against starvation and cold, against poverty and want. A war to make the world richer, to satisfy our needs better. In a war between nations, science is used only to kill and destroy, but in the war between humanity and nature, science produces and constructs. But in neither war is science alone all that is needed. There must be planning, too. In both wars the same kind of decisions have to be made—decisions

about how people shall spend their time, how the resources of nature shall be used.

In the "nation-war" each country plans independently, each country has a single aim—to defeat the enemy. Somebody is appointed to direct operations, and everybody else carries them out. But how is the planning done in the "nature-war"? This is the question which it is my business to answer. This is the ECONOMIC question. ECONOMIC activities are all the things that people do in fighting this "nature-war." ECONOMIC science, or ECONOMICS, is the study of the way people fight this war.

In the "nature-war" the nations are not fighting one another, yet they do not plan together. Most of them do not even plan for themselves in the way that they would in a "nation-war." To-day it is only in Russia (see *Peoples of the World*, p. 595, and *Problems and Solutions*, p. 713) that there is planning of this kind. In the rest of the world there is no dictator or supreme council to decide how many miners there shall be, how many fields shall grow barley or wheat, or how many ships or railways and engines are needed. Governments do not discuss these things. Yet somehow even in the rest of the world different things are produced, resources are directed to different uses, and people to different jobs. One man becomes an engine-driver, another man a teacher. There are machines for all kinds of different uses. There are railways and ships, food and clothes, roads and houses, in the rest of the world as in Russia, in peace-time as in war. How is this done? How do we in the rest of the world fight this war with nature? How is the campaign conducted without generals, without commands?

RAISING CAPITAL

Suppose a new discovery is made: an aeroplane which can drop like a bird and land in the space in front of a house, an aeroplane which is small and easy to drive and quite safe. How could it come to be used? Remember,

there is no supreme body which decides these things. Someone would have to decide on his own to organise the production of aeroplanes like this. He would have to build a factory where they could be made; he would have to get the materials for making them—steel for the struts and the body, special canvas for the wings, timber for the propeller, rubber tyres for the wheels; he would have to get machines for making the different parts, for fashioning the steel and the propeller and the delicate powerful engine, and he would have to arrange for electric or steam power to drive the machines; he would have to get workers to come to the factories to work—mechanics, woodworkers, draughtsmen, painters, each man a specialist, each man to his job.

How can this be done? One thing is essential. MONEY. The factory, the machines, the materials, the men, will all come if they are offered enough money.

How much money will be needed? Probably a great deal—perhaps £100,000. How is this to be found? Would the inventor have it? Not very likely; few individuals have so much. More than one person will have to contribute. The inventor and his friends have some money, but not enough. How are they to get more? They will have to go to the CAPITAL MARKET. What does this mean? It means a place where money is lent and borrowed for rather long periods. If you are going to build a factory with the money you borrow, it is no good promising to repay it in three months. When money is lent for long periods it is generally said to be INVESTED, so in future I shall talk of investing instead of simply lending. How are people induced to invest their money? How can they be persuaded to join with the inventor and let their money be spent on a factory for producing aeroplanes? Obviously, there is no need for them to do this. They can spend the money, and buy all sorts of things they like with it. To get them to invest there must be some inducement. The inducement will be the prospect of getting more money in the future. There are various ways in which this inducement can be offered. The inventor and his friends can borrow the money by agreeing to pay INTEREST for it. That is, they may

guarantee to pay a sum of money every year for the use of it. Or they may persuade those who lend the money to join with them and share the PROFITS. I will explain what exactly this means later (p. 653), but first there are some other things to say about the capital market.

What is meant by CAPITAL? Here it means quite simply money for investment. This is just what the inventor and his friends have come to the market to get. If they can persuade those who have money, which they are thinking of not spending, that they will make large profits, they will easily be able to get it. This business of investment is very important. For, unless people were prepared to invest, the aeroplane factory could not be started. Unless people had invested, other factories that exist to-day could not have existed. When investment takes place, people decide to spend their money on things which are going to be used for producing other things. In fact, they buy factories and machines and materials which would not be made unless they were prepared to buy them. If, instead of investing, they chose to spend their money on clothes or food, the factories and machines and materials would not exist, food and clothes and other things would have been made instead, and, since the food and clothes would be used up quickly and could not help to produce other things, there would be less capital in the country. The same word is used to describe both the money raised or borrowed in the capital market and the things which are bought with it. The factories and machines and materials are called Real Capital. Real Capital is necessary for making things. Real Capital only comes into existence because people do not spend all their money, because people invest, because people are willing to provide money capital.

Supposing the inventor and his friends have borrowed money in the second way that I mentioned. Instead of insisting on interest, every year the lenders have agreed to join with them and share the profits. What is the position? Here is a pool of £100,000—owned by all sorts of people. They agree that this new aeroplane shall be produced: that is how the money is to be spent. But they

cannot each spend it ; they must act together. What will they do? They will form a **JOINT STOCK COMPANY**. A joint stock company is just an association of people who each contribute money and start a business. The people themselves are called **SHAREHOLDERS**, because they hold **SHARES** in the company, each owning some of the £100,000, and therefore some of the things on which it is spent. The company must have a name. Let us call it "The Swallow Aeroplane Company." Also the company must have somebody in charge, somebody in control. The shareholders will appoint a **BOARD OF DIRECTORS**, and these directors will be responsible to the shareholders and have to see that the company is well managed.

The shareholders will be given certificates for the shares which they hold. These certificates can be sold or bought. And there is a special place where this is done, called the **STOCK EXCHANGE**. If you look at a daily newspaper you will see long lists of prices on the "financial" page ; these are the prices of the shares or certificates as they are bought and sold from day to day.

PRODUCING AND SELLING: COSTS AND PRICES

Now at last we can visit the factory, the factory which is paid for out of the money capital, the factory which is now Real Capital. Work has just begun. The new machines hum and throb, and gradually the steel and timber are transformed and the parts of the aeroplane fitted together. The first one appears complete, and then another and another. When the factory has been working for a time, it produces fifty a week. But what is to be done with them now they are ready to fly, standing new and shining beside the factory? They have to go to the **CONSUMER**, the person who wants, and is going to use, the aeroplane. Who is he? Surely everybody will want one. What could be nicer than to go about in a small aeroplane? But can anybody have one? Only on one condition—*that it is paid for*.

These aeroplanes will not be given away free. A price will

be charged, and money must be given for them. After all, they have cost money to produce. Perhaps 1,000 workers are employed. Suppose their wages average £3 a week. There is £3,000 gone. And for the materials and the power and the other things needed for production, perhaps £2,000 every week. So the fifty aeroplanes cost at least £5,000, or £100 each to produce, and that without counting the factory and machines, which cost perhaps £50,000.

What about the factory and the machines? Should we really add something on for them? Obviously they are rather different from the materials. For the materials have been used up, and so has the work which is paid for in wages, but the factory and the machines are still there. Of course, the materials and the work have not been wasted. They have gone into the aeroplanes. Still, the factory has also helped to produce them and yet it is still there at the end. So what are we to do? The truth is, we must count in something for the factory. For, though it is still there, it is no longer new. It is worn out a little, and so are the machines. Bits of them have really gone into making the aeroplanes too. They do not last for ever. Suppose they last three years and they cost £30,000. Then at the end of three years the machines will have gone, like the materials, into the aeroplanes. The materials are used up quickly; the machines are used up gradually. That is the only difference. In a week not much difference will be made, but we should add on something—perhaps £200. The factory is just the same, only it lasts still longer than the machines. It lasts perhaps twenty years and it cost £20,000. For what it loses in a week we should really add £20, a sum so small that we need not bother about it.

The fifty aeroplanes cost, then, about £104 each. No, they will certainly not be given away. But at what price will they be sold? When you go to a shop to buy sweets, you find the price, the money you have to give, settled. It is marked in the window: "Acid Drops, 4d. a $\frac{1}{4}$ lb." Who has put it there, decided on the price? The person who is selling sweets, of course. It is the same with the aeroplanes. The directors, or the manager who acts for them, must

settle the price. This sounds easy. They want a high price—as much money as they can get for each aeroplane. Naturally they will fix the price high. But this may not do. What is the good of a high price if nobody will buy the aeroplanes? The directors can fix a price, but they cannot force people to buy at that price. The acid drops might be 1s. a $\frac{1}{4}$ lb., but would you buy them at that price? No, you would probably buy bull's eyes at 6d. a $\frac{1}{4}$ lb., or you might spend your money on something quite different. So if the directors charge too much they will not sell many aeroplanes. They might begin at £1,000; but this is too much for most people, and they only sell five a week, while fifty are being produced. So they have to lower the price, and as they lower it people begin to buy more, until eventually at a price of £120, they sell the whole fifty every week.

This means that the company is receiving £6,000 every week. What happens to this money? Does it go back to the shareholders, the people who spent £50,000 on the factory and the machines and then began spending the rest of the capital, the other £50,000, on wages and materials at the rate of £5,000 a week? No, it will not go back to them, because if it did the factory would stop. After ten weeks' working, that part of the capital which was not spent on the factory and machines would all be used up. There was only £50,000, and in ten weeks, at £5,000 a week, it would all be gone. In these ten weeks the shareholders would get £60,000. But, if they insisted on keeping it, the factory would have to stop, for there would be no money to pay wages and buy materials. So if the factory is to continue, the directors must go on spending £5,000 a week. Really they must spend more; they must keep the machines up to date; they must spend another £200 a week doing this. But that does not account for all the £6,000. There is £800 a week left. This is what will go to the shareholders. This is the PROFIT on their investment which I promised to explain. *It is the difference between the costs of producing, including the wearing out of the machines, and the money received in selling the aeroplanes.* In a year it will

be more than £40,000. At the end of a year the shareholders can receive this huge sum, and yet in the factory and machines, in the half-finished and finished aeroplanes, they will still have the £100,000 which they invested. Profits are generally expressed as so many pounds per cent., so that in this case we can say that the profits for the year were 40 per cent.

If the people who provided the money had refused to become shareholders and had preferred to be simply Lenders, they would have been paid interest at a much lower rate than this—perhaps only at 5 or 6 per cent. But then the 5 per cent. would be much safer. The inventor and his friends would have *had* to pay it, whatever happened. The profit is much less certain and is not guaranteed, so that when it is paid we should expect it to be larger.

So here is the invention, originally perhaps the work of a scientist, made use of. There are real aeroplanes. Every week fifty are turned out and sold, and by the end of a year they have become quite common. And why are they produced? They are produced to be sold for money. Those who organise their production do so to “make money”—that is, to get back more, as much more as they can, than they put in. Aeroplanes go to consumers, money goes to producers—money for wages, for materials, and for profits.

But this situation, so pleasant for the shareholders of the Swallow Aeroplane Company, will not go on for ever. Other people with money to invest will say, “Here is a way of making large profits; we will produce these aeroplanes too.” So several new companies will be formed, and more capital will be raised from the capital market, and we shall have the Skylark Aeroplane Company and the Hawk Aeroplane Company and the Kingfisher Aeroplane Company, each with a factory, each producing aeroplanes which can drop like a bird and land in front of a house, and are small and safe and easy to drive. Now with more factories there will be more aeroplanes produced, and so more aeroplanes which have to be sold—not fifty a week, but several hundreds or even thousands.

But do you remember how, to sell fifty a week, the price had to be reduced to £120? So to sell more the price will have to come down now. Each company will be compelled to reduce its prices. For, supposing that the Swallow Company—the first one—insists on charging £120, it will no longer sell the aeroplanes, for people will buy them more cheaply—perhaps for £100 or less from the Skylark. Each company will want to sell its aeroplanes, and each company, so long as it still has some unsold, will reduce its price until it sells them. Supposing there are 2,000 produced every week. Then the price will have to fall perhaps to £80 before they can all be sold. We call this state of affairs **COMPETITION**. All the companies **COMPETE** against one another, and no company can charge more than another unless its aeroplane is better.

But this fall in prices may be very awkward. For if aeroplanes will only sell for £80, then, supposing the Swallow Company still sells fifty a week, what it receives—its receipts—will only be £4,000 a week. But this is less than what is paid out. The aeroplanes cost £104 each to produce. So the company will try and reduce its expenses; it will try and use less materials and less workers; it will probably try and pay the workers less. Supposing it manages to reduce its expenses to £90 for aeroplanes, even so it will still not be getting as much back as it pays out. It will be losing £10 on every aeroplane—that is, £500 a week or £25,000 a year. This will be the **LOSS** just as the £40,000 was the profit. If it is losing like this, it will not go on making aeroplanes. In fact, it will only be able to go on making aeroplanes if it can get more money, for if it is only receiving £4,000 a week it will not have enough money to buy the same materials and pay the same wages. But who will provide the money? Obviously, if the losses are likely to go on, nobody will, and so the company will have to come to an end.

Does this mean that no aeroplanes will be produced? No; for some companies will last longer than others, and as the Swallow and perhaps a few others disappear, so it becomes possible for the prices of aeroplanes to rise, as

there will be fewer which have to be sold. Eventually prices will rise above costs and profits will again be made.

Do you remember the question we asked some time ago? How was it that workers and the mines and fields of nature were divided out, some used for producing one thing, some used for producing another? Now at least we know something about aeroplanes. Aeroplanes are made so long as investors can make profits by making them. If there are profits, they will be made, and people and things will be used for making them. If there are losses, they will not be made, and people and things will not be used for making them.

But what about all the things that we buy in shops? Bread and meat, clothes and books, chocolates and cigarettes. It is just the same with these. For instance, it is the shopkeeper who sells them to you directly. To own a shop he had to invest. He had to buy the materials, the things he was going to sell, and perhaps he had to pay someone to work in the shop with him. He will go on being a shopkeeper so long as he is making a profit—that is, so long as the amount he gets from people like you who buy from him is more than his costs—what he had to pay for the materials and for his assistant, for the rent of the shop and something for his own work too. Then take the people from whom he bought his supplies—the manufacturers. They produce, too, for a profit. They will go on producing so long as they make a profit, so long as their prices are higher than their costs. But if their costs are higher than their prices, they will be losing and they will stop.

It is the same with almost everything. Why is coal produced? To produce it, workers are needed, and machines—machines to drill the coal from the seams, workers to work the machines, trucks to carry the coal underground, winding apparatus to bring it to the surface. It is all done because somebody has thought it worth while to invest, to pay for the sinking of the shaft and the instalment of the apparatus, and somebody still thinks it worth while to organise the working of the mine, to pay the wages, direct the workers, and arrange for the selling of the coal. Aeroplanes

fly. But coal and the things in shop windows must be carried, and so must everything else—everything which is not a carrier. Railways and ships and lorries and buses were built because people decided to invest, and hoped to make profits. Profits are the difference between what they have to pay to provide the services and what they receive in payment from those who buy them.

So profits control production. If there are no profits, nobody will invest, nobody will buy the things needed for production. Factories, shops, and mines will be closed. If there are large profits, people will invest, and production will continue and increase. Also, if more profits can be made in producing one thing—houses, for instance—more houses will be made, and materials and men used in less profitable industries will be transferred to the house-building industry. Does this help us to answer the questions, “Why are some things produced and not others?” “Why are some people farmers, others miners, others railway workers, and others teachers?” It is a beginning, but we must go further and find what causes the change in profits, what makes them larger or smaller.

THE CONTROLLING POWER OF MONEY

A good way to think of money is as something moving and flowing in the way that it does in the diagram overleaf.

At one end of the stream people are buying things in shops. Things are being taken from the shops, and money is being paid into the shopkeepers' tills. But the money does not stay there and accumulate. It is paid out by the shopkeeper. Most of it is paid to the manufacturer in return for fresh supplies of goods, so that the shop never becomes empty. Some of it is paid out in other ways—to those who work in the shop, including the shopkeeper himself, and to the landlord who owns the shop and from whom it is rented. If we go back to the manufacturing stage, the same thing is happening—money is moving in and the products of the factory are moving out. Some of the money is paid

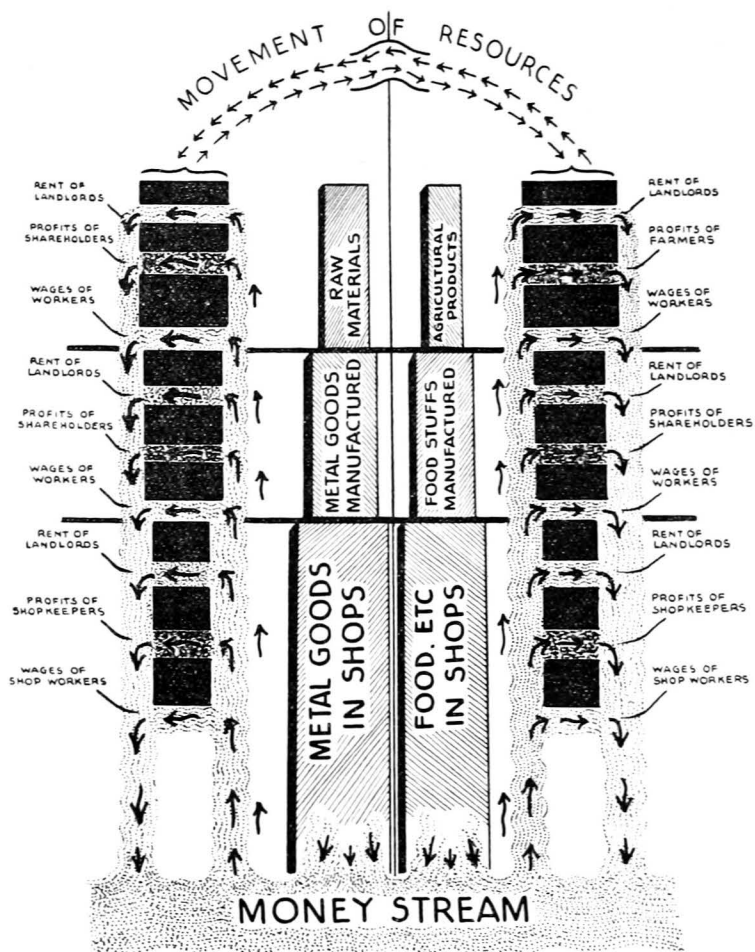


Fig. 89. THE MONEY STREAM

to workers, some to shareholders, and some goes back to a still earlier stage—to the producers of raw materials.

All this is shown in the diagram. To simplify it, there are only two groups of industries included. One produces foodstuffs, the other metal goods of all kinds. The things which are being produced are shown as coming forward to the shops and then passing on to the consumer in a continuous stream. Moving back at the same time is just as continuous a stream of money. But the money never disappears, is not used up as the products of industry are. It is handed over to people who have helped in some way to produce the goods for which it is paid. First, of course, to the workers of all kinds who, at all stages from the mine to the shop counter, have helped to make the goods and bring them nearer the consumer. Second, to the owners of one kind of property, the landlords, the owners of the land and the buildings—shops, offices, and factories which have to be hired. Third, to the owners of a slightly different kind of property, the shareholders, those who really own the machines and all the stocks of goods, some completed, some only half made. Sometimes the farmer owns the land he cultivates, or the company owns the sites and buildings it needs (as the Swallow Aeroplane Company did). But in England, at least, they are frequently different persons or different companies. So that which is paid out at each stage is divided into three streams, corresponding to these three different groups who receive the money. What is done with the money which is paid out? It is used by those who receive it to buy what they need. It returns to the main stream at the bottom of the diagram, where it may be spent on any of the things which are being produced. This is what happens in the diagram, but it is not quite accurate. For something else might be done with the money. It might go to the capital market and be invested. Some money always does go in this direction. It is spent on buildings, factories, and machines with which more goods will eventually be produced.

Now we can return to the problem of changes in profits. Profits consist of the difference between the money received

by shareholders and the money paid out by them. This money which is paid out by them is called COSTS. It is what has to be spent to produce the goods. In the diagram it is shown by the stream of wages, the stream of rent, and the stream flowing back to the stage above to pay for the materials. The other stream is not COSTS ; it is PROFITS, and goes to the shareholders. It is the size of this stream which directly controls production. How will it be altered ? Well, let us suppose that we start with a situation in which that stream in all the different industries is of such a size as to give the shareholders an equal rate of profit —say 10 per cent. on the capital invested. And now suppose that consumers decided to buy more of one thing—more, for example, of the miscellaneous metal products—and less of another—less of the foodstuffs. What happens ? The money stream running through the metal industry becomes larger. Since there is more money, and the same amount of metal products, this will lead to a rise in the price of the metal products. Prices will move up above costs, and larger profits will be earned. In the diagram this will lead to each profit channel becoming larger in the stages of the metal industry. The increased stream of money will go to the shareholders at first, and not to the other persons who receive payment. Meanwhile, in the food industries exactly the opposite will be happening. The stream of money will become smaller, and, since for the moment the amount of foodstuffs being produced is unchanged, the price of foodstuffs will fall. In the diagram we should see the profit channel at each stage becoming smaller, and the shareholders no longer receiving the profits that they were receiving before.

But production will not remain unaffected by this change. People will stop investing in the foodstuff industries and will invest instead in the metal industries. As the direction of investment changes, workers will move as well, for it will be harder to find employment in the food industries and easier to find employment in the metal industries. As investment changes and workers move, less food is produced—the food stream becomes smaller. But this will

mean higher prices for food, and so profits will become larger. Meanwhile, in the metal industry the opposite will be happening: more metal goods will be made, and, since the money stream is the same, lower prices will be charged. This will bring profits down until eventually the rate is about the same in both industries. After that there will be no more movement.

What is the result of all this? Simply that there are more metal products and less foodstuffs. But this is just what is wanted. Consumers spent more on metal products because they wanted them more. For the moment they could not have more, and so prices rose. But the effect of prices rising was eventually to attract more investment, and so to lead to more production of the metal products.

Is this all that needs to be said about changes in profits? No; there is the other side, the side of costs. Profits depend not only on the money coming in, but also on the money going out. We have seen how the money coming in may change. What is there to say about the money going out? Does not this ever change? May not costs rise or fall as prices can rise and fall, so that profits remain the same or are only slightly changed?

Costs depend on the amounts of different things bought by producers, and the price paid for each particular thing. In the aeroplane factory 1,000 workers were employed, and their price, or wage, was £3 a week. Therefore the costs of labour were £3,000 a week. If costs are to be reduced while the same amount of workers are employed, providing the factory was already efficiently managed, there is only one way to do it—a lower price must be paid. And it is just the same with the other things needed for production. To lower costs, their prices must fall—the prices of coal or steel, the rents of land or buildings. The question is, Can this be done? The answer is, Sometimes not at all, sometimes a little, sometimes quite a lot. Take coal, for example. Can the food producers pay less per ton for their coal? Certainly not. Coal is something used by everybody—in factories and railways, in houses and ships. If there is competition, it must be sold for the same price to everyone,

just as the aeroplanes were. If the food producers refuse to pay the old price, the sellers of coal will take it to other buyers instead.

On the other hand labour costs may be different. Take the agricultural workers. Can their wages fall? For a time, yes, for nobody else employs them except the farmers. They cannot do what the coal merchants would do and just take their labour, which is what they are selling, to people who will buy at the old price. There are none who will do so. But even here there is a limit to the fall in costs. For agricultural workers, if they absolutely must, can leave the farms and try for jobs of a different kind. They can become miners or porters or building labourers. This is what will eventually stop the fall in wages.

Take a third kind of "cost": the rent of the baker's shop. When the baker's profits are dwindling, he will go to the landlord and ask for a reduction in rent. Will the landlord agree to this? It depends on whether somebody else—a bookseller or a draper or a shoemaker—can be persuaded to pay the old rent. The landlord who owns the shop will try and get the highest rent for it.

Now we can say some things in general about this question of costs. Any fall in the prices of those things used in production—coal or steel, farming land or shops, the work of a ploughman or a skilled engineer—will be checked by the fact that their owners will be able to get more for them somewhere else. This check comes quickly where the things are not specialised—that is, when they are and can be used in many different ways and for many different purposes—things like coal and steel, oil and electric power, offices and shops, the work of typists and clerks. The check comes slowly when the things are specialised—that is, when they cannot be used in other ways, for producing other things. Examples of this are the services of skilled engineers or trained craftsmen, land which grows one particular crop, mines which yield only one kind of mineral. This is very important, for it shows just why, when consumers change the way in which they spend their money, there will be a general change round where it is possible in

the use to which the resources of a society are put. Not merely investors, but owners of all the other things used in production, move from one industry to another, attracted by the rising stream of money and repulsed by the falling stream. By means of the money stream and changing prices, resources are likely to move to those places where they are most wanted by consumers.

TAXES

Is this control by prices and profits quite universal? Not altogether, for everything that we buy is not exactly the result of investment and production. For example, we pay doctors for their services directly. These are not "produced," and the payments for them do not result in "profits," or "losses": it is the same with lawyers and artists, with gardeners and cooks, and any persons who, working on their own, sell directly to the public the services they have to offer. And there are some things we use for which we do not pay directly at all. We are protected by policemen and by soldiers and sailors, and yet we do not hire their services. The roads that we use have to be repaired, but we do not pay the roadmenders directly. These things are paid for by the Government, and the Government collects the money to pay for them by what are called TAXES. Some of the money paid to workers and shareholders and landlords is taken away by the Government and spent for everybody on roadmaking, on defence forces, on the judges and police (see *Law and Government*, p. 623), and anything else which Parliament has decided shall be provided by the State. In this way new industries and professions may be created, industries like national armaments, professions like the civil service and the police force.

THE CAPITALIST SYSTEM

Sometimes, then, that which people buy is not the result of investment, or produced for profit. Sometimes the Government spends people's money for them. But these are

exceptions, at least in all countries except Russia. The vast majority of the things we need are provided because people are prepared to pay enough for them to make a profit for investors. This system in which production is really controlled by individuals who have capital, and invest that capital to make profits, is called the CAPITALIST system. This is how the greater part of the world to-day meets the problem of economic organisation, and plans the use of its human and natural resources. Is the system a good one? Is it really the best way of fighting the perpetual campaign against scarcity? Can we think of other ways which are better?

Here are some points in its favour. It leaves people *legally* free to do what work they like. They can become engineers, farm workers, railwaymen, or office workers, just as they feel inclined. Nobody is compelled by the law to work at one particular job. This freedom does not lead to chaos. On the contrary, it leads to people working at those jobs, and in those places, where consumers are prepared to pay most for them. And there is the other side of the picture. Producers are free to move. Consumers also are free to spend. Except where the Government steps in and taxes and spends the money for them, people can spend their incomes as they like, and according to their tastes. So that, when more is spent on one thing and less on another, it is a free action, and does seem to represent a real preference. Production appears to be organised according to the real wishes of consumers. Yet there are many bitter complaints about the system. There are lots of people who think we must try something else. Why? What is wrong with the capitalist system?

To begin with, the whole thing depends on money. Things cannot be bought without money. Things will not be made unless they are going to be bought. Those who have more money get what they want, while those who have less money have to go without. This system, which is supposed to produce what people want, produces actually what people can pay for; men and machines are used to produce private aeroplanes, exquisite dresses, and anything

which will make life still more luxurious for the rich, while there are still children without shoes and stockings, houses overcrowded, and families who can never afford to buy meat for their dinners.

If people had the same money incomes, things would be fairer, and a capitalist system might produce what was really needed and not merely what could be paid for. But in most countries we are very far indeed from this equality. Overleaf is a picture of the distribution of incomes in Great Britain.

The differences are very great, perhaps greater than in most other countries. Why do these differences exist? Where do people get their money from? They get their money from two sources—either from property, as shareholders or landlords, or from their work. This property and work is used in production, and is paid for ultimately by the consumer (see Fig. 90). The source of income is clear, but the differences between the incomes have not been explained. Take the sources in turn. First, the incomes from work. People ultimately get paid what they are worth to consumers. Employers pay them as much as, but not more than, the use of their services brings in money payments from the consumer. But this does not *explain* inequalities; it only gives an immediate reason. For example, doctors are paid more than miners—perhaps ten times as much. Directly, this is because consumers are prepared to pay so much more for their services. But why should not the miners give up their jobs in the coal industry and become doctors? This is what we might expect to happen. We might expect it to go on until doctors' incomes fell and miners' incomes rose until they were equal. Indeed, we might expect it to go farther. Hewing coal is unpleasant work, monotonous and exhausting; most people would prefer to be doctors. They would be willing to accept less as doctors rather than go and work in a coal-mine.

Beside the doctors, there are lawyers, architects, scientists, teachers, accountants, managers. Beside the miners, there are dockers, stokers, roadmenders, factory workers. The first group of jobs are more attractive, and yet they are much

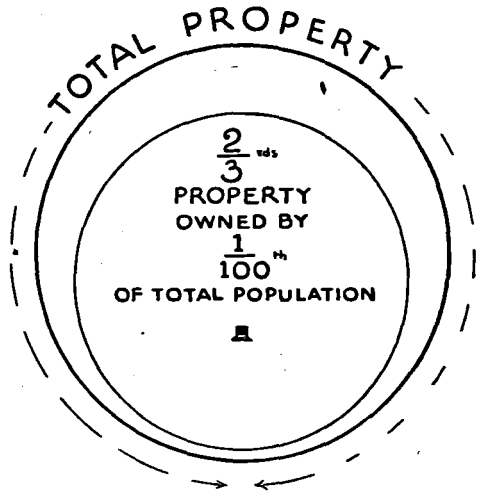
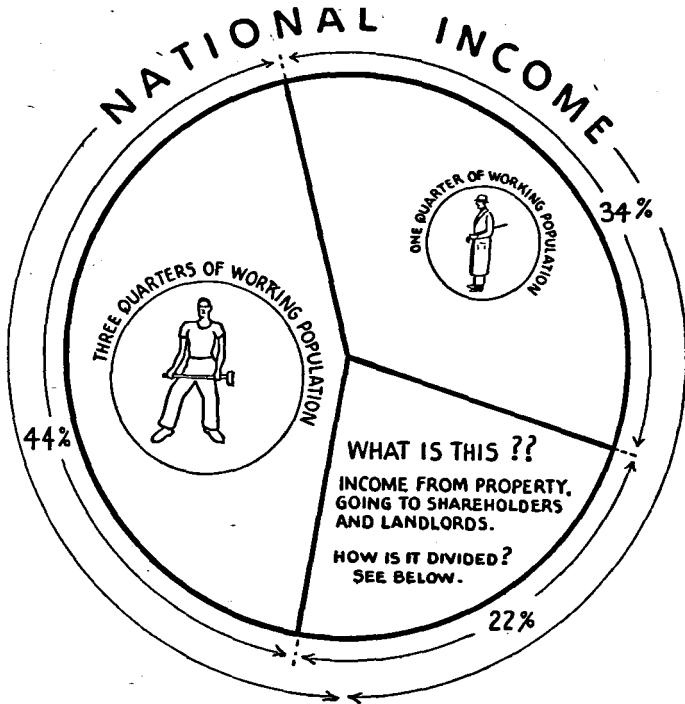


Fig. 90. THE DISTRIBUTION OF WEALTH

more highly paid. We should expect people to move out of manual work into these professions until incomes of manual workers were higher than those of professional men. Why doesn't this happen? It is mainly because the manual workers are too poor. It is almost impossible to enter a profession without expensive training, first at school, then at a university, and perhaps for some years after that. Where is the money to come from? How will the worker's child live during this period of training? Instead of earning money and helping his family, he will have to be kept and paid for by them. And how can a family with perhaps £3 a week do this? Obviously it is impossible; there is barely enough to keep the younger children and the mother and father. Very few of the worker's children reach the university and enter the professions. The vast majority have to go to work when they leave school at fourteen, and so become manual workers for life. There are other reasons why some people earn more money than others. One is obviously that some are cleverer or more hard working, and will probably be paid more. But none of them is nearly as important as poverty itself.

And what about property? In 1927, nearly a quarter of the national income of Great Britain was paid to property owners. Was the property distributed equally? No; you can see from the picture how very unequally it was divided. How has this come about? We can only explain it through the past. Go back six or seven centuries: the land which was the chief form of property was very unequally divided. As time went on, investment grew, mostly because those who were already rich could more easily afford to save, so that property was not often divided. It was handed down from father to son, from one rich man to another. The rich marry the rich, and so the property is preserved and increased. Of course, this is not the whole story. Some people started very poor and became very rich, and families which were once rich were sometimes reduced to poverty. But in the main we need only look to the process of time to explain the unequal distribution of property.

This is a great fundamental weakness of the capitalist system. It produces, not what people need, but what they can pay for. What people can pay for depends on the distribution of money incomes. This is very unequal, and, with a system of private property, must remain so. Suppose you start with everybody equal, differences will arise. Some people will be more successful and earn more than others. If they are allowed to accumulate property, this will increase their incomes still further. Since they are rich, their children can now be trained for more highly paid posts. Being rich, these children will save more, and their wealth will increase like a snowball. Private property and inherited wealth make this inevitable. They make inequality, and the kind of production which follows it, a permanent accompaniment of the capitalist system.

But things are not as bad as they seem. Those figures of the inequality of money incomes do not give a perfectly true picture of the way in which different people's wants are satisfied. Remember that people are not allowed to spend *all* the money stream which they receive. The Government takes part of it in taxation. If the money which the Government takes comes from the rich is spent for the benefit of everybody, this will make up for some of the inequality. So it will if the money is taken from everybody but spent for the benefit of the poor only.

SOCIAL SERVICES

This is just what has been happening during the last fifty years, particularly in Great Britain but also in other countries. More taxation money is needed, and a greater part of it is taken from the rich now than before. At the same time, much more is spent, especially for the poor. There has been a big development of what are called SOCIAL SERVICES. What are these social services? One of the biggest is EDUCATION. Until quite recently, most children were sent to school only if their parents could

afford to pay for them. Nowadays the Government pays, and it is compulsory for parents to send their children to school. It is true that this free school only lasts until children are fourteen. But this is better than nothing, and may be the beginning of something much more complete. Eighty million pounds was spent in 1930 on education by local and central governments.

HOUSING is another social service. People who are very poor cannot afford to live in large, clean, comfortable houses. They have to crowd together, a whole family packed into a single room, in damp, unhealthy houses with bad sanitation and not enough light and air. This leads to the growth and spreading of disease. Very recently the Government has stepped in. It does not provide houses free, as it provides education free. But it gives a **SUBSIDY**. It pays so much a week to the builder, while the person who is using the house, the tenant, pays a lower rent. Over £15,000,000 was spent in 1930 in housing subsidies.

The Government also helps the unemployed. Who are they? They are the people who wish to work, and are able to work, but cannot find employment. Why should people be unemployed? There are many reasons. Some trades depend on the weather. You cannot build houses if it is very wet, while, if it is very hot, fewer fires are needed and less coal will be ordered. So builders may be unemployed in the winter and miners unemployed in the summer. Or perhaps new machinery is being introduced, and takes the place of manual workers, who then lose their jobs. They cannot find new ones at once. In the meanwhile, they are unemployed. Some trades cannot sell all their products, because consumers are wanting them less. Others may be expanding, but workers cannot move immediately into these. So there will be unemployment as people's wants change. But there are times when many more people are unemployed. Sometimes practically no trades are expanding and many are contracting. Profits are falling everywhere, and more and more people are unemployed. In fact, production under the capitalist system is not at all

regular. For a time it increases rapidly, but then it declines, and when it declines people are "out of work" in almost all trades.

When a man has no work, how can he live? He has little or no property; he lives on what he earns. When he earns nothing, there is nothing to live on. He must be supported by somebody else or starve. So, twenty years ago, what is known as the UNEMPLOYMENT INSURANCE SYSTEM was started by the Government; this is a way of providing money for the workers when they are unemployed. They are given so much money a week for themselves and their wives and children. This money comes from a fund, or pool, into which is paid every week so much money by each worker who is not unemployed, so much money by the employers of these workers, and so much money by the State. The State must get its money by taxation. The amounts which are paid in or paid out are continually being altered. Just at the moment a man with a wife and two children gets 27*s.* 3*d.* a week, while the sum paid in is 2*s.* 6*d.* a week, the worker, the employer, and the State each paying 10*d.*

These social services, and others not quite so important, do something to make up for the unequal distribution of income. Can we go on increasing them? Can we go on transferring money from the rich by taxation and giving it to the poor in social services? It is very doubtful. It is doubtful if we can make the capitalist system fairer in this way. For at the moment much of that money which is used for investment comes from the rich. Poorer people have to spend almost all their incomes. Richer people have more left over, which they invest. But if the State takes money from them by taxation, they may invest less, and, if they invest less, there will be less Real Capital, less of the factories and machines which are made because of investment. If there is less capital, we shall produce less. The stream of goods will not grow larger, and we shall be poorer.

WASTE

But there are other objections to the capitalist system. Perhaps you will think, from the way I describe it, that just the right amount of each product is made, that there is no wasting, and that people never make things which are not wanted. This is certainly not true. Those who organise production have to make decisions about how much to produce without knowing *exactly* how consumers are going to behave, without knowing how large the different money streams are going to be. So mistakes are often made. Do you remember how those aeroplane companies produced between them so many aeroplanes that the price fell far below cost, and how those factories had to be closed down? This is an example of what happens a great deal under the conditions of competition. There are many different companies within a single industry. Each company acts alone. To make as large a profit as possible, each company produces as much as it can. But, when they all do this, prices fall, sometimes below costs; then factories are closed and machines are idle, and there is that much wastage.

[There is another objection, a more serious one. Not that competition is wasteful, but that it is no longer there. MONOPOLY takes its place. Monopoly means that, instead of having several companies competing against one another, you only have one company. This one company, or association of several companies, arranges how much is to be produced and sold in the industry. It is called a TRUST, or COMBINE. This may seem a good thing; you get rid of the wastage of competition. But there is another side to it. A monopoly can sell at higher prices, prices which are far above costs, so that big profits are made. But it can only do this by producing less. Now, when less is produced, there is first of all unemployment, and then workers and land and materials must find employment in other industries, where they will be paid less, because consumers do not want them so much there. If there are a great many monopolies there may be barriers everywhere—prices

higher, resources unused, and workers unemployed. And this really is a great danger nowadays. There has been a big increase in the number of monopolies during the last fifty years. It is not surprising. It is much more profitable to combine together than to compete. One can almost say that, if profits are left to control production, competition will always be followed by monopoly.]

There is another thing which stops production working smoothly. Within an industry the workers form themselves into what are called **TRADE UNIONS**—a miners' union, a railwaymen's union, an engineers' union. It is the purpose of these trade unions to improve the conditions of work, and in particular to get higher wages for their particular group. At the same time there are employers' associations—firms linked together to bargain with the trade unions. To-day wages are not settled by a separate bargain between each worker and each employer. They are settled for the whole industry by the discussion between the trade union and the employers' association. This is called **COLLECTIVE BARGAINING**. Every now and then no agreement is reached. The trade union demands are too high for the employers. The employers' offers are too low for the workers. Then work stops. There is a strike or lock-out. It is called a strike when the workers refuse to work until their demands are satisfied. It is called a lock-out when the employers refuse to continue to employ men under the old conditions and the trade unions will not accept the employers' offers. Between 1924 and 1930, 193,000,000 working days were lost through strikes or lock-outs.

But worst of all are those changes in the amount produced by all the industries together. Periods of prosperity, when the amounts produced increase, when all, or almost all, workers are employed, are followed by periods of "depression," when less and less is produced and more and more workers are unemployed. If we take two points of time—1850 and 1930—with eighty years between them, we find a vast increase in production, the results of scientific discoveries. But, if we look at the way this production has grown, we find it has not grown smoothly. It has

advanced in jerks, like a man climbing a cliff who slips back two feet to every four that he climbs. What is the cause of the slipping? Why does not production grow more smoothly? How can we cure the colossal wasting of millions of men and millions of machines unused, unemployed? These are questions too difficult to deal with here. They are the hardest problems for the scientist of economics, the science of man's behaviour as a seeker of wealth and a fighter of poverty. All one can say is that these problems are probably connected with money. So now we must think about money, where it comes from, and what it can do.

MONEY: THE THREE KINDS

Money is always running round the economic system. It runs in the opposite direction to the goods and services. This is natural, for it is always given in exchange for them. The goods and services go to the buyer; the money goes to the seller. What is this money? Where does it come from? Is there always the same amount of it, or sometimes more and sometimes less?

There are three kinds of money which can be distinguished, because they look different from one another: coins like pennies, shillings, and half-crowns; "notes"—ten-shilling notes, pound notes, five-pound notes—and "cheques." What "cheques" are will be explained later (p. 678). Almost all the sales which take place involve the exchange of one or other of these kinds of money for goods or services. Those who are paid one of these three kinds of money can almost immediately buy other things with them.

People don't want money for its own sake, but only because they can buy other things with it. For this reason money is different from other goods—from wheat, or iron, or cotton, or coal. Money is different from other things in another way. Everything else has a price. The price is the money for which it can be bought and sold. What is meant by "the money"? The number of *units* of money, so many

pounds, shillings, pence. So the value of everything else is expressed in money, and money acts as a measuring-rod. But it could not be a measuring-rod unless it were something which could be added and subtracted, multiplied and divided. The pound is generally taken to be the English unit of money—the shillings and pence are just exact sub-divisions of it. Yards, feet, and inches measure length and height and breadth ; tons, pounds, and ounces measure weight ; but pounds, shillings, and pence measure values.

From very early times one thing in particular was used as money—metal, especially GOLD and SILVER. Why? To begin with, everyone seems to have liked gold and silver; they were always prepared to use them as ornaments, partly because they were pretty, perhaps also because they were thought to be life-giving (see *Chemistry*, p. 250). Also they did not wear out ; they scarcely altered at all, however long they were kept. You could melt them, and change or divide them up into different weights. Also very small amounts of them would exchange for large quantities of other things, so that a great deal of “buying power” could be carried about quite easily.

COINS

So gold and silver were the first forms of money. But none of the three kinds of money mentioned were gold or silver, except perhaps some of the coins. How has the change come about? How have we come to use coins and notes and cheques instead of gold and silver? Let's begin with the coins, which are the easiest to explain.

When gold and silver came to be used as money, they had to be measured in some way. The natural way to measure them was by weight, and goods were exchanged for definite weights of the precious metals. To prevent fraud, the Governments of the different countries made all the gold which was brought to them into coins and stamped them with their mark, to show that they were guaranteed the right weight by Athens or Syracuse or Rome or wherever it was. These coins generally became *Legal Tender*.

That is to say, by the laws of the country they could always be paid in settlement of a debt. Coins of this kind were used, together with other kinds of money, until very recently. When I was a boy, my grandfather gave me for my birthday a *gold sovereign*. This was a coin of a certain weight of gold, and worth as much as £1. It was legal tender in Great Britain. The coins we do actually use to-day appear to be just like the sovereigns or the early stamped weights of gold and silver. But there is a difference. The amount of sovereigns or earlier coins of gold and silver depended directly on the supply of gold and silver which was brought to the Government to be transformed; the amount of half-crowns and shillings and pennies depends on the number the Government like to produce, and this is simply what the Government thinks people need in the way of small change. Naturally it varies with the amount of the more valuable money, the amount of the notes, and this brings me to the second part of the story.

Why did we come to use "notes" as money? Notes were first produced—or "issued," as we say—by BANKERS. What is a banker? A banker is a person who deals in money. He borrows it from some people and lends it to others. You will remember that people want to borrow money to produce things, and that, to induce others to lend, they offer them either interest, which they guarantee to pay, or a share in the profits. A banker simply helps this business of saving and investment. He pays interest to those who lend him money, and he charges interest to those who borrow from him. He lends money, as a rule, only for short periods, at a fixed rate of interest, and does not become a "shareholder." He prefers the smaller but safer interest payment instead of a larger but more uncertain "profit."

The banks—which are, of course, just places where the bankers do their business—are like pools into which streams of money flow from lenders and out of which streams of money flow to borrowers.

And what about the notes? There have been banks and bankers for a very long time, but it was not until

three or four hundred years ago that notes began to be used. Those who lent, or "deposited," money with the bankers were given a paper receipt. This was simply a promise to pay the money which had been deposited. Those paper receipts began to be used as money. Those who held them did not bother to turn them into gold but passed them on directly, and they were accepted by others just because everyone thought them "as good as gold." Now came an even more important change. The bankers began to lend notes instead of gold. Their promise to pay was accepted as gold. Why should they bother to lend gold? If they lent gold, there was a definite limit to what could be lent. It depended on what was deposited with them. But, if they lent notes, this limit did not matter. So long as their promise to pay was accepted as money, it seemed that they could go on lending as much as they liked. And this was very profitable, for what they lent cost them nothing. They might *pay* interest on £1,000 gold deposited with them. But they could *charge* interest on £10,000 notes which they lent.

Of course, it was risky. The notes were promises to pay gold "on demand." What would happen if they were all presented for payment at once? The bank could not possibly fulfil its promises. It would be made "bankrupt." But, if everybody accepted the notes as genuine money, everything went well. There might be some "cashing" of the notes (exchanging them for gold), but not enough to put the bank in difficulties. It was when people became suspicious that there was danger. They would feel that they might not be able to use the notes. They would hurry to the bank to exchange them for gold. A panic would begin and spread quickly, and the bank would be besieged by the note-holders, frantic to change this sham money into good solid gold.

During the eighteenth century a great many of these note-issuing banks were started all over the country. Often the profits were too tempting, too many notes were issued, and many bankruptcies took place. Naturally these sudden changes in the amount of money were disturbing. To those

who used money continually for buying and selling, it was awkward not to be sure whether these notes were "safe" or not. So in Great Britain, where banking of this kind had developed rather faster than elsewhere, the Government made several attempts to deal with the matter.

THE BANK OF ENGLAND

At last, in 1844, a very important and very drastic step was taken. Practically speaking, the right of note issue was given to one bank alone. This bank was the Bank of England. At the same time, its notes were made legal tender. People had to accept them in payment. This gave the bank great strength. But there were limitations too. The bank was compelled to convert these notes into gold whenever requested. It must always sell gold for notes at the rate of £3 17s. 10½d. an ounce. And it must give notes for gold, when people wanted them, at very nearly the same rate—£3 17s. 9d. an ounce. [Finally, there was to be no danger of bankruptcy. The bank had to keep in its vaults enough gold to exchange for the greater part of its notes. Only £14,000,000 of notes were allowed to be issued without the gold into which they could be exchanged. Because they were, so to speak, on trust these notes were called the "fiduciary" issue. Except that the number of these "fiduciary" notes has increased to £275,000,000, the position until September 1931 was very much the same. What has happened since then we shall discover later. But until that date, except for eleven years between 1914 and 1925, the Bank of England had the sole right of note issue, had always to give notes for gold or gold for notes, and could only issue more notes when its stock of gold increased.]

So we come back to gold after all. Look at a £1 Bank of England note. You will find the following sentence printed upon it: "Bank of England—Promise to pay the bearer on Demand the sum of One Pound." Apparently it is a silly phrase. As if anybody would bother to go to the Bank

of England and give one green note and be given another just like it in exchange! But the story of the notes has revealed the secret. The pound is really a pound's worth of gold. This is what the bank promises to pay. And this is what, until September 1931, it did pay. Because it had to pay that gold, and could only issue notes if it had gold to "back" them, the supply of "note" money depended directly on the supply of gold.

CHEQUES

But there is the third kind of money and the third part of the story. What is a cheque? It is an order, a written command to a bank, telling the bank to pay to a certain person whose name is written on the cheque a sum of money. Naturally the order has to be signed—signed by the person who "draws" the cheque, who is telling the bank to make the payment. It is easy to see how cheques came to be used. Suppose Charles II had "deposited" money with a bank or borrowed from a banker. He wishes to pay some money he owes. How much simpler to give the creditor an order "on the bank" for the sum which is owing rather than to go to the bank for notes or gold. What will the creditor do with the cheque? Suppose it is the Admiral of the Fleet. He might merely take it to the bank and turn it into notes or gold. The Admiral would have the trouble instead of the King. But, supposing the Admiral did not want notes or gold just at the moment he could simply have paid the cheque into the bank and asked them to keep the money which was owing to him. Supposing the King and the Admiral both used the same bank, what would happen? Only this—the bank would add the sum of money which was written on the cheque to the Admiral's "account," and take the same sum off the King's account.

Cheques came into use very rapidly after 1844. It was a way out for the other banks who could no longer issue notes. Do you remember how profitable the issue of notes was? Do you remember how the early banks could lend

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in notes perhaps ten times the value of the gold deposited with them? If they could no longer issue notes, an increase of lending would be impossible. But if people would only use cheques, fresh money could be lent to them. They would not be taking their loans in notes or gold. After 1844 the amount of notes depended on the amount of gold held by the Bank of England. But the amount of cheque money was still left to the other banks. And cheque money gradually became much more important than notes. People borrowed cheque money instead of borrowing notes.

What settles the amount of this cheque money? Can the banks go on lending as much as they like? There will be one thing to stop them. Banks can lend cheque money, but they must always be prepared to change cheque money, which they lend, into notes and coin, or "cash." Some of those who borrow the cheque money, or to whom it is paid, will want to change it into "cash." After all, everything cannot be bought by cheques. Small shops will not accept them. Wages are not paid by cheque. So the banks realise that, if they are to lend more, they must have "cash" to meet the needs of those who want it. It is this which eventually stops the banks lending more and more.

Because of this need for cash, the banks always have to keep some ready. At any moment there may be £500,000,000 of cheque money. People have a right to draw cheques for this amount. The banks will not have nearly as much cash ready. But they must have a proportion—the proportion which they think necessary. In England this is about one-ninth. So for £500,000,000 of cheque money there would have to be £55,000,000 in cash. Where do the banks keep their "cash"? They keep most of it with the Bank of England. Just as a private individual has an account with a bank which he can change into cash, so the banks themselves have accounts with the Bank of England which they can turn into cash.

Because of this need for a proportion of cash, the amount of cheque money is limited by the size of the banks' accounts, or "balances," at the Bank of England. It is only when they are increased that more cheque money can

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be lent. How can they be changed? They can be changed by the decision of the Bank of England. Just as the other banks, by lending more or lending less, can increase or decrease the accounts of all who use cheque money, so the Bank of England, by lending more or lending less, can increase or decrease the accounts of the banks themselves. In this way the Bank of England ultimately controls the supply of cheque money.

But in fact this ultimate check of changing the size of the accounts of the other banks is not always used. The Bank of England can generally affect the amount of cheque money in existence in another way. It can simply change the rate of interest which it charges for lending money. This rate is called **BANK RATE**. The rates of interest which the other banks charge are generally controlled by bank rate, so that when it rises they rise, when it falls they fall too.

Now, if people have to pay more for loans, probably they will borrow less and there will be less cheque money; if they have to pay less they borrow more and there will be more cheque money. So if bank rate falls, there is likely to be more cheque money; if bank rate rises, there is likely to be less cheque money. How does the Bank of England decide whether to encourage or discourage borrowing, whether to increase or decrease cheque money? Some of its reasons must be left out, but there is one obvious one. Just as the other banks have a cash reserve behind all the cheque money which their customers hold, so the Bank of England has a cash reserve against the cheque money which its customers hold. The Bank of England's cash reserve is almost all notes. There is no other bank behind it in the way that it itself stands behind other banks. But its reserve is a much higher proportion of its cheque money, a proportion of about one-half instead of one-ninth. Now, if the cash reserve is increased, the Bank of England will be able to create more cheque money, and it will be ready for the other banks to lend more, and have more cash for them when they want it. But the only way in which the Bank of England can increase this reserve is

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by an increase of its gold supply. When this is increased, therefore, it will encourage borrowing; when this is decreasing, it will discourage borrowing.

So, you see, there are three kinds of money to-day—coins, notes, and cheques; but how much there is of them depends on the amount of something quite different, on the amount of something which was once used as money itself, on the amount of that precious metal—GOLD.

THE FLOW OF MONEY

Now that we have seen how the amount of money can be altered, let us consider another problem—what happens when it does change. Suppose the Bank of England lowers its rate. The lever is pushed across, and, as interest rates fall elsewhere in the system, new money comes into circulation. Gradually the money runs through the channels of the system. So long as the flow of goods for which it is exchanged does not increase, one result must follow. There must be a rise in the price of goods. But as prices rise profits increase, for “costs” do not rise so rapidly. The workers and the landlords are paid no more than before, and the new money goes in profits to the shareholders. But this rise in prices will have other effects. It will be encouraging to producers. Already they will be making profits. If prices continue to rise, they see that they will make more, for what they buy to-day will be worth more when they sell it a few weeks hence. So they will go back to the banks for more money. They will want to borrow as much as they can, and when they borrow more the money flow becomes still larger, and prices and profits go on rising. If, to begin with, there were factories not working and workers unemployed, this rise in prices will lead to greater production and more employment. For producers will want to produce as much as they can, and will therefore employ all the resources they can.

Now suppose the opposite takes place. Suppose the lever is moved the other way. Interest rates rise. Banks which

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lent money ask for it back. Borrowers are discouraged, because borrowing has become so expensive. The flow of money becomes smaller, and in consequence prices begin to fall. Costs will not fall so quickly, and this time the shareholders will lose while workers and landlords and all those with money incomes fixed will gain. For prices will be falling, and each pound will buy more than it did before. But producers who work for profit will be discouraged. Their profits disappear. They see that, if prices continue to fall, their position will be still worse, for things that they buy will fall in value before they sell them. So they borrow less and buy as little as possible, and this makes the money flow still smaller. Thus falling prices, when they are caused by less money, have a bad effect on production. If there are no profits to be earned, people will not invest, and so resources become unemployed and less is produced.

Do you remember the last criticism of the capitalist system? How production did not increase steadily, but jerkily, like a man climbing a cliff and slipping back all the time? Some people think the jerks are all due to changes in the money let loose into the system. Certainly the slipping back always seems to have something to do with falling prices. But whether this is due to too much money before—climbing too quickly when prices rise—or because there is not enough money to keep the climbing going, is a matter of dispute. It is one of the things about which we shall discover a lot more in the next few years.

INTERNATIONAL TRADE

But remember, all this is the story of one country only, the story of English money. In fact, there are other countries each with its own money and its own banks, and a system much the same as the English one. Now countries are not isolated. The people in one country buy and sell to those in others. Go into a grocer's shop. From how many different countries do the goods in the shop come?

Tea from China and India, sugar from Jamaica and Cuba, coffee from Brazil, flour from American wheat, wine from France and Spain, bananas and oranges from Africa (see *Peoples of the World*, p. 579). Almost every country in the world is represented. Go to a shop like it in America, or Germany, or almost any other country. You will find the same thing. This leads to a puzzle. To buy something in England you use English money; that is what you pay the grocer. And he, too, if he buys English things, will pay in English money, and so will all the dealers and manufacturers and farmers. But supposing the grocer wants to buy foreign goods, how will he pay for them? What good is English money to him now? The American or German or Frenchman who has sold to him will want his own kind of money. Americans want dollars and cents, Germans marks and pfennigs, Frenchmen francs and centimes.

THE GOLD STANDARD

Yet somehow or other the things must be paid for. One method would be to pay in gold. This would work providing his own country—England—and the countries where he owes money have GOLD STANDARD money. Gold standard money is money which can be exchanged into gold at fixed rates. For example, the English money we have described was “gold standard,” because it could always be changed into gold at the fixed rate of £3 17s. 10½d. an ounce. Most other countries, until very recently, have had gold standard moneys. In America you could buy the same gold at the rate of \$18.95 an ounce. In this case the English buyer could take English pounds to the Bank of England and get gold, then send the gold to America or Germany, where it could be changed into dollars or marks. An American buyer could do just the same thing. He could get gold for his dollar notes and send the gold to England, where it could be changed into English pounds. If this was the usual method, gold would evidently be the international money.

But think of the trouble! For example, Great Britain buys from other countries perhaps £800,000,000 worth of goods every year. This would be the amount of gold which would have to be exported by the English buyers. But just about the same sum of money is owing to Great Britain every year, and those who owed would have to ship the same amount of gold here. Surely there must be a simpler method of making all these payments! Take two countries—Great Britain and America. In each there are EXPORTERS and IMPORTERS. Exporters are those who sell goods to other countries, and these goods are called EXPORTS. Importers are those who buy goods from other countries, and these goods are called IMPORTS. The English importer wishes to pay for the American goods he has bought without going to the trouble of sending gold. How can he do this? He wants to buy American dollars. He will give in exchange English pounds. But now consider the English exporter. He has been paid American dollars for the goods he has sold in America. He wants to exchange these dollars into English pounds. So the problem is easily solved. The English exporter sells his dollars to the English importer. They meet in what is called the “Foreign Exchange” market, where people come to exchange the money of different countries.

However there is still one small mystery. Pounds were exchanged for dollars. But how many pounds for the dollars? Suppose the exporter had 400 dollars, how many pounds would he get for them? The best way to deal with this is to think of the diagram in the early part of the chapter. You remember how, when the flow of money given in exchange for metal products increased, their prices rose. It is just the same with the Foreign Exchange. Leave the flow of money as English money—as pounds—but put in the place of metal products American money—dollars. Then, if the English money increases and the American money does not, the price of American money will rise. The dollars, like the metal products, will be worth more pounds. Each pound will be worth fewer dollars. If the flow of dollars increased, while the flow of pounds

did not, the opposite would happen. The EXCHANGE RATE between the two moneys, just like the exchange rate between metals and money, depends on the amounts of each available for exchange.

But does this mean that the exchange rate can change a great deal? Can £1 be worth \$7 one day and \$3 the next? No. If the two countries are "on the gold standard," this is impossible. For there is another way of settling debts besides this direct buying of dollars or pounds. The importer could always pay for his goods by sending gold direct to America. He can buy an ounce of gold for £3 17s. 10½d., and in America he can get for this gold \$18.95. If you work it out, you will find that, if he bought £1 worth of gold at this rate, he would get \$4.86 for it in America. This rate of exchange—\$4.86 to £1—is called the par of exchange. The exchanges can never move far from this so long as the countries concerned are on the gold standard. For instance, if they moved to \$4 to £1, the English importer would find it cheaper to go to the Bank of England and send gold and pay his debt that way. He could not get quite \$4.86 for £1, for there would be the cost of sending the gold to allow for, but he would get only a little less—say \$4.84.

In the same way, if the exchange rate moved to \$5 to £1 the American importer would prefer to pay his debts in England by sending gold. He also would not get quite £1 for \$4.86, but he would get something very near it—say a rate of \$4.88 to £1. So, when countries are on a gold standard, the exchange rates cannot move more than the cost of exporting or importing gold. This means that the prices of imports are not continually changing, as they would be if the exchange rates changed. Consequently it is a great convenience to traders.

Another result is that, if prices all round rise or fall in one country, they must rise or fall in others. Why? It is explained in the diagram. Supposing a gold-mine was discovered in England. The producers of gold would be able to sell it to the Bank of England. The bank would now have larger reserves. It would encourage the other banks to

THE WORKING OF THE GOLD STANDARD

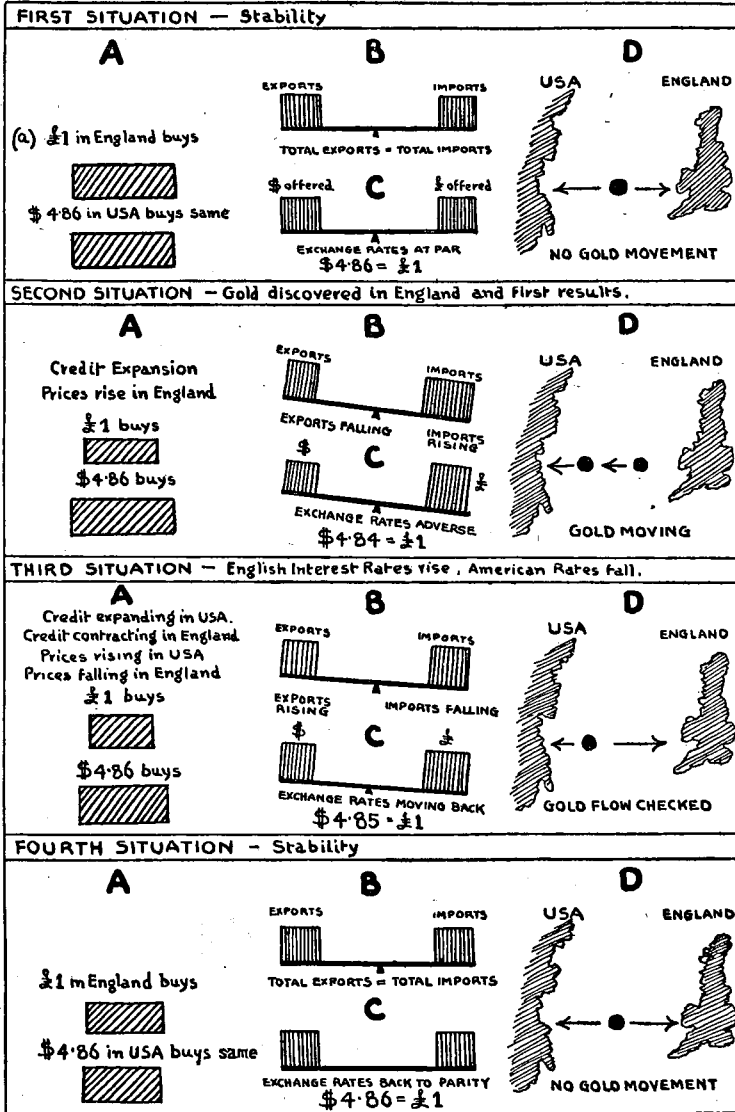


Fig. 91

lend more cheque money. Interest rates would be low. But this would mean a rise in prices all round, as the new money flowed into the system. This is not all. For if prices in England are higher, goods from other countries where prices have not risen will be cheaper. So there will be more imports. And there will be fewer exports, because the English prices will be too high. So you have more goods coming in and fewer goods going out. But this will affect the foreign exchange market, because, of course, there will be more English pounds for sale to pay for the imports and fewer American dollars for sale to pay for the exports. So the pound will be worth slightly less dollars until those who want to buy dollars, to pay their debts, will do it by first exchanging pounds into gold and then sending gold to America. So gold will be moving to America.

But, as the gold goes out, the Bank of England will find its reserves falling. It will discourage the other banks from lending, and interest rates will rise. This will mean less money, and so lower prices. Meanwhile, just the opposite will be happening to America. There will be more gold, and so banks will be lending more and prices will be rising.

But this will push the exchange rates back. For imports from America will be more expensive, because of the rise in prices there, and less will be bought, while exports from England will be cheaper and more will be sold. This will mean more dollars to pay for the exports and fewer pounds to pay for the imports.

So the rise in prices in England will spread to America, and the gold which was discovered in England will not all stay here. Some of it will go to other countries, and lead to higher prices there. This general rise in prices seems harmless. But supposing what spreads is a general fall in prices. Science is applied to industry in America, so that more goods are produced and prices fall. Each piece of money is worth more goods. What will happen? America will begin to export more and import less. Exchanges will move, so that dollars are worth more. Gold will begin to move too. This will compel the banks in other countries to lend less, so as to lower prices. The lower prices in America

will spread to other countries. But deliberately to take away money, which is what these other countries must do, will have very unpleasant effects. It lowers prices and profits, discourages those who control production, and leads to unemployment. Yet all this must be endured if these other countries are to remain "on the gold standard."

PROTECTION

The people of one country will not always allow those of others to sell things to them quite freely. They put a tax on imports ; they make those who import foreign goods pay so much extra on the goods they import. This is called a **TARIFF**. Suppose that in England a tariff has been imposed. This may simply cause prices to be higher than before, so that the English consumers who buy the goods really pay the tax which the Government takes. But often it means more than this. It means that English producers are "protected." The foreign goods which are sold in competition with what they produce must now cost more. The English producers have an advantage. Their prices, which were too high before, are now lower than those of the foreign goods. Is this a good thing ? For the moment it will obviously encourage the English producers, and, if there was unemployment, more people may be employed. But there are other effects. The countries who now sell less to England may just buy less at once, and this will bring a fall-off in English exports. If they buy the same as before, the exchange rates will be altered. There will be fewer pounds offered, since English imports are lower. The pound will rise in value, and gold will be sent over. This will tend to lower prices in other countries and raise them here so that again English exports will fall off and imports begin to rise again. Since the goods we export are not given away, they must be paid for by imports, so that *eventually* either a tariff must be ineffective or else exports must fall off.

GOING OFF THE GOLD STANDARD

Now it is time to describe what happened in England in September 1931. In that month England "went off" the gold standard. The Bank of England, which had before been compelled by law to exchange gold for notes and notes for gold at £3 17s. 10½d. an ounce, was relieved of the burden. This was because the bank had not been able to prevent gold from being taken out of the country. Naturally there were immediate results on the exchanges. For now payments to other countries could not be made in gold. So the exchange rates depended entirely on the pounds offered for sale compared with the other money offered for sale. The exchange rate between dollars and pounds moved from \$4.86 to £1 to between \$3 and \$4 to £1.

What do people think of this change? The exchange rates move about, and this makes things difficult for importers and exporters, but the advantage is that prices here are no longer bound to move the way prices move in other countries. It happens that prices everywhere have fallen in the last three years, and this has had terrible effects on production. There has been a very bad slipping back down the cliff. Now prices in England and in other countries which have also "gone off" the gold standard need not move as prices move in the gold standard countries. For if prices rise here, as many people hope they will, gold will not move out of the country. All that will happen will be that the *exchange-value* of the pound will fall.

For with higher prices there would be less exported and more imported, and so more pounds offered and less foreign money. You can see it on the see-saw diagram, only there the exchanges would not move very far. But when we are off the gold standard they can move much farther. They will move just as much as prices rise. For instance, if prices rise 25 per cent. then until the exchange value of the pound has fallen 25 per cent.—say from \$4 to \$3—people will buy more foreign goods, because they are cheaper, and foreigners will buy less English goods, because they are more expensive. But when the exchange rate *has* fallen

25 per cent., this will not be the case. Foreign goods will be just as expensive as English goods ; £1 buys 25 per cent. less of them as it buys 25 per cent. less of English goods. There will be no further increase in imports, and the exchanges will move no farther. So being " off the gold standard " does make us more independent, and I think it has prevented us slipping back quite so fast. But, all the same, it does not seem to allow us to start climbing again just as we like, and also will not necessarily prevent us slipping back again when the next " slump " comes.

This is all the editor will let me write. I am afraid that this last part has been rather difficult. The working of the money system and international trade is complicated. Also just at the moment it is not working at all well. Partly this is because we do not understand it enough and do not know what to do, partly because, when we do know what to do, we cannot or will not do it. Economics probably all seems rather dreary and difficult to you. But the worst part is that there is such a lot that can't be done or enjoyed, until we have properly organised our campaigns in the " nature-war."

PROBLEMS AND SOLUTIONS

OR

THE FUTURE

by

OLAF STAPLEDON



OLAF STAPLEDON says he is descended from a martyr who was killed for trying to educate people. When he was a boy he lived in Port Said ; then he came back and went to school at Abbotsholme, where he learnt to wash sheep and all sorts of things like that ; then he went to Oxford. Then he went into a shipping office, and lost £20 of the petty cash, which is a thing which I always think must be so easy to do, and after that he became interested in ethics. Then he was a master at Manchester Grammar School, where he and his history form always acted history plays until they made too much noise for the other masters. Part of the time he was back at Port Said, where he used to board ships at midnight from a motor-boat to see if they needed coal. During the War he served with the Friends' Ambulance Unit, driving a motor ambulance. His experience of the War made him, as you will see in this chapter, a strong pacifist, intent on having no more wars. And exactly the same thing happened, sooner or later, to

all the other contributors to this book who were old enough to be in the War. Now he lectures to the W. E. A. and writes books. He wrote a book called *Last and First Men*, about the future, some of which seems to be likely to come true. He knows a good deal about science and history ; he sees there are dangers, yet he is full of hope for the future, if only people in the future—that is to say, you when you are grown-up—will be reasonable, and really make use of all the knowledge which is waiting for you to use. As well as all this, Olaf Stapledon has two children, a girl and a boy, for whom he makes electric motor-boats, and he swims in the sea all the year round.

PROBLEMS AND SOLUTIONS

A. WHAT DO WE WANT FOR OURSELVES? —TO LIVE FULLY

I. SIMPLE ACTIONS

LET US try to decide what we really want to do with our world. I do not mean with the universe of many great wandering stars and a few little planets. I mean the world that is made up of men and women and their dealings with one another. What kind of a world ought this human world to be? What do we want to make of it?

First we must decide what any one person wants for himself, or, rather, what he really needs for himself. We all want to live, and, if we are healthy and vigorous, we want to live in the fullest possible way—not like a cabbage, but actively. What we want for its own sake is always some kind of active living. Other things we do often want, but only to help us in one of the actions that we want for its own sake. For instance, we want knives and forks to help us in eating. But eating we enjoy for its own sake. We want to use all the powers of our bodies and minds fully. And we want to use them at the right time, when we are “set” for them, ready for them, ripe for them (see *Psychology*, p. 156). When our stomachs are empty, we want to eat, but not when they are full. When our noses tickle, we want to sneeze, but not otherwise. When our bodies are tired, when our muscles are no longer fit for work, we want to rest, perhaps to sleep. But when our bodies are rested, when our muscles are ready once more, we begin to feel lively, and want exercise. What we hate is to be checked in our actions. Also, we hate doing things in ways not suited to our own nature. For instance, we dislike walking in step with someone whose pace is either too long or too short for our own natural pace.

These are some of our simpler likes and dislikes. Now let us think of the different *kinds* of action that each of us can do. There are many simple actions besides eating and moving our limbs. There is drinking, also breathing, and seeing and hearing. For eyes and ears need using, no less than muscles. Then, also, when our bodies are ready for it, we need the bodily act which brings new human beings into existence. If, when the time comes, we get none of this, we shall certainly be to some extent unhealthy. Something in us will always be trying to act, and failing. And the constant strain of it may worry us and confuse us.

2. SKILLED ACTIONS

These simple actions are satisfying up to a point, but we are able to do many more difficult things. And, because we are able, we want to do them. Just moving our muscles is all very well, if we have been keeping still for a long time, but running is better, and playing games of skill is better still. We get more out of football and hockey, swimming, skating, and riding, than out of mere treadmill exercise. In the skilled action, what happens is that we bring simpler actions into play, one after the other in a special order, to form a single pattern of actions. We control the simpler actions for some purpose beyond them, as we might control a team of horses. We are most satisfied by doing those actions that need most skill, but are not too difficult for us. Of course, sometimes we are not in the mood for skilled actions. Sometimes what we need is a simpler action, like eating or resting. But, apart from these occasions, skilled actions give more intense delight than unskilled.

Besides skilled movements we do skilled seeing and hearing, and this is more delightful than simpler seeing and hearing. For instance, watching birds is interesting, but it is more interesting the more we can see in them, the more we can distinguish between one bird and another by its shape and colour, or by its voice. In fact we want, not merely to see and hear, but to grasp complicated patterns

with our seeing and hearing. In music, for instance, we enjoy following the way the different sounds fit together to make one tune.

We enjoy seeing things whole, and hearing things whole. We like to understand how things fit together. When they don't seem to fit together, we want to solve the puzzle. Some of us have more of an itch of curiosity than others. Some feel that they must go on and on, trying to understand how everything fits in with other things, trying to get beyond the first look of things to what they really are. These are the people who need to become scientists and historians and philosophers.

Another action that we all want to some extent is making things, with as much skill as we can manage. We want to make meccano models, or boats, or dolls' clothes, or wireless sets, or great buildings, or railway systems, and so on. Or we want to make beautiful things like pictures, or stories, or music. Or we want to invent new dodges, just for the love of inventing. Some want one kind of making or inventing, some another. For some this need is much more important or urgent than for others. Some, too, are much better at it than others. These need to become craftsmen, engineers, inventors, or in other cases artists. But all of us have some powers of this kind, and, if we never have the chance of using them properly, we miss one of the very best things in life. And then we may even try to get satisfaction by cleverly destroying things that others have made. But the sort of satisfaction that can be had in this way is very damaging even to ourselves.

8. ACTIONS CONCERNED WITH PERSONS AND GROUPS

Many of our actions have to do not so much with things as with persons. Sometimes, for instance, we want to be with other persons, sometimes by ourselves. There should be times for companionship, and times for lonely doings and thinkings. And we want to be able to think well of



Fig. 92. SKILLED ACTIONS

The cabbage can only "live like a cabbage." The baby is learning the skilled action of managing his arms and legs. The athlete and the skater have gone much further in solitary skilled action. In the game of rugby, members of a team are skilfully fitting their actions together so as to win the game, while the referee sees that both teams "play the game" together. The aviator and the scientist are doing highly skilled work which depends very much on the skilled work of others. The musicians are doing a very highly skilled piece of work together, under the guidance of the conductor, whom they agree to obey.

ourselves, as persons. Also we want others to think well of us. We want to be strong, clever, brave, good, generous, masterful. And in order to be all this we want, or anyhow we need, difficulties to overcome, dangers to face, opportunities for being generous.

Besides wanting to be splendid persons ourselves, we want friends to play with, work with, friends to admire, love, help, be loyal to. We are all able to do these things to some extent, and we need them even for our own well-being. (At the moment I am talking only about our own well-being, not about what we *ought* to do for others.)

Sooner or later we want the strangely absorbing and thrilling and intense friendship which is called falling in love. And when our bodies are full-grown, and we are very much in love with some person of the opposite sex (with a woman if we are a man, or with a man if we are a woman), then we want to come as close to the other as we can. We want to live with them, and to do with them the bodily act which starts a baby growing in the woman.

Also, when we are full-grown, we want, or at any rate need for our own complete well-being, parenthood, or something like it. We need to be helping young human creatures, to prepare them for a life which, we hope, will go on after we ourselves are dead. They may be our own children, or the children of other people. Or it may be that some work, which interests us very much and will outlast us, comes to satisfy this need for parenthood (see *Writing*, p. 864). Instead of having real children, we come to feel towards our work almost as towards a child.

Also, with regard to our work, we want to feel, or at any rate for true well-being we need to feel, that it fits in with the work of others, helping others to live fully. Even our own selves seem greater, somehow, if we can feel that they are parts of something greater still, and more important.

4. HIGH-GRADE AND LOW-GRADE LIVING

I said that what each of us needs is to use his powers as fully as possible, to be as alive as possible, to live skilfully, not clumsily. Let us distinguish between low-grade living and high-grade living, and say that what we need, what we want if we are in a healthy state, is to live with as high a grade of living as possible. This means, first, that our perceiving and thinking should be as skilled as possible, as full and true as possible, and, second, that our feeling and desiring should be as skilled as possible, as right as possible.

From another point of view we can put it this way. There seem to be two sides to high-grade living. The first is, being skilled in seeing what is really worth living for. This is just the power of taking everything into account when we are deciding what we really want. The other side of high-grade living is being skilled in actually getting what we want, actually getting what we have decided is most worth striving for. This means being able to regulate our actions accurately, so that they will have the results that we intend. Some people are content with very simple wants, such as food and comfort. Others see much farther, and want all sorts of things that the simpler minds cannot care for at all. Their interests are wider and more subtle. Their aims are more far-reaching and all-embracing.

We all despise behaviour that we regard as low-grade, behaviour that seems short-sighted, or that seems selfish, or clumsy, stupid, lazy, cowardly. We all admire behaviour that we regard as high-grade, behaviour that seems far-seeing or generous, or that seems skilled, clever, vigorous, courageous.

Often our low-grade wants clash with our high-grade wants, as when we want to be both selfish and generous, or when, in danger, we want to be both safe and brave. It is well then to remember that the high-grade action is more worth while in the long run. On the other hand, it is generally stupid to take serious risks just for the sake of taking risks. We only need to take risks when there is

something or other at stake more important than safety. Always it is stupid to forgo any of our wants, however humble, except for the sake of some want which is more important. The most important wants, the highest-grade wants, are those which we can see to be best when we are most alive, when we are most "wide-awake," most sensitive, most far-seeing, most ready to take everything into account.

Sometimes our less important wants can find satisfaction in service of more important wants. Running is itself good fun, but a game of football, which includes runnings and dodgings and other actions, is more satisfying. Also, running itself is more fun if you are running *for* something, if there is something more than mere running at stake, namely the game. And the game itself is more fun when it is played for the school. And the school itself is more fun, more satisfying, more a thing to be proud of, when it is felt to be part of the great life of a people, a nation. And, to the most alive men and women, their nation itself seems fit to be loved and served only if it plays its part rightly in the greater life of mankind. When a nation harms the rest of the world, it is no longer fit to be loved and served, even if it happens to be our own nation.

The very best kind of life that anyone could have would be one in which each of his actions, besides being a delight in itself, fitted beautifully together with all his other actions in service of one most important need ; in fact, in service of the aim which seems most important when we try to take everything into account. Is there any such greatest of all needs, or aims, or wants, or purposes ? I shall try to persuade you that there is, and that for the most alive kind of people it is the need to feel that one is playing a right part, however humble, in the life of mankind.

Of course, even if we rule our lives for one most important of all wants, we shall often find ourselves wanting to do things that cannot both be done. Then we have to decide somehow which will give the fullest living in the long run. For instance, it would be foolish to stop and buy sweets

when we have only just enough time to catch a train for a country holiday or to take us to work. It is always foolish to shut one's eyes to a big want merely so as to satisfy some little want that happens to be pricking very hard at the moment. We have to say to ourselves, "I shall be the same I to-morrow as to-day, so I cannot afford to ignore the big want that I know I shall feel to-morrow." We have, of course, to look ahead much farther than to-morrow. While we are children we have to say to ourselves, "I shall be the same I next year as this year. I shall even be the same I when I am grown up. I must take into account the wants that I shall feel then, even though at present I am not interested in them."

If we are wise, then, we try to take a long view. Not that it is wise to forgo all the possible goods of to-day for the sake of some goal right at the end of one's life. It is stupid, for instance, to spend all one's life slaving to get a lot of money, and never allowing oneself time to enjoy life. The best is that one's whole life should be as fully alive as possible from beginning to end. It should be full throughout, like a fine game, or beautiful throughout, like a piece of music.

But at every stage of life we have to sacrifice the present to the future to some extent, and the small to the great. To what extent? There are two dangers here. The first is the danger of letting our lower-grade wants have it all their own way, so that we live always in a hand-to-mouth, muddled style, and never rise to the higher grades, or serve the more important aims. The other danger is that we shall care so much for some particular activity of a fairly high grade that we never give the humbler wants a proper outlet. For instance, if we spend all our leisure in reading and none in exercise, we shall have unhealthy bodies, and therefore unhealthy minds. Or, worse, if we try to keep some moral code that condemns the bodily acts as base or evil, our whole minds may be twisted by endless secret cravings which we dare not even admit to ourselves.

Somehow we have to strike a balance between these two extremes of too much control and too little. This is made

far easier if we can give ourselves "heart and soul" to some most important aim which does itself demand of us the fullest aliveness both of body and mind.

B. OURSELVES AND THE WORLD

I. TREATING OTHERS AS SELVES

So far I have been talking as though each of us cared only about himself; as though, for instance, he only cared about his friends because he wanted the excitement of loving somebody. In fact, I have talked as though a human being were a complete thing all by himself. But he is not. To ask what is good for a single self is almost as queer as to ask what is good for a hand by itself, or for an eye, or a stomach, and so on, without considering the whole man. What is good for them is to play each its right part in the life of the man. And so with persons, what is good for them is to play their parts in the life of something greater than any of them.

But, before talking about that greater thing, I will say something about the ways in which one person may feel toward another person.

There are two very different ways of dealing with other people, a low-grade way and a high-grade way. The first is to use them as aids to our own living. For instance, we may steal money from them, or get them to protect us or comfort us. Or we may be kind to them just so that we may have a good opinion of ourselves, or, again, for the same reason we may try to conquer them. The other way of dealing with them, is to treat them as selves, just as important as our own selves. This is a higher grade of living. In order to do it we must have the power of imagining what other people are really like, and of feeling their wants, and taking their wants into account just as much as our own in deciding what is really worth striving for. This has been called the power of loving our neighbours as ourselves. The most

alive kind of love is not just wanting to eat up the other person for oneself, but wanting to know him through and through, wanting to imagine him as he really is, so as to admire him rightly. It is also wanting to help, or even to live for, and be one with, the other person. We all have this power to some extent, but in very few of us is it at all strong. This is partly because we are still very bad at imagining other people as the alive things they really are, and partly because, even when we do imagine them, we are very bad at controlling our actions for their sakes.

2. CARING FOR GROUPS

There is a way of living that is perhaps still more alive than caring for persons. When we are parts of a lasting group of persons, we may come to care for the group itself as a single thing, though made up of separate persons. We do of course care for the persons that make it up, especially for our own friends, but also we care for the group, or society. Everyone who becomes a member of the group, say a school, is made in a sense more alive by being a member. He discovers new ways of living that were not possible to him before. His mind is remade, to some extent, by taking over the school's way of life, the customs and rules and tradition of the school, the "spirit" of the school. He finds his own special task within the great common life of the school. He works for the honour or credit of the school. Even when he is really working for his own sake, to fit him for his life as a grown man, he works better if he can feel that he ought to be a credit to the school. And when he is doing things simply for the school itself, such as playing in a match, or being a prefect, he feels as though in some way the school itself had got hold of him, got into him, and was using him. In this way he may have a wonderful sense of increased aliveness. Also he feels that this is how he *ought* to be living, not for his little private self, but for something bigger than himself, something bigger than any self. This, he feels, is what he is *for*, to play a

part in the life of a great and beautiful whole made up of many selves, all fitting together, and feeling themselves in some way *one together*, one very great and live thing, the group (see the whole chapter on the *History of Ideas*, p. 417).

In some cases the pattern of the group is exactly and beautifully fitted together; the group is beautifully *one thing*. In some cases it is very muddled and ragged, with some minds hindering other minds, and only a very faint kind of common spirit, or way of life, running through them all. In a good school the spirit may be strong. Everything may fit together well; the members may really care for the school. But even in a school there may be groups of members that care nothing for the school, and harm it by their disloyal actions. In a people, too, a nation, there is a good deal of real pattern, which holds the members together, each with his special work in the pattern. Some make clothes, some work the railways, some teach, and so on. It is all supposed to be for the common good; everyone is supposed to care about the well-being of the whole people. Also, each has grown up into the particular way of life of his own nation. He speaks its language, thinks and feels in its ways. Though, of course, he is also just himself, with his *own* particular tricks of speech and ways of thinking and feeling, there is also something running right through his mind which we may call the spirit of his nation.

But even a closely knit people or nation is really a very ragged sort of pattern of minds. Its members do not work together properly. Most care more about themselves than the group. And even those that do care about the group disagree about it. Some want one thing for the group, and some another. Some want it to be strong for war and to rule many other countries. Some, on the other hand, want it to be made up of very alive people, who have, all of them, the chance of living fully. Within the nation-group there are many smaller groups which often care more about getting the better of one another than playing their part in the group. The loyalty to the nation, which should be in all minds, is only present now and then, here and there. In

fact, the life of a nation-group is really a horrible muddle.

All the same, the nation *has* one strong pattern running through it. A nation is, nowadays, a very real thing, though long ago it was not. England, as we know, used to be not one nation, but a crowd of little quarrelling kingdoms.

The greatest of all groups is the human race, made up of many very different peoples. At present there is little oneness, or pattern, about the human race, far less than in a nation. Not only are there ever so many different languages, but also ever so many different ways of feeling and thinking. This would be all to the good if the nations could also feel strongly that they were one in spite of their differences. But at present most men and women feel their national differences much more strongly than their human likeness and oneness (see *Peoples of the World*, p. 582). And so the groups within the greatest of all groups, the human race, seldom try to play a real part within the life of the whole. Instead, each tries to get the better of the others. And so there are all kinds of struggles and waste, of which the worst is war.

3. CARING FOR THE MUSIC OF LIVING

To care for selves or persons is a more alive kind of caring than to care only for satisfying our passing wants, like hunger. To care for groups or patterns of persons is even more alive. To care really earnestly for the greatest of all groups, the human race, is more alive still. It demands more complicated powers of understanding and feeling. But perhaps there is an aim which needs an even higher kind of aliveness than caring for the human race as a pattern of selves. It is possible to care, not only for persons or groups or even the greatest of all groups, but for what might be called the music of living.

A man may come to regard himself as a musical instrument which may make either a mean, clumsy, "empty" kind of music, or a very beautiful, rich, kind of music; in fact, a very gloriously alive kind of living. He may feel

loyalty to this ideal of high-grade living. He may feel that what he is really *for* is to perceive and think as well as possible (as fully and truly as possible), and to will and behave as rightly as possible (taking everything into account at its proper value). He may say to himself, "I do not matter so long as I make my living as beautiful as possible. There will come a time when I must die. That will not matter, so long as the music of my life is properly finished."

It is this sense of the music of living that makes some people feel, for instance, that cruelty is ugly quite apart from the pain it produces, and that love is beautiful quite apart from the help that it gives to the person loved. Some feel, too, that it is good to imagine and make beautiful things, such as pictures and poems and songs, and good to understand and enjoy the fascinating things that science finds out. They feel that this kind of living is what a mind is really for. Those who have cared very much for the music of living have been ready to suffer all sorts of pains and painful deaths for the sake of the lovely pattern of life, or way of life, which they felt they must at all costs make.

Now it is possible to feel even about the human race that what matters most is not it, a great swarm of persons, but the music of living which it makes. We may think of it as an orchestra of very many instruments, each playing its own part, but all helping to produce one single music of living. Or, rather, we may feel that this is how things ought to be, though at present the living of mankind on this planet is more like an endless jangle of instruments, each playing its own tune, with almost no regard for the music of the whole orchestra.

In the orchestra of the human race the different players come in at different times to play their parts, and then go out again, never to return. But the orchestra as a whole goes on playing, and the music goes on. In some millions of years it will probably end. The music will be finished. This will not matter, if it has been a beautiful thing brought to a fitting end.

Each of us, of course, wants to fulfil his own passing

needs, whenever he is ripe for them. He wants to eat when he is empty, sleep when he is tired. He also wants to be as much a fine person as possible, and is ready to control his passing wants for that end. He also cares for other persons, and will sometimes sacrifice himself for those he loves. He also cares for groups, and expects himself, and others also, to be loyal to groups. He may care, feebly or earnestly, for the greatest group, mankind. He may feel that all lesser groups should play their part in the life of mankind. But also he may feel that what all these things are really for, what he himself is for, and other persons are for, and nations are for, and mankind itself is for, is to make a very beautiful music of living. When anyone is as alive as it is possible for us to be, he seems to wake up into a very earnest desire that the living of mankind should be as alive as possible, that it should be highly skilled living, high-grade living, that it should be, not a muddle of little blind conflicting lives, but a clear pattern of lives all working together; that each person, though he plays his own special part in the music, should also grasp the pattern of the whole, and enjoy it; that the perceiving and thinking of each should be as full and true as possible, and his willing and doing as right and skilled as possible, just for the sake of the rightness or fullness of living.

At any particular time the orchestra of mankind is doing two very different things. It is producing its own music of living, and it is helping to make the orchestra of the future. According to whether it acts wisely or foolishly, the future generations will be more able or less able to live in a high-grade manner. When we are most alive ourselves, we earnestly desire that the music of human living may become more and more beautiful, more and more alive. We feel that the people of the world to-day ought not only to fulfil their own powers of living, but also begin the work of improving human nature, so that a far future mankind may be able to live in very beautiful ways which we ourselves cannot even imagine.

Meanwhile there is our own present world to remake. That is the most urgent task before us.

4. THE KIND OF WORLD WE WANT

What do we really want to do with this world of ours? We want everyone to live fully according to his capacity. Now, capacities vary. Even in the ideal world there would be many different kinds of people, fitted for the many different kinds of life which would be needed for the great pattern of the life of the world. There would be some who would be best at handwork of one sort or another, others best at arranging matters, others at inventing things, others at teaching, and so on. We want each to do what he can do best, and with a sense of fullest aliveness in his work.

Also we want the work of each, and the whole life of each, to help, not hinder, others, and to fit beautifully into the lovely pattern of the whole world. We want each to do his own special bit in the great work of the world, and also we want each to enjoy and profit by the lives of others and their work. The differences between people should not make them enemies. Instead, differences should make all the sorts of people more interesting and valuable to one another. Each should be able to enrich his own mind by seeing into, and enjoying, minds and points of view different from his own. Also we want each person to know at least in outline the pattern of the life of the world, and to see it as very beautiful, to care for it, and be proud to have a part to play in it. If he does not feel all this he will be a stranger, an alien in the world-life, and sooner or later he will become an enemy. He will run amok, damaging the lovely life of the world. He will be like a cancer-cell in the great body of the race, living for itself alone and harming the whole. If he gets power, and help from others like him, he may do very great damage.

To-day people have very different ideas about what the world should be like. Most do not care what it is like so long as their own nation or their own social class is prosperous. And so the world as a whole is an ugly muddle, full of unnecessary pain and hate. But the world which we want to

make must be of such a pattern that it will seem right to every kind of person. And the people in that ideal world must be all of them alive enough to approve of that pattern. In spite of all their differences of character and powers they must be able to agree to this extent, they must have this very precious thing in common. None of them must be so stupid or so mean that they cannot be willing citizens of the world. None of them must be so unjustly treated, or so cramped and crippled by their circumstances, that, instead of loving the life-pattern of the world, they hate it. None of them must come into the world with such a nature that they are bound to be failures either in body or mind, and so always miserable, and harmful to others. None must be diseased or crippled or insane. There must be plenty of higher-grade intelligence to do the exploring and the inventing, plenty of fresh and daring minds to see things in new ways and feel things in new ways, so as to do away with old bad ways and to work out better ones. Though there should be many kinds of persons, and as many persons of each kind as are needed for the world's full living, there should not be too many of any kind. Otherwise there will be overlapping and clashing of work, and also wasted lives. People will keep on interfering with one another, snatching work from one another. Many will have no chance of using their powers fully and for the common good. People who cannot serve the world have nothing better to do than be mischief-makers, trying to spoil the lives of others and the life of the whole. Each, then, must have work, and work suited to *his* abilities. There must be no square pegs in round holes. And, of course, no one must be favoured in any respect over other people, whether in respect of money or power or pleasure or education. He may have special advantages only if for some reason the world needs him to have such advantages.

In short, we want the whole world of men and women to be a thing of beauty, cherished by all, served by all, fully organised, but allowing plenty of freedom for everyone. Of course, there will be conflicts within the world, but

they must be only conflicts which really serve the life of the whole, as the conflicts between two football teams serve the school. Wars there certainly must not be, but only rivalries in doing things well for the sake of the world. There will be many kinds of groups within the world-group, such as families, villages, cities, schools, colleges, peoples. And each group will, so far as possible, live its own life in its own way, and manage its private affairs. But the affairs that all have in common will be managed by the world as a whole.

Very roughly, this is the kind of world we want when we are thinking about things most seriously. But we have not only to want it. We must fight for it, in one way or another. If we are to do this, we must care for it very much. And, so as to care for it, we must try to *see* it with the mind's eye. We must imagine as clearly and fully as we can the world that we want to make. It must come alive in our hearts. We must help everyone to see it and earnestly desire it to be real. To-day, either through laziness or fear or selfishness or blindness, most of us are content with the bad old world. Most want to use modern knowledge merely to prop up that tottering old world, not at all to make a new world on a better plan. All this must change. It can only be changed by those who have the will to change it, to live for changing it.

Let us think now about some of the particular problems that must be faced at once if we are to begin making a better world.

C. SOME PROBLEMS

1. FREEDOM AND EFFICIENCY

The first problem is this. We must arrange people's lives so that they all fit together to make a happy world, but also we must leave each person as free as possible to live as best suits him. How can this be done? The ideal is

of course that each one should freely want to do just what the world as a whole needs him to do. To-day this is impossible, because we are too ignorant and selfish, and the world is too muddled. If we had no laws and no police, the muddle would become much worse. So we all have to put up with some check on our freedom.

Can we find any rule to help us to decide in each case whether there ought to be interference or not? I think we can. In matters which concern the group as a whole at all seriously a person's freedom must be interfered with for the sake of the group. But in matters which are of no serious concern to the group he should be allowed to do as he likes. Thus, if he wants to play games on Sundays, let him, unless it cannot be done without giving other people extra work. But if he wants to drive his motor-car dangerously, he must be checked, for the sake of the other people who use the roads. If he wants to do anything which will make him unfit to do his work, or make him in any way a burden to other people, he must not be allowed. For instance, he must not be allowed to soak himself with beer every day, or take any harmful drugs, or merely to live in expensive luxury.

It is often very difficult to decide whether particular actions do or do not concern society. All the same, this rule not to interfere unless society really is concerned, is important. Too much regulation makes for a life of hateful "don'ts." Too little makes for muddle, waste, danger, quarrels, and kills the life of the group. "Don'ts" matter less to us if we ourselves really approve of them. Laws should depend as little as possible on force, on policemen, prisons, and guns. They should depend as much as possible on the *self*-rule of each person for the sake of others or of society. Why is it that most of us do not cheat and murder? Partly, no doubt, it is because we are afraid of punishment, but mostly because when we are most alive we do not *want* to cheat and murder, because we feel that such acts are stupid, low-grade acts, harmful to others and to society.

2. GOVERNMENT

Who is to make the laws, and enforce them? The ideal is that the government should be approved by everyone in the society governed, otherwise the society cannot be healthy. Government is *for* the people, and it must be, in some sense, carried on by the people. Otherwise there will surely be trouble. If one man, or a number of men, tries to rule a people which does not want to be ruled so, no one will keep the laws freely, but only because the government forces him. And no one can force a whole people to do what it has really decided not to do. Sooner or later there will be a revolution. Even the kindest despotism will not work for long, because the point of view of the despot is not the same as the point of view of the people. *They* want freedom. *He* cannot help wanting power over them. Power is intoxicating, like drink. The more you take, the more you want.

So some kind of democracy, or rule by the people, is absolutely necessary, in spite of all its faults. The people must have power to express its opinions and dismiss the persons whom it has appointed as governors if they fail to do their work properly. But the actual daily work of governing is very difficult, needing much detailed knowledge and skill. For instance, it needs much knowledge of history and politics and economics, and much skill in devising plans of action. If all the members of a society had to know all that is necessary for sound government, no one would have any time for anything else. There must be some people whose special work is suggesting laws and organising the affairs of the society, just as there are some people whose special work is making engines, or doctoring, or teaching. But these organisers should be men of the right sort, and properly trained. Government should not be carried on, as it is now, by men who have merely the gift of talking cleverly and persuading people to send them to Parliament.

The Russian way of governing is quite different from ours. Russia is a very large group of people spread over a very

large country. It is divided into smaller groups, and these again into smaller, and so on. At the bottom are particular villages and the groups of people engaged in particular trades. Each group chooses its own governors to meet in council and manage the group's affairs. The governors of many small groups choose a few of their number to meet together and manage the affairs of the larger groups of groups. These larger councils choose some of their members to help in the government of still larger groups, and so on. The government of the country as a whole is carried on by men who have been moved up from small group-governments to greater and greater group-governments, and are therefore likely to be thoroughly skilled in governing. At least, this is how government is supposed to be carried on in Russia, but really the whole machinery seems to be largely controlled by a few men at the top. All the same, if these made themselves extremely unpopular they would certainly lose their power.

Perhaps the world as a whole will some day be governed in some such way as Russia is now supposed to be governed. Whatever machinery of government proves best in the long run, the governors of the world must be fit to be trusted by the people of the world. But the people must be made really capable of understanding and caring for the general plan of world-society, and the general aim of governing. At present there is no world-government at all; there are only national governments. Most people understand very little even about the working of a national State and the general aim of governing. They are not educated up to it. Most are easily persuaded by politicians and bad newspapers to care more about national glory or the well-being of the rich than for making a happy people. For a happy world they care still less.

Now, many of us do not like politics at all. We would much rather that others did the politics and governing for us, while we were left to get on with our own work. In the best sort of world this would be possible. We should trust our governors to do *their* work, just as we trust our doctors to do *theirs*. But to-day all those who care about having a

better world *must* force themselves to take politics very seriously, just because our governors and politicians are at present making such a shocking muddle of the world. However much we dislike politics, we must at present all think much about them, and do whatever we can to put things right. On the other hand, though there are many people who do not care enough for politics, there are also some for whom politics is just an interesting game, and no more. They thoroughly enjoy it as a game, but they do not really care what comes out of the game. Let us beware of them.

3. NATIONALISM AND WORLD-LOYALTY

The love of one's country, or nation, once played a great part in helping men to care for something more than themselves or their own families or villages. But to-day patriotism is doing very great harm to the world. Because people find patriotism so easy and exciting, they cannot learn to feel loyalty to the whole world of men and women. If we want to avoid having very horrible wars, and perhaps wrecking our civilisation, this world-loyalty must somehow be brought to life in the majority of people.

In some ways the world is, all the while, becoming more and more one single pattern, one system. When a stone is thrown into a pond, ripples spread all over the pond. Just so, in the world, now that there is so much communication between different countries, so much travel by land and sea and air, so much letter-writing, telegraphing, wireless, so much trade, so many international arrangements about trade and about money, what happens in one country affects all other countries. If one country refuses to use goods made in another, people in the other will be thrown out of work. To-day we see posters telling us to "Buy British" so as to help British industry and give work to British workers. If we do so, what is to happen to the people in foreign countries who have been making things for us? They are thrown out of work. If they happen to be in

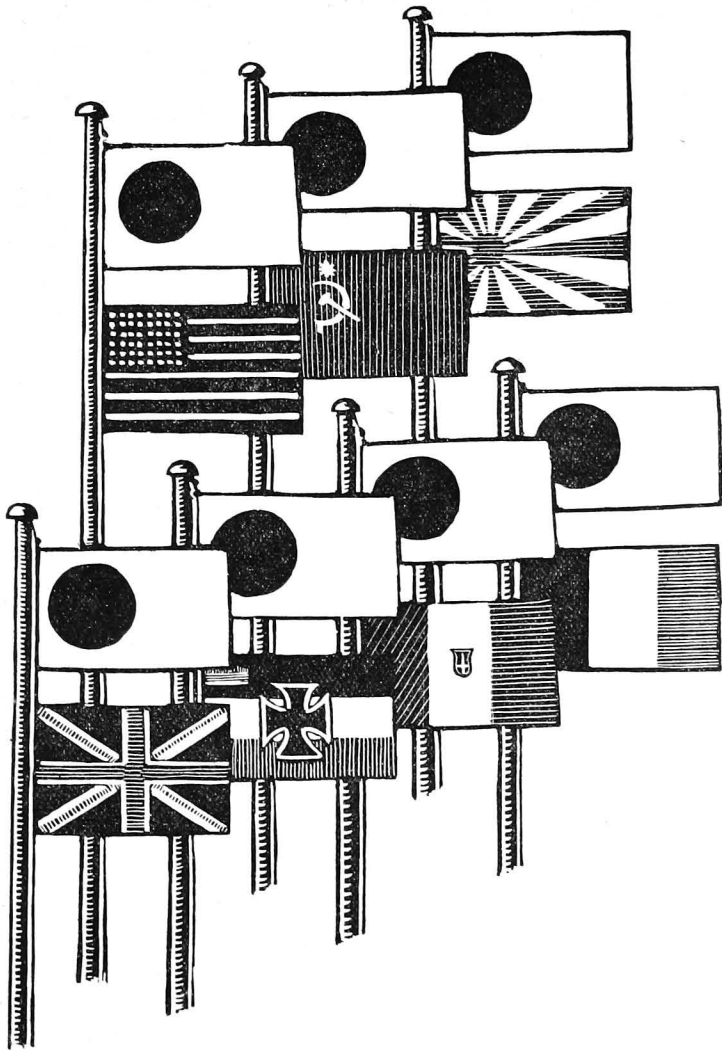


Fig. 93. THE FLAG OF THE WORLD STATE

Here we have pretended that the World State has been established, and we have invented a flag for it, a flag with the round world upon it. To show that the world is more important than any nation, we have put the flags of the "Great Powers" under the World Flag.

Germany, where things are much worse than they are here, the effect will be very serious (see *Economics*, p. 688).

But, though the world is quickly becoming one in this sense, it is only very slowly becoming one in another sense; people are only very slowly beginning to feel loyalty toward the world as a whole. This feeling for the world as a whole is a high-grade activity; and few are able to do it at all constantly. But it will come. It must. The young, either the present young or those that will follow after, will very surely feel this loyalty. Meanwhile, what stands in the way is our rather blind and mean loyalty to nations, our too easy and comfortable and cheaply exciting patriotism. Patriotism must be outgrown.

This does not mean that we ought not to feel any loyalty at all toward smaller groups within the world group. No. Each people or nation may well have its own particular spirit or way of living, its own particular triumphs of thinking and imagining and feeling. We may be proud of what our nation or our city or school stands for in the world. But we must never for a moment care more for this than for the world. We must never want to serve our nation at the expense of the world. We must be ready to live, and, if necessary, die, for the making of a real world-state and the kindling of a true world-loyalty in the hearts of all men and women. The world-state will, no doubt, allow each people to manage its own affairs through some kind of government of its own, just as a city manages its own affairs to-day. But in all matters that seriously concern more than one people, or that concern the world as a whole, power will lie with the world-government alone.

We must not allow any people to be ruled by the government of another people. If there are peoples that cannot be trusted to manage their own affairs without harming the world, they must be governed, not by one or other of the powerful nations, but by the world-government. At present the parts of the world that are less civilised, or merely less able to defend themselves, are nearly all governed by some great foreign national State or other.

Think, for instance, of India (see *Peoples of the World*,

p. 591). The English went to India to trade. But to secure their trade they had to conquer the country. No doubt they have given the Indians many good things, such as peace and order. But they have behaved haughtily. And, now that Western ideas of democracy and nationalism are spreading in India, the Indians are growing more and more determined to govern themselves. They will soon make it impossible for the English to carry on. But the English cannot bring themselves to trust the Indians enough to give them any serious power. They say the Indians shall govern themselves some day. But the day never comes. This kind of thing is bound to happen wherever one people governs another. Of course, the Indian problem is really very complicated. What would happen if the English were to go? India is not one people, but many. There might perhaps be civil war. If it is true that the Indians could not yet look after themselves, then they ought to be governed by the world-government, not by England. But very many Indians believe that India could govern itself.

The League of Nations is something like a world-government, and it is to-day in charge of certain lands (see *Peoples of the World*, p. 604), which it hands over to a particular great nation or other to govern for it. But the League, though it is far better than nothing, cannot speak for the world, since Russia and the United States are not in it. Moreover, the League is a league of national governments, some of which are very hostile to one another. Each tries to use the League for its own ends. The League itself has a certain moral power over its members, but, since they have armaments and it has not, it can never enforce its will against any of its half-dozen most powerful members. If the nations were to disarm, the League might begin to have real authority. But even then it would still be a league of national governments, each concerned chiefly with its own nation. When the Japanese Government, breaking various treaties and its covenant with the League, drove the Chinese out of Manchuria and attacked them at Shanghai, the League did little to restrain it, seemingly because the League governments did not seriously want to do so.

4. WAR

In the world that we want to make there must not be any national armies. Long ago, war was perhaps a good thing for the world, but now it is wholly bad. Not only does it destroy many precious lives and much hard-won wealth. It also poisons men's minds, so that their powers of high-grade living gradually fail. In the last great war, millions of the best young men of Europe and America were killed, or maimed for the rest of their lives. Millions more, who came through with no bodily hurt, were really very seriously damaged in other ways. They had spent four of the best years of their lives in a barbarous and filthy occupation, instead of living the kind of life that was suited to them. Deep down in their hearts they were poisoned with disgust and shame, with shame about the war and the world and human nature itself. Some had gone out to fight in the hope of making a better world. They suffered terrible things, and found that the world merely grew worse and worse. Some thought that war was going to be a glorious adventure. It turned out almost entirely boredom, beastliness, mud, and horror. Some people to-day are apt to remember the moments of adventure, and forget the months of weariness.

Those who did not see the war cannot possibly imagine what it was like. Nor can they realise what it has done to men's minds. War rouses very strong feelings of fear and hate. When people are busy fearing and hating very violently, they lose the power of thinking coolly and clearly. They believe any stories that make the enemy seem brutal and their own nation noble. In the last war some people even believed that the Germans were selling dead babies as meat in butchers' shops. If anyone dared to think differently from the rest about the war, or about the rightness of his nation's part in it, he was treated as an "outsider" and cruelly bullied. In the war-mood all the old low-grade ways of feeling and behaving cease to be properly controlled by the finer, high-grade ways.

After the last war the victorious nations disarmed the

beaten nations. They promised also to disarm themselves, but twelve years after the war they have still not done so. They also forced the beaten nations to agree to pay for all the damage caused by invasion, and also for the whole cost of the war. This they did because, being still in the war mood, they believed that the enemy alone had caused the war. Since then, feelings have cooled somewhat, and most people realise that the war was caused, not by one nation, but by the whole muddled condition of Europe. Yet even to-day the victors, or the most powerful of them, still insist on the payment which they made the enemy promise at the point of the bayonet.

If there is another war, it will be far worse than the last. Ever since the last war, people have been inventing more terrible bombs and poison gases. Unfortunately, to-day we are much more able to damage an enemy than defend ourselves. We could destroy the cities of the enemy people, but could not prevent the enemy from destroying ours. A few enemy planes over London could smash half the city and poison millions of people. The next war will not be a gallant adventure. It will be more like being run over by a motor or crushed under a falling house, or like dropping into a furnace.

Why are there wars? How can we prevent them? The causes of war are patriotism, fear, greed. Patriotic people want their nation to be strong enough to bully others. Since all nations are patriotic, all are terrified of one another. Therefore they spend an immense amount of money on armies and navies, so as to feel "secure" against one another. But the more "security" they have, the more they fear and hate their neighbours, because they know that they themselves are feared and hated, on account of their armament. Sooner or later they are sure to start fighting. A great armament is like a loaded pistol carried in a man's pocket. Every time he quarrels with anyone he is tempted to use his weapon. He fingers the thing in his pocket. A touch may send it off.

Another cause of war is greed. Some nation, or some powerful group within it, wants to have control of a



Fig. 94 THE NEXT WAR

will be a war upon civilians, especially in crowded areas. In this picture homes are being smashed and burned, and people are being gassed.

coal-field or oil-field which is possessed by another nation. Or else it wants to prevent other nations from competing with it in selling things at high prices to the natives of some uncivilised country. Then, again, there is generally some nation which is blamed for all the wrongs of the world. It becomes the "scapegoat" for the sins of all the others. The scapegoat used to be Germany; now it is Russia. Wars with Russia are likely to be caused by the fact that the rich people of Europe are frightened lest Europe should follow Russia's example and do away with rich people altogether.

Clearly all national armaments must be abolished. This is one of the greatest needs of the world to-day. The mere expense of war, and of the preparation for war, is a terrible burden on the world. Ever so much thought and labour and material which might have been used for making a better world is now used merely for destruction. Three-quarters of the money paid in taxes to the British State goes to pay for past wars and prepare for future wars. Only a quarter is spent in ways really useful to the people.

So long as there are armaments, the peoples cannot trust one another. So long as the peoples do not trust one another there will be armaments. What is to be done about it? One plan is to arrange a programme of gradual disarmament, to be agreed on by all the nations. This would be something very good. It would save an immense amount of money, and it would very greatly help to persuade the people to trust one another. But this alone is not enough. Aeroplanes that are used in peace-time for carrying passengers and mails can easily be used for carrying bombs. And bombs can be made fairly quickly. There is really no chance of doing away with war altogether until most men and women in all countries have learned to care more for the world as a whole than for their nation. No Londoner would dream of fighting against Manchester and Birmingham under any circumstances. He must learn to feel the same about fighting against Paris or Berlin or Moscow.

There is one other cause of war. People who live humdrum lives in modern towns, spending nearly all their days

in safe but tiresome work, naturally want adventure. They think that war will give them the chance to live a violent and chivalrous life. There was once some reason to believe this. Old wars were just very violent games. But the last war was not at all like a game. And the next war will merely give people the fun of being suddenly smashed or burnt or choked in their homes or their familiar streets. But this need for adventure and courage is wholesome, and should be satisfied, though not by war. Everyone while he is young ought to have the chance of some kind of skilled and dangerous action, for hard games, rock-climbing, exploring, dangerous scientific research, flying, and so on. Rather than preserve war, we had better allow duels again, and tournaments.

5. RICH AND POOR

Many people nowadays agree that war is bad. But unfortunately not nearly so many agree that there should not be rich people and poor people. Even those who do agree are seldom anxious to do anything much about it, if they happen to be fairly well off themselves. In the world that we are going to make, no one will be allowed to have a big house and three cars while elsewhere a whole family lives in a single room and cannot even share a push-bicycle (see *Economics*, p. 665).

At present, owing to the way money works, and the laws about it, some people inherit the power of setting others to work for them. Some gain this power by luck, or clever trading on other people's wants. The result is that, while many lead shockingly cramped lives, others have far more power and pleasure than is good for them. The many do not have the chance to grow up freely and fully in body and mind. They cannot use all the powers of life that they have, and they cannot develop other powers that they might have if they were better treated. They may also be tormented by a sense of injustice. Society treats them so badly that they cannot feel any loyalty toward it. Why should they ?

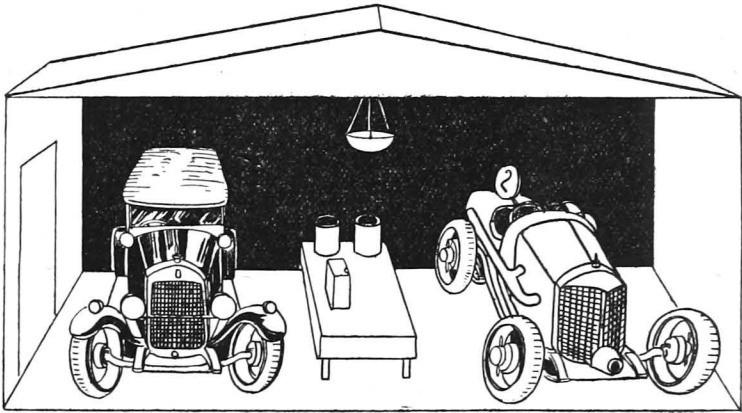
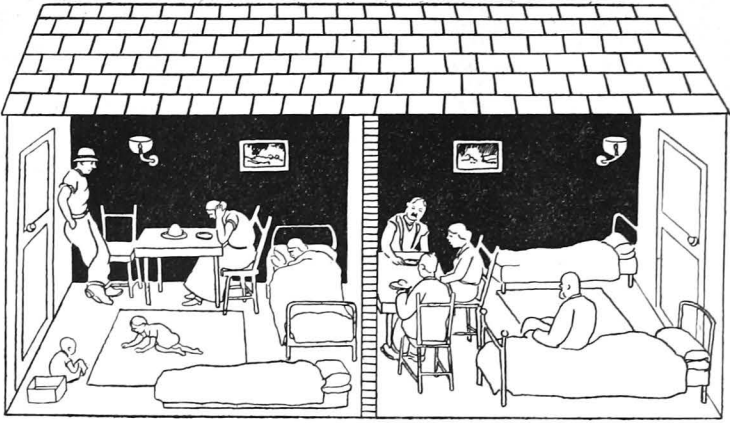


Fig. 95. These two families have only got two rooms to live and sleep and cook and eat in.

These two motor-cars belonging to one man have a big garage to stand in while they are not being used.

All this is fantastically wrong and harmful to the world. The ideal is that everyone should have all the wealth that he can use for his own and the world's good, but that no one should waste anything in undertakings which are of no real benefit to the whole. The ideal also is that no one should have power over another through the possession of money. A man should never have power over others except when he has to do so in service of the world, as policemen and railway officials and park-keepers have power. The ideal is that wealth should be shared out evenly, that no one should be favoured. Each of us should regard his own possessions as "held on trust" from the world, so that he may live his life well for the world's sake. Surely all this, which some of the old still find so difficult to see, must be quite obvious to every intelligent child who looks at the world with fresh eyes.

We are told that some people can use wealth better than others, and therefore should have more of it, just as some, who can make better use of education than others, should be more fully educated. There may be some truth in this. But to-day most of the people who cannot use wealth well are either the poor, who have never had the chance to learn how to use it for high-grade living, or the vulgar rich, who squander it on horse-racing, expensive cars, and other luxury. This they do because they have been badly brought up, and have the minds of spoilt children. It is true, of course, as we are always being told, that all this squandering gives employment to those who breed and tend racehorses, and make cars, and so on. But clearly these people might have been employed in other ways, in serving the needs, not of the rich, but of the poor and of the world as a whole. The only people who can by nature really make use of more wealth than others are those who are fit for costly work, which is itself part of, or necessary to, the high-grade living of the world, work such as exploration, scientific research, and certain kinds of art. In the world that we shall make these will not be neglected.

We are sometimes told that there is not enough wealth to make everyone comfortable. Even if that is true, it is

no reason why some should be much more comfortable than others. But it is not true. While some are saying there is too little wealth, others are actually saying there is too much. They talk about *over*-production of wealth, and tell us that there is more produced than can be bought. This is true, but it does not mean that there is more produced than could be *used*, if people were given a chance to use it. We all want many more things than we have, but we cannot afford them. While in North America the cotton growers are burning huge piles of cotton that they cannot sell, the poor people of every country are short of clothing. While the corn-growers are burning their corn, a million people in China are actually starving (see *Peoples of the World*, p. 607). While coffee-growers in Brazil are burning their coffee, or at best using it instead of coal for locomotives, people in North America and Europe are wanting more coffee. In the East Indies the rubber planters, unable to sell their rubber, are actually setting a rubber-pest to destroy their precious trees, in case people who would be content with a smaller profit should steal the rubber and sell it to the rest of the world. Meanwhile we are all wanting rubber for motor-tyres and a thousand other purposes.

Clearly there is no real over-production of goods at all. On the other hand, there is no real shortage of goods, or inability to produce the goods that are wanted. The world has far more wealth than ever before. But the way in which goods have hitherto been passed from the producers to those who can use them has broken down. And it has broken down because it depends on private buying and selling, because all the great operations of producing and distributing goods are carried out by people whose chief concern is to make a success of their business, not to serve the world. It has broken down because the people who have power, in all countries but Russia, are rich people, often kindly and generous in small matters, but desperately frightened of any serious change in society, lest they should lose their power (see chapter on *Economics*, p. 643).

The rich are those who, either by luck or by skill, have gained power to decide what the workers shall make, and



Fig. 96. Here is the well-fed farm hand with his clothes ragged and boots broken, there the half-starved worker in the clothing or boot factory. Neither can send the other the things he needs, though the ships are lying idle between them.

how the goods shall be distributed. This they do through their control of money, the counters which give to anyone who holds them powers of buying what others have made. Since most of the work of the world is controlled by companies of people who have money to spare for setting others to work for them, nearly all the world's work is really carried out for private gain and not public benefit (see *Economics*, p. 664).

This method, by which, so to speak, public good is gained, accidentally by the interplay of many private self-seeking, is now breaking down. Because neither the world as a whole, nor even the national States, have seriously controlled all this buying and selling, we are now in a strange plight. Something has gone wrong with the great system of counters that we call money (see *Economics*, p. 673). It is no longer reliable. Money has no longer the steady buying power that it had. So less buying is being done, less goods can be sold profitably, and therefore less are made. Ships are lying idle, fields are not tilled, factories are being closed, because the goods which they make or carry cannot be sold at a high enough price to give a profit to the manufacturers, shipowners, and farmers. So millions of workers in most countries are thrown out of work, and left without wages. They have to be fed and clothed by the State or by private charity. They are paid for doing nothing instead of for making things that are wanted. Of course, they are paid as little as possible, and so they can only buy what is absolutely necessary. At the same time, those who are lucky enough to be still at work are having their wages reduced, because the goods they make can only be sold at low prices (since we are all becoming too poor to spend much), and the factory owners will not hand out much of their small profit as wages. So those who are still paid wages are paid less than before, and therefore cannot buy as much as before. And this, once more, is bad for the factories. And so the whole muddle goes round and round, getting worse and worse every year. Yet everyone wants goods of all sorts, and everyone is ready to work.

There are two ways of putting an end to all this madness. One is by revolution. The poor might suddenly rise against the rich and sweep the whole system away. They might make the State own all the factories, ships, mines, railways, land, and all the spare money. The other way of putting things right is by slow change carried out by rich and poor together ; in fact, by society as a whole. The first is the way it has been done in Russia ; the second is the way it has *not* been done in the rest of Europe. Yet perhaps the second way is really the best, at any rate for States that are less rotten than Russia was before the revolution. For a violent revolution does destroy what is good along with what is bad. When those who were formerly poor and oppressed become masters of the State, they are apt to think that nothing matters at all but politics and economics. It is hard for them to see that the government and industrial organisation of a State are only means, not ends, just as housekeeping is only a means to enable the people of the house to live fully. Obviously, to live fully they must do much more than eating. They must use all their powers of high-grade living. But people who have been oppressed and cramped all their lives have not had much chance of living in high-grade ways, except, of course, in high-grade loyalty and love toward one another. They may have only the vaguest idea of what the other kinds of high-grade living are. Or they may care only about those kinds of high-grade living, like scientific research, which may be useful to the State. They may consider all other kinds of high-grade living a waste of time, as small children think difficult games a waste of time. This is a real danger. But, on the other hand, when a house begins to fall down, the only thing that matters is to repair it. The high-grade living that might be done in it must wait. To-day, it might be said, the world is a house that is falling to pieces, and nothing matters at present but mending it. And there is another point to remember. Those who were once poor and oppressed may sometimes be able to see what really matters better than people who have always been comfortable.

The upshot seems to be that, if possible, we should all

remake our world together, and not merely trust to a revolution carried out by the poor. Anyhow, in one way or another it must be remade.

We cannot now talk about the details of this great remaking. But one or two points ought to be mentioned. Obviously all the great industries, like coal and iron and agriculture, should be managed, not for private profit, but for the world, and by the world's representatives. Clearly, also, we must not allow anyone to have more than a very modest income, and we must do away with the private ownerships of large tracts of land. If possible, we should allow private gardens or peasant holdings, but not great farms and estates. Also we must not allow some people to inherit fortunes while others have to start their careers without such help. We must see that everyone who can work does work, and that work is actually provided for everyone. On the other hand, if for a time there is no work for certain people, we must still feed them properly and keep them healthy and contented, just as nowadays we keep soldiers in health and comfort even while there is no fighting to be done.

6. HEALTH, MENTAL AND PHYSICAL

At present money can buy health. The rich are more healthy than the poor. They have better medical care, and more wholesome lives, more space, freedom, fresh air, better food, less exhausting work. Records of illness show that most rich people are much healthier than most poor, and that they live longer. In the world that we are going to make there will not be rich and poor. But meanwhile we must see that the poor can be as healthy as the rich. A great population of tired and sickly people means a tired and sickly world.

There is still very much work to do in the conquest of illness. At present diseases of the heart, the lungs, the nerves, and all the other parts of man's body, cause immense misery, immense waste of life and wealth. To-day



Fig. 97. TWO WAYS OF REGARDING THE LAW

Above : Someone who denies the right of society to control him is removed by force.

Below : The motorist accepts the traffic regulations, and freely does as the policeman tells him.

very much human energy has to be spent in keeping up our many great hospitals and lunatic asylums, and in looking after invalids in thousands of private houses. In the world that is to come there will be no need for hospitals and lunatic asylums. Science will have found how to abolish all the diseases, and all people will live in healthy conditions (see *Applied Biology*, p. 228).

One extremely important thing to do is to prevent bad stocks from breeding. People in whose family history there are serious diseases, of the sort that depend on inherited weaknesses, must not be allowed to have children (see *Biology*, p. 205). It is cruel to bring children into the world who are bound to be miserable through inherited bodily or mental weakness. It is also disloyal to the world, and to the future human race. We must see that those who are likely to produce children of that sort are prevented from doing so.

7. MAKING A BETTER HUMAN RACE

It is very important to stop the breeding of bad stocks as soon as possible, but some day we may do more than that. We may encourage the best stocks to breed, or even encourage particular matings that seem to promise fine children. By other means also we may be able to control the growth of human beings. We may, for instance, be able to produce in them all sorts of improvements of character and ability (see *Biology*, p. 204, and *Applied Biology*, p. 214). Our aim must be to make a race of splendid men and women with beautiful bodies and lively, daring minds. Some day mankind will control human nature by these methods, just as to-day we control the breeding of racehorses for speed, and control plants by putting chemicals in the ground.

The task will be dangerous. If we tackle it before the sciences of genetics and physiology are worked out, we shall produce all sorts of deformed, unhappy kinds of men and women. Also, before we begin to alter human nature we must be sure we know what kind of human nature

would be best. However cleverly we were to control breeding, we might easily ruin the human species for ever if we were to breed for one good quality only, forgetting all the others—if, for instance, we were to breed only for muscle, or only for industriousness.

We must see, too, that the remaking of human nature does not get into the wrong hands. Governments, for instance, are greedy of power, and might use the new knowledge merely to produce docile slaves for industry and war. It is possible that some day the government of the world will be carried on by the scientists of the world. In many ways this would be good. But the governing scientists might very well come to feel that nothing mattered but scientific management. They might breed their own class to be pure managers and inventors, careless of all kinds of high-grade living except the one kind. And they might breed the rest of the world-population to be almost mindless robots.

Now, clearly, the fully alive human world of the far future will need many kinds of persons, fitted by temperament to many kinds of work. But ought we to agree with this idea of breeding a race of very low-grade slaves to do all the low-grade work of the world? I think it is a dangerous idea. I think we should rather try to have as much as possible of the low-grade work done by machines. Any that cannot be done by machines should be shared out over the whole population. A certain amount of drudgery is probably good for us. The ideal seems to be that, though there should be many kinds of human beings, all should be fully *human*. The many kinds are needed not only for the many kinds of work, but also, as we have seen, so that each mind may be enriched by its understanding and love of minds very different from itself. But all the kinds should be fully human. All should be intelligent enough and sensitive enough to be free, responsible citizens of the world, understanding and approving of the whole pattern of world-life. We must never forget that the goal is not merely to get as much work done as efficiently as possible, but to make a happy and a gloriously alive world.

8. LEISURE

If we want, not slaves or robots, but free men, all able to care for the life of the world, we must arrange that each shall have the chance of knowing something of what the rest are doing. People must not be so tied to their work that they have no time or no strength for anything else. Even from the point of view of getting good work out of them, we should allow them fairly short working hours. If people work much too long, they actually produce less. They also become unhealthy, and may fail through sickness. Moreover, since they are overstraining some of their powers, and finding no opportunity for using other powers, they become discontented and miserable. Leisure is important both for resting the powers used in work, and for giving an outlet to powers not used in work. For instance, people who have to sit still for their work need leisure for exercise. People whose work is unskilled may want leisure for skilled amusements, like carpentry or model engineering.

At present, leisure, like so much else, can be bought. The rich have most of it. Some people have more leisure than is good for them, some not enough. Factory workers, who spend their whole day in some single tedious action like putting things into a machine, need more leisure than people whose work is varied and interesting. On the other hand, anxious work, that "strains the nerves," needs more leisure than peaceful work. But people with very interesting work, which they feel they can do well, may find holidays a nuisance, though necessary.

People who are overstrained by their work can do nothing but rest during their leisure. Everyone ought to be allowed to have some energy left over from work, so that he can use his leisure not only for rest and for lazy amusements, but actively, or "creatively."

Think of some of the different ways in which leisure can be used. Think of sleeping, resting, eating, tramping about the country. Think of all the skilled powers that may be exercised in playing games, either muscular games like football, or mental games like crossword puzzles and

bridge, or in skilled hobbies. Then there is frittering away one's time over nothing in particular. And there is a delightful sort of idling in which, though you seem to be doing nothing, you are really very busy watching things, exercising your powers of perception. There are the many tiresome "amusements" which are done just because they are "the done thing." Then, again, there is being with other people, talking to them, understanding them, enjoying them. There is reading about things, and about the great world, and about the people in it, and how they think and feel. There is enjoying beautiful things like pictures and songs and poetry, or actually making them.

There are all these different ways of spending leisure time. Some are low-grade, some high-grade. The low-grade ones are quite good in their way, and often very necessary. But, just because low-grade actions are easy, people are apt to spend all their leisure in doing low-grade actions, and none on high-grade actions. Most people have no idea how to use their leisure so as to get the most life out of it. They just do the things that are supposed to be "amusing," like watching cinema shows, or motoring. Such amusements sometimes really are amusing, and, taken in small doses, they are refreshing. But many people do them over and over again, without noticing how bored they are growing. They cannot help doing them too much, because they have never learned to do anything better. Most people, even if they are not really too tired after their work, are content with the easiest, emptiest kinds of amusement. They want to get some kind of pleasant thrill with as little trouble as possible. Yet there are ever so many things they might do, which, though not quite so easy at first, would give them much more fun in the long run. These higher-grade leisure activities have to be learned. People have to be educated for leisure just as much as for work.

How are people encouraged to spend their leisure in our modern world? Many kinds of public amusements are provided, mostly by persons whose aim is to make money for themselves. Naturally they offer what is most likely to attract people. And what attracts most surely is what

affords excitement or "thrills" of one sort or another, and can be enjoyed with very little effort. Even those who have decided that they really want to do something better with their leisure are fatally tempted by the easy amusements which they see going on everywhere.

The main leisure-time occupations that are offered to-day are sport, the cinema, wireless, and the newspapers. By sport I mean the games and races that we pay to watch and read about, not the games that we ourselves play for the delight of exercise and skill. The players are doing skilled actions, but the watchers are being excited in a lazy way.

The picture-houses show us nearly always films which can give us nothing but low-grade thrills of one sort or another. They aim at being funny or exciting or sentimental. The funny parts are sometimes very good, but quite often they are too stupid to be funny—at least, to anyone who has passed beyond a very low level of humour. The exciting parts of films are terribly attractive to people whose lives are dull. Excitement, even of the lazy cinema sort, may be good in small doses, but, taken every day, it dulls our powers. As for the sentiment of the cinema, it is nearly always sloppy. The aim is not to show us real live people, but to show certain very well-worn types of "character," such as the faithful lover, the defeated villain, the devoted son. Everything is done so that we are sure to have a gush of cheap sickly-sweet feeling. People who live humdrum lives enjoy that sort of thing. But, like cinema adventures and horrors, cinema gushes of love and hate make people want more and more of the lazy but syrupy kind of emotion. The cinema also probably makes them less and less capable of sincere emotions about things in real life.

There are, of course, some very beautiful films about the lives of people in other parts of the world, and about animals, and explorations. But these do not pay nearly so well, and therefore there are few of them.

The wireless in England is not run for private profit, and so it really has done more than tickle our low-grade

wants. We are given a chance to hear good music and interesting talks of all sorts. There can be no doubt that this has greatly helped those who wanted to be helped. But most people do not care for that sort of thing. They therefore switch off, or try another station. For most people, therefore, wireless has the same kind of effect as the cinema.

Then there are the daily papers. Most of them, but not all, are managed by people who merely want to make money out of them. They do not tell us things so as to help us to know the truth about our own country and the rest of the world. It is our money they want. And so they tell us merely what will make us buy the paper. Even if we really want to know the truth about the world, most of us, when it comes to the point of buying a paper, do so for the sake of the simple and exciting things in it, like sport, murders, motor accidents, preparations for war, and stories about film-stars, boxers, princes, or princesses. The serious things, the things that are really more interesting though not quite so easy to grasp, can wait. And so day by day we put them off, and they have to wait for ever. Therefore it pays newspaper men to tickle and satisfy these lazy wants rather than the high-grade wants. There is another bad side to newspapers, and the wireless also. It pays better to give people the old, familiar, easy ideas rather than new and difficult ideas. So we find, for instance, that most newspapers praise patriotism and empire and armies and navies, and say very little about the League of Nations or world-loyalty. In fact, they are bound to influence people in such a way that they will swallow any sort of ready-made ideas, and will never bother to think for themselves.

In the world that we want to make, all this must be changed. But how? Clearly these public amusements must not be run by private persons for private profit. But, even if they were run by the State, there would be a danger. The government might use them, not to make people more alive, but to make them more easily governed. It might spread those ideas which suited its policy, and make other ideas seem ridiculous or wicked. This would not matter if

we could trust governments to *want* to spread just the truth. But we cannot trust them. The British Government uses its influence to spread the idea that Bolshevism is foolish and wicked. The Russian Government does the same about the aims of England. There is only one way out of the muddle. People must be educated so that they can use their leisure wisely, and they must be given more leisure, and more energy to spend in leisure. Then they will no longer be content to have only low-grade amusements. They will use part of their leisure for exercising their high-grade powers, and for keeping in touch with the life of the rest of the world. Then at last, perhaps, they will be able to choose governors that can be trusted.

9. EDUCATION

Education is perhaps the most important of all our problems. All our high-grade wants depend very much on how we are educated. Therefore on education depends whether the world is to be, on the whole, a high-grade world or a low-grade world.

As soon as a baby is born he begins to educate himself, to learn how to live successfully in his little world. His elders help him all the while, but it is he that has to do the learning. Childhood is in a way the most important time in anyone's life, since in childhood his mind is given a set or tilt or direction which will last till death. His character and interests throughout his life depend partly on the genes inherited from his ancestors (see *Biology*, p. 196), and partly on what happens to him in childhood. Events that happen after childhood do of course affect him, but not nearly so deeply. Bad homes make bad children, and, in the long run, bad citizens of the world. Things that happen to us in those earliest years may make us for ever after frivolous wasters who can never be trusted in anything, or grim self-seekers who care nothing for the world, or poor weak creatures who have no confidence in ourselves, or criminals with a mad itch to smash things. On

the other hand, those early influences may make us into wholesome, happy men and women, in whose minds there are, so to speak, no running sores to poison our whole lives and make them a trouble to the world.

Though the earliest education is the most important, school and college education is also very important. At present only the rich parent can buy what is supposed to be the best kind of education for his child. But, as a matter of fact, the most expensive education is sometimes bad, because the educators have wrong aims. They sometimes try to produce "gentlemen" and "ladies" with expensive tastes, little interest in the world, and little skill in living.

Education should have two aims: to fit a person for his work and to call out all his powers of high-grade living. The first is called vocational training, and the second general education. From the point of view of the person himself, and equally from the point of view of the world, both these aims are necessary. For his own well-being he must work, and he must live as fully as he can. For the world's sake also he must work, and he must be a fully alive, responsible citizen. If people are not properly trained for their work, they will be incompetent and helpless. A world made up of such people will be a world of muddle and waste. Trains will run late, and often have accidents; ships will be unseaworthy; houses will fall down, and so on. On the other hand, if people are not taught how to use all their powers, especially their high-grade powers, if they never learn to be interested in all the many sides of human living, and can never feel loyalty to the world, clearly the world cannot possibly be a world of high-grade living.

General education is less obviously urgent than vocational training, but is really quite as important. Its true aim is not to stuff us with facts about the world, though of course there are very many facts that must be learned if we are to know what kind of a world it is. One of the true aims of education is to help us to think clearly. It is so easy to believe that a chain of reasoning is sound when, as a matter of fact, one little almost unnoticeable link is false,

and the whole chain is useless. Another aim of education is to make us think honestly, fearlessly, so that we shall never believe things merely because we want them to be true, or disbelieve them because we are afraid of them. And it should make us think for ourselves, and not lazily believe whatever we are told. Also it should help us to get the best out of life, by making us interested in everything—in all human affairs, and the whole story of mankind, and in the whole universe of living things and atoms and stars. It should also teach us to distinguish between less important things and more important, and to care most for the things that are truly best, namely for the race as a whole and for the music of its living. It should help us to enjoy fully all enjoyable things and actions, both simple and complicated, bodily and mental. But also it should make us want to discipline ourselves very strictly for the service of the world. It should help us to be fearless in doing what seems best, whatever the consequences. It should give us self-confidence in dealing with others, but also it should help us to feel the reality of others, and to treat them as selves. It should help us to know ourselves through and through, and never be trapped into thinking we are better than we are, or worse than we are. It should help us to "get outside ourselves," and see ourselves as we see others, without prejudice. It should teach us to feel that, however real we are to ourselves, the human race also is real, and much more important. It should fit all the bits of our knowledge together, so that we may get a clear idea of the world as modern thought finds it, and of our own place in it.

Education is not nearly so fumbling and dreary as it used to be, but it is still very unsatisfactory. If a boy or girl is to have a "good start in life," he or she must pass certain examinations. And so the whole of school and college education is arranged with a view to examinations. Whole subjects are taught which are no use either as training for work in the world or to help toward a clear view of the world. They are merely needed for passing examinations. Ideas of right and wrong are given which are based on old-fashioned and mistaken views of the world. Little is

done to set hearts on fire with a vision of man and the universe and a will to play some part in the great awakening of man. And, because the whole business is so muddled and toilsome, boys and girls mostly dislike education, and it has to be forced on them.

All the same, things are changing for the better. And, on the whole, it is probably true that to-day much less harm is done by schools and colleges than by bad homes.

10. THE FAMILY (see *The Family*, p. 461)

In the world as it is to-day, people are educated partly by schools and colleges, partly by outside influences like cinemas, wireless, and newspapers, and partly by family life, by the tone or spirit of a particular home, which is nearly always the home of a family. Clearly there are many sorts of families besides the sort we all know. Clearly, also, though our Western kind of society is made up of families, that is not the only kind of society. So there is no need to think of our trick of living in little separate families as something holy, or absolutely necessary to a healthy world. If family life is good for the world, we must keep it. If not, we must do away with it, or alter it, whichever seems best.

What is good in a really good family? It is good that children should grow up in a little group in which each has his own place and his own part to play in the life of the group. In a good family a child does feel that he is "all of a piece" with a big and precious thing which has an easily flowing life of its own. Everything fits in; everyone is kind to everyone else, and ready to take trouble for everyone else. In any family there is a particular way of living, of thinking, feeling, and behaving, a family tradition, or spirit. In a good family this may be a very good influence. It may so set a child toward high-grade living that he will be a high-grade person ever after.

But all these good things might be had in other small groups besides a family. What good things are there that

can only be had in families? A good family is based on the well-trying love of a man and a woman. Their feeling for one another, and understanding of one another, may have a very important influence on their children. It may make the children feel for ever after that a group's "life-blood," so to speak, is love and not selfishness. Then, again, a family is a group of persons of very different ages, and one of the best things in a good family is the understanding and friendship between old and young. This may very greatly enrich the minds of both. Grown-up people who have nothing to do with children are often strangely blind to the things which children see most easily. And children, on the other hand, may learn very much from friendship with their elders.

Really good families are perhaps rare. And even the best family has its bad points. The young members and the old are bound to feel very differently about things, and so there must be a good deal of strain between them. Often this gives rise to an endless quarrel between them, which is very bad for both. Then also family life cannot help being to some extent "closed in," narrow, cut off from the world (see *The Family*, p. 464). Some people, of all ages, are so wrapt up in family life that they can never take anything else seriously. In the last resort, what they care for is their family, not the world. This way of feeling cramps the mind, and prevents a man from playing his part in the world.

Then, again, in some families which seem very good the children become so fond of their parents, and so dependent on them, that when the time comes for them to go out into the world on their own, and live their own lives, they cannot bring themselves to it. As citizens they become timid, stay-at-home, unenterprising. Or, again, the struggle between parent-love and the longing to be able to strike out for themselves may cause them all sorts of disorders of mind.

In really bad families, in which the parents are always quarrelling or trying not to quarrel, or always worrying the child or spoiling him, or giving him a sense of his own

wickedness or stupidity, children may be harmed in all sorts of queer mental ways, so that they grow up to be invalids, wasters, or criminals.

What is to be done about it all? In Russia they are trying to make the child feel himself more a member of the State than a member of a family. He is taught to feel more interest and responsibility toward the children's group to which he belongs than toward his family. People who have been in Russia are often very full of praise for the children and young people who are the outcome of this new plan. They say that Russian children are healthy, vigorous, and very much alive.

In the rest of Europe also the family is changing, though not so quickly. Children are becoming more independent. They treat their parents more as equals and friends than as superior beings. All this is to the good.

Clearly, in the world that we intend to make, family life, if it is to go on at all, must be rid of its dangers. I do not think that the family will disappear, since it is based on the biological needs of parents and children. But it will be greatly changed. Parents must learn to feel that if they keep their children at all, they must hold them on trust for the world's sake. No parent must be allowed to "do as he likes with his own child." The State must see that no children are brought up in bad homes. Perhaps parents will have to get a licence to look after their own children, just as nowadays a man has to have a licence to have firearms.

II. THE OLD AND THE YOUNG

Each one of us is apt to think of anyone older than himself as "old," and anyone younger than himself as "young." To a child, all full-grown men and women seem "old." To the oldest man in the world all the rest must seem young. But there is a real difference between those who are on the whole young and those who are on the whole old. In a sense the world-population really is divided into the young and the old, though it is not entirely a matter of years. The difference between the young and

the old is a difference in the state of their bodies, and it results in a difference in their behaviour, both bodily and mental. It is bound to be very hard for the young and the old to understand one another and feel one another's point of view.

Both, of course, have their good points and their bad points. The young are more active in body, and often in mind too. Their muscles are more supple, their bones less brittle. They see better, hear better, and are more sensitive in every way. They can learn much more quickly. Not only their muscles, but their thinking and feeling, is more supple. They are more able to grasp new ideas, and less ready to be content with bad old ways of doing things. They are often more eager and adventurous.

The old are, on the whole, the opposite of all this, but, on the other hand, they have seen a lot of things and people, and may be able to make good use of their past in judging about the present. They may have a more far-seeing wisdom and a greater balance of mind than is possible to the young. Also, if they have grown old in the best way, they may be more able to "stand outside themselves," to see themselves as others see them, to forget their private affairs through their interest in the world. It is often very difficult for the young to realise that, though for each of them his own happiness is very important, there may be other things even more important for the world.

Growing up is exciting and absorbing, though it is often very worrying and painful. But growing old is boring, disheartening. You feel yourself becoming less alive year by year, your senses failing, your interests fading, all that you do turning more difficult and less successful. To grow old, with nothing to care about but your decaying self, is very distressing. But if you have had all along other things to care for, and can go on caring for them, growing old does not matter, especially if what you care for most is the world and the endless music of its living. If you know you have played your little part well and finished it, you can put up with the failing of your body. In old age one's body's needs sting less than in youth.

The old are to be pitied when they are distressed, but also if they have successfully done their work, finished their music of living, they are very much to be envied. They ought to be treated neither with contempt for their weakness, nor yet with false respect for their mere length of life. But above all they must not be allowed to stand in the way of the world's great task of remaking itself. This is what they tend to do, just as the young tend to be in too much of a hurry for change.

The old and the middle-aged hold most of the important posts in the world. This can hardly be avoided. The young could not do the work, since they have not seen enough of the world to know what to do in complicated situations. But, of course, the old and the middle-aged do their work with the bias of age. They care too much for the old ways, and are often blind to the badness of them. Mostly they cannot feel the new spirit which is waking in the hearts of the young, the spirit of loyalty to the human race.

The old are a very serious problem for the world to-day. In savage life people mostly die as soon as they begin to grow at all old. They cannot stand the strain. And so there are few old, many young. But in the modern world people live much longer, and so there are many old and ageing—too many in proportion to the young. And if the population begins to dwindle, as it will probably do, the proportion of old people will grow even greater. This may make the living of the world an "old" kind of living. World policy may become unadventurous.

On the other hand, owing to our better conditions of life, we grow old less quickly than in earlier times. A hundred years ago a woman of thirty was old. Now she is full of life and joy and adventure.

There are two problems to face. The first is how to balance the old and the young in the present world so that the life of the world has full benefit from both, yet escapes the danger of both. How are we to arrange that the old, with all their power, shall not stand in the way of the world's remaking? Again, how are we to contrive that old and young may live in the same world without being a

burden to one another, as they so often are to-day? How can each person contrive to be wise though young, fresh though old?

The other problem is this : Can we find out how to abolish old age altogether? Can we make a race of long-lived yet ever-young beings, always fresh and vital, yet rich in experience? Of course, if people were to live for ever, the stock would never be improved. And, even in a race of long-lived but not immortal generations, biological improvement must be slow, since the generations take so long to succeed one another. But short-lived generations are wasteful. So much of the energy of the race has to be spent in re-learning. To-day much of our life is spent in catching up to our elders, learning their wisdom, unlearning their mistakes. And then, when at last we really do know a thing or two, we are already beginning to grow mentally old and stiff and unadventurous. Clearly the aim should be to make man's life-time much longer than it is, but also to ensure that he may keep young right to the end. But if this is to be done we shall have to see that very few children are born. Otherwise the world will become overcrowded.

12. WHAT TO THINK OF THE WORLD AND FEEL ABOUT IT

Our modern knowledge has made nonsense of many old beliefs and aims, which were perhaps helpful once, but now are a hindrance to the life of mankind. In the old view, the most important thing for anyone to do was to "save his soul." By living according to a certain set of rules, said to be God's law, he was to earn an everlasting life of joy in heaven after his death. Life here on earth was not supposed to matter at all except as preparation for that other life. But now we are beginning to feel that the desire to live for ever as a little self is, after all, not a very alive kind of desire; in fact, it is not what a man ought to desire. While we are children, the thought of dying, of ceasing to

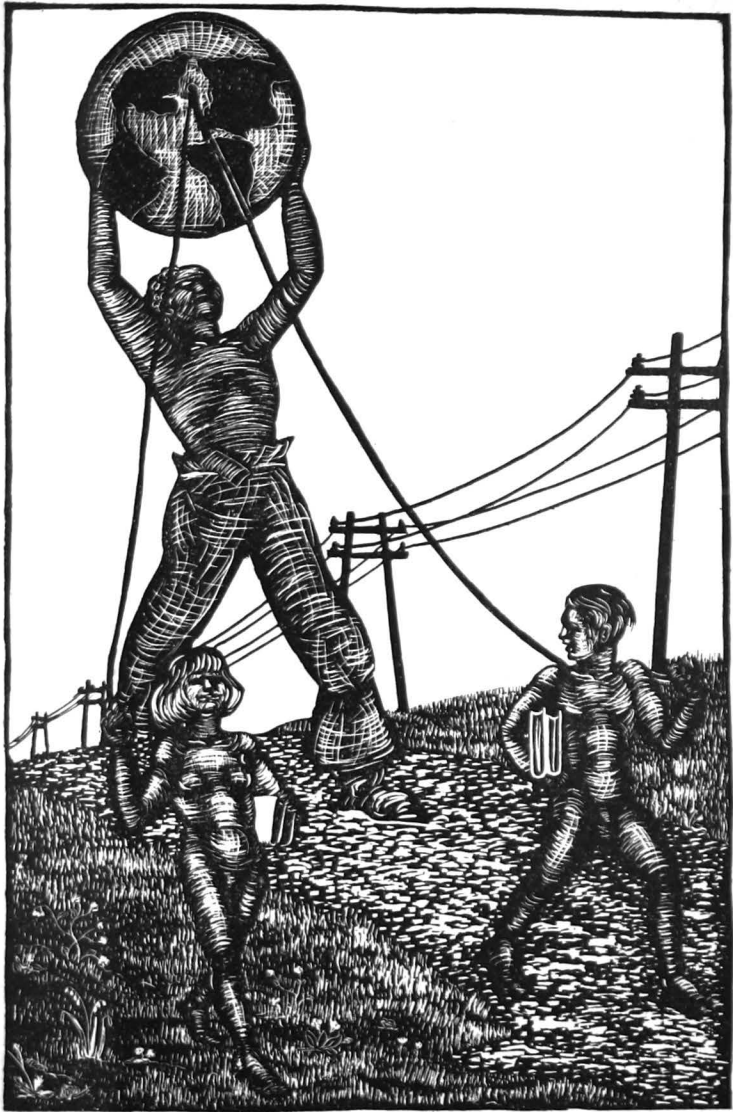


Fig. 98. BOYS AND GIRLS BRING IN THE NEW WORLD!

be, of being snuffed out like a flame, is rather frightening. But later, if we grow up in a healthy way, it becomes no more alarming than the thought of going to sleep. To-day we are beginning to think of a human being less as something precious in itself, like a jewel to be stored up for ever, and more as a musical instrument which has a part to play in the music of the world, or even as an actual tune or chord or single note in the music. It is foolish to want one note of the music to last for ever.

Modern thought is impressed by the bigness of things—by the distances of the stars, the huge length of their lives, and even of our planet's past. Man, it seems, is a tiny thing, and has only just begun. He grew out of an animal, which grew out of simpler animals. And all has grown out of the stuff of a star. So men are not something utterly different from the rest of things. Man is all of a piece with his world. His nature is just a rather complicated bit of the world's nature.

There are two ways of facing all this. One is the way of disgust and despair. We may feel that, if man is nothing more than a tiny microbe living for a moment on a world that is less than a sand-grain among the stars, then nothing really matters. We may give up caring about man and his gradual awakening into more alive ways of living. We may settle down to seeking easy pleasures for ourselves and escaping pain.

But there is another way of facing modern knowledge. We may accept it gladly, as good news, as a gospel. We may rejoice to find that we are all of a piece with the great world. We may look at the world with a new respect, a new love, a new hope. We may begin seriously to make the best of it, and of ourselves, and of the human race. We may outgrow the old cramped hopes that were good enough for the blind past, such as the hope of a pleasant life in heaven. Instead, we may learn to desire above all things to make mankind into something very beautiful and happy. And, remembering that man is all of a piece with the rest of the universe, we may feel that this effort of his is really in some way an effort of the universe itself to wake.

And if man should, after all, fail, we may still hope that somewhere else this great awakening may occur.

Those who believe the new knowledge, yet cannot out-grow the old hopes, must indeed feel disgust and despair. There are still many in this sad plight. They cannot see any good in anything. They sigh over the impossible old hopes, and laugh bitterly at the new hope which they cannot either believe or desire.

But things are changing. The new hope is growing. At present our thought is very confused, and our hearts do not easily accept even what we are forced to believe. But both our knowledge and our world, and also our own desires about our world, are changing very-fast. Those who are children to-day may help to make a world more different from ours than ours is from the world of the ancient Egyptians. They may do easily things that seem to us impossible. They may one and all constantly desire things that are too difficult for us to desire except in our most alive moments. They may see clearly what is really desirable, and actually desire it. They may get control of their world and their own nature, and know how to use their power wisely.

Meanwhile, those who are children to-day are growing up in a very strange world indeed. It is all strains and crackings and crumbings. It is in the act of changing into something very different, which may be better or worse. Human nature is not yet half made. It is mostly ape nature, with a few gleams of the nature which we hope man will some day have. Formerly man's apishness did not matter so much, but now he is gaining dangerous powers, and may destroy himself. He is like a monkey that has learnt how to strike matches, and may set the house on fire. To-day all depends on the young, on their preparing to take charge of the world which their elders have so shockingly muddled, on their sweeping away bad old customs and ideals and working out better ones, on their accepting whole-heartedly the new supreme loyalty, the loyalty to the slowly awakening spirit that is man.

PART III
VALUES

EDITOR'S INTRODUCTION TO PART III

Now you have read all we are going to have about knowledge, and the organisation and application of knowledge. You might think that was all there was to say in an outline like this. But it isn't. What we come to now is much harder to put into words. Still, I will try.

The difficulty about the arts is that they have really got to be experienced before they can be explained. You don't know what dancing feels like until you have danced ; nobody can show pictures to a blind man or music to a deaf one, however many words they use. Unless you can somehow begin by having an inkling of what the arts are about, they will seem to you just as silly as a lot of boys and girls playing forts or touchwood might seem to a cross or stupid grown-up person. But just as play is necessary—just as, when you are quite young, you feel you must burst unless you can play part of the time—so the arts are necessary to a proper life for a growing and adult person. That is why at the beginning of this part I have called them Values : because they are essentially what makes life feel valuable, what makes civilisation worth living in or for. If you live uglily in an ugly place, without rhythm or pattern in the way you do things or think things, life stops feeling worth while. But if you have rhythm or pattern in your life, and make the place you live in beautiful (which is not the same as making it elaborate or expensive), life does feel worth while.

Of course, this isn't entirely true. It isn't *exactly* the arts which give value to life. A few rare scientists and historians find all the worth-whileness they need in their searching and questioning : it looks as if truth were taking the place of beauty for them. And a few people who are intensely interested in some other kind of work find that it gives their lives complete worth-whileness. But perhaps what has happened is that these people have turned what

they are doing into art. Because they love it so much they have given science or history, or whatever it may be, a kind of heightening that turns it into a pure value. It shows itself in their minds as pattern and rhythm; it joins them up with everything else in the universe: it has become beauty. If you say that this doesn't really mean anything, all I can say is that I have got to describe things like this in symbols—I can't talk about them plainly and solidly, any more than chemists or physicists can about electrons and protons—I have got to talk about them in pictures, and hope that the pictures will light up some idea in your mind corresponding to the idea in mine.

Now, again, people who are deeply in love haven't any real need for art. All the value they want in life is in one another; this is what "love in a cottage" really means. But, unhappily, in civilisation as it is at present only very few people get the chance of being happily in love with one another, and there are fewer still for whom it can go on year after year. And there ought to be some kind of beauty for everyone, all the time. That seems—doesn't it?—the least we can ask of all the complications and elaborations that we call civilisation.

But beauty is a very difficult word. No one in this book has tried to define or explain it; I can't myself—I don't know exactly what I mean by it, though I know what I feel by it, and I expect you do. Finding out about beauty, and putting it into words, is called *æsthetics*, but dealing practically with beauty is called art. There has been art for a very long time, but I think *æsthetics* only began when people became bothered and uncertain about beauty. All I can do is to give you a few clues to work out for yourselves.

First, you will find that all the authors in this part talk about pattern. Turn back to *The History of Ideas* and see what Gerald Heard says about that (p. 443).

Second, if you read the chapter on *Dancing* and the chapter on *Writing* you will find that Beryl de Zoete and Wystan Auden both say, in different words, that the point of their particular chapter is that it bridges the gap

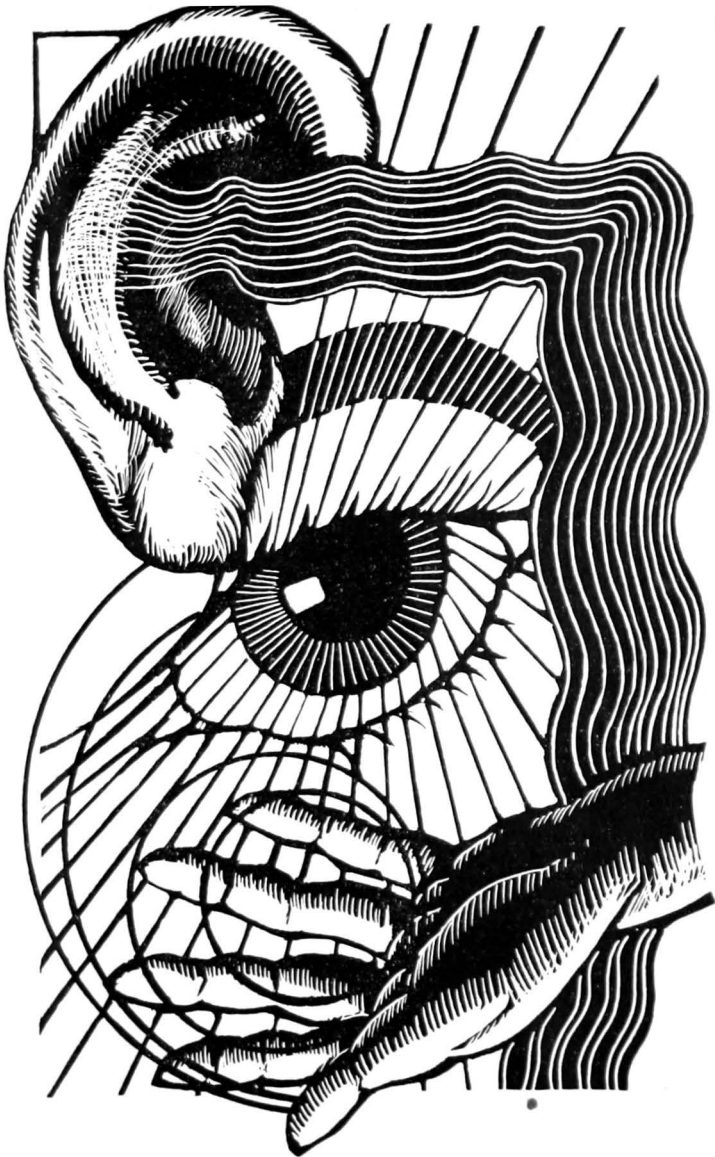


Fig. 99. HOW BEAUTY COMES TO US

between people, and stops them being separate and lonely all the time. Perhaps this might be the real value of art : that it gives the feeling of being all part of something big and everlasting, it makes us feel we are joining together, like ice-blocks melting in spring and swinging down a great river. But yet art is an intensely individual thing. A whole group of people can't paint a picture. It must be the work of one separate man or woman. How can we make these two ideas, of separation and of joining together, fit ?

Third, what sort of person is an artist ? a writer, sculptor, musician, architect, dancer, decorator ? He or she is apt to feel things very hard ; to be either violently happy or violently unhappy. This is rather a tiring kind of life, but those who know it say it is more worth while—has more value—than any other life they can imagine. There are times when one feels a worm, but there are also times when one feels a god ! That's one side of it ; but the other is that artists aren't really special people ; anyone can be, and should be to some extent, an artist ; they can, as Dick Gleadowe says (p. 803), do a thing beautifully by doing it well—doing it deliberately, with pattern, with form. Everything can be designed : machines, stamps, boots, towns ; everyone can understand and help with this beauty. I suppose this means that everyone has the possibility of feeling like an artist, being violently happy and unhappy, being very sensitive to everything. And I suppose, if you are sensitive in one way, you are likely to be sensitive in others—to feel deeply about people and about pure knowledge, as well as about beauty.

That is all rather tangled still, I'm afraid. Perhaps you can make sense of it. I can't—not, at least, in ordinary words and sentences. Just as science needs the number-language to express it properly, so beauty needs the poetry-language, and there are even fewer poets than mathematicians.

DANCING AND DRAMA
OR
THE FIRST PATTERN OF LIFE
by
BERYL DE ZOETE



BERYL DE ZOETE is a pupil of Dalcroze, and his rhythmic training has helped her to understand many kinds of dancing and the rhythm of people in their ordinary life. She has taught eurhythmics and ballroom dancing, which she loves, though she would never teach it to children and could not write about it here. She spends much time in learning the languages of other countries, so that she may get to know the people who live there, and understand their poetry and their stories and, above all, their dancing.

DANCING AND DRAMA

*O chestnut-tree, great-rooted blossomer,
Are you the leaf, the blossom, or the bole?
O body swayed to music, O brightening glance,
How can we know the dancer from the dance?*

—YEATS.

WHAT IS DANCING?

VOLUMES have been written about dancers and about different kinds of dances, about actors and different kinds of plays; and now, in a few pages, I have to write, not only about dancing, but about drama. I have to travel to many countries and see many people. What thread can I hold in my hand, like Theseus when he went down the long passages in the palace of the Minotaur, to pull me back if I begin to lose my way?

If dancing is the art of movement, are not games and gymnastics and acrobatics and all the many labours of man—sowing and reaping and cooking and swimming, and sailing ships and flying aeroplanes—arts of movement too? There is, indeed, no reason why acrobatics or swimming, or boxing or skating, or ball and all other forms of play, should not enter into the dance. The Russian ballet has included almost every bodily activity, even card-playing, even work in factories; but only as part of the pattern of a dance, a line or accent.

We must define dancing more closely, and say that it is the art of expressive movement, or of expression by bodily movement. So now I may not even count as dancers such miracles of grace and rhythm and harmonious movement as the Codonas, those aerial gymnasts whom you may have seen at Olympia, nor most of the other acrobatic dancers I have seen.

The need of considering drama as well as dancing really makes my journey shorter. I can only wave my hand

regretfully at ballroom dancing, and pass by ; it is expressive movement, but it is hardly dramatic, though some of the dances it has lately borrowed from distant lands were in their origin very dramatic indeed. Nor can I consider the theatre as we know it to-day in England. Tragedy, or crook-play, or modern comedy—it is an entertainment which has no relation to that drama which grew out of the dance, and which in certain countries is still closely bound up with it.

Dancing, then, is the art of expressive movement, and, as the earth is our dwelling-place, the art of expressive movement on the ground. Every day we walk to get somewhere, to fetch and carry, but we seldom take any interest in the steps themselves. Grown-up people generally take as few as possible in order to get from one place to another, while children leap about and twist and curl, and cover twice the distance necessary. A grown-up person who, for sheer joy in a letter he had received, or because the sun was shining or the birds singing, ran three times round the pillar-box when he went to post the answer, or pranced shouting down the road, would certainly be thought mad ; even children who bark or chase their tails like dogs, or jump for joy, or drag their feet in a slow rhythm to express reluctance, are not always encouraged. If you stamp your feet when angry, or fling your arms out in despair, or roll on the ground with rage, you are almost certain to be scolded. If, instead of walking soberly, you come pirouetting into the room, or strut like a peacock or imitate a bear, or pretend to gather flowers from the carpet or fruit from the chandelier, it is not certain that anyone will applaud you ! Yet all these exuberant movements are the expression of some energy pushing up like the first small leaves of a plant out of the earth: *life*, which we still cannot define though we know so much about it.

THE FIRST DANCING

Things have been discovered, things are done, which less than fifty years ago were regarded as the wild fancies

of a few eccentric beings. We can all fly ; we can all look down on the clouds ; we can even, by a little study, understand how we fly. We can put a small machine on a table and, by turning it slowly round, listen to words that are spoken, to music that is played thousands of miles away ; we can keep all the orchestras and all the singers of the world on one small shelf, and hear them by making a needle move on a revolving disc. We can see all the landscapes and all the cities of the world follow one another in bewildering succession over a white screen : and hear crowds shouting and birds singing, and see camels cross the desert, and naked Africans dancing in their villages and Eskimos crouching in their furs, and climbers on the highest mountains and divers in the deepest seas, and bright fish swimming among coral reefs.

Yet we still do not know what life is. There are still almost as many secrets undiscovered as when the first men drew their first pictures of beasts and dancing-men in prehistoric caves, and danced the first dances and acted the first plays. Those first men and their descendants for many thousands of years knew very little about the world, and lived in dread of what they knew. They feared wild beasts ; they feared the great forces which they felt to be moving behind storms and lightning and floods and earthquakes, and to be speaking through them (see *History of Ideas*, p. 430). Everything was mysterious to them. But they had in their bodies the same breath as us, the same need to express themselves by movement. They had more force than they needed for their bare existence, and, like animals, they began to play with their force. They beat the ground with their feet ; they took pleasure in the pattern of their beating. They moved their limbs together, and took pleasure in the movements they made. They danced, and they still dance.

Dancing in the beginning had a magic purpose. Savages, and many ancient races who are far from savage, believe that by dancing certain dances, repeating certain sounds, making certain music, they can compel the spirits which they feel behind the forces of nature to do their will,

also that they can themselves acquire the power of animals by imitating them. So they make for themselves dresses like birds and beasts; they imitate the movements of birds and beasts in order to increase the supply of game; they imitate the thunder and the rain, the trees and the plants and water. By imitation they acquire the power they fear and covet.

You must remember that among all primitive peoples men and animals are very closely associated; men do not feel themselves to be distinct from animals. In all the animal stories which exist all over the world, animals have taught men their wisdom, and one could change into the other very easily. Fairy-tales are full of these changes. You must often have played at being animals, and thought that by imitating animals you became them. I knew a German sculptor who, by continually watching and drawing pumas in the Zoo, had himself taken on much of the grace and secret strength of the puma. There is a religious sect in Morocco called the Aïssaouas, who have a strange wild dance in which men change into wolves and jackals, and howl and fight together, and make the noises and movements of the animals which possess them. Similar dances are danced all over Central Africa, all over Asia, and as far as Java; in Australia and America. There are panther-men, and chimpanzee-men; grizzly bears, wolves, lions, and tigers, realistically danced by men. They are "beside themselves" when they dance, and it is this capacity for being beside oneself, for getting out of one's body and becoming something else, which is at the root of all these early dances, and of all the greatest dancing and drama of the world.

The Boy Scout movement, though as far as I know it practises no magic dances, is inspired by American Indian tradition, and perhaps the Wolf Cubs do really go through certain wolf rites. In any case, I am sure they will feel a certain sympathy for this story of the origin of Brave Dog Society. Red Blanket, a member of the tribe who had been hunting in vain for his dog, heard a mysterious drum, and a voice saying: "Lone Chief invites you to come and

eat, for he is ready to give a dance." He looked round and saw a large female dog, to which he gave a piece of meat. The dog told him she was giving a dance that night on behalf of a mother dog and her six little puppies who had been left behind when the camp moved on. "We will show you our dance, and when you return to camp you can make use of it to found a Dog Society." So Red Blanket went through a long course of training under these fairy dogs, and taught the movements to his tribe when he got home. By becoming a dog he had learnt their qualities, their bravery and cunning. Of course, Boy Scouts and Wolf Cubs only play at these things. They do not really have to hunt for food without weapons, but they do like to feel it is important for them to find their way by secret signs in pathless woods, to make fire without matches, and to tell the kind of tree by the feel of its bark, and I agree with them.

Do animals dance? Birds certainly dance when they are courting, and practise the most lovely and alluring gestures. Perhaps, also, their evolutions in the air at evening, by thousands and thousands, are really a dance. I saw once at the Zoo a polar bear performing repeatedly a sort of dance which seemed to express the very soul of boredom, and communicated a tragic despair. Was it a conscious dance? He advanced in five minims to the edge of his terrace, the fifth coinciding always with the swinging of his right foot and the whole of his right side over the abyss, as if he never foresaw it, but only just saved himself in time from falling. Then in eight crotchets he went backwards, always describing exactly the same curve, and so on for half an hour on end, never deviating from his course. Was he expressing his *ennui* in a rhythm, or was each progress dictated to him by the very spirit of captivity?

But it was probably not the dance of animals, but their customary movements, which the first hunters imitated when they danced. They dressed themselves in the rhythm of animals in order to acquire power over the spirit of those animals. Gradually the order of this rhythm became more elaborate; for every important act of their lives there

was a dance. Their bodies were the instruments on which the music of the world was played. They drove away disease by a devil dance. They danced the birth and death of heroes, their victory over men and beasts ; they danced their joys and sorrows, their love-making, their anger, their hatred of enemies, their desire of battle, their pride in victory. They danced the death of the Old Year and the birth of the New. They made drums and horns and flutes and many varieties of stringed instruments, with tender or penetrating tones, to stimulate the rhythm of their bodies. They not only commemorated their past deeds, but stirred up new courage in their hearts by dancing the battle dances, or love by their love dances. They danced their gods and demons, dressed, as they imagined them, in devil masks and fearful, terrifying disguises, like the present devil dancers of Tibet.

There were certain people more gifted than others, who were more easily affected by the rhythm of the dance, and who saw in their faculty for becoming " possessed " a way of proving their superiority and getting power in their tribe. These go-betweens, priests or medicine-men, learned the will of the spirits when in a state of ecstasy produced by dancing or the sound of drumming or drugs. The shaman or shamaness—for there were women priests as well as men—became persons of great importance because of their communication with the spirit world. For music and dancing were not merely amusement, but a very important part of the social system, at a time when the social group or tribe had to make itself strong and hold together against enemies. These medicine-men were trained from youth in the rites necessary for bringing the natural world into touch with the supernatural. I shall return to them later on, for they have always played, and in certain parts of the world still play, a very important part.

TRADITIONAL DANCING

A tradition began to grow up, and gradually came to have tremendous power, so that it was like another self—

more important than a man's own life. To go against tradition was a terrible sin. This question of tradition is very important. You can easily understand what an enormous part it may play in the lives of people who are cut off from the outer world by great rivers or mountains or jungle, so that nothing from outside has touched the customs in which they were brought up. Even amongst ourselves, who have so much contact with foreign countries, there are certain very powerful traditions which are difficult to define, even for those who would most loudly cry out at seeing them violated—the traditions of the Navy, for instance, or the Public School tradition. Here is an example of quite another kind of tradition. In a very ancient and highly developed civilisation like India, certain airs, known as *ragas*, and certain dance-movements and pictures which correspond to them, are so closely connected with certain hours of the day and seasons of the year, that a musician would not consent to play at midday the *raga* which belongs to dawn. It would be as impossible for him as for a perfect English gentleman to go to a dinner-party in a white tie and smoking-jacket. It is not "done," and he *could* not do it. It would wound his soul, for this is much more than a fashion; it is a tradition. The odd thing is that, though the Indian musician would at once understand that the English gentleman's teeth were set on edge by such a breach with tradition, the latter would probably look on the Indian's prejudice as senseless (see *History of Ideas*, on tradition, pp. 435 and 441).

In the development of dancing and drama, tradition has played an enormous part, and all the loveliest examples of both which we can still see in the world remain because of an age-long tradition, which has been more powerful than all the wars and the shocks of modern life which have broken against it. So this chapter is really about the birth and life and weakening and revival—sometimes also the death—of traditions.

In England, too, we have our traditional dances, dances connected with all the seasons of the year, with all the activities of social life. Very few people dreamed that they



Fig. 100. HOW SHE DANCED THEN

existed until Cecil Sharp began his long and patient search for old and forgotten folk-songs through all the counties of England. Many of these songs are connected with special dances, and gradually, from one village and another, old people began to emerge who knew the steps of the dances and could teach them to the young. All over the country now the tradition of these folk-dances has been revived, and many strange ceremonial dances, associated with long-forgotten customs, are found to be closely related to festivals and ritual dances in remote parts of the world.

But the meaning of these dances, as of many ritual customs, like Beating the Bounds, the Helston Furry Dance, Bringing in the May, has been lost. They were once a drama of the year, and it was of vital importance to the well-being of the community that they should be performed properly and at the proper seasons. The Morris Dance at Whitsuntide, the sword-dances, were dances in which the whole community took part, at first no doubt dancing themselves, and later getting specially chosen dancers to dance for them, with the purpose of reviving the spirit of vegetation and the spirit of fertility, of making the crops grow and the cattle prosper by imitative magic. Now the dances are only a shadow, though they are danced by village dancers on the right festival, and by town dwellers the year round. Yet sometimes I think the lovely tunes and movements summon up the ghosts of the past. Even in the Albert Hall, at a great public display, the melancholy air of the violin which leads in and dances with the dancers in the Horn Dance of Abbots Bromley, the strange and solemn movements of the reindeer-horned men, the fantastic hobby-horse, and the jogging man-woman, perhaps once a pagan priest, produce an extraordinary and haunting impression. This dance was probably attached first to some very early nature festival (the dancers wear breeches patterned with oak-leaves and acorns), and the horns were perhaps those of sacrificial animals.

The sword-dances of Yorkshire and Northumberland, which have never died out, also had their beginning in

some very ancient drama, perhaps the conquest of the old year by the new, perhaps in a human sacrifice. When the swords clash together, and are held aloft at the close of the last closely woven pattern of the sword-dance, a comic figure, who has roved outside the circle during the whole dance, rushes into the middle, among the upraised swords, and drops to the ground in mimic death. As one watches this dance, and listens to the patterns made by the tramping feet, it seems that a kind of magic force comes to the dancers from the sticks and sham swords by which each is joined to each and on which, even in the most elaborate figures, they never lose their hold. The sword-dance of the Highlands, which is very exciting and very difficult to perform, was probably a war dance, designed, like war dances all over the world, to stir up the courage of the fighters or to celebrate their victory.

No one has ever been able quite to decide where the Morris came from, though the name suggests that it came from the Moors through Spain. It is a man's dance, and often an action-dance, as in Bean-setting, where the dancers mimic the preparation of the soil and the setting of the beans with their sticks, while dancing. Another, in which one of the dancers is lifted high on the shoulders of the rest, symbolised, perhaps, the choosing of a chieftain. The dress is a tradition carefully observed. The dancers must wear white pleated shirts, white trousers, and a bowler hat decorated with ribbons and bunches of flowers. Coloured ribbons cross their bodies, like braces, back and front, and pads of bells, carefully chosen for their tone, are tied with ribbons below the knee.

The country dances, where men and women dance together, which were once the courting-dances of a peasant people, are in England a rather shadowy performance, though they make lovely patterns, and are danced to exquisite airs. All over Europe these dances are still alive, and in Scotland and part of France and Spain, Catalonia and the Basque country, in Sweden, Denmark, Bavaria, in the Balkans, in Russia and in Greece, where seasonal festivals still have meaning and where dancing is a passion,

they have far more vitality than in England. At every New Year's festival held by the Folk-Dance Society in London, folk-dancers from the Continent are invited to come and dance, and then suddenly the shadow becomes a reality ; for here are real peasants, born and bred in the tradition of the soil, and dressed in peasant dress, and they bring the simple and solid spirit which belongs to these dances.

I think folk-dancing is one of the best revivals ever undertaken, not only because it has set dancing all over the country people who would not otherwise have danced, and because it has saved many lovely tunes from being forgotten, but also because its members have been brought into touch with folk-dancers all over the world, and have been able to see how our surviving dances fit on to a living tradition.

We have suddenly begun to fall in love with the old world just as it is passing for ever into the past, and we are frantically trying to save what we have spent so many years in destroying. Above all, we have discovered that the dancing and folk-lore of other civilisations than our own contain treasures of wisdom and beauty that we cannot do without, and we are trying to stop the tide which is robbing the world of what makes it perhaps most interesting. Let us save all we can of what is still alive.

DRAMA COMES FROM DANCING

You see that all these folk-dances are really drama, something done or acted, and that dancing developed out of the desire to express some feeling, some sense of relationship with men or beasts or nature, through movement or gesture. There was the ecstatic dance, still to be seen to-day in the dances of the dervishes and other religious sects throughout the world, where the dancer is entirely possessed by a spirit greater than himself, and dances himself into a state of unconsciousness. At the great popular festivals in Morocco I have constantly seen such dancers, women amongst them, who, sweeping the ground with their wildly

flowing hair, sway and whirl in an ecstatic circle, till they fall unconscious to the ground. Another sect swing great hatchets to and fro, and every now and then one of them, tottering between the lines of frantic, leaping dancers, will bring the curved blade down upon his head, and blood will stream over his dark, naked shoulders and white tunic. But these are vulgar versions of ecstatic dancing, which among the dervishes reached a high degree of beauty. The Dionysiac Dance of the Greeks was of this kind. Then there was the dramatic dance, in which were enacted the stories of imagined beings—demi-gods, heroes, and demons. Poets arose who expressed in verse, through the mouth of the characters in the drama, the conflict of human passions, their ideas about man's relation to the world and to the gods who ruled it. Plays were acted and danced before the people, and the speech of the actors, the song of the chorus, the rhythm of the dancers, broke at once upon their senses, and through their senses to their mind.

We can only faintly imagine what the Greek plays really were, under Greek skies, in those vast theatres where the drama of man's life was unrolled with music and dance. It was the highest form, no doubt, of those great play-festivals which existed in all the great civilisations of the ancient world—in Egypt, in India, in Babylonia and Persia, and the buried Mayan cities of Central America.

Temples in which men worshipped their gods were also theatres in which were enacted the deeds and "Passion"—in other words, the suffering or ordeal of these hero-gods—by the priests and the children devoted to their service, just as in the churches and cathedrals of Europe in the Middle Ages, Mystery and Miracle Plays set forth the life and Passion of Christ, and the story of the Old Testament, in a pantomime danced and sung, which grew directly out of the office of the Church. The Greek trilogy of *Œdipus* was in a sense a Passion Play of a very high order.

In the Catholic countries of Europe these Passion Plays are still fervently acted. You have all heard of Oberammergau. And from Western Africa almost to the Far East, at the Mohammedan festival known as Moharram, the

Passion Play of the hero and martyr Hussein, a descendant of Mohammed, has been performed for over twelve centuries with feeling so profound that the town is plunged in mourning for ten days, no laughter or loud voices are heard in the streets, no wedding is held, nothing new is bought, the women wear no colours. The feeling is so intense, the acting so real, as the drama of Hussein's martyrdom is unrolled, that the crowds weep and wail, and many inflict wounds by beating themselves with chains, while they raise their hands together and cry in chorus, "Hassan ! Hussein !"

I have seen two companies of actors, both Jewish, who gave me the impression of a Passion and Mystery Play—the Habima Players from Jerusalem, who acted in Hebrew, and the Granowsky Jewish theatre from Moscow, who acted in Yiddish. They acted tragedy and comedy, danced and performed acrobatics on the stage, but they always gave the impression of acting, not before the back-cloth of a stage, but before a mysterious, invisible world which is in the soul of all of us, and which every now and then broke through. One felt their gesture and their dance were inspired by a very ancient tradition.

Hindu India also has its Passion Plays, one of the greatest being the story of the sorrows of Rama, the hero of the great epic of the *Ramayana*, whom, as perhaps you know, hosts of monkeys finally helped to victory. This epic, with its countless episodes, is also the subject of many dance dramas of Cambodia, Java, and Bali.

We have seen that the actor began by being a man set apart and consecrated to the rôle of making visible a god or hero, as the priest in the Catholic Church makes Christ visible in the symbols of bread and wine. In India and the Far East, and among the Indians of New Mexico, dance and drama still keep their original symbolic character. The actor, who is also the dancer, translates by his gesture the rhythm of his part ; but he does it indirectly and by suggestion. Suppose that you want to dance reeds by a river. You cannot really become a reed, but must feel their bending and swaying, and fill yourself with their rhythm,

before you can suggest it in your movements. And your body must be supple in every joint and limb, so that it will obey every movement of your mind.

In the temple schools of the East a tradition was gradually developed, a complete system of symbols recognised by those who watched, a language of signs and gestures. In the ritual of the Mass, the Catholic Church has kept something of this gesture language which is infinitely old. In India and the Far East, the delicacy of the joints and marvellous suppleness of the limbs aided the development of this gesture-language, the Mudras, which means "Seal," therefore originally something closed or hidden from the profane. By these gestures it is possible to make yourself understood in India to-day in a district where your own dialect is unknown.

In India, in Cambodia, in Java, in Bali to-day, the dance is a life-long art. Little children of six years old are devoted to be dancers, and undergo a training beside which the training of the classical ballet dancer seems very superficial. The expression of the eyes—the glance—plays a great part. If you see a Javanese dancer, you will notice the strange power of his glance and of the slightest movement of his head; above all, the endless variety of finger-movements, which make one feel that our Western hands move only in one block.

It is not possible, by imitation alone, to reproduce these gestures, for they are the expression of something hidden; gesture, glance, and attitude have a great spiritual meaning in the East which we cannot even imagine. The exquisite child-dancers of Cambodia and Bali create a world which is altogether outside our experience, but fortunately not outside our understanding. And their music creates forests and temples, filled with the undertone of birds and beasts and the rhythm of mysterious events.

REBELS

I am well on my way to Japan, where still exists one of the oldest and most perfect dance-dramas in the world—

the Nō—but I feel a sharp tug at my thread. I have talked much about tradition, and of the great art we owe to it. I want to close by showing you that rebels against tradition sometimes play as important a part as the traditions themselves. At the very beginning of this century there came to Europe a young American woman with a new gospel of art, who by her beauty and attraction converted all the world—Isadora Duncan. She broke with all tradition, except the Greek, which she thought she had re-discovered. She danced barefoot and in transparent draperies which followed the lines of her body. Some say she was a great dancer; she was certainly a great force of nature, and a wonderful woman. Now that everyone dances barefoot, it seems so simple; and directly she did it, it was simple—perhaps too simple. But that was her genius. Like a beautiful young colt, she leapt over all the fences and shook her mane in the wind, and turned winter into spring. Her influence was enormous. The old and rigid school of classical ballet had reached in Russia the highest point of technical perfection; it needed to be set free. And, fortunately, several great Russian artists felt the charm of Isadora Duncan and shared her ardour. The Russian ballet, under Diaghileff, kept all that was exquisite and valuable in its long tradition, but enriched itself by countless new and exciting elements which had before seemed alien and almost hostile to each other. Painters, poets, musicians and dancers of every nation were drawn to the Russian ballet by the great attraction of Diaghileff's genius, and created with him what was almost a new art, built up on the union of various old and glorious traditions.

Isadora Duncan was too irresponsible to found a school, though she put out more spiritual energy in a year than most people in a lifetime. Many things are done in her name which she would probably have hated. But she inspired everyone—painters, sculptors, and dancers, and a host of people who longed to dance but had thought of dancing as guarded by an impenetrable and prickly hedge of difficulties, like the *Sleeping Beauty*.

She inspired, above all, one of the great teachers of the

world, a Swiss composer and professor of harmony, Jaques Dalcroze, who imagined and put into practice an idea very familiar to the East, a favourite idea of the Greeks, but very strange indeed to the Western world: the idea of making music educate the body, with all that it contains of muscles and nerves and blood and brains and the images that come to it from the outer world by hearing and sight and smell, and the endless patterns which memory weaves out of those images; for all this is in the body.

We have seen how all the old nations of the world cultivated dancing, and turned their work into a kind of dance by rhythm and song. You can see one of their labour rhythms for yourselves, wherever four or five men, working together on the road, are beating a wedge into the ground, each in turn swinging his great hammer, so as to make a canon of movement. All over the world, where men work with their hands, there are labour rhythms. This is not dancing, but very near to it, for every dance grew out of man's need to bring himself into touch with other men and the world outside him. Though we see and hear and smell and taste the world of nature by our senses, it is by rhythm that we understand it. We dance with our bodies, but if only our limbs danced our movements would have no meaning. Something dances through them which is the rhythm of the world.

So you see that Dalcroze and rhythmic gymnastics bring us back to the beginning. By the magic which we call genius, the greatest poetry springs from words which express our simplest thoughts, and the most wonderful dancing out of our simplest gestures. And I believe that by music and rhythm we may dance our way into the knowledge of the things which it most matters for us to know in the world.

BOOKS TO READ

Manners and Customs of Mankind. A 1s. 3d. publication in 24 fortnightly parts, which contains excellent articles, beautifully illustrated, on dance and drama and folk-lore all over the world.

W. D. HAMBLY: *Tribal Dancing and Social Development.*

A. LEVINSON: *La Danse.* An expensive book with many good illustrations.

D. H. LAWRENCE: *Mornings in Mexico.*

ERNA FERGUSON: *Dancing Gods.* An excellent account, with illustrations, of the nature dances and Indian ceremonials of New Mexico.

LELYFELD: *La Danse dans le Théâtre Javanais.*

ARTHUR WALEY: *The Nō Plays of Japan.*

PAUL VALÉRY: *L'âme et la Danse.* A Socratic dialogue, one of the best things ever written about dancing.

NIETZSCHE: *The Birth of Tragedy.*

JAQUES DALCROZE: *Music, Rhythm, and Education.*

GILBERT MURRAY: *Bacchæ* (translated from Euripides).

Watch every kind of dancing—solo dancers of different nations like Argentina, Teresina, Lifar, Shan-kar and Simkie, Nyota Inyoka, Helba Huara, the Rezvanis, the Sakharoffs, Hladek, etc.—and try to understand what their movements express and how they differ from the very skilful acrobatic dancers of the music-hall stage.

Ballet. Shan-kar, the great Indian dancer, and his ballet and orchestra.

The ballet russe de Monte Carlo.

The Ballet Club at Notting Hill Gate under Marie Rambert, the best ballet-school in London.

The Camargo Club.

Dance Films, above all native dancing in Oriental and African films, and at the Shaftesbury Avenue Pavilion, where you can often see dances, labour rhythms, etc., in the fifty-minute programmes.

Kriss—a film of Bali, *Trader Horn*, *Tabu*, etc.

Watch professional ball-room dancers—above all, if possible, at the *Star* Championship at the Albert Hall.

See the performances of the Folk-Dance Society.

And do not forget to dance yourselves.

VISUAL ART
OR
THE PATTERN SET DOWN
by
PROFESSOR R. Y. GLEADOWE



DICK GLEADOWE teaches drawing and design at Winchester and is the Slade Professor at Oxford, and lectures about æsthetics. But the thing which is realest is that he himself draws extremely well. It is not much use lecturing and teaching about a thing unless one can do it well oneself—unless, that is to say, one is a good craftsman. He believes in craftsmanship, not only in drawing and design, but in every kind of thing one ever wants to do. He loves sailing, because that needs as fine craftsmanship as drawing; he designs his own boats and sails them. That is to say, he takes seriously a part of life which many people are apt not to take seriously, but to lump together as “arty” and “sloppy” and a kind of plaything which isn’t worth bothering about. In this article he is explaining why it is worth bothering about. He is rather older than I; his wife is a craftsman too—she dances; they have two children, Richard and Tess.

VISUAL ART

ART IS the business of inventing, planning, and making certain kinds of things. Sometimes one man invents the thing, another makes it; and the two together may plan it. The inventor is the designer; the maker is the craftsman. The artist invents and makes some things which are clearly useful, others which may seem useless. Among the useful things the most obvious and important are buildings, about the good invention and making of which you can read in the chapter on *Architecture*.

THE ARTIST

If a thing is invented, planned, and made for use, many people will say that it need only serve its purpose to be a good thing of its kind. But it is not therefore a work of art (see *Architecture*, p. 821). There is something in artists which wants not even useful things to be simply useful. And some of the things they want to invent and plan and make may seem quite useless. Artists don't much like dividing up things into useful and useless. Who is to decide which is which? Men cannot get on very well with nothing but obviously useful things. After all, anything which makes people glad to be alive is useful. The artist gets excited and interested in things, and he wants to make them go on longer and to share them with others; he wants to add to the number of things of which people may be glad. When he sees or thinks of beautiful things, he wants to make something of them, just as most of us, when we hear certain kinds of music, want to dance. One artist has said that drawing is dancing on paper; another that he wanted to paint as a bird sings.

The artist therefore wants to invent, plan, and make new things of a kind which he likes; and he may also want to make some kind of a copy or reminder of things which have

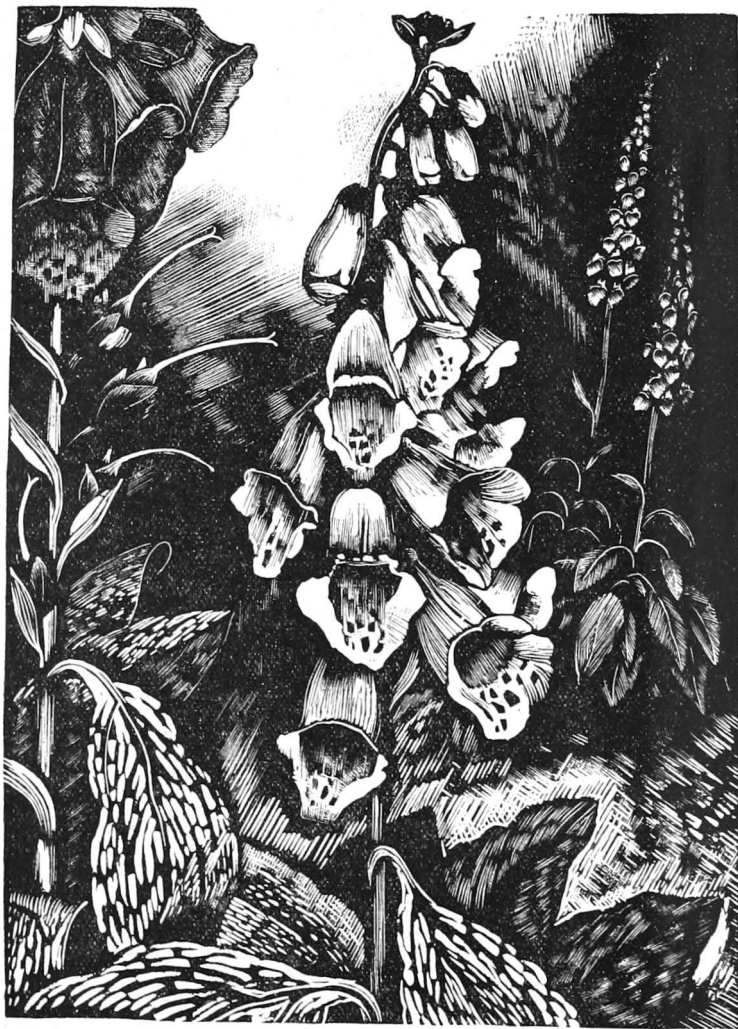


Fig. 101. Wouldn't a photograph of a foxglove be disappointing compared with the shadowy woodiness of this? It is a wood-cut of a foxglove by Paul Nash.



Fig. 102. PURE DECORATIVE FORM, BY ERIC GILL

made him glad to be alive, or glad, at any rate, to have seen them. It is never easy to make a new thing well. To make a reminder of things you like looking at is easy with a camera. But a photograph is often disappointing compared even with a memory of the things it is meant to show. Look at Fig. 101 and see what this means.

FORM

By making a thing well an artist means more than other people mean. He means making it good to look at, a good shape, and a good colour. The word he sometimes uses for shape is form. Most of us find form harder to enjoy than colour. But artists usually think form more important than colour. Look, for instance, at Fig. 102. These are wood-cuts by Eric Gill to go one at each side of a page of the *Canterbury Tales*. They are such pleasing shapes (and go so well with the type in which the book they were made for is set) that no amount of colour could improve them. Colour may be very pleasant, but it cannot so easily be made to say things as form can. Life seems to go into form better than into colour. People want to sing or dance or whistle or leap or run when they are suddenly happy; to be very still when they are sad. But, whether he prefer form or colour, the artist, when he makes something for use, is always thinking how it will look, as well as how it will serve its purpose. And, if he has his choice, the things of which he tries to make reminders will be things of which either the form or the colour, or both, have seemed to him good. As he makes his reminder he is thinking: "How can I make this new thing, which is both like and unlike the original, itself a good shape and a good colour?" In Fig. 103 you will see how Durer did that.

You can see that these are two quite different jobs; but, though some find it easier to make a thing a good shape and colour when it is rather like something they have enjoyed seeing, others find it easier to make up good shapes and colours out of their heads. Often great artists have done

both equally well. And you would expect anyone who cared very much for shape and colour to care both for those which he sees and for those he invents out of his head.

DRAWING, PAINTING, AND SCULPTURE

The most simple and ancient way of making a record or reminder is by drawing. A good new shape is most easily

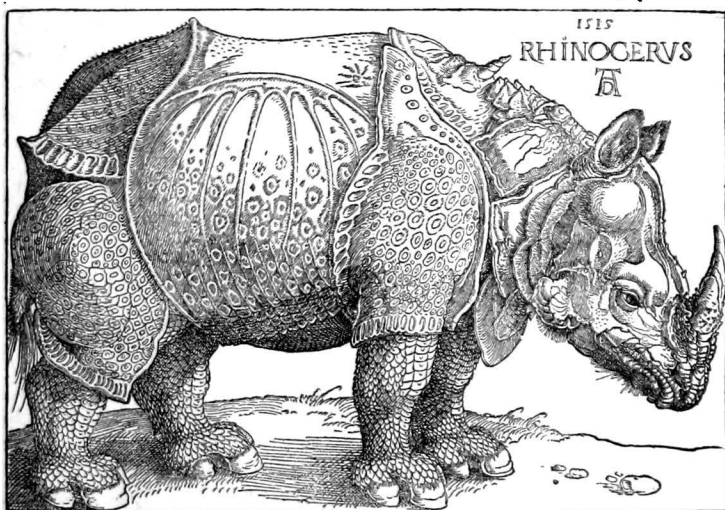


Fig. 108. This rhinoceros is a "new thing"—a good shape, and both like and unlike a real rhinoceros. Durer drew it in 1515 because he was so excited by the description a friend sent him of a rhinoceros which was brought from India to Lisbon. Durer was always looking at ordinary but interesting things, especially animals, and making "new things" out of them. He was interested in other kinds of "new things" too, for instance magic squares; he put one into one of his pictures.

made either by modelling or scratching some softish stuff, like clay or wood. For making things like other things you might think that modelling or carving a solid thing should be easier and better than drawing. But drawing seems to be more natural to early men, as it is still to children. Look at the kind of drawings which the earliest men made (*History of Ideas*, Fig. 73). Sometimes, in the very difficult business of making things and people look alive, the

draughtsmen and painters, making marks on a flat surface, have been ahead of the sculptors. Sometimes the sculptors have got ahead.

IMITATION

The simplest kind of drawing, done in lines with a burnt stick or a bit of chalk, has over and over again proved a good way of making a lively record. But it is not a good way of making a copy which looks "exactly like." Usually people have not wanted their pictures or drawings or carvings to look just like something in nature. But for the last 500 years or so in Europe, and for a short time some 2,000 years ago, some people have wanted this. It is often supposed to-day that anyone who wants to can do exact imitation and that it is a silly thing to do. But though many have tried to do it, only a few great men have succeeded; and there is no need to call their work silly.

The best way of trying to imitate on a flat surface is by oil-painting; water-colour, tempera, pastels, mosaic, embroidery, tapestry and other kinds of weaving, are all harder to manage, and none of them give the deep, rich shadows and colours of nature. These strong tones can be got in coloured glass; but coloured windows and enamel glazes on metal seem best thought of as bright, clear patterns, so that imitative painting has not often been done on glass. A very exact imitation can, of course, be made by taking a soft mould of a thing, or even of a living person and making a cast from this, precisely reproducing the shape. But though this may be useful for sculptors, it isn't art, for it is neither invented nor planned.

THREE KINDS OF PAINTING AND SCULPTURE: IMITATION, LIFE, PATTERN

We can now perhaps distinguish between three rather different kinds of painting and sculpture:

(1) That which imitates the exact look of things : See Fig. 104. (This picture does not really imitate quite exactly, but as exactly as good art can.)

(2) That which, though not imitative, is lively or life-like : See Fig. 105.

(3) That which pleases, not by any likeness, but by its form and pattern : See Fig. 106.



Fig. 104. Here is an ordinary, every-day grasshopper, walking along a grass blade which has bent in the way ordinary broad grass blades do bend ; you can see the marks on the little animal's legs and wing-cases. A large wood-ant is walking up another grass blade. This is imitated from life and might be rather dull if it were not by a really good wood engraver, Agnes Miller Parker, though much of her delicate work is lost when the picture is made smaller. It is an illustration for *Æsop's Fables*, and meant to be as observant and close to the look and manner of natural things as *Æsop* was.

If the imitative artist is also interested in pattern, all he can do is to select and arrange the things he is going to paint so as to make good patterns of form and colour, and to choose the view of them which gives the best pattern, as a good photographer would—cutting it off in the right place at top, bottom, and sides so that it looks right.

The artist who tries to be life-like is much freer to make the patterns he most wants. The rhythmical motion of a good dancer, a tree in a strong wind, a breaking wave, a flying gull, make patterns in themselves. The difficulty is

to catch these subtle and elusive wills-o'-the wisp, and to find a way of giving others a sense of them. The endless patterns of which nature at rest is made up are easier to catch.

The third kind of artist is quite free to make any form and patterns he likes; though his ideas of good patterns probably come to him largely from seeing and enjoying the

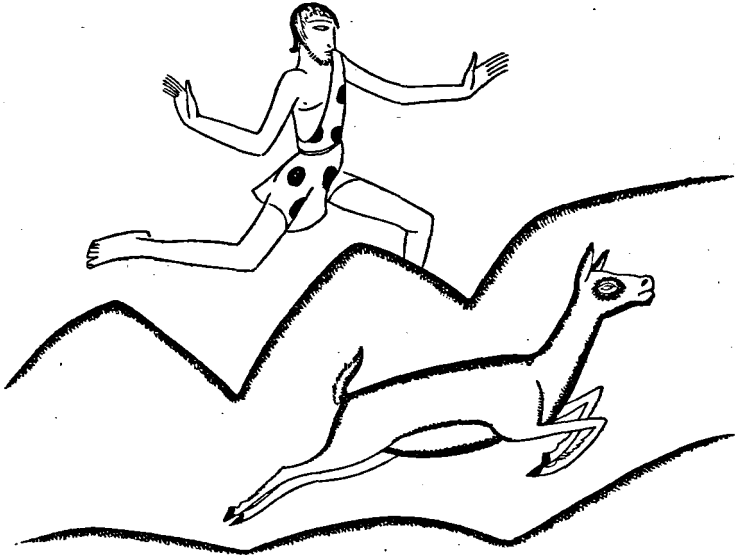


Fig. 105. This young Faun is by Eric Gill who also did the "form" woodcuts. This is done from a copper plate, so the technique is rather different. The original is a warm, red-brown colour. Neither the running man nor the running animal are at all exactly imitated; they are simplified—only the essential lines are given. But they are deliciously gay and lively. Even the pattern of the hillside is running too! (and some of the fine work is blurred in reproduction).

actual rhythms and patterns of nature. Pictures, sculpture, and other things made by such artists are sometimes called "abstract," because they are abstracted or withdrawn from life. Paul Nash's picture was completely abstract, but here (Fig. 107) is one which is very much of a pattern, in some ways more like a carpet or a piece of tapestry, a long way from nature, but yet derived from solid natural things. Some of Kermode's pictures in this book are copies of real things, as exact as possible, some less exact, but still imitation,

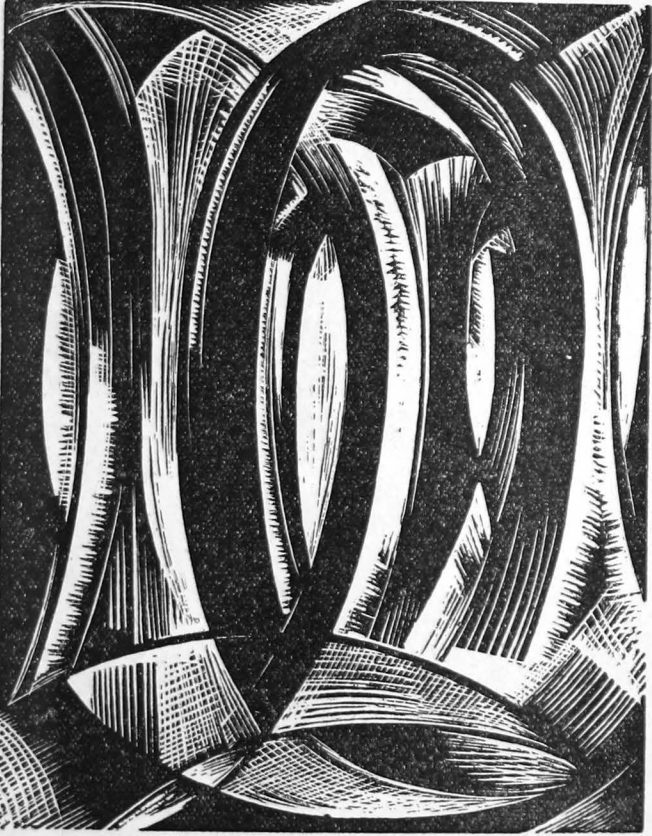


Fig. 106. This wood-cut by Paul Nash is called **The Creation of the Firmament**. It gives one a feeling of immense depth and space, of arches forming out of chaos ; but yet it isn't like anything any of us have actually seen. Ideas have passed through the artist's mind and come out as forms and patterns of abstract beauty.

while others are patterns, derived from natural things, but made into a shape quite unlike the original.



Fig. 107. John Austen has made a pattern out of Adonis, his horse, his greyhound, the flowers, the trees and the waves of the sea. We can tell that he arrived at this pattern after seeing and enjoying the beauty and rhythm of natural things, and then making them into picture forms in his mind.

WHERE AND WHEN IT HAPPENED

The best imitative painting was done by people living in the Netherlands from the fourteenth century to the seventeenth. About the same time a few Italians worked hard for similar results. During the nineteenth century some Englishmen and Frenchmen made new experiments

for the same end. Imitative sculpture was very well done by the late Greeks and the Romans ; and, since the Middle Ages, in Europe, especially in the seventeenth and nineteenth centuries ; also by the Japanese. The best life-like painting is perhaps the Chinese ; but the earliest known cave-paintings in Europe are of this kind. French, Germans, and English in the thirteenth and fourteenth centuries did good life-like sculpture ; also some ancient Egyptians, early Greeks, Scythians, Chinese, Indians, Cambodians, Japanese, and Negroes ; and a few Europeans and Englishmen of to-day. The best abstract patterns have often been made by backward peoples and peasants all over the world. Among civilised people, perhaps the best pattern-makers have been the group round Mesopotamia, and the Chinese. Some of the finest patterns in the world are Irish. The power of making good patterns seems quite common, even with modern children, living in big cities, very few of whom find imitative or life-like art at all easy.

ART USED FOR OTHER PURPOSES

Artists have not usually been free to do what they most wanted to and could probably have done best. They have mostly worked under orders. From an early time, clever and powerful men have realised that art could be used for quite other purposes than the enjoyment of shapes and colours. Sometimes painters and sculptors have agreed that their art was a kind of language for saying things with. When both the artists and their employers, or patrons, agreed as to what should be said, things went easily, no doubt ; but there is little reason to suppose that anyone but an artist has ever had much idea of what was good shape or good colour. Other people mostly think about the meaning and not about the language. Questions of form and colour seem naturally matters for the artist who cares and knows ; but it is common nowadays for people who have hardly tried to learn to draw or carve, and who cannot care so much as the artist about form and

colour, to judge works of art, because they have read and seen much.

Among the things which art has been used for by people who are not artists, and not necessarily at all interested in form, are religion, magic, and illustration and advertisement of all kinds. For none of these purposes need the art be at all good. Indeed, for all four, shapes and colours which artists would agree are worthless may be very successful. Most modern advertisers obviously don't care in the least what artists think about the things they put up. Many publishers, and even writers, seem to care little about the illustrations in their books, so long as it is clear what they illustrate. You could not find a worse collection of sculpture, pictures, and ornaments than the usual "Catholic repository," which sells what are supposed to be works of art for religious purposes. Almost as bad are the shops selling furniture for churches, and the cemeteries full of false and feeble monuments. Most magic art is "primitive," and so not vulgar or cheap; it is usually good pattern, and sometimes finely planned and made. Most people are so unaware of form and colour that religious art will aim at almost any other quality, unless the work happens to be given to good men who are fully trusted by their patrons.

Besides using art for illustrating stories and giving people an idea of what the priests wanted them to think gods and goddesses and devils and saints looked like, and even making them believe that they were really there, religion has often advertised by means of great temples and churches, bells, processions, plays, dances, elaborate shrines, and every kind of rich and rare furniture and ornament. To such kind of advertisement none but those puritans who are afraid of beauty, and, indeed, almost of life, could object, if it is done by good artists; and such men will think that the best service they can render their faith is by designing and making, "for the greater glory of God," the best things they can. Sometimes artists will have religious or quite other ideas of their own—nothing to do with form and colour—which they want to illustrate and express; for instance, the dignity of labour, the badness of luxury or

cruelty, the bravery of sailors or martyrs, motherly love, or their own affection for animals. The goodness of these ideas does not make the illustrations good. Portraiture is the illustration of people or the idea of people. Portrait figures, often of huge size, in hard materials such as granite, were made to impress and frighten people during the lifetime of those represented, and to continue their fame, and something of their life, after death; and the humbler, cheaper, painted portrait had a like origin.

WHAT IS HAPPENING NOW

To-day it is probably more difficult than ever before to find your way about in the world of art. You can see far more things, in original or reproduction, and these come from widely different times and places. Even the most learned and clear-headed find this confusing. Competent people do not agree as to what is good and what bad; some do not allow that there can be bad art, finding all art "interesting." You might think that what a Chinaman, a Peruvian, or an Aurignacian cave-man did hundreds or thousands of years ago is nothing to do with you. But there is no doubt that each of us will find things, designed and made by someone remote from us in time and space, both exciting and satisfying to look at. Many people seem to find it easier to enjoy old and remote works than new ones. They imagine that people living a thousand or more years ago, or ten thousand miles away, made no mistakes, but that new work, invented and made to-day, is simply there for them to find fault with. They are excited about old work because it is rare or famous or costly, and suggests forgotten, far-off things, which they like dreaming about. It is like the things in the museums, which must be good or they wouldn't be there. This kind of "snobbery"—pretending to like things because it is the thing to do—works in favour of old art. But there is another kind, which thinks a thing good just because it is new; if anyone designs or makes in an old familiar or traditional way, his work is

of no account. The latest ideas must be the best. It is hard to know which of these two views is the more wrong.

The best works of art designed and made for use and ornament to-day—furniture and fittings for houses, ships, and cars ; shoes, dresses, jewellery ; and many other things, of glass and metal, silk and wool and clay—are easy to enjoy. Their beauty is different to that of machines—which have a beauty of their own, especially such things as hydroplanes, which are streamlined for speed. Modern design has the clean lines of living, growing things, or is more often akin to the clear-cut curves and planes of pebbles, shells, and crystals. Fine materials and colours, old and new, are used with a new skill and understanding, and all the old crafts have been revived. Mass-produced, machine-made things are often well designed. But modern painting and some modern sculpture are harder to like. The painters and sculptors feel they are working out something new and they do not much care what people think of it. They show little interest in actual life, or ability to bring their things alive. As patterns, their works do not show the rhythmical order and perfection of nature. They seem content only to appeal to the few who see and feel as they do ; and to want to escape from ordinary life and the obvious ways of getting and giving delight. Here, for instance, is a wood-cut by David Jones (Fig. 108). He is one of the people who are working towards a new way of seeing things. He is trying to escape from the old kind of beauty and from ordinary life. This is probably a half-way stage in escape. You may not like it at first, but I think you will if you look at it for a little longer, trying to see what it is trying to show you. The art of to-day is, at any rate, various and interesting, and, apart from painting and sculpture, simple, sensible and easy.

But perhaps it is best for both artists and others to get out of their heads the difference between new and old, near and far. Good work is bound to belong to its own age, without self-consciously trying to. Bad work of any age need only be considered as a warning. It is, of course, an absurd mistake to think that art started by being bad and gradually

got better ; but this mistake is still made, especially by those who forget that painting and sculpture need not even try to imitate exact appearances—to look “ exactly like.” Quite often a very good art of a life-like or pattern kind has



Fig. 108. DAVID JONES' THE DELUGE : THE SCENE OF THE SACRIFICE

developed into bad art of an imitative kind ; and there have been only occasional short periods of “ progress ” or improvement, and these only in scientific knowledge and technical method. The big changes have been mostly made by individuals, and they have sometimes done more harm

than good, because people have thought that things must be good if they looked like the work of the great man who made the change, and so he has been just feebly imitated. What looks at the moment like progress or change for the better may be only a change of fashion, which likes change for its own sake, and despises or laughs at what was fashionable last year.

ARTISTS

Artists, like scholars and philosophers, are often thought to be unpractical. It is hard to see why, for they are always doing and making things; quick to learn, and less creatures of dull habit than most men. Inventing, planning, and making—especially making—beautiful things may seem a rather pointless kind of amusement. What is the good of such things? Well, more and more we are beginning to think the work of artists, not only good, but necessary for the human race, if it is to avoid becoming just part of a silly machine which cannot have any life of its own and has to go on running because it cannot help it. Bold and serious countries, determined to make the best they can of the life of their peoples, are getting the artists to help. Often artists have found their strong imagination, their sensitive love of life and of things being "just right," make them want the world to be very different from what it is. They have dreamed and planned, and even tried to do what they could to make their dreams come true—imagining, not only lovely towns and countrysides, but even ways of living and working in them, which might make people more happy and healthy, and so, of course, more beautiful.

The artist who has not got into the habit of doing the same kind of work over and over again, to earn his living, will like inventing and planning many different kinds of things. Art is a bigger thing than painting or drawing or carving; it means a whole way of feeling and imagining life. Artists and scientists would mostly agree that it is high time that the world were planned to give human

beings the best chance of finding out new good without destroying old. " Practical " men call artists mere dreamers, and tell them to face the facts. But facing the facts does not mean accepting the bad ones ; and the artists hope for a time when they will be able to do more to help mankind.

TECHNIQUE

So far we have dealt mainly with painting, drawing, and sculpture. But works of art are made by many other methods.

You can divide up works of art into flat and solid ; a picture, for instance, and a building. Some things are a bit of both ; a dish with a pattern on it, or a painted wall. The materials out of which solid things are made are often interesting and beautiful in their surfaces. Such things are designed in flat drawings ; but they need not be. It may be better that a bridge should be built, or a glass blown, without the shape or colour being decided beforehand. The colour of all works of art may add to or lessen their beauty.

Technique comes from a Greek word meaning both art and craft ; it is the way in which a thing is made or done. The maker's way of doing it, by which you can know that it is his work, is called his style.

The chief kinds of technique are :

<i>Flat</i>	<i>Solid</i>
Drawing	Building
Painting	Carving
Mosaic	Modelling
Writing	Throwing
Printing	Raising
Engraving	Blowing
Weaving	Dress
Embroidery	Décor
Photography	Ballet
Cinema	

Drawing can be done on any smoothish surface with a brush, a pen, or any pointed stick that leaves a mark,

e.g. charcoal, chalk, gold-point, silver-point, or lead pencil.

Painting is done with brushes on walls, paper, silk, leather, glass, or "primed" canvas or wood. The colours are powders, natural or artificial, ground in a "medium" of oil or other sticky "binding" substance which dries hard. A "diluent" or "vehicle" is also used to make them easier to lay on: water, oil, varnish, or turpentine.

The medium for "tempera" is often yolk of egg; the binding substance for "fresco" painting on walls is in the fresh plaster on the walls, not in the paint or pigment, which is mixed with water. Water-colour is bound by glycerine, sugar, or gum. Painting on a small scale is called miniature—in books, illumination.

Mosaic is made with small bits of coloured glass, marble, etc., called "tesserae," arranged in patterns or so as to suggest people and things. It is used chiefly on floors and walls and ceilings. Coloured windows are a kind of mosaic, the bits of glass being joined with bands of grooved lead.

Writing has, both in Europe and the East, sometimes been regarded as a great art. Fine writing is done in Europe with a pen, in Asia with a brush.

Printing, by means of letters cut out of metal, smeared with a pigment mixed in varnish, has largely taken its place; and hand-writing, of which people used to be proud, is getting worse and worse. Both can be so done, with or without "illuminations" or illustrations, as to produce exquisite patterns.

Engraving is the cutting of fine grooves on the surface of metal or wood, to decorate it, and also as a means of making a print on paper. *Prints* are made either from the ink lying in the cut lines and spaces, it being wiped away from the plain surface of the block, or by the ink being transferred from the plain surface, but not from the cut lines. By "etching," lines drawn on a metal plate are "bitten" into grooves by acid. Good prints can be made, even in colours, with the help of photography. The best methods are called collotype and photogravure. It is so difficult to get the colours exactly right that to do a coloured collotype well requires a real artist.

Weaving (Textiles) is based on the process of passing a thread (woof) backwards and forwards horizontally in and out between upright threads (warp) fixed in a frame. Tapestry and most carpets and rugs are woven ; but similar things can be done with needlework.

Embroidery is needlework using many different kinds of stitches, colours, and materials to produce simple or intricate patterns. Embroidered patterns can be singularly beautiful.

Photography is more and more regarded as an art. The decision of exactly what to take, in what light, and what kind of a print to make needs an artist.

Cinema is perhaps at the moment the most interesting of all the arts because it is quite new, and nobody knows yet just what should and could be done to make it good. It should not be regarded as a series of photographs ; it is a separate technique. In some ways it is like the theatre, but it may well have an infinite capacity all of its own for exciting and delighting the eye.

Building includes the crafts of the joiner, carpenter, mason, bricklayer, glazier, plasterer, painter, plumber, shipwright, riveter, blacksmith and engineer. The colour, texture, surface, grain, figure, etc., of the materials used are important for the effect. The effective use of carefully designed lighting for beautifying the inside and outside of a building is almost a new art. Glass is being put to more and more new uses in building—for instance, for outside walls and dancing-floors.

Sculpture can be either *carved* or *modelled*—that is, either worked out of solid, hard material or formed out of soft material. It is worked out of stone, marble, granite, etc., by hammering “ punches ” with a mallet more or less at right angles into it, by gradually working back the surface by rubbing or hitting with a blunt instrument, and by taking off pieces from the surface with chisels, and “ claw-chisels ” which have teeth. *Modelling* is done with the fingers and with instruments of wood and wire. It consists of building up shapes, often on an “ armature ” or skeleton, with small bits of clay or wax. When the soft material is formed

to the required shape, a plaster *cast* is made of it, and from this moulds can be made. The last stage is to get a permanent metal or earthenware casting from the moulds. Bronze, brass, iron, gold, silver, lead, plaster, or cement can be used. The earthenware can be either fired plain to harden it (*terra cotta*) or covered with one or more coats of coloured glaze and then fired.

Sculpture made to be seen from all sides is called "in the round"; sculpture to be seen from more or less in front is called "relief"—low relief is nearly flat, high relief nearly round.

It is a mistake to think that good sculpture cannot be made by both methods; good sculptors have commonly used both. The sculptor's business is to make a good durable shape as best he can. Some prefer cutting to modelling. It is quicker and easier to rough out a form with soft material, but easier to finish a job in hardish material such as stone or ivory.

Circular objects of *earthenware* and *porcelain* are *thrown* into shape on a horizontal wheel. They are shaped in the wet clay chiefly with the fingers, burnt to harden them, and may be covered with slips or glazes which are melted on to the surface by firing in a furnace. Painted glass and enamel are similarly fired. Turning objects in wood, ivory, and metals is rather like throwing.

Vessels of softish *metal*—gold, silver, pewter, copper, etc., are *raised* by being beaten or hammered up from a flat sheet of metal. Wrought iron is hammered, pinched, and twisted when hot.

Glass vessels are usually *blown*, like bubbles, from molten glass or "pot-metal," with an iron tube. But glass can be cast in moulds and rolled and hammered into sheets or other shapes.

Dress is almost as essential an art as architecture. The dress designer and maker must have something of the sculptor, painter, and draughtsman in him. Dress is, more than any art, subject to fickle fashion, and easily becomes, even while fashionable, dully uniform. But beautiful uniforms, especially for peasants and religious, have gone

on unchanged for centuries. Most of the world is nowadays affected by rapidly changing but uniform fashions. Modern dress tends to be based on a sense of the beauty of the well-exercised and freely moving body.

Décor, though it may also be used of the decoration of rooms, usually means the scenery, dresses, lighting, and other devices by which the designer can make a play good to look at. Electricity makes elaborate and subtly various light-effects possible ; and stage-effects, especially of ballet; and the dances and spectacles of opera and revue, give artists great chances of inventing fine harmonies of form and colour.

Ballet is essentially to be looked at as well as danced ; so that it must be designed as a kind of moving sculpture and pattern. Pageants, ceremonies, and processions should be similarly regarded.

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And now you have read something about art, it would be well to remember that knowing a little or even a lot about a thing does not make you see the point of it. If you think that art must be a good thing, you can only get at it by being in your own way an artist. Other people's art never can be quite yours, any more than their life can. Art is worth while, but mostly for the artist. Art is sympathy, awareness, intensity of life. To be an artist means first enjoying all the sights and sounds and thrills that are in the world for your delight ; but it also means minding very much, and the hard job of always doing your best. It means loving doing whatever you do—running, walking, standing, playing, washing your hands, folding a napkin, writing a letter, closing a door—because you are doing it as well as you can, and will do it better and better. And even if you never try to make a work of art, and no one thinks you care at all about it, you will be on the way to knowing what art means.

BOOKS, ETC. TO LOOK AT

The Propylæen History of Art.

S. REINACH : *Apollo.*

SIR C. HOLMES : *A Grammar of the Arts.*

ROGER FRY : The chapter on Art in *The Outline of Modern Knowledge.*

H. GARDNER : *Art Through the Ages.*

GOWANS' Art Books.

Studio World's Masters.

Victoria and Albert Museum Picture Books.

Orbis Pictus.

Picture postcards at British Museum, Victoria and Albert Museum, etc.

ARCHITECTURE

OR

USING THE PATTERN

by

CLOUGH WILLIAMS-ELLIS



CLOUGH WILLIAMS-ELLIS is an architect. Among other things, he has built a complete village on the edge of a cliff in Wales ; all the houses are different colours and shapes, and there are lots of balconies and steps and towers and ponds and statues and things. He wants all the buildings in England to be a good kind of buildings, and he wants to get rid of the ones that aren't, but that is usually very difficult. He is always trying experiments with new materials for building and decorating. He went out to France with the Welsh Guards early in the War and had a grimmish time, with intervals of hunting architecture behind the lines ; he made plans of trenches, panorama pictures of the German works, and, incidentally, got a Military Cross and various " mentions." At the end of the War he was head of the Tank Corps Intelligence ; at various times he suggested new inventions, which were usually turned down by the authorities because they were not in the military tradition. He has curly hair and laughs a great deal ;

I have seen him do a high kick and hit the beam across a room (for fun, not because he wanted to knock the house down). His three children are some of the ones who lived on the ship with Richard Hughes.

ARCHITECTURE

ARCHITECTURE AND ITS PATTERNS

ARCHITECTURE may be said to be "building with a regard for appearance," or "the provision of adequate shelter in a pleasing manner," though no one has defined it better than the great Roman architect, Vitruvius, who wisely called it "well building." "Well building," said he, "hath three conditions; firmness, commodity, and delight."

What he meant, of course, was that, in order to be worth calling "architecture," a building must:

1. Be honestly constructed of sound, lasting, and suitable materials, so that it would stand securely and be weatherproof.

That is "Firmness."

2. Be convenient and fit for its purpose, well planned, efficient—commodious.

That is "Commodity."

3. Give pleasure to the beholder—which is the meaning of "Delight."

It is agreed that our delight in all the arts depends greatly on "pattern," and just as sounds without a pattern are not music, but a noise, so is building without a pattern not architecture, but a mess. Certainly you can have stupid, dull, and ugly patterns in all the arts—it is not the mere making of a pattern that is rare and difficult, but the making of a *beautiful* pattern.

Yet quite simple patterns can be very beautiful if made exactly right—more beautiful sometimes than very grand and elaborate ones, which may be so clever and complicated that they end by looking like no pattern at all, but more like the sort of jumble that could only please a savage.

But what may please one person may not please another. You may say to someone, "You will find our house just

past the dreadful, mad-looking church in Laburnum Road," and he may reply, "You don't mean that lovely, grand one in blue and yellow brick, all nobbly with ornaments and

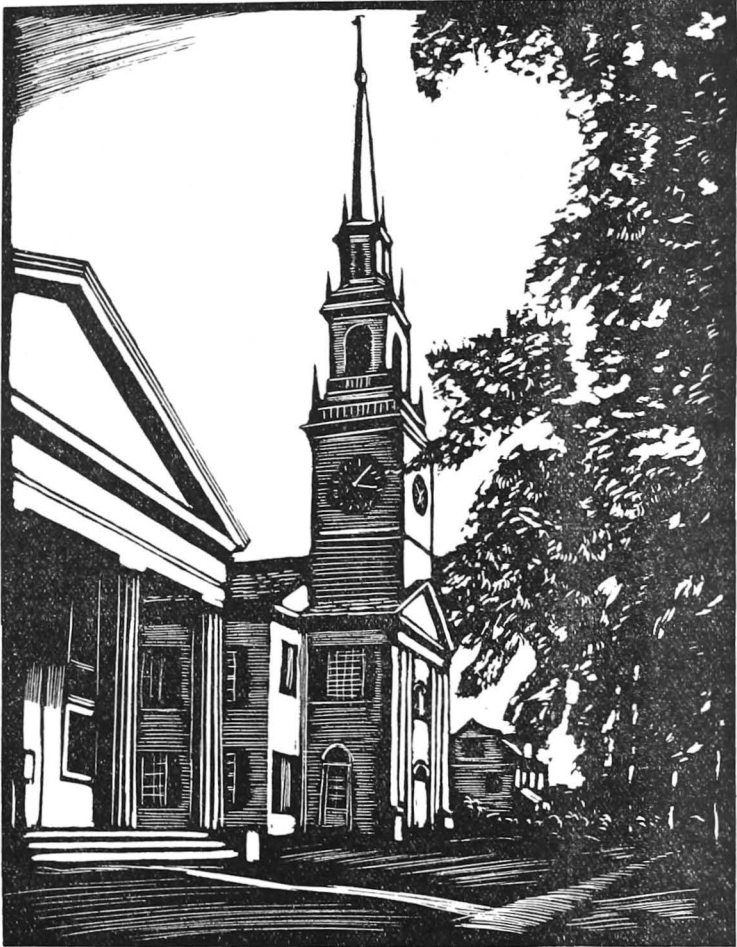


Fig. 109. 18TH CENTURY CLASSIC AND RENAISSANCE ARCHITECTURE IN AMERICA

Old "Colonial" Buildings at Hadley, Mass.

covered with carving? I think it is beautiful." You do mean the same building, only you feel about it quite differently. Well, which of you is right?

Though you may *know* you are right, your parents or anyone else that you appeal to (unless they are themselves artists of some kind, or so happy at any rate as to understand some one of the arts) will perhaps tell you that, "It's all a matter of taste"—as though it were a question of sugar in your tea, and no more important. But it is *not* the same, and it really is important. Opinion or taste may both be silly, ignorant, savage, or, as we say, "wrong." So when Smith says a building is good architecture and Jones says it is bad, how are you to judge who is right?

Supposing they were arguing, not about buildings, but about motor-cars or ships, you would quite sensibly believe whoever seemed to know most about whatever it was.

But *how* to know which knows the most? Well, that is a real difficulty, but on the whole those who really care greatly about something generally seem to know most about it, and that is, perhaps, why modern motor-cars and ships are so often beautiful—because those who design them really care, and therefore really know about such things and how they should be.

So if you ever meet anyone who cares enough about architecture to spend quite a lot of time looking at buildings, and thinking and reading about them, trying to sketch them or perhaps to design others, and always ready to discuss them keenly, even excitedly—then that person is worth listening to, and will probably talk sense. He *cares*—therefore he probably *knows*.

FEELING ARCHITECTURE

You may not like the best things best to begin with; you may be attracted, quite naturally, by rather decorated, "birthday-cakey" buildings, such as Milan Cathedral, more than you are by the plainer, severer, "grown-up" sort, like, say, the St. James's Park Underground building (or the building shown in Fig. 110 or Fig. 114), that you will probably come to prefer later on as your eye gets

practised and your taste improves. But remember, you were once entirely satisfied by any toy that was an amusing shape and brightly coloured, without bothering whether it was really well designed. Some people go on like that all their lives, and can see no beauty and get no enjoyment from plain, simple, quiet things, but only from such as are bright and fussy, like a Christmas-tree or the outside page of a comic paper.

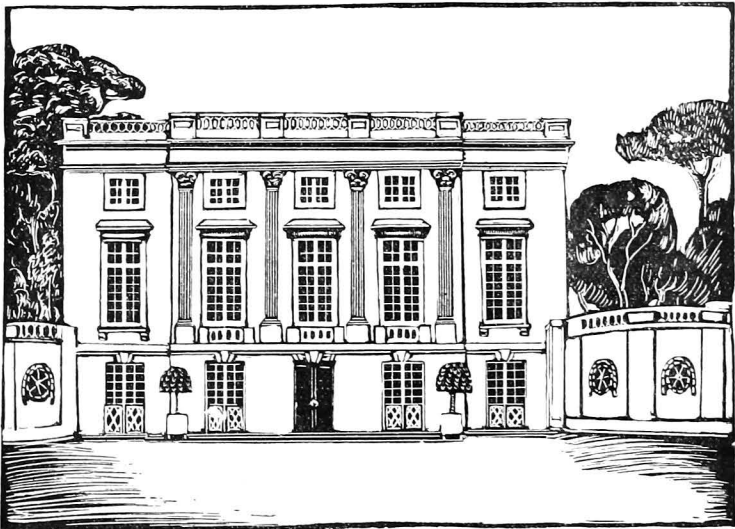


Fig. 110. A FAIRLY PLAIN YET VERY LOVELY BUILDING
The *Petit Trianon* at Versailles (18th Century).

They even stupidly call things “ plain ” when what they really mean is that they think them ugly.

You will probably be most attracted at first by what is called “ Romantic ” architecture—the complicated tracery of a Gothic church (see Fig. 111), the twisted brick chimneys and stone-framed lattices of a Tudor manor house, the twidly gables and carvings of Elizabethan or Jacobean mansions (Fig. 112), perhaps in the Cotswolds, where beautiful building-stone was easily worked and where people were rich enough to build splendidly (chiefly because of the wool trade) just when architects and builders both happened to know their jobs to perfection. These may be



Fig. 111. THE *ABBAYE AUX HOMMES* AT CAEN
French Romanesque-Gothic—early, but already elaborate and
“romantic.”

truly beautiful, and then you will be quite right to admire them, but you will find that lots of people will think them lovely, not for the good reason that they are well designed and well built, but merely because they are old or ruined or mouldy or because they once belonged to Queen Elizabeth!

The old-fashioned architecture books talked about little but "periods" and "styles," "details" and "mouldings," just as the old history-books talked chiefly about

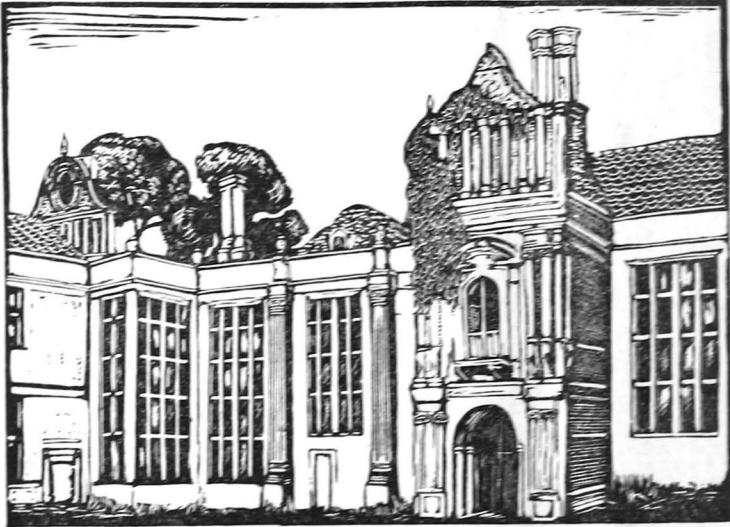


Fig. 112. PICTURESQUE, BUT ALSO FINE ARCHITECTURE
The ruins of Kirby Hall, Northamptonshire (Elizabethan).

kings and queens, battles and dates. But we now feel that such things do not really matter much. We do not "know" architecture so much as "feel" it, and some people might read all the books in the world and yet not know whether a building was a good building or not. They could only tell you if it were "correct," like something in one of their books with the right sort of trimmings for some particular "date" or "period" or "style." What is far more important is whether the building gives you yourself pleasure or whether it does not.

Of course, it does look odd if you mix things up too much, just as you yourself would look rather foolish if you stood in the street dressed in a top hat, a steel breast-plate, and a pair of shorts. The clothes all belong to different times and different kinds of living; they do not make a very happy or comfortable mixture; they are certainly not convenient, and no one (except perhaps a savage) would think you beautiful. Yet plenty of buildings stand along our streets got up just as absurdly in odds and ends out of the architectural "dressing up" cupboard, and nobody seems to notice how silly they really are or to laugh at them as they deserve.

That is because so few of us nowadays "feel" architecture as we can still feel clothes and certain other things. If you saw a man in armour selling modern mechanical toys outside Charing Cross Station you would guess he was mad, yet you may see plenty of new shops selling motor-cars or wireless sets that also imitate in their architecture the fashions of the Middle Ages, which does not seem very suitable or sensible. It would be only slightly more foolish if the young men who sold the motor-cars wore armour like the mad toy-seller, when you would rather expect to buy battle-axes from them and not wonderful new inventions.

Of course, if a new building has to be built amongst old ones that are good of their kind, it ought to take some notice of them, and not be so different in its general size and shape and colour as to spoil the picture or make its older neighbours look silly. To do that would be architectural bad manners; it would be rude and pushing. But fitting your building into the picture does not mean imitation or dressing-up or disguise, or a pretence that you are old or of some other age than your own. It simply means being careful about the general look, so that the new building does not give those who admired the old group any unnecessary shock.

It is best to make the buildings themselves teach you to use your eyes ("observation"), and in the end teach you architecture, for, though books will help you, it is

buildings that you will learn the most from. Here is a sort of Catechism for Buildings, and according to how they answer your questions (which you will find they will do fast enough as soon as you get good at asking them) you will be able to make up your mind about them and decide whether they are good or bad.

A CATECHISM

Firstly : Are you practical—that is, are you an efficient house, shop, school, factory, or church? Can a family be brought up in you, or cheese be sold, or children taught, or boots made, or services be held in you, with convenience?

Secondly : Are you well and truly built, solid, safe, and sound?

Thirdly : If you are new, are you going to look (a) shabby, or (b) still raw, in ten years' time, or have your materials been so wisely chosen and used that the years will pleasantly mature and mellow you?

Fourthly : Are you beautiful, at any rate to me, or, if not, did you seem so to those who built you, and, if so, why?

Fifthly : Is there any special idea about you? Are you say, restful or vigorous, long-strung-out (horizontal) or all up-and-down (vertical), quiet or gay, delicate or strong, light or dark, feminine or masculine—like a birch-tree or like an oak? In short, have you “character,” and, if so, of what kind?

Sixthly : Are you a good neighbour—do you love the Tudor inn next door, or the Regency chemist's shop opposite, or the pollarded lime-trees, or the near-by church and elm-grove, as yourself? Do you do-as-you-would-be-done-by? Do the other buildings and the hills and trees, and your surroundings near you generally, gain or lose by your presence? In short, *have you civilised manners?*

MORE QUESTIONS

Questions such as these will naturally lead on to more detailed and technical ones ; for example, what is the relation or proportion between wall surface and window opening? ("Hardwick Hall, more glass than wall"—the old Bank of England, no windows at all.) What the proportions of the windows themselves, and even of their panes? Is the pattern a pleasant one? Or is the general effect rather blank and sad, or too cut up and fussy? What is the roof like? Does it finish behind a little wall or parapet, or does it overhang at the eaves, and, if so, too much or too little? Is the slope or pitch of the roof too high or too low or just right? Are its slates or tiles a pleasant colour and texture, soft and "strokeable," or crude, hard, and machine-made looking? Are the chimneys tall and important enough, or, on the other hand, top-heavy looking? If there are any mouldings or stone dressings or ornaments, are they well proportioned and well placed, or too light or too heavy, or too many? Finally, is it a decent, sensible, straightforward-looking job, or a brutal, clumsy, "don't care" botch, or a silly, dolled-up affair of whim-whams and "features," that make it a worse neighbour even than the downright "tough," the frankly blackguard building, that has no illusions or pretensions about being genteel?

Quite soon, by a little practice, you may come to question every building that you meet in this way, and, even if the particular building is a bad one (as it generally will be), such architectural conversations are always interesting, and can be exceedingly pleasant. Indeed, to travel about without knowing something of architecture is almost like wandering about a foreign country without being able to speak its language.

PROPORTION

The "delight" that is in all true architecture depends on many things, some easy to understand, some difficult, the most difficult of all being what is called "proportion."

No one has ever been able to put all the meaning of this into a few words, though every real architect and artist of every kind somehow knows, or rather *feels*, inside him, what it means, and when it is right and when it is wrong.

Perhaps pictures will show best what is meant.

Fig. 1 shows the front of a very simple little house with a door in the middle, five windows, and two chimneys.

Fig. 2 shows another house of exactly the same size, also with five windows, a door, and two chimneys, but all these

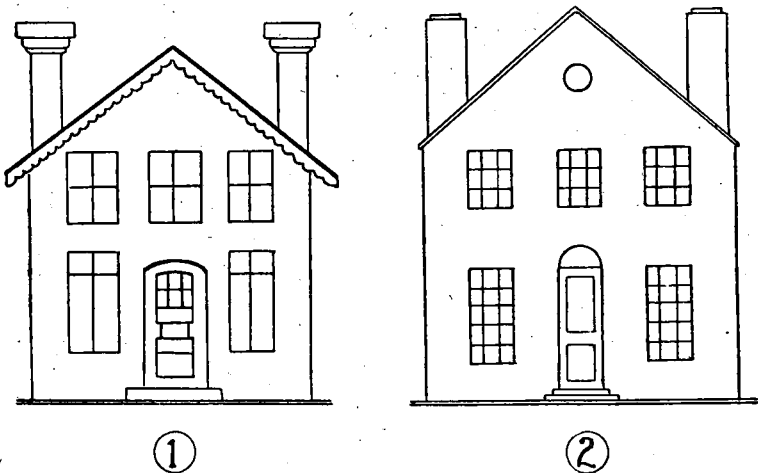


Fig. 118. NEITHER IS GREAT ARCHITECTURE—BUT ONE IS SURELY PLEASANTER THAN THE OTHER? WHICH?

things of *different* shapes and sizes to those in the first house.

It is difficult to explain why, but all those who bother about such things would tell you that Fig. 2 was well proportioned and Fig. 1 ill proportioned, and you must believe them right until you are fit to judge for yourself.

You might put the meaning of architectural proportion into words, rather clumsily, like this :

“The size and shape or importance-to-the-eye of any one thing compared to any other thing seen at the same time.”

People have often tried to make simple rules for proportion, so as to make things easier for those who have no

natural feeling or instinct for it, but though, for example, it is agreed that "a double cube" (i.e. a shape twice as long as it is wide, with its height the same as its width) makes a very beautiful room, and that certain other shapes and proportions are "happy," rules are not really very much help except perhaps in keeping you from quite silly mistakes that you ought to feel were silly anyway. And those who try to live or to build by such rules *only*, without any ideas of their own, will always make a pretty dull job of whatever they do. Certainly it may keep them out of serious trouble, but that is hardly good enough.

RULES AND FASHIONS

At different times in the past architects have bound down themselves and their work to all sorts of rules, and generally the more tightly they were bound the less they were alive—both the men and their buildings.

Our mid-Victorian grandfathers built imitation "Gothic" buildings by a set of rules they invented, and there is nothing so dead as a mid-Victorian Gothic church. But their old ancestors in an utterly different world built real Gothic churches, because in their day that was the fresh and modern and up-to-date way to do things; they invented new dodges and ornaments as they went along, and thoroughly enjoyed the whole adventure. *They* were not working to copy-book rules, but building to please themselves just as daringly and as beautifully as they knew how, and much of their work is indeed lovely.

In exactly the same way, and for the same reason, some of the newest buildings of to-day are lovely and exciting. It is because they *are* "of to-day"—truly—built to please ourselves in our own quite different modern way, of different materials, for different purposes, in a very different world. And because such buildings of ours are our own invention and not mere copies, and because they are bold and adventurous, honest and straightforward, and because they meet our needs, but most of all *because they please us*,

they will probably also please our remote descendants, just as the best Gothic churches please us.

It is not likely that your children will admire what you yourself may build or admire, because there is fashion in architecture as in everything else, and for some queer reason we do not seem to like anything that is in between quite new and quite old, however good it may really be, whether it is buildings or dress or writing or music or whatever.

All things go out of fashion, but if they are really good of their kind they "come in again," as we say, only to go out yet again in due time.

About three hundred years ago brick building began to become fairly common in England, and good brickwork was much admired until about a hundred years ago, when people got the idea that brick was rather common, and ought to be covered over with cement to make it look grand and more expensive, like stone. Then, about fifty years ago, people like John Ruskin and Philip Webb said that such covering up was a dishonest sham, and gradually plain brick became fashionable again, and people began scraping off the plaster that their parents had put on.

Then again, quite lately, we have come to admire the plaster-fronted or "stuccoed" houses—especially when they are pleasantly painted, as in Regent's Park or at Cheltenham or on the Front at Brighton—and once more people are plastering and painting their houses as our great-grandfathers did. Probably the children of these same people will scrape the plaster off again to show the brickwork, and will think their parents' architectural ideas just as absurd as their ridiculous old-fashioned clothes.

So don't bother to quarrel with older people about architecture when you disagree, because they are bound to see things differently, and you may both be right, but what is right for someone of fifty is not likely to be right for someone else of twelve.

Like what you like, make up your own mind—even if you make it up wrong.

USE AND ORNAMENT

Very naturally and rightly, most architectural discussion is about new buildings, and some of the best buildings being put up to-day are really and truly new, even architecturally. In England we always accept new ideas about anything rather slowly and cautiously, but especially if they are ideas about art.

To see the best really modern architecture you will have to go to Sweden, Germany, or Russia (Fig. 115), where, especially in Russia, they are apt to like things just because they *are* new. Of course, they are not always right, because plenty of the new buildings are very poor architecture, just as some Gothic churches are. They were bad when they were built, and merely being old has made them no better.

Still, there is a great deal to be said for what some people already call the new architecture, though other people say that it does not deserve to be called architecture at all, and that it is nothing but engineering. Some of the most modern architects insist that if a thing is useful, and fit for its purpose, it must be beautiful (see *Visual Art*, p. 783). I should say that they are both right and wrong—right for machines and tools and things that only exist to be used, but wrong for all buildings except possibly factories, because, unlike most machines, there are generally many ways in which a building may be designed, yet all of them perhaps equally good from the point of view of *use*. Their difference as “architecture” may be tremendous, ranging from the very dull to something perhaps truly beautiful, and full of what we called “delight.”

That is because the architect generally has far more choice as to how he will arrange things than has the engineer. For example, in the English climate, for reasonable light and ventilation the windows of ordinary rooms need to be not less than one-tenth the area of their floors, which is indeed insisted on in the by-laws regulating building. Suppose, then, that an architect has to make his window twenty square feet in area, he can make it 2 feet wide and 10 feet high or 5 feet wide by 4 feet high, or, in fact, any

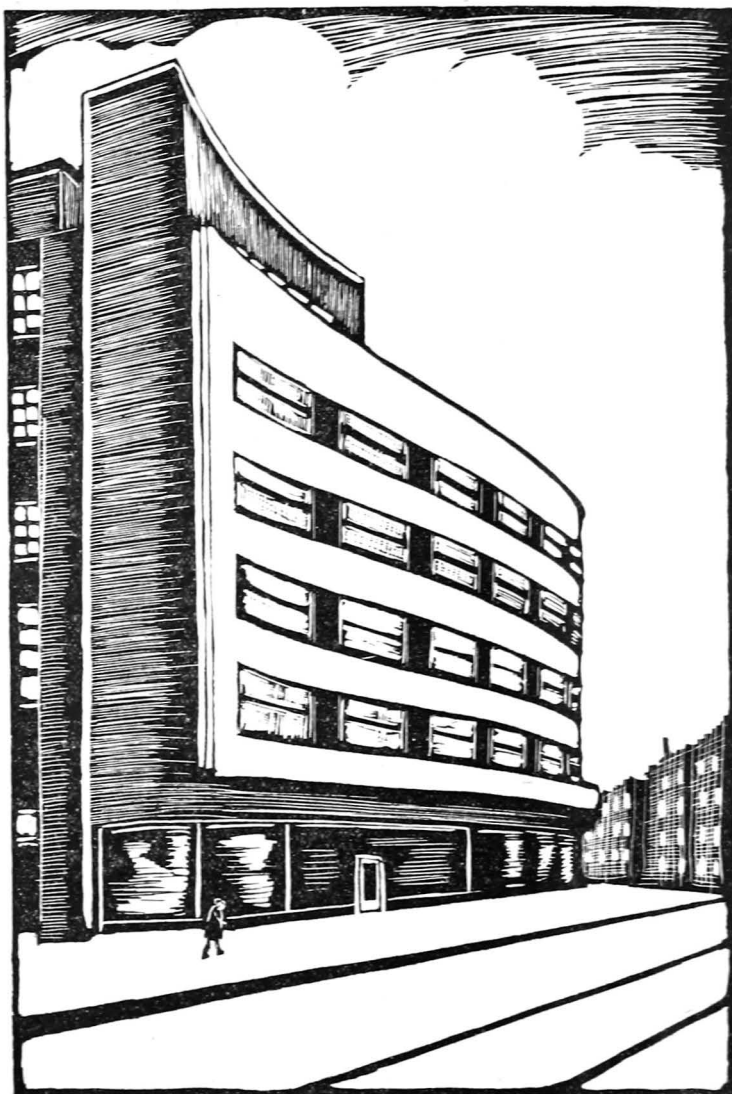


Fig. 114. A TRULY MODERN BUILDING

(German)—in which a most interesting “ pattern ” is produced by very simple means.

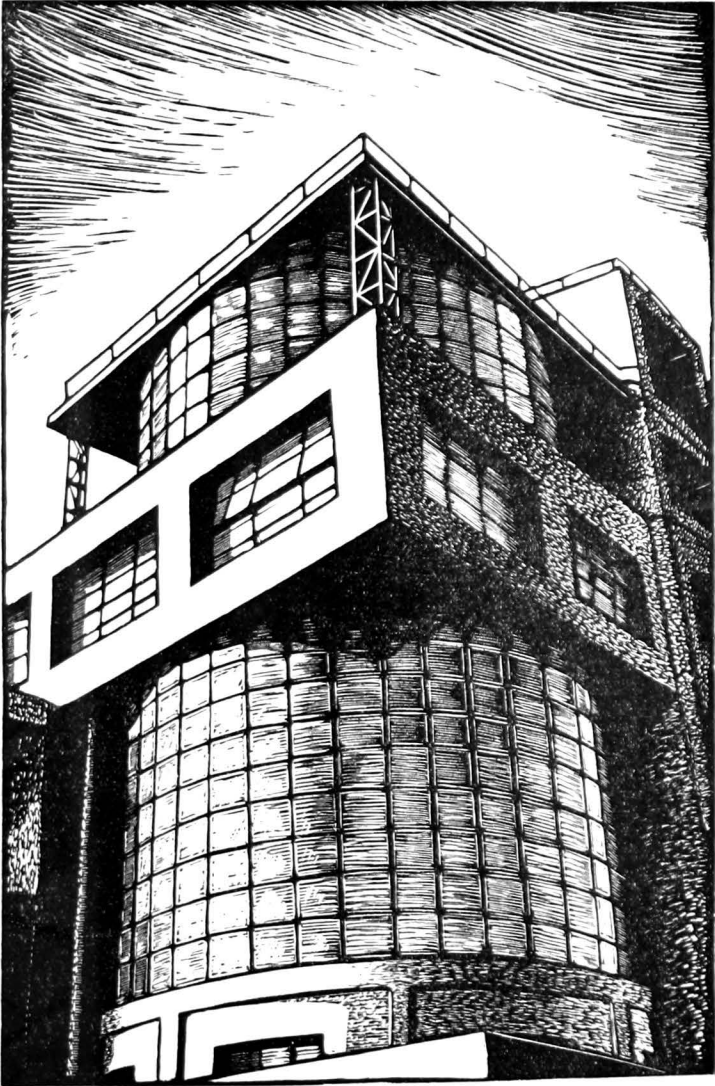


Fig. 115. A MODERN RUSSIAN BUILDING

Where likeness to a piece of pure engineering—even to a machine—is not disguised but welcomed.

proportion he likes within reason, and, indeed, any *shape*—round, oval, square, oblong, triangular, or many-sided, so long as the window is convenient and not too expensive.

Furthermore, he can put his windows high up or low down in the wall of the room, in regular rows or in some other pattern along the front of his building, or here and there, just wherever they happen to fit best inside. In the same way he can play about with the other parts of his building, and, if he is a skilful architect, he may get very beautiful effects by quite simple means—by slight changes in proportion, colour, or texture at different levels, by arranging his windows in groups instead of regularly, by making his building “balance” and exactly or roughly repeat on each side of a central line or axis (“symmetry”), or by giving special importance to this or that feature—perhaps to a doorway, a dome, or a chimney. “Ornament,” in the way of sculpture or mouldings or projections, might be helpful in adding importance to some point that it is desired to make stand out, but there are plenty of fine buildings—Courtauld’s new offices in St. Martin’s Le Grand, London, for example—where there is little or no ornament of that kind.

Thus, though a successful building must certainly be fit for its purpose or “function,” such mere usefulness or “functionalism” is not enough by itself to make it good architecture, though it may be excellent engineering.

A good deal of the German, Swedish, and Russian architecture is what they call “functionalist,” and when done by a clever architect it can at any rate look fresh and clean and honest, and certainly never “dolled up” or vulgar, because nothing is there but what is needed for use. Indeed, they try to leave out everything that they can—but beautifully (see Fig. 115).

HISTORY OF ARCHITECTURE

But it is time that we took things in their proper order.

Prehistoric architecture did not amount to very much, for, if it had, the buildings themselves would have told us such a lot about their builders that the times would be

historic. The first buildings were very rough affairs, put up from the handiest materials in the easiest way—wigwams of branches, circles of stone boulders, log huts, and such-like—just shelters from the weather and little more. That kind of almost nest-like building went on for hundreds of thousands of years before, at last, the highly civilised Egyptians began building to set pattern in a regular architectural style that could not possibly be the work of any other animal but *man*.

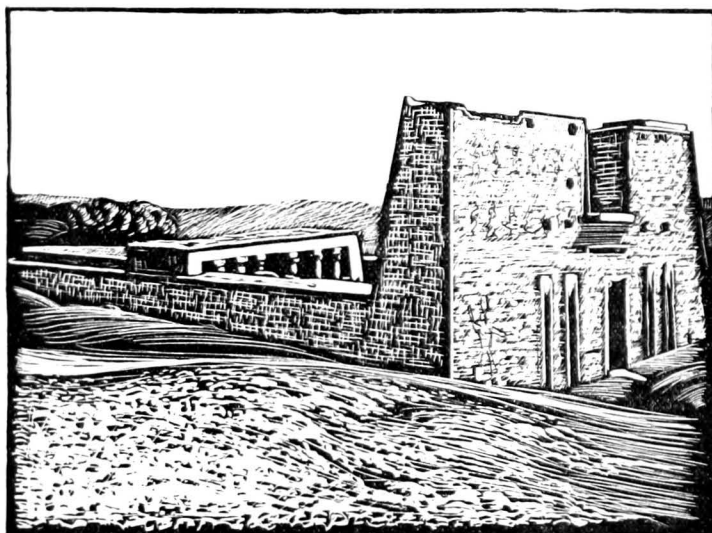


Fig. 116. THE GREAT TEMPLE OF EDFU, EGYPT

There are odd remains of true architecture even earlier than that of the Egyptians scattered about, but it was all more or less leading up to the vast building works along the Nile that are the first really important examples in the long development of architecture which is still going on, more quickly just now, perhaps, than ever before in its history.

The Egyptians had plenty of excellent and easily worked building-stone, and a wonderful climate, without frost, fog, or rain, so that those of their buildings not destroyed by man stand to-day almost as perfect as when first built. Indeed, so great and solid are they that destruction would

be exceedingly difficult, which is exactly why the Pharaohs built them like that—they wanted what they hoped would be everlasting tombs for their mummified selves (see *Organisation of Society in the Past*, p. 507). But though the Pharaohs thought more of housing their corpses when dead than their living selves (and always more of themselves rather than of their subjects), there are also the remains of splendid palaces, and rather grim and mysterious great temples from which their powerful priests helped them to keep the people obediently in order (see Fig. 116).

Without a very obedient people and thousands of slaves and captives, the tyrant Pharaohs could never have got their tremendous monuments built, for they had only the simplest sorts of tools and machinery, and no power at all except that of men and beasts with which to haul their enormous blocks of stone into position. Indeed, from the Egyptian buildings themselves, quite apart from the inscriptions carved upon them, we can guess pretty certainly what sort of a country Egypt was to live in during its great age of building, and the massive pillars of its palaces and tombs still stand witness to its manner of life.

In Syria and Persia, at Nineveh and in Babylon, great temples were also built, from the upper terraces of which the astrologer-priests observed the stars and foretold the future—not very helpfully. The Assyrians and Persians used brick arches and vaults in addition to the flat stone beams with which the Egyptians bridged their openings or covered in their buildings, and the architecture of the Greeks is supposed to have grown up from these various early experiments, though they made no use of arch and vault.

The first Greek buildings that we know of were rough and sturdy, like wooden buildings clumsily copied in stone. The earlier wood-temples with their bronze ornaments crumbled away ages ago. Gradually, however, the Greeks became the most splendid builders, their architects and sculptors being as good as, if not better than, any before or since (see Fig. 117).

The Acropolis at Athens, a lovely high citadel of temples, mostly built during the fifth century B.C., was, and still is,

one of the wonders of the world. Built of honey-coloured marble most skilfully worked, these many-columned buildings are almost perfect as architecture; everything about them seems exactly right—their proportions, their patterns of light and shade, the size and shape and position of their supporting pillars, their mouldings, and their clean-cut carving, which originally were all gaily painted (see Fig. 117—a temple built by Greek colonists in Italy).

The Greeks seem to have had extremely sensitive and well-trained eyes, so that they did not like living with

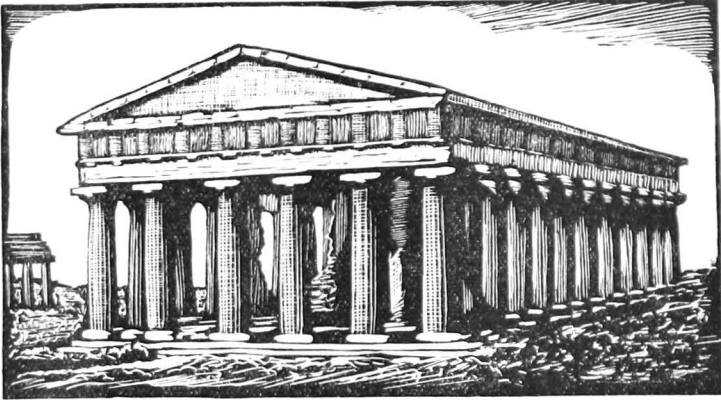


Fig. 117. THE TEMPLE OF POSEIDON, PAESTUM (GREEK)

things that did not look to them quite right in shape or proportion. They invented and gradually perfected three standard types of pillar-and-beam construction called "The Three Orders"—first the "Doric," then the "Ionic," and lastly the "Corinthian." Not only were the heads or capitals of these pillars or columns quite different, but the mouldings and trimmings that went with each were different from those that were used with the others, and the proportions were different too, the "Doric" (from Sparta) being the plainest and sturdiest order of the three (Fig. 118). After Greece was conquered by the Romans (second century B.C.) there was no more pure Greek building, for though the conquerors borrowed most of the architectural ideas of their

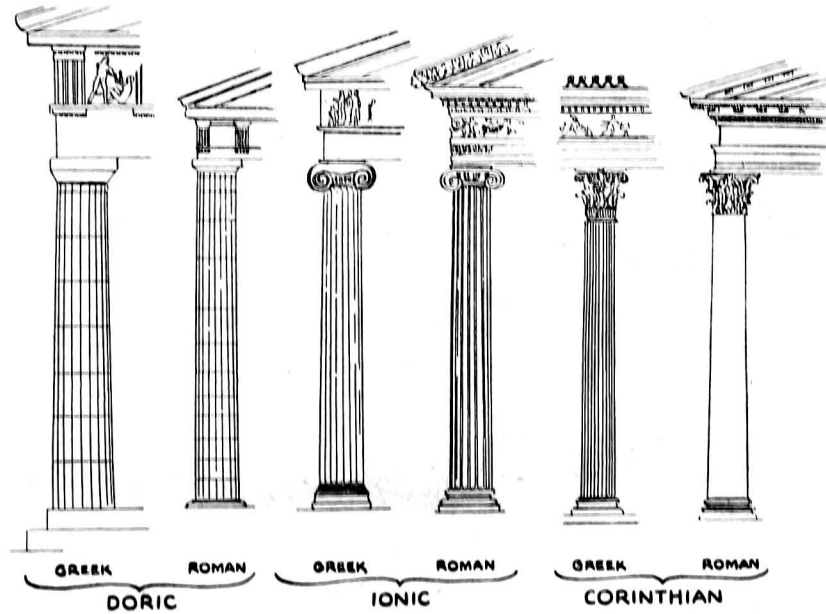


Fig. 118. THE GREEK AND ROMAN ORDERS COMPARED

new subjects, they mixed them up with other ideas of their own, not always very happily.

The Romans were a very vigorous, enterprising, practical people, never afraid of big jobs and with a wonderful way of getting things done. They were more interested in size and magnificence than in perfection of beauty. They were full of clever dodges for getting grand effects as cheaply

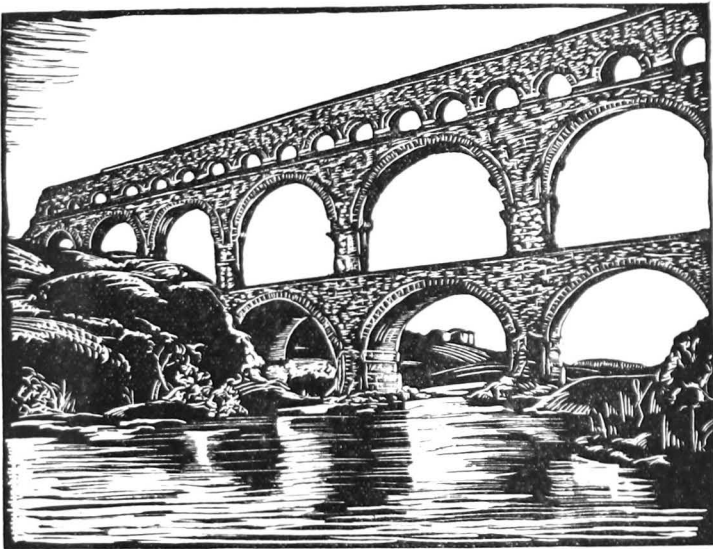


Fig. 119. PONT DU GARD, NÎMES, FRANCE

One of the many remains of the vast works constructed by the Romans.

and quickly as possible, facing brick or concrete buildings with slabs of marble and dressing up blank walls with columns and arches, stuck on just to make them look rich and impressive.

But in spite of these "shams," as some people consider them, the Romans were fine architects and very good builders, and plenty of their great buildings still stand here and there about the old world, of which they were so long the masters (see Fig. 119).

They, too, had their Orders of Architecture—three more or less copied from those of the Greeks and a fourth rather

fussed-up one of their own, called the " composite " order ; but, unlike the Greeks, they used and gloried in the arch and the dome instead of flat beams or lintels (Fig. 120).

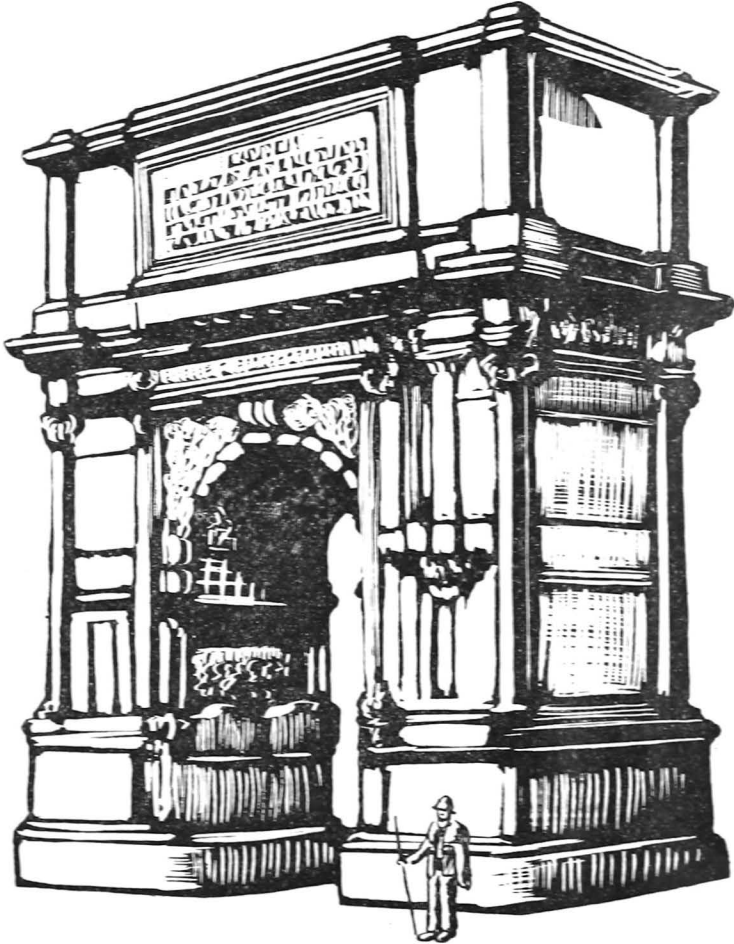


Fig. 120. THE TRIUMPHAL ARCH OF TITUS

From their buildings, as always, we get a pretty good idea of what the life of the Romans was like, first under a Republican Government and then under the Emperors—from the early hard-working efficient days, down to the

slack and luxurious times that ended in the defeat and break-up of the once all-powerful empire.

The capital of the territory still left to the Romans was later moved from Rome to Byzantium (Constantinople),



Fig. 121. A NOBLE BYZANTINE BUILDING
Santa Sophia, Constantinople.

where a style of building that we call "Byzantine" had been developing (Fig. 121). Brick was the local material, and it was used with great skill, especially for building domes, which, showing their shape outside the building as well as inside, marked them as different from the older Roman

buildings, though otherwise they were sometimes not altogether unlike them.

The Christians, now becoming more powerful, built many fine churches in this style, their earlier ones having been rather plain, and modelled on the old Roman Courts of Justice, or "Basilicas," and mostly built with columns and other materials actually collected from Roman ruins (see

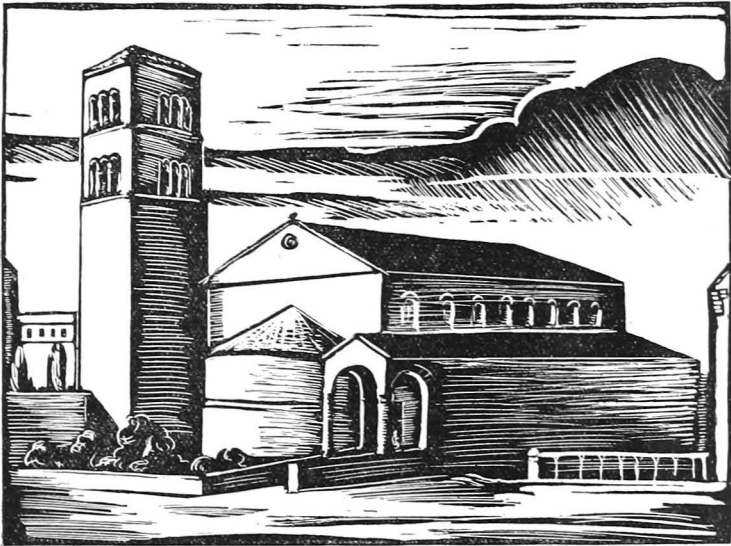


Fig. 122. A TYPICAL EARLY CHRISTIAN "BASILICAN" CHURCH
St. Agnes, Rome.

Fig. 122). In the same way, a little later, the native barbarians inhabiting the provinces of what had been the Roman Empire set about building on their own account, using up odds and ends of the abandoned buildings of the Romans or roughly imitating them.

As Christianity spread, church building increased, and ideas were borrowed from the Byzantines as well as from the departed Roman style, resulting in what we call Romanesque. Both the Norman style, that was brought to England after the Conquest, and our own native Saxon style that it replaced, were local variations of the

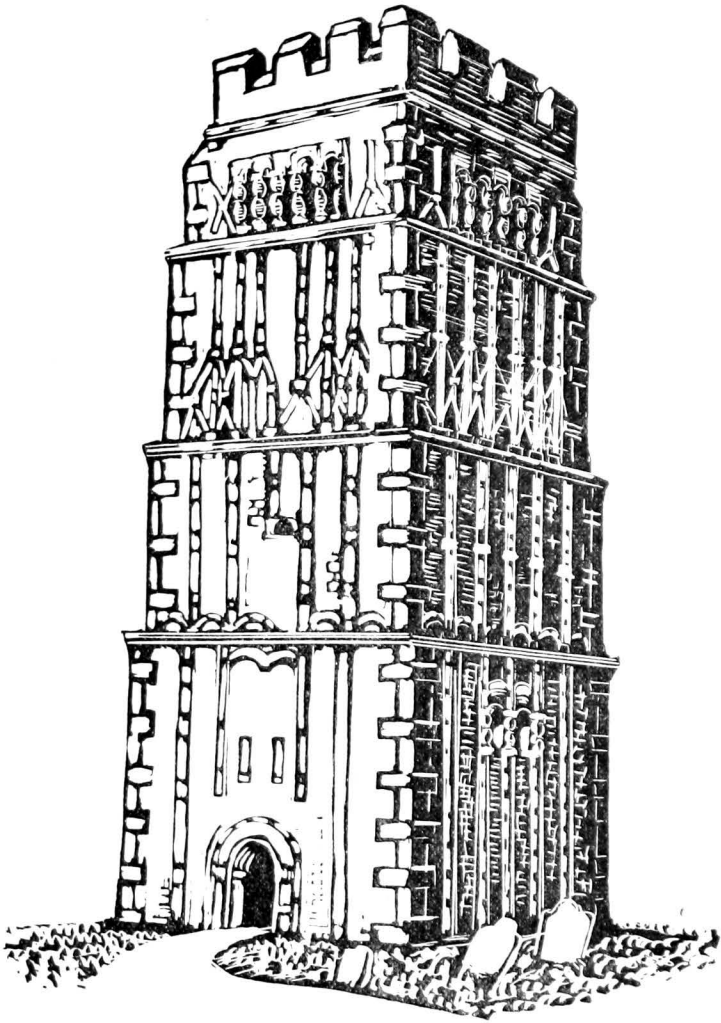


Fig. 123. THE SAXON TOWER, EARLS BARTON

Romanesque that developed a little differently in each different country (see Fig. 123).

From these several Romanesque variations, which were like the Roman buildings in depending on great mass for

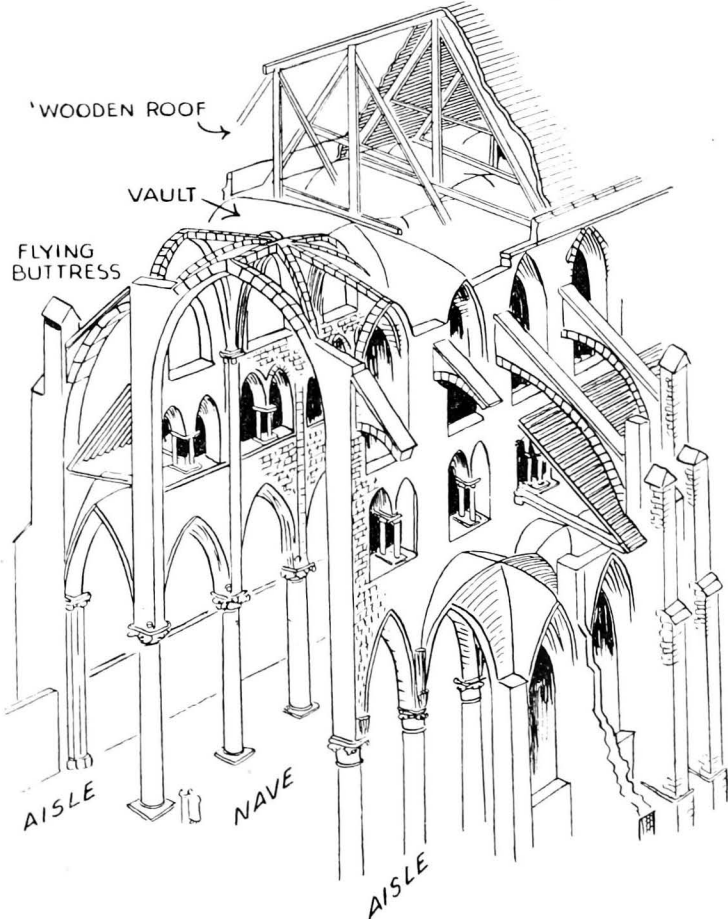


Fig. 124. A diagram to show how a Gothic Church was built, balanced and propped

their stability, gradually developed a very different architecture that we call Gothic, where the building was made to stand up by clever balancing rather than by great solidity. Pointed arches and windows were introduced, and light domes or vaults carried by stone ribs, the sideways

push or "thrust" of arches and vaults being skilfully balanced against other thrusts, so that nothing could crack or move (Fig. 124). As the builders got more and more practised, and learnt more and more about what was just as much engineering as architecture, they cut things finer



Fig. 125

RAUNDS

MAGDALEN
COLLEGE, OXFORD

KETTERING

The variety and beauty of Mediæval building shown by English Church Towers.

and finer, until their buildings became almost as light and airy as great stone birdcages. Beauvais Cathedral, indeed, was built so high and fragile that it actually fell in.

All the while they were not only building skilfully, but also very beautifully (Fig. 125) and, though architectural development went on during the Middle Ages over most of Europe, each country had its own peculiarities. In England,

for convenience, we roughly divide up the Gothic period into :

The Early English style—Thirteenth century.

The Decorated style—Fourteenth century.

The Perpendicular style—Fifteenth century.

Finally, in the sixteenth century, the Gothic style faded away in what we in England call " Tudor " architecture, which in turn, with old Roman or Classical ideas grafted on to it, gave us our Early Renaissance building.

The great re-birth of learning and of interest in the arts which happened in Italy in the fifteenth century (see *History of Science*, p. 62) had resulted in Italian architects carefully studying the ancient Roman buildings, and gradually working out new and beautiful variations of the old style. England, being a far-away island, went on building in the old way, undisturbed by the new fashions, long after Italy and its nearer neighbours had dropped the Gothic style. When the Renaissance did at last reach her, it was through France and the Netherlands and not direct, so that the first English Renaissance buildings were generally a rather odd mixture, partly Gothic or Tudor and partly Italian, with a Dutch or French or German accent.

Changes of fashion generally appear first in small decorative details, and it was not until these new ideas had been tried and liked in jewellery, metal-work, embroidery, painting, and things like choir-stalls and tombs that the English gradually came to accept them for their actual buildings. The change, like most changes of the kind, was slow and uneven, sometimes taking a long time to reach out-of-the-way parts of the country, which might thus be perhaps fifty years behind London.

What we call the Early Renaissance style of building was, however, fairly general throughout England during the reigns of Elizabeth and James I. But when the great architect Inigo Jones came back to the Court of Charles I straight from studying the work of the Italian architects of his time (especially Palladio), (Fig. 126) English architecture took a fresh turn towards something less mixed, and

more like the work of the Romans and their skilful successors. Though he made numbers of plans and designs for stage settings and so on, the interruption of the Civil War prevented Inigo Jones from actually building very much. His best-known work, the banqueting house in Whitehall, was only a fragment of the great palace he had hoped to build for Charles I.

Our next great architect, Sir Christopher Wren, never went to Italy, but he met Italian architects, as well as

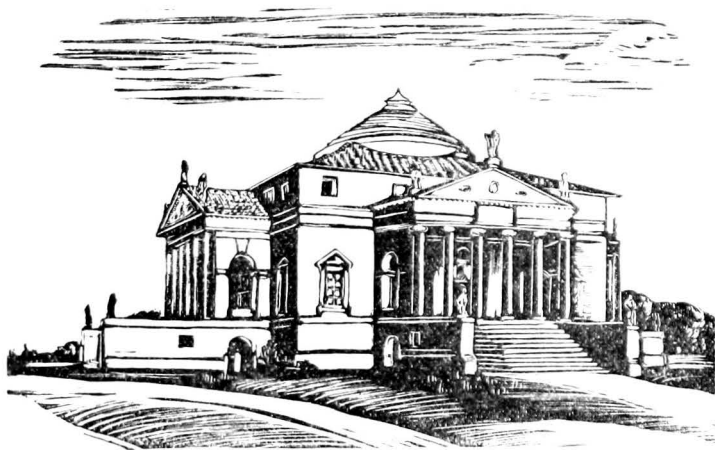


Fig. 126. VILLA BUILT BY PALLADIO AT VICENZA, ITALY
Later it was much admired and copied in England in the 18th Century.

French, when he went to see how Louis XIV's vast new palace of the Louvre in Paris was being built.

Though Wren brought back Italian as well as French-Italian ideas (Fig. 127), he had all sorts of ingenious ideas of his own as well, and was really the founder of what is sometimes called the "Anglo-Classic" style. The rebuilding of London after the Great Fire gave him a chance of showing how fine an architect he was, and St. Paul's (Fig. 128) and the City churches remain the chief monuments of his genius. But he also built Hampton Court Palace, Greenwich and Chelsea Hospitals, and many beautiful private houses, both in town and country. English architecture certainly owes



Fig. 127. SANTA MARIA DELLA SALUTE, VENICE



Fig. 128. THE DOME OF ST. PAUL'S CATHEDRAL,
LONDON

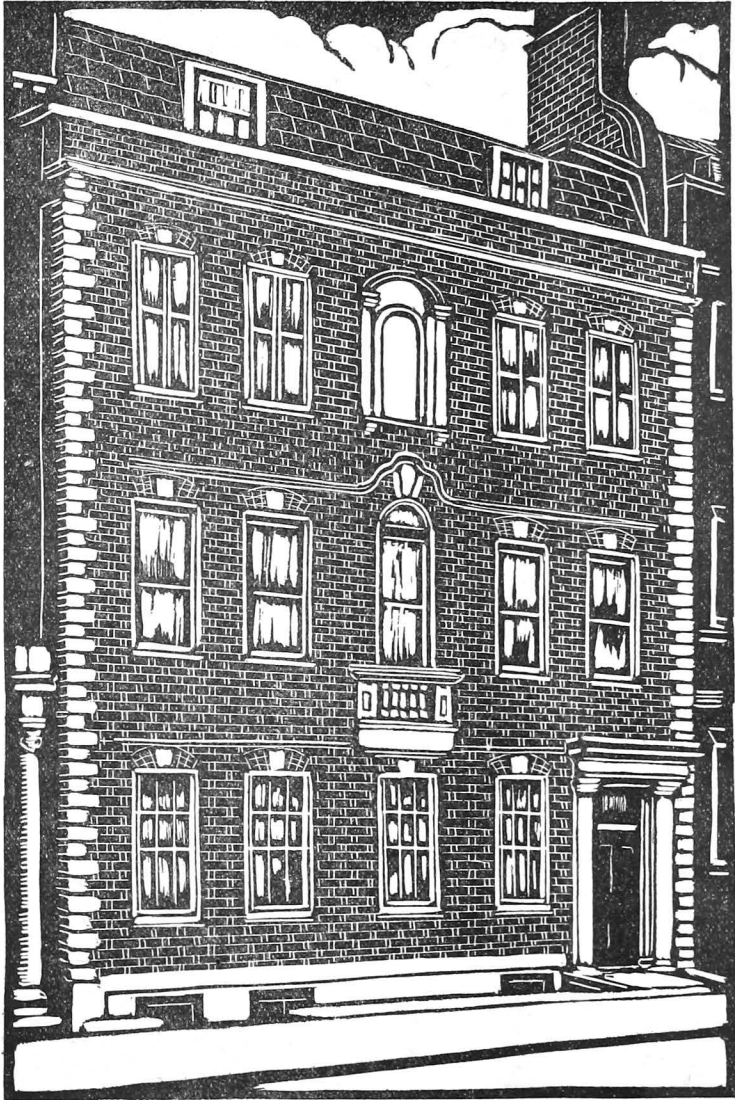


Fig. 129. A TOWN HOUSE OF THE TIME OF QUEEN ANNE
Buckingham Gate, London.

more to him than to any other man, before or since, and if only London had been rebuilt to his skilful plan that he prepared after the Fire, England might have had a really worthy capital.

Many good architects followed Wren throughout the eighteenth century, each with his own slightly different ideas, yet all building in the dignified classical style that Wren had so skilfully made "English" (see Fig. 129).



Fig. 130. THE MOST NOTABLE OUTCOME OF THE ENGLISH GOthic REVIVAL—THE HOUSES OF PARLIAMENT

At the beginning of the nineteenth century, new discoveries, surveys, and drawings of ancient Greek and Roman ruins turned people's thoughts back to the real origins of Classical architecture, and what was called a Classical Revival resulted, producing buildings that were often noble enough, such as the St. George's Hall at Liverpool, but not perhaps altogether suitable to England.

But there was a Gothic Revival too (see Fig. 130). People like Horace Walpole at Strawberry Hill, and Beckford at

Fonthill Abbey, were enthusiastic but not very understanding; they built themselves fantastic houses that they hoped looked correctly mediæval, though their turrets and vaulted ceilings were apt to be lath and plaster and the window tracery of wood painted to imitate stone. In spite of poky little windows, cranky, odd-shaped rooms, cold stone passages (in imitation of the old monks' cloisters), and general inconvenience, such Romantic houses became quite the fashion. Even to-day the English have not entirely recovered from this epidemic of cock-eyed "picturesqueness," and still rather like little turrets and things stuck about anyhow on their houses.

Thus at the same time, and even alongside one another you might find one house being built in the late Classic manner and another in Mock Gothic, and perhaps a third that was a mixture of both, which might or might not be pleasant in its mongrel way. These were the "Muddle Ages" of architecture, and we are in them yet—to some extent.

GETTING OUT OF THE "MUDDLE AGES"

About fifty years ago, at any rate, people were mostly in this muddle, imitating this or that in an idle sort of way, without trying to think out or solve their problems in terms of a living, practical architecture—which is *right building*.

Then the architect Philip Webb, and later Norman Shaw, thought it would be wise to go back to the point that English architecture had reached before these various "Revivals" had broken the tradition—that is, to mid-eighteenth century or Georgian architecture. This gradually became more or less the fashion, and most of the best English architecture of the past fifty years has been in this revived Anglo-Classic style, or in new variations or developments of it. There are many very good architects who, like Sir Edwin Lutyens, are not afraid of solving new problems in their own way, even though they mostly

clothe their new ideas in the fashions of the eighteenth century.

Yet although—thanks largely to Wren's example—this manner of building seems almost always to suit the English background, we seem now on the edge of giving it up. This is partly because our ways of living have just lately been changing so much and so unusually fast. We moderns, with our strange new habits and new inventions, do not seem to fit into the old-fashioned house or to match our old

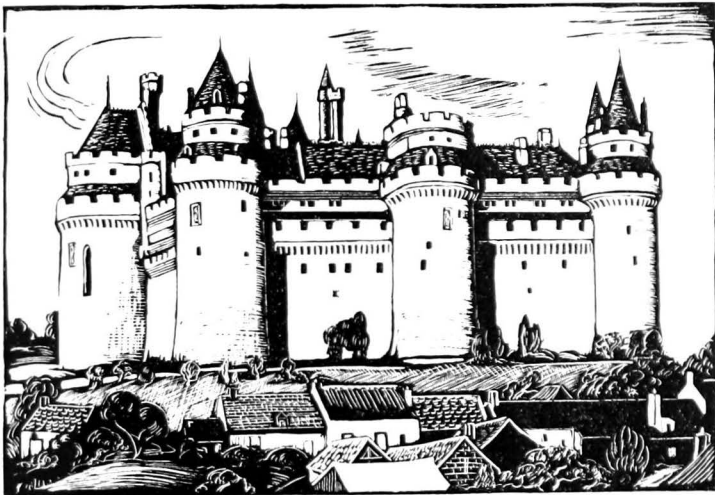


Fig. 131. AN EXTREME CONTRAST

The magnificence of the great Chateau de Pierrefonds and the cringing little houses around it.

background as well as we used to. Also the use of steel girders and reinforced concrete, and all manner of new materials needs a new way of designing and building if we are to make the best of them.

Though few people even now, may care very much about a building being beautiful, most of us want our homes to be light and airy, convenient, reasonably cheap to build, to keep in order, and to run. We want nothing unnecessary or pretentious, yet we desire all the comforts and advantages that science has made possible in heating, lighting, cooking,



Fig. 132. A BIRD'S-EYE VIEW OF MODERN AMERICAN
SKY-SCRAPERS



Fig. 133. LATE RENAISSANCE (OR BAROQUE) ARCHITECTURE

This is a German building (1704) but there are thousands of others very much like it, yet all interesting in their differences, scattered about throughout Europe and even South America.

cleaning, and general labour-saving. There are now fewer of the very rich who want, or can afford, the luxurious palaces of the past (Fig. 131), and it is likely that in the future there will be a more even distribution of wealth, allowing more and more people to have homes that are recognisable as "architectural"—having, that is, firmness, commodity, and delight.

That would probably mean small, compact homes for the great majority, which might be most conveniently provided in the cities as flats—great blocks of dwellings around garden courts, as so often is done in Germany, Scandinavia, and the U.S.S.R., or as in the skyscrapers of New York (Fig. 132). Having small homes of their own, people would probably want fine and spacious public buildings where they would use their leisure for all sorts of recreations and social or educational purposes—as in modern Russia.

As so many have not found the old way of living satisfactory, a new way will probably be tried, and out of Functionalism, in due course, some sort of architecture suited to that new way of life will doubtless come, to change and change again perpetually through the ages, to suit men's new needs and new ideals.

As in the past, so in the future—everlasting change, for better or for worse.

SOME BOOKS TO READ

General :

J. GLOAG : *Men and Buildings.*

CLOUGH and A. WILLIAMS-ELLIS : *The Pleasures of Architecture.*

History :

F. CHATTERTON : *English Architecture at a Glance.*

SIR BANISTER FLETCHER : *A History of Architecture on the Comparative Method* (9th edition). This is the big book, giving a complete panorama of architectural development from the first beginnings until to-day, on the illustrations of which the pictures in this chapter have largely been based.

W. R. LETHABY : *Architecture.*

A. POWYS : *The English House.*

Modern Buildings :

NASH : *The Room and the Book.*

F. R. YERBURY : *Modern European Buildings.* A lovely picture-book. There are also some excellent cheap picture-books, mostly German and Scandinavian, but unfortunately they are difficult to get here.

Town Planning :

S. D. ADSHEAD : *Town Planning and Town Development.*

WRITING
OR
THE PATTERN BETWEEN PEOPLE
by
WYSTAN AUDEN



WYSTAN AUDEN (born 1907) writes poetry and teaches at a school in Scotland.

WRITING

SPEECH

IF AN Australian aborigine sits down on a pin he says "Ow." Dogs with bones growl at the approach of other dogs. English, Russian, Brazilian, all mothers, "coo" to their babies. Sailors at any port, pulling together on a hawser: watch them and listen—heaving, they grunt together "Ee-Ah."

This is the first language.

We generally think of language being words used to point to things, to say that something is *this* or *that*, but the earliest use of language was not this; it was used to express the feelings of the speaker; feelings about something happening to him (the prick of the pin), or attitudes towards other things in the world (the other hungry dog; the darling baby), or, again, as a help to doing something with others of his own kind (pulling the boat in). The first two uses are common to many animals, but the last is peculiar to the most highly organised, and contains more possibilities of development.

Life is one whole thing made up of smaller whole things, which again are made up of smaller whole things, and so on. The largest thing we can talk about is the universe, the smallest the negative electrons of the atom which run round its central positive nucleus, already a group. So too for us, nucleus and cell, cell and organ, organ and the human individual, individual and family, nation and world, always groups linked up with larger groups, each group unique, different from every other, but without meaning except in its connection with others. The whole cannot exist without the part, nor the part without the whole; and each whole is more than just the sum of its parts; it is a new thing.

But suppose the part begins to work, not only as if it

were a whole (which it is), but as if there were no larger whole, then there is a breakdown (e.g. a cancer growth in the body). And this is what has happened to us. At some time or other in human history, when and how we don't know, man became self-conscious ; he began to feel, I am I, and you are not I ; we are shut inside ourselves and apart from each other. There is no whole but the self (see *History of Ideas*, p. 431).

The more this feeling grew, the more man felt the need to bridge over the gulf, to recover the sense of being as much part of life as the cells in his body are part of him. Before he had lost it, when he was still doing things together in a group, such as hunting ; when feeling was strongest, as when, say, the quarry was first sighted, the group had made noises, grunts, howls, grimaces. Noise and this feeling he had now lost had gone together ; then, if he made the noise, could he not recover the feeling ? In some way like this language began, but its development must have been very slow. Among savage tribes, for example, news travels much quicker than a messenger could carry it, by a sympathy which we, ignorant of its nature and incapable of practising it, call telepathy. Dr. Rivers tells a story of some natives in Melanesia getting into a rowing-boat. There was no discussion as to who should stroke or steer. All found their places, as we should say, by instinct.

Even among ourselves, two friends have to say very much less to understand each other's meaning than two strangers. Their conversation is often unintelligible to a third person. Even when we are listening to anyone, it is not only the words themselves which tell us what he means, but his gestures (try listening with your eyes shut), and also the extent to which he is talking to us personally. (It is always difficult to understand what people are saying at another table in a restaurant. We are outside the group.)

Words are a bridge between a speaker and a listener. What the bridge carries, i.e. what the speaker gives and the listener receives, we call the *meaning* of the words.

MEANING

In anything we say there are four different kinds of meaning; any one of them may be more important than the other three, but there is generally something of all four.

(1) *Sense* (typical case, fat stock prices on the wireless). We say *something*, or expect *something* to be said to us about something. "Snig is a man." We now know that there is a thing called Snig, and that thing is a man and not a dog or anything else.

(2) *Feeling* (typical case, the conversation of lovers). We generally have feelings about the things of which we are talking. "There's that horrible man Snig." We now know that the speaker does not like Snig.

(3) *Tone* (typical case, an after-dinner speech). We generally have an attitude to the person we are talking to. We say the same thing in a different way to different people. "There's that swine Snig." "There's Mr. Snig; of course, I expect he's charming, really, but I don't like him very much, I'm afraid."

(4) *Intention* (typical case, a speech at a General Election). Apart from what we say or feel we often want to make our listeners act or think in a particular way. "There's that man Snig. I shouldn't have much to do with him if I were you." The speaker is trying to stop us seeing Mr. Snig.

LANGUAGE AND WORDS

Language, as we know it, consists of words—that is, a comparatively small number of different sounds (between forty and fifty in English) arranged in different orders or groups, each sound, or group of sounds, standing for something; an object, an action, a colour, an idea, etc.

To go back to our sketch of the origin of language. Before language we have the people who feel something (the hunting group), the feeling (feeling of unity in the face of hunger or danger, etc.), the object which excites the feeling (the hunted bison), and the noise which expressed

the feeling. If the noise was later used to recover the feeling, it would also present to the memory the idea or the image of the animal, or whatever it was excited the feeling. Thus sounds would begin to have sense meaning, to stand for things, as well as having meaning as an expression of feeling.

It is unlikely, therefore, even at the first that language was entirely onomatopœic—that is, that words were sounds imitating the sounds of things spoken about. Many words, no doubt, did, just as they still do (e.g. hissing, growling, splashing). It is only possible to imitate in this way actions or objects which make a noise. You could never, for example, imitate the sound of a mountain. In fact, most of the power of words comes from their *not* being like what they stand for. If the word “ruin,” for instance, was only like a particular ruin, it would only serve to describe the one solitary building; as it is, the word conjures up all the kinds of ruins which we know, and our various feelings about them—ruined churches, ruined houses, ruined gasworks, loss of money, etc.

INFLECTION

All languages are originally inflected; that is to say, the sounds standing for a particular object or action changes slightly according to how we are looking at it.

e.g. the Roman said :

Homo canem amat (The man loves the dog).

Canis hominem amat (The dog loves the man).

He felt that the man is a different man and the dog is a different dog if he is loving or being loved (see *History of Ideas*, p. 431). But, as people get more self-conscious, more aware of what they are feeling and thinking, they separate their feelings and thoughts from the things they are feeling and thinking about. They show the difference in attitude

either by changing the word order or by using special words like prepositions. Thus in English, the least inflected language :

The man loves the dog.
The dog loves the man.
The man gives a bone *to* the dog.

All languages show some inflection. (*I love him. He loves me.*)

WRITING

Writing and speech are like two tributary streams, rising at different sources, flowing apart for a time until they unite to form a large river. Just as it is possible for sounds conveying their meaning by the ear to stand for things, pictures conveying their meaning through the eye can do the same.

The earliest kinds of writing, such as Egyptian hieroglyphs, or Mexican writings, are a series of pictures telling a story, as a sentence tells a story. The urge to write, like the urge to speak, came from man's growing sense of personal loneliness, of the need for group communication. But, while speech begins with the feeling of separateness in space, of I-here-in-this-chair and you-there-in-that-chair, writing begins from the sense of separateness in time, of "I'm here to-day, but I shall be dead to-morrow, and you will be active in my place, and how can I speak to you?"

Primitive people, living in small groups, have very little idea of death, only a very strong sense of the life of the tribe, which, of course, never dies. The moment man loses this sense of the continuously present group life, he becomes increasingly aware of the shortness and uncertainty of the life of the individual. He looks round desperately for some means of prolonging it, of living into the future, of uniting the past with the present. The earliest writings of which we know tell the exploits of dead kings. The writer is like a schoolboy who carves his initials on a desk; he wishes to live for ever.

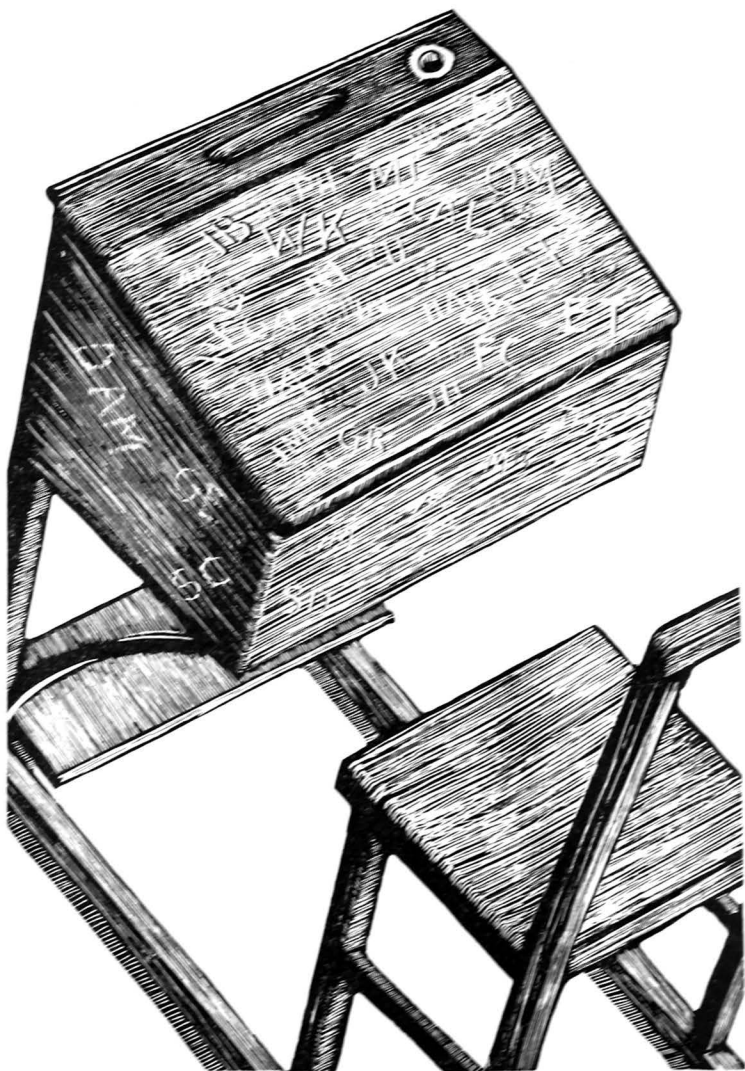


Fig. 134. LIVING FOR EVER

How early speech joined up with writing it is impossible to say, but writing must soon have stopped being purely pictorial—drawings of each separate object. A language of this kind would have had to contain thousands of letters, and would have been very difficult to know, and slow and clumsy to write. Chinese is still a language of this kind. Further, abstract ideas would be impossible to represent by pictures (how, for example, could you draw a picture of “habit”?). Luckily, the fact that the number of different sounds which it is possible to make are comparatively few presented a solution to the difficulty. In inventing an alphabet, or code, where one kind of mark stands for one kind of sound, any word could be written by arranging the marks or letters in the order in which the sounds were made. (Our own alphabet comes originally from Egypt, through Phœnicia, Colchis, and Italy.)

SPOKEN AND WRITTEN LANGUAGE

As long as people are living in small societies, and living generation after generation in one place, they have little need of writing. Poems, stories, moral advice, are learnt by heart and handed down by word of mouth from father to son. Oral tradition has certain advantages and certain disadvantages over writing. Generally speaking, the *feelings* meaning is transmitted with extraordinary accuracy, as the gestures and the tone of voice that go with the words are remembered also. (With a statement in writing it is often impossible, after a time, to decide exactly what the author meant. Think how easy it is to misunderstand a letter.) On the other hand, in speaking, the *sense* meaning is apt to get strangely distorted. It is easy not to catch or to forget the exact words told to one, and to guess them wrongly; again, we may be asked to explain something and add our own explanation, which is passed on with the story; e.g. this message was once passed back from the front lines from mouth to mouth to the officer commanding the reserve: “Send reinforcements; the

regiment is going to advance." What actually reached him was: "Send three and fourpence; the regiment is going to a dance."

But as the communities became larger and government became more centralised, writing became more and more important. Still, as long as copying of original manuscripts had to be done by hand, books were rare and too costly for any but the few. The invention of printing in the fifteenth century greatly increased the power of the written word, but the cost of books still limited their circulation. Popular printed literature during the sixteenth and seventeenth centuries, apart from some religious books, was confined to broadsheets and pamphlets peddled in the streets. The eighteenth century saw the rise of the magazine and the newspaper; and the introduction of steam power at the beginning of the nineteenth century, by cheapening the cost of production, put printed matter within the reach of anyone who could read or write. (Think also of the introduction of the penny post, and the effect of universal education. The last five years, with the wireless and the talkies, have produced a revival of the spoken word.)

The effect of this has been a mixed one. It has made the language able to deal with a great many more subjects, particularly those which are abstract, like some of the sciences; it can be more accurate, draw finer distinctions of meaning. Words written down in one language can be translated into another. Thus the world's knowledge can be pooled, and words borrowed from another language for which the borrower has no word in his own, with the exact shade of meaning which he wants (clock—chronometer: stranger—alien, etc.). But increase in vocabulary makes a language more difficult to learn—not only just to learn the words, but to learn to use them. Education in the use of the language becomes more and more necessary. At present nobody gets such an education. The speech of a peasant is generally better, i.e. more vivid, better able to say what he wants to say, than the speech of the average University graduate. It's like juggling with balls. You may be able to juggle fairly well with three, but, if you try six, without

careful practice you will probably drop them all. It is not the language that is to blame, but our skill in using it.

VERSE FORMS

Speech originated in noises made during group excitement. Excitement seems naturally to excite movement. When we are excited, we want to dance about. Noise was thus in the beginning associated with movements of a group—perhaps dancing round food or advancing together to attack. The greater the excitement, the more in sympathy with each other each member of the group is, the more regular the movements; they keep time with each other; every foot comes down together (see *Dancing*, p. 757).

Again, imagine a circle of people dancing; the circle revolves and comes back to its starting-place; at each revolution the set of movements is repeated.

When words move in this kind of repeated pattern, we call the effect of the movement in our minds the metre. Words arranged in metre are verse. Just as in a crowd we are much more easily carried away by feeling than when alone, so metre excites us, prepares us to listen readily to what is being said. We expect something to happen, and therefore it does. When a poet is writing verse, the feeling, as it were, excites the words and makes them fall into a definite group, going through definite dancing movements, just as feeling excites the different members of a crowd and makes them act together. Metre is group excitement among words, a series of repeated movements. The weaker the excitement, the less the words act together and upon each other. (Rhythm is what is expected by one word of another.) In scientific prose, for example, what words do is only controlled by the sense of what is being said. They are like people in a street on an ordinary day. They can be or do anything they like as long as they keep to the left of the pavement and don't annoy each other. But even here this much is expected. There is always some degree of rhythm in all language. The degree depends on the power of feeling.

Accents, long and short syllables, feet and all that, are really quite simple. You will always read a line of poetry rightly if you know its meaning (all four kinds). There are certain traditional rules in writing poetry, just as there are traditional steps in a dance, but every good poet, like every good dancer, uses them in his own way, which is generally quite distinct from that of any other poet. If you were describing a certain dance, you could do it in various ways—as consisting of ten steps, or of four long steps and six little steps, or of three heavy steps and six light ones; in the same way the motion or metre of a line of poetry can be described in different ways according as to how you choose to look at it. In English poetry, for example, we generally describe it by accents—light and heavy steps—because that is the most obvious feature about the movements of English speech. But remember always that such a description of movement is only a description; it isn't the movement itself (see *Music*, p. 876).

Lastly, language may be ornamented in various ways. The two most familiar ornaments are alliteration (e.g. In a summer season when soft was the sun), and rhyme (Old King Cole was a merry old soul). Alliteration is found in the early verse of the Teutonic people, and rhyme, beginning perhaps in the marching-songs of the Roman soldiers, was adopted by the early Christian hymn-writers and so came into modern verse. Alliteration is the effect produced by an arrangement of words beginning with a similar sound; rhyme that produced by an arrangement of words ending in a similar sound. The sounds are similar, but belong to different words, and, therefore, have different meanings in each place. Through the likeness, thoughts and feelings hitherto distinct in the mind are joined together. They are, in fact, sound metaphors.

DIFFERENT KINDS OF WRITING

The difference between different kinds of writing lies not so much in the writing itself, but in the way we look at it (and, of course, in the way the author wished us to look

at it ; but we often know very little about that). Literary forms do not exist outside our own minds. When we read anything, no matter what—a description of a scientific experiment, a history book, a ballad, or a novel—in so far as we pay attention only to what things are happening one after another to something or somebody, it is a story ; in so far as we read it only to learn the way in which something or someone behaves in certain circumstances, it is science ; in so far as we read it only to find out what has actually happened in the past, it is history.

People often ask what is the difference between poetry and prose. The only difference is in the way the writer looks at things. (There is another difference between prose and verse ; see above.) For instance, the novelist starts with a general idea in his mind ; say, that people are always trying to escape from their responsibilities, and that escape only leaves them in a worse mess. Then he writes a story about what happened to Mr. and Mrs. Smith. He may never say, in so many words, that they tried to escape, never mention his idea, but this idea is the force that drives the story along. The poet, on the other hand, hears people talking in his club about the sad story of Mr. and Mrs. Smith. He thinks, "There now, that's very interesting. They are just like everybody else ; trying to get round life. It's like those sailors who tried to get to India by the North-West Passage. On they go, getting farther and farther into the ice, miles from home. Why, that's a good idea for a poem." He writes a poem about explorers ; he may never mention Mr. and Mrs. Smith at all. The novelist then goes from the general to the particular, the poet from the particular to the general, and you can see this also in the way they use words. The novelist uses words with their general meaning, and uses a whole lot of them to build up a particular effect : his character. The poet uses words with their particular meanings and puts them together to give a general effect : his ideas. Actually, of course, nearly all novels and all poems except very short ones have both ways of looking at things in them (e.g. Chaucer's *Canterbury Tales* is more like a novel in verse ; Melville's *Moby Dick* is more like a

poem in prose). All you can say is that one way is typical of the novelist and the other of the poet.

WHY PEOPLE WRITE BOOKS

People write in order to be read. They would like to be read by everybody and for ever. They feel alone, cut off from each other in an indifferent world where they do not live for very long. How can they get in touch again? How can they prolong their lives? Children by their bodies live on in a life they will not live to see, meet friends they will never know, and will in their turn have children, some tiny part of them living on all the time. These by their bodies; books by their minds.

But the satisfaction of any want is pleasant: we not only enjoy feeling full, we enjoy eating; so people write books because they enjoy it, as a carpenter enjoys making a cupboard. Books are written for money, to convert the world, to pass the time; but these reasons are always trivial, beside the first two—company and creation.

HOW PEOPLE WRITE BOOKS

We know as much, and no more, about how books are made as we know about the making of babies or plants. Suddenly an idea, a feeling, germinates in the mind of the author and begins to grow. He has to look after it, and water the soil with his own experience—all that he knows and has felt, all that has happened to him in his life; straightening a shoot here, pruning a bit there, never quite certain what it is going to do next, whether it will just wither and die, come up in a single night like a mushroom, or strengthen quietly into a great oak-tree. The author is both soil and gardener; the soil part of him does not know what is going on, the gardener part of him has learnt the routine. He may be a careful gardener but poor soil; his books are then beautifully written, but they

seem to have nothing in them. We say he lacks inspiration. Or he may be excellent soil but a careless gardener. His books are exciting, but badly arranged, out of proportion, harsh to the ear. We say he lacks technique. Good soil is more important than good gardening, but the finest plants are the product of both.

WHY PEOPLE READ BOOKS

When we read a book, it is as if we were with a person. A book is not only the meaning of the words inside it ; it is the person who means them. In real life we treat people in all sorts of ways. Suppose we ask a policeman the way. As long as he is polite we do not bother whether he beats his wife or not ; in fact, if he started to tell us about his wife we should get impatient ; all we expect of him is that he shall know the way and be able clearly to explain it. But other people we treat differently ; we want more from them than information ; we want to live *with* them, to feel and think *with* them. When we say a book is good or bad, we mean that we feel towards it as we feel towards what we call a good or bad person. (Remember, though, that a book about bad characters is not therefore bad, any more than a person is bad because he talks about bad people.) Actually we know that we cannot divide people into good and bad like that ; everyone is a mixture ; we like some people in some moods and some in others, and as we grow older our taste in people changes. The same is true of books. People who say they only read good books are prigs. We all like some good books and some bad. The only silly thing to do is to pretend that bad books are good. The awful nonsense that most people utter when they are discussing or criticising a book would be avoided if they would remember that they would never think of criticising a person in the same way.

For instance, people will often say that they don't like the book because they don't agree with it. We think it rather silly when people can only be friends with those who hold the same views in everything.

EGG

Reading is valuable just because books are like people, and make the same demands on us to understand and like them. Our actual circle of friends is generally limited ; we feel that our relations with them are not as good as they might be, more muddled, difficult, unsatisfying than necessary. Just as a boxer exercises for a real fight with a punch-ball or a sparring-partner, so you can train yourself for relations with real people with a book. It's not easy, and you can't begin until you have had some experience of real people first (any more than a boxer can practise with a punch-ball until he has learnt a little about boxing), but books can't die or quarrel or go away as people can. Reading and living are not two watertight compartments. You must use your knowledge of people to guide you when reading books, and your knowledge of books to guide you when living with people. The more you read the more you will realise what difficult and delicate things relations with people are, but how worth while they can be when they really come off ; and the more you know of other people, the more you will be able to get out of each kind of book, and the more you will realise what a true good a really great book can be, but that great books are as rare as great men.

Reading is valuable when it improves our technique of living, helps us to live fuller and more satisfactory lives. It fails when we can't understand or feel with what we read, either because of ignorance of our own or obscurity in the writing.

It is a danger when we only read what encourages us in lax and crude ways of feeling and thinking : like cheap company (too many people only read what flatters them ; they like to be told they are fine fellows, and all is for the best in the best of all possible worlds ; or they only want to be excited or to forget to-morrow's bills). It is also dangerous when it becomes a substitute for living, when we get frightened of real people and find books safer company ; they are a rehearsal for living, not living itself. Swots and " bookish " people have stage fright.

BOOKS AND LIFE

A book is the product of somebody living in a particular place at a particular time. People have a nature they are born with, and they have a life which they lead and live through, which alters that original nature: They may be born with great talents but live in a society where they can't develop or use them; or they may be only averagely gifted but get the opportunity to make the most of them. Great men are a combination of talent and opportunity. Great books are as rare as great men, and, like them, they often come in batches. It is improbable that the men living in England in the sixteenth century were more naturally talented than those living in the eleventh, but they had a better chance, a more stimulating world. Take the greatest names in literature—Homer, Dante, Shakespeare. Homer is typical of a kind of writing called epic—long stories in verse about the exploits of a small group of young warriors under a leader, the pioneer or pirate band society, held together by their devotion to their leader, and by common interests in fighting and farming and wife-getting. Dante was a citizen of Florence, a small and ambitious city State (he was also a citizen of the universal religious State, the Catholic Church). Shakespeare was born in a small, young country, fighting for its existence as an independent nation. There is something common to all three: the small size of the society and the unity of interests. Whenever a society is united (and the larger the society the harder it is to unite and the cruder and more violent the only feelings which come) it has a great outburst of good writing; we don't only find one or two first-class writers, we find a whole mass of good small writers (think of Athens in the fifth century and the Elizabethan song-writers). 'Being made one, like the sailors pulling on the rope, it has all power.

But whenever society breaks up into classes, sects, towns-people and peasants, rich and poor, literature suffers. There is writing for the gentle and writing for the simple, for the highbrow and the lowbrow; the latter gets cruder and coarser, the former more and more refined. And so,

to-day, writing gets shut up in a circle of clever people writing about themselves for themselves, or ekes out an underworld existence, cheap and nasty. Talent does not die out, but it can't make itself understood. Since the underlying reason for writing is to bridge the gulf between one person and another, as the sense of loneliness increases, more and more books are written by more and more people, most of them with little or no talent. Forests are cut down, rivers of ink absorbed, but the lust to write is still unsatisfied. What is going to happen? If it were only a question of writing it wouldn't matter; but it is an index of our health. It's not only books, but our lives, that are going to pot.

BOOKS TO READ

- P. H. B. LYON : *The Discovery of Poetry.*
T. WARNER : *On the Writing of English.*
W. DE LA MARE : *Come Hither.*
A. QUILLER-COUCH : *The Art of Writing.*
L. A. G. STRONG : *Common Sense about Poetry.*
I. A. RICHARDS : *Science and Poetry.*

MUSIC
OR
THE LAST PATTERN

by
J. B. TREND



MUSICIANS are probably the oddest kind of people, and J. B. Trend is a musician. It is most exciting being in the same house with him, because he goes on talking about music very quickly and sometimes unintelligibly. Then quite suddenly he says something which sticks in one's mind for years. He goes about with quantities of music, which he reads in the train or anywhere ; and he belongs to queer musical secret societies in England, Germany, and Switzerland. He has sometimes been on the edge of the most exciting plots and adventures—for instance, the Spanish Revolution ; for he spends a lot of time in Spain, where some of the most interesting and lovely modern music is being made, and he has written two or three books about Spain, and one about the greatest living Spanish composer, Manuel de Falla, besides articles on Spain in *Encyclopædia Britannica* and the big dictionaries of music. As well as being a musician, he is an historian and critic ; but the real reason I asked him to write about music is

that he has managed to explain the patterns of music so that I can understand them myself, and, as I am quite densely stupid about music, that shows that he is very good at explaining.

MUSIC

THE PATTERN OF MUSIC

MUSIC is a succession of sounds made by voices or instruments. There may be only one voice or one instrument, or several voices, and several instruments; but something more is needed than mere sounds. The sounds of the voices or instruments must be arranged in some order, some sort of pattern; and they must be expressive: they must have some mood, or feeling, although that feeling can never be expressed in words. Without arrangement, and without expressiveness, sounds (even the sounds of voices and instruments) are not music. People shouting, an orchestra tuning, a person strumming vague chords on the piano, are not making music; they are making a noise.

What is the difference between music and noise? Noises can have order and arrangement—the noises made by machinery, for instance; they can even be expressive, such as a gong ringing to express the fact that it is time for dinner, a crowd booing to express its disapproval. Yet these noises are not music. Their intention is not musical; they are not made for the sheer joy of making a pleasant sound, of creating something beautiful.

Music must have some sort of pattern or shape. It is a shape which is less substantial even than dream shapes; yet to a musician these musical shapes are not only not less real than visible shapes, but more so. The true musician is a person to whom sound is more vivid than sight, and things heard more memorable than things seen. A musician may easily forget a face, but can never forget a voice. His most intimate thoughts are not thoughts which can be expressed in words or images, but in sounds and successions of sounds. When he sits down to compose, one musical thought will naturally lead to another, and, without his quite knowing how, there will be a certain family likeness

between them, a connection of ideas, which will be clearly recognisable when at last his thoughts are expressed in music and written down on paper. Yet, even when these musical thoughts are written down, the composition is still in a very early stage; the scribbled notes in Beethoven's sketch-books needed endless labour before they could be written out as a symphony or a quartet, and still more labour before they could be played by musicians and heard as a piece of music. Beethoven grew very deaf; he could only hear music in his head, he could not listen to it in the ordinary way, and he used to walk about grunting and growling his tunes and his rhythms over to himself. They used to come to him at all sorts of odd moments; one of his greatest (and also one of his shortest—the three notes at the beginning of the Scherzo of his Ninth Symphony) came to him one evening as he went into a brightly lighted room out of a dark street. As he worked at his sketch-books, the music he was composing gradually took shape in his mind; the tunes and the little scraps of tune arranged themselves in patterns in his head, while the general plan which he had had at the beginning became a musical design. This general plan on which a piece of music is written is called its "form."

The great difficulty of listening to music is this: to grasp the idea of musical form, the invisible shape and design, the arrangement of invisible patterns in sound. We have to remember what we heard before, while we listen to what is being played now; and from the little bits remembered in our minds we have to build up the pattern for ourselves. As a matter of fact, that is exactly what we do with the pattern on a carpet, for we cannot see the whole pattern unless all the furniture has been taken away. We look at one little piece after another, and so get an idea of what the whole pattern will be. The pattern on the carpet is easier to grasp because, unlike the pattern in a piece of music, it stands still, and if we lose the place we can always go back and look again. The carpet and its pattern will still be there, but music and its pattern are always dancing away from us.

HOW MUSIC BEGAN

Music begins with the dances of savages, and the howling and drumming that go with it. Explorers have never found a primitive race which did not make music, no matter how backward that race may have been in other respects. Music was magic; it had the power of putting men into touch with the invisible world, the world of ghosts and spirits.

Primitive tunes are very short, and are repeated over and over again. They are of two sorts: those that start from a howl and those that start from the beating of a drum. Gradually they become more varied; instead of repeating the same three or four notes, they bring in different groups of notes by way of contrast. This is already a sort of design: two things in contrast, two snatches of tune which are different, but joined together; and this sense of design persists throughout the whole history of music. The most complicated musical forms all go back to this: two halves of a tune, which are different from one another and yet belong to one another.

MELODY AND RHYTHM

Music so far consists of two things: melody and rhythm. *Melody* is really the same as "tune," although in ordinary conversation a melody is called a tune when it is an obvious melody which can be easily remembered. Tune or melody means notes in succession. The notes must not always be the same notes—some must be higher or lower in pitch; and they must not always be of the same length, or the same loudness. One note repeated indefinitely at the same pitch does not make a tune, although some hymn-writers seem to have thought so—for instance, the authors of "Fight the good fight," "Peace, perfect peace," or the composer of that popular war-time song, "It's a long, long trail." These are not really tunes at all.

Rhythm means "flow"; we get into difficulties if we try

to nail it down to a more exact meaning. All the arts are said to have rhythm in various degrees, even painting, sculpture, and architecture, which can only be said to "flow" by a considerable stretch of the imagination, by a metaphor. Rhythm, strictly speaking, can only be applied to something that moves, like poetry, drama, dance, and music. To a musician it seems absurd to talk about the "rhythm" of something which does not move—as absurd as it is to talk about the "harmony" of something which does not sound. Poetry, however, flows; and can truly be said to have rhythm. But poetry is made of words, not sounds; and words are complicated by having associations with things outside them—by having meanings; while musical sounds have no connection with things outside them. So the rhythm of poetry depends on a blend of sound and meaning; while the rhythm of music is not so tied; for music has no meaning in the sense that poetry has, and concerns itself only with sounds.

In other respects, rhythm in music is based on much the same principles as rhythm in poetry. Music may also be in a free rhythm, like prose, without regularly returning accents, or beats; and this is the rhythm of many of those songs which are derived from the howling of savages. Yet music with regular accents is almost as old as music without them. It is "as old as the possession of a pair of legs, and the tendency to drag more heavily on one of them." The rhythm of a pair of legs is a two-beat rhythm: "one, two; one, two," or "left, right; left, right." The tendency to drag one foot more than the other gives "o n e, two; o n e, two"—the "one" taking up twice as much time as the "two."

What is it that makes the "one" prominent? The "one," the first beat, may be *louder* than the "two," *higher* than the "two," or *longer* than the "two." If it is louder or higher it produces "two-time," or two-beat rhythm: both "one" and "two" are of equal length. But if it is longer it produces "three-time," three-beat rhythm: in which "one" takes up twice as much time as "two." Thus the "one" can have two kinds of accent: in the first case it is

a "stress-accent" or "pitch-accent," like the accent in modern English poetry; in the second case it is a "quantity-accent," as in the poetry of the more ancient peoples: Greeks, Romans, Arabs. Music, like ancient poetry, often gains in interest by employing both kinds of accent together, sometimes on the same note or syllable, sometimes on different notes or syllables, so that the two kinds of accents "cross" or clash. This may seem difficult to grasp; but cross-accent is common, and is actually one of the principal things in *jazz*. *Jazz* comes from the primitive music of certain negro tribes (Bantu) in Africa, where singers like to get in some of their notes before the beat of the drum accompanying them, thus producing a cross-rhythm or syncopation. This device had been invented independently by European musicians, and composers in the time of Haydn and Beethoven knew it well; for they had come across something of the same kind in Hungarian folk-music. At the end of the nineteenth century the Czech composer Dvořák made delightful use of syncopation in the tunes of his "New World" Symphony and other pieces.

FOLK-MUSIC

The beginnings of music are as old as the beginnings of dance and speech among primitive man, and music takes the lead among the arts in expressing what men feel at any particular moment. It is the art which most directly expresses the emotions, and is the form of artistic expression which goes most immediately to people's imagination and consciousness.

Folk-song, and folk-music generally, is music invented by someone whose name has been forgotten, music handed on from one performer to another and gradually altered by the players and singers who perform it. These players and singers were unlettered folk; country-people living where new ideas and new music did not easily reach them, and where music was learnt, not from books, but from men and

women. Folk-tunes were the tunes which country-people liked best—tunes with which they did as they pleased. If a singer or a player did not particularly fancy anything in a tune—if it did not suit his voice or his dialect—he altered it; if he heard another singer alter it in a way he liked, he copied that; and so at last, after several generations, the tune came to take the shape that most people preferred, without knowing why. Folk-music, in fact, came into existence in the same way as fairy-tales, ballads, and nursery-rhymes. And since folk-music is the music made by one singer or player after another from the same country or district, it comes in a curious way to show the character of the people in that country or district. Folk-songs from the eastern counties of England, from Wales, from the Hebrides, or from Ireland, are all as different as possible; and no one would confuse them with folk-songs from Norway or Hungary or the South of Spain. Eastern folk-song, again, shows in all its hundreds of varieties a love of ornamentation and flourish that is quite unknown in the north-west of Europe.

In all countries there are two types of folk-tunes: the rhythmical tunes, and the more expressive, emotional tunes. The highest type of tune is a combination of both. It shows careful and deliberate art in the way the little bits of tune and rhythm are contrasted and arranged so as to lead up to a climax, which is often the highest note in the song. The more primitive tunes have only one climax, but the more highly developed tunes have several climaxes arranged in a steady gradation, so as to produce a feeling of increasing excitement. The "Londonderry Air" is one of the finest emotional tunes in existence.

Pattern or Expression: all folk-tunes are the one or the other, or sometimes both at once; and all music in the same way is a mixture of pattern and expression. Sometimes one side is uppermost, sometimes the other; some music is more a pattern, other music is more expression. What composers aim at is a balance of the two, a balance which is called "the balance of expression and design."

MUSICAL INSTRUMENTS

Folk-music is not the only kind of music among civilised peoples. Side by side with folk-music, the music of unlettered folk, there has always existed art-music, the music of musicians. The ancient Greeks, for instance, had a highly developed art of music. Unfortunately, we know more about its theory than its performance; but, from what certain Greek writers have said, and from Greek sculptures or vase-painting of musical instruments, it has been possible to make copies of some of the ancient Greek instruments and even to play them.

The first invention of musical instruments must have belonged to a very early stage of civilisation; many other countries besides Greece have legends and fairy-stories describing how it happened—explaining the invention of a whistle which was to be the ancestor of all instruments that are blown, or a stretched bow-string which was to turn into all the string-instruments of to-day. One of the earliest instruments was the Pan-pipes, or *syrinx*—the instrument which the man with a Punch-and-Judy show generally tucks into his scarf—a row of little pipes of different lengths, tied together, and sounded by blowing across the open ends. By cutting the pipes on a regular plan—each one proportionately shorter than the next—*scales* were discovered: sets of notes at fixed distances apart; and when, later, the instrument was fitted with a large number of carefully graduated pipes and a mechanical means of blowing air into them, the result was the *organ*.

Other developments of the simple pipe came when it was pierced with holes (for the fingers to cover or leave uncovered) and fitted with a mouthpiece. Pipes with the holes in different positions played in different scales, "modes," from which our modern major and minor modes are derived. But the most important part of the pipe—the part which makes the sound—is the mouthpiece: a double vibrating reed made like the "squeakers" which country children make out of the shoots of fresh green wheat. This mouthpiece makes an *oboe* (*hautboy*) or one of the other

instruments of the same family. Another form of mouthpiece has a single "beating" or flapping reed of straw; and this (which produces an entirely different tone) makes an instrument like the modern *clarinet*. When pipes came to be made of metal (silver or brass), the result was the *trumpet*, which is a tube equally wide throughout its length, and the *horn* ("French" horn), which gets wider in diameter the farther it gets away from the mouthpiece. The *trombone* is a trumpet in sections which can be pulled in and out; it will play any note.

Other wind instruments would only play certain notes and not all. They had scales of their own, which they forced on the players; and it was only in the eighteenth and nineteenth centuries that wind instruments were fitted with appliances which made it possible for them to play any note the composer or player wanted.

String instruments could be tuned as the player liked; their usual tunings are the result of scientific, mathematical theory combined with practical experience. String-instruments may be twanged, hit, or scraped. *Lutes*, *guitars*, *mandolines*, and *harps* are all twanged; and the *harpsichord*, though it looks like a piano, twangs the strings with little quills whenever the notes are struck. In the *piano* the strings are hit by little hammers which are worked by touching the notes; and in the favourite instrument of Hungarian gipsies—which looks like the top of a grand piano with the lid off—the strings are struck with little sticks which the player holds in his hands. Instruments that are scraped (more politely described as being played with a bow) include the *violin* and its family, *viola*, *'cello*, and *double-bass*; they are those which are capable of the greatest expressiveness, and the greatest beauty of tone.

HISTORY OF MUSIC

Music so far had consisted of two things: melody (or tune) and rhythm. It was like drawing or painting in two dimensions, before the discovery of perspective.



Fig. 135. THINGS THAT MAKE MUSIC

In the early Middle Ages, however, an entirely new type of music began to develop in the north of Europe ; there is some reason for believing that it began in England or Wales. It consisted in singing a second part to a tune, a second part which was four or five notes higher—singing, in fact, in harmony. By *harmony* is meant two or more notes sounding at the same time. We first hear of it in the ninth century, when a complete account of this way of performing music was given by a monk who lived in an abbey near Tournay in France.

In the barbarous conditions of the early Middle Ages, the only places in which music was seriously studied in Christian countries were the churches ; and this practice of singing a second part to a tune, though it seems not to have begun in the Church, was soon taken up by the Church, and here harmony underwent its early development.

The music of the Church had so far been plainsong. *Plainsong* is the traditional musical setting of the Latin words of the Roman Catholic service. It is melody without harmony ; and its rhythm is the free rhythm of prose. Plainsong was derived partly from ancient Hebrew music, and partly from Greek music, or Greek music heard in Rome ; and, though the Hebrew part of it may have come from chants which had once been sung in the Temple at Jerusalem, the Græco-Roman part was probably street-music.

Harmony is sometimes supposed to have arisen from two or more voices singing together, and singing different tunes at the same time. But it is more likely that the idea of harmony did not come from two tunes being sung at the same time, but from two notes sounding together as a chord. There are still places in the world (Java, for instance) where music sounds as if it were made up entirely of constantly changing harmonies, while the idea of melody hardly exists. The music of the great Norman cathedrals may have been like that : a flood of sound produced by a large number of voices and instruments, while a few men with powerful bass voices bawled a plainsong melody underneath.

That, at any rate, was the foundation of early church-music in the next age, the age of the Gothic cathedrals in northern Europe. It was music built up on and supported by the long notes of plainsong melodies, plainsong melodies sung very slowly—indeed, much too slowly. Plainsong had originally been sung quickly and easily, thrown off like the songs which country-people can still be heard singing in the south of Europe, in North Africa, and the Near East. In the north of Europe, however, plainsong was sung so slowly that it came to be known as *canto fermo*, firm or steady song.

The earlier attempts at harmonised church-music had no obvious rhythm. It was precisely to rhythm that the musicians of the Gothic period turned their attention. Pérotin, choirmaster of the church which once stood where the cathedral of Notre-Dame stands in Paris to-day, was the leader of the new movement. His compositions are some of the most astonishing things in the whole of music. With his higher voices, tenors and trebles, he produced rapturous effects of swinging rhythms combined with great chords, while the plainsong was sung in enormously long notes by the bass voices. His music was written down, and some of it has been preserved; while his performances were described by a wandering English musician who travelled in France in the thirteenth century and is known (since his real name is a mystery) as "Anonymus IV."

About the year 1300 the plainsong foundation began to be dropped. Composers found that other tunes made just as good foundations as plainsong tunes, and the congregation seemed to enjoy it most when the bass voices sang a well-known popular song. That was better than bawling a plainsong melody in notes which were so long that no one could recognise it; and the custom of basing church-music on a popular song, and even of singing the popular words which usually went with the tune, went on for nearly 300 years.

Hitherto, all the voices had sung together in the same three-beat rhythm; now composers began to use two-beat rhythm and to combine several different rhythms

together. As music gradually escaped from the Church and became an independent, self-supporting art, even the idea of having a well-known tune in the bass or tenor was given up, and composers began to invent bass and tenor parts for themselves. Already, by 1260, John of Fornsete, the "Monk of Reading," had composed his wonderful "round" for six voices, the "Cuckoo Song," in which the four top voices sing the words, beginning one after another in the style of "Three Blind Mice."

*Sumer is icumen in,
Lhudè sing cuccu.*

(Summer is a-comin' in, loudè sing cuckoo.)

The two bottom voices repeat: "Sing cuccu." Even this song, early as it is, is not the oldest song in the English language; but it is the oldest song which is singable now. The oldest of all English songs is probably the song of King Canute, and it shows at any rate that King Canute liked listening to music:

*Merrie sungen monkès within Ely,
When Cnut King rew thereby.
"Roweth, knightès, near the strand,
And hearè we these monkès sang!"*

(rew = rowed; roweth = row; hearè we = let us hear.)

It is most unfortunate that the scribe who wrote down the words did not think of giving the music, and the tune is lost.

The first composers to write artistic music for several voices and instruments, music that was secular and not sacred, were the Italians, in the fourteenth century.

Francisco Landino (known to his friends as Franciscus Cæcus, or "Blind-man Francis") was a famous Florentine musician, who played the organ and every other kind of instrument and was the inventor of *madrigals*. His madrigals are of all kinds, grave and gay. One by a pupil of his describes a fire, and the excitement of people running about

trying to save their furniture. Another describes a hunt, and even gives the names of the hounds ("Come along, Pansy ! Now, Primrose ! . . . There : Charcoal's got him ! ") like the famous English hunting-song "John Peel" nearly 500 years later ("Yes, I ken John Peel and Ruby too, Ranter and Ringwood and Bellman true").

Besides the madrigal, the earlier Italians also invented something else : *counterpoint*—that is to say, the trick of making the voices and instruments sing or play different tunes at the same time. The tunes must seem to be independent of one another and be all equally "tuney" and interesting for all the players and singers, yet they must hang together and combine to produce a pleasant, harmonious sound. Here the secular musicians left the Church composers far behind. They got right away from the necessity of using a piece of plainsong or a popular song by somebody else. They tried to invent tunes of their own, especially for the voice which was heard at the top ; and they made the other voices and instruments accompany it with as good tunes as they possibly could. The great point was that everyone, every singer and player, should have something that he could clearly recognise as a tune in his own part, and give it out boldly as if he meant it ; this way all the performers become much more interested in what they are doing, and the whole piece of music sounds much more alive and interesting to the audience. Counterpoint was a wonderful invention ; its possibilities, even in modern music, are still infinite, and it has been a vital principle of musical composition from that day to this.

Yet it is not always easy to take in a tune, and remember it, at a first hearing. A tune often seems better when one has heard it before, even if one had not particularly noticed it ; and a tune generally sounds more moving when it is sung by a voice after having been first played on an instrument. The composer who first noticed this was John Dunstable (he died on Christmas Eve, 1453) and his ideas were carried out by his pupils, Dufay, Josquin des Prés, and others, who were mostly from the Low Countries. Their method was to make the voices begin one after

another, singing the same tune ; and then, when all the voices had come in and were singing together, to make them imitate every now and then little bits of what the others were singing. This makes the listeners feel that the music hangs together, and that, though all the voices seem to be singing different tunes, they somehow belong to one another, because they all begin in the same way, and sometimes mimic one another in curious little phrases that attract the hearer's attention.

The "Cuckoo Song," in which each voice begins separately and sings exactly the same tune all the way through, made too strict and hard a pattern to be of much use, except for comic music, like "Three Blind Mice" or tavern catches. But Dunstable's gentler and more elaborate pattern proved enormously fruitful and is still used by every composer, including the most advanced composers of to-day. It led eventually to the kind of composition known as *fugue*.

Professor Dent explained, in *Music Letters* for July 1930, what happened next. The Netherlandish composers who came after Dunstable usually set their music to French or Flemish words ; they called it a *chanson* ("song") ; for it was originally a simple tune like a folk-song (though not often a real folk-song) harmonised in a simple way. If a composer thought mostly of the words and of adequate music to express them, the *chanson* turned into a *madrigal*—like the later Italian or English madrigals—and eventually led to the recitation of words to music, and so to *opera*. But, if the composer was carried away by his sense of rhythm, the result was a *dance-tune* played by the instruments without the voices ; and this led to those collections of dance-tunes called *suites* (which were meant to be listened to and not danced), and eventually to modern *symphonies* and *sonatas*. If, however, the composer began his *chanson* in Dunstable's way (that is, by making the voices or instruments begin one after the other and imitate one another), the result was either one of those songs in which the voice sings a tune already played by an instrument or else a *fugue*, in which all the different parts, voices

or instruments, "discuss" the same tune in different ways, in different keys, and in different parts of the scale.

Fugue reached its greatest development with John Sebastian Bach ; or, perhaps, it would be truer to say that fugue was the way of writing music which came most naturally to him, as the sonata was the natural way of writing music in the time of Haydn, Mozart, and Beethoven. Yet fugue did not end with Bach. It became a vital principle with Beethoven, especially towards the end of his life, in his latest piano-sonatas and string-quartets, and it is still a vital principle with modern composers to-day.

PATTERNS AND SCHEMES

Since the time of Dunstable, musicians have gradually become aware of something else which is important ; that something is the sense of the *key*, "the feeling for contrast of pitch, not merely of a note, but of a phrase." As the feeling grew stronger among musicians that every piece of music was in some definite major or minor key, it occurred to composers to arrange their melodies, and snatches of melody, so that the differences of key might give the impression of design. They would begin a tune in one key, guide it (not let it drift) into another, and then gently lead it back again into the key from which it started ; or pass, perhaps, through yet another key before they finally got back to the key in which they had been at the beginning. There were regular schemes for doing this, especially in the *suites* of Bach and Handel. Their melodies do not drift haphazard from one key to another. They visit different keys in a definite order which is seldom varied ; and this plan gives their music a sense of form and design which is most important to its effect when heard as a whole, while it is not obvious enough to be monotonous.

Purcell's exquisite "Airs for the Theatre" (incidental music to plays) are almost entirely composed of dance-tunes, though they often have a loud and serious overture, or introduction, to make the audience stop talking ; and

several of the dance-tunes became anything but frivolous, like the solemn sarabands in Handel's "Lessons for the Harpsichord" or the "passionate pavans" in English music of the time of James I. All the dance-tunes which went to make the separate "movements" of a suite were in the same key; and that, in the end, was inclined to give the audience a feeling of monotony. The regular pattern of these dance-movements is almost as simple as that of a folk-song, like "Barbara Allen." It is divided into two halves: the first half consists of a melody (or "subject") which ends in a different key to that in which it began; in the second half the "subject" comes over again, beginning in the new key but ending in the old one.

THE SONATA

The most important form in the history of music has been the *sonata*. Sonata form is the plan on which not only real *sonatas* (i.e. for piano alone, or for piano and one other instrument) have been composed since the middle of the eighteenth century, but also *trios* (three instruments), *quartets* (four instruments), *quintets*, and so on up to *octets* and *nonets*. It is also the plan of *symphonies* (which we might call sonatas for a whole orchestra), and *concertos*, which are like symphonies in which one instrument is more prominent than the others, and in which the effect depends on the balance and contrast of the solo-instrument with the rest of the orchestra.

A sonata, like a suite, is in several movements; but the movements are fewer (usually four) and not all in the same key. The distinguishing thing about a sonata-movement is its form. The musical pattern does different things in different places; the different parts of the pattern are different in appearance, and contrast with one another; and finally the pattern comes back again to the place where it originally started. Of the four sections into which a sonata or symphony is usually divided, the most complicated pattern is that of the first. It has two chief melodies,

or "subjects," which are stated, contrasted, varied, broken up into short phrases, and finally stated again near the end of the movement. The composer presents us with his first subject in one key, and his second subject in another key contrasting with it. That forms the first half of the movement. At the beginning of the second half there comes a moment when the composer mixes up his two subjects; lets us hear first a bit of one, then a bit of the other; puts them into different keys, lets us look at them in a fresh light and in different colours. But the great moment of a sonata-movement is the return of the first subject in its original key. After the confusion and uncertainty which has gone before, to recognise that tune is like recognising a character in a play, a character who enters in the nick of time to save the situation. This device, this return of the first subject in its original key, never fails to thrill you, even if you know the music well and know exactly when to expect it. It is followed by the second subject in the same key as the first; and this is like recognising another character, an old friend in a new dress. It is as if Mozart himself had come back as he was in the beginning, in his green coat and his little wig with a bow at the back. After him comes Aloysia Weber (whom he wanted to marry, and didn't), but she is wearing a new dress—a green one, the colour of Mozart's coat.

The second and third movements of a sonata or a symphony are generally a slow *andante* or *adagio*, and a *minuet*. Sometimes one comes first, sometimes the other. The slow movement is usually in the form of a song—a beginning, a middle in a different key, and an ending which is practically the beginning over again. The minuet was originally a dance, which (once it was taken into the sonata) came to be played very fast and was eventually called a *scherzo* ("joke"). In reality it consists of three dances: a minuet, a second minuet in a different key, and the first minuet over again.

The last movement of a sonata may be made on much the same principle as the first. Usually, however, it is in the form of a *rondo*: there is a sprightly tune which comes

several times over, with several other tunes sandwiched in between its various reappearances. The last movement of a sonata, or sometimes the slow movement, may be an air with variations ; but the most usual form is the rondo.

In the nineteenth century the formal pattern of the sonata was made less rigid. Beethoven was much freer in his choice of keys and changes of key, and Brahms went further still in that direction. Another idea—which came originally from Beethoven, was used by Schumann in one of his symphonies, by Liszt in his sonata, and taken up generally by César Franck—was to bring the tunes of one sonata-movement into another and bring them all back at the end. Sonatas and symphonies are not, of course, mere musical patterns. Haydn and Mozart express the deepest feelings in sonata-form ; but it was Beethoven who discovered how to “make the sonata a means of tragic expression.” He was writing music, too, for larger audiences than any composer before his time ; he played many of his sonatas and piano-concertos himself, and he had a way of commanding the attention of the audience at the very beginning, with some downright and imperious phrase which compelled people to sit up and listen to him.

MODERN MUSIC

The nineteenth century was a time when expression was more sought after than formal pattern. One thing which helped to lead in this direction was the great development of the instruments of the orchestra, and the fact that a little tune or musical phrase sounds very different when it is played on different instruments, or by various combinations of instruments playing together. The art of orchestration—of deciding exactly what the instruments are to play, and how—has become of immense importance to a composer. Many modern composers, when they think a musical “thought,” think it straight away as being played by such and such instruments. With this rise of importance of the orchestra has come the rise of the conductor, who hardly existed a hundred years ago.

The nineteenth-century composers often tried to write music which should express some idea or mood which had been already expressed in a poem or picture ; but in the end their works must be judged—or condemned—as music. Even opera, the musical declamation of drama, stands or falls by its music, by the drama that is going on in the music as well as on the stage. The early operas of Monteverdi, Scarlatti, and Purcell, and the great operas of Mozart, Verdi, and Wagner, all depend, in the long run, on their completeness as pieces of music.

The great difference between the composers of to-day and the composers of the nineteenth century lies in their treatment of the key-system. Modern composers do not feel themselves to be tied to keys and to key-relationships as the older composers were ; they jump from one key to another ; and some have written in two or three keys at once. Purcell, in his dramatic music and even in his anthems, has a device known as “ false relation ” which gives the impression that one voice is singing in a different key to the others ; it is a device far older than Purcell, and was used by English composers in the time of Queen Elizabeth. Some modern composers have gone much further, and have thrown over the idea of key altogether. Since sonata-form largely depends on the contrast of the keys in which the subjects appear, modern music has also changed its shape, and with this change has come a change in rhythm. Composers to-day do not repeat themselves as their predecessors did ; they expect their audiences to have sharper ears and quicker musical wits than they used to. Formerly, listening to music meant listening to tunes and recognising them when they came back, however changed they might be since they last appeared. It meant realising that the tunes *would* come back, and knowing when to expect them. In listening to the music of to-day—especially the music of Schönberg, Webern, Hauer, and others of the most advanced group—we are fixing our attention, not on a melody, but on a “ melody-type,” a family of notes in a particular order, something that we remember, not as a tune, but as something in our minds. It is difficult enough

to do, and still more difficult to explain in words ; for we are at the beginning of a new epoch in the history of music—perhaps one of the most exciting there has ever been—and our chief thought should be how fortunate we are in being there to hear it.

BOOKS TO READ

C. H. H. PARRY : *Studies of Great Composers* (lives and works) ;

C. H. H. PARRY : *The Art of Music* (more advanced).

C. V. STANFORD and C. FORSYTH : *A History of Music* (illustrated).

URSULA CREIGHTON : *Music* (illustrated).

H. C. COLES : *The Growth of Music*.

PERCY SCHOLLS : *The Listener's Guide to Music* ; and other useful books.

R. A. STREATFEILD : *The Opera* (5th edition).

GEORGE GROVE : *Beethoven and his Nine Symphonies*.

Anyone who really likes music will enjoy reading the lives and letters of great musicians, and browsing on musical dictionaries, such as Grove's *Dictionary of Music*.

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