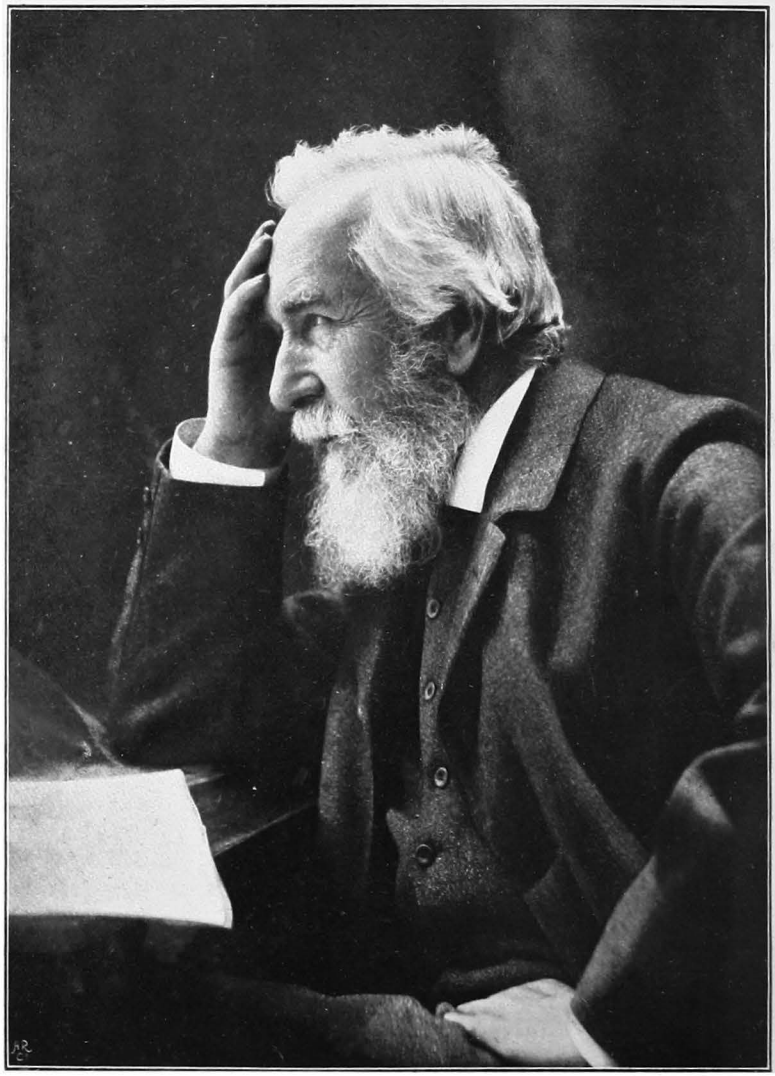
LAST WORDS ON EVOLUTION

ERNST HAECKEL



Bräunlich & Tesch (Emil Tesch), Hofphot, Jena.

Ernst Haeckel.

Frontispiece.

LAST WORDS ON EVOLUTION

Last Words on Evolution

A Popular Retrospect and Summary

BY

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TRANSLATED FROM THE SECOND EDITION

BY

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INTRODUCTION

Not very long ago the sensational announcement was made that Professor Haeckel had abandoned Darwinism and given public support to the teaching of a Jesuit writer. There was something piquant in the suggestion that the "Darwin of Germany" had recanted the conclusions of fifty years of laborious study. Nor could people forget that only two years before Haeckel had written with some feeling about the partial recantation of some of his colleagues. Many of our journals boldly declined to insert the romantic news, which came through one of the chief international press agencies. Others drew the attention of their readers, in jubilant editorial notes, to the lively prospect it opened out. To the many inquiries addressed to me as the "apostle of Professor Haeckel," as Sir Oliver Lodge dubs me in a genial letter, I timidly represented that even a German reporter sometimes drank. But the correction quickly came that the telegram had exactly reversed the position taken up by the great biologist. It is only just to the honourable calling of the reporter to add that, according to the theory current in Germany, the message was tampered with by subtle and ubiquitous Jesuitry. Did they not penetrate even into the culinary service at Hatfield?

I have pleasure in now introducing the three famous

lectures delivered by Professor Haeckel at Berlin, and the reader will see the grotesqueness of the original announcement. They are the last public deliverance that the aged professor will ever make. His enfeebled health forbids us to hope that his decision may yet be undone. He is now condemned, he tells me, to remain a passive spectator of the tense drama in which he has played so prominent a part for half a century. For him the red rays fall level on the scene and the people about him. It may be that they light up too luridly, too falsely, the situation in Germany; but the reader will understand how a Liberal of Haeckel's temper must feel his country to be between Scylla and Charybdis—between an increasingly clear alternative of Catholicism or Socialism—with a helmsman at the wheel whose vagaries inspire no confidence.

The English reader will care to be instructed on the antithesis of Virchow and Haeckel which gives point to these lectures, and which is often misrepresented in this country. Virchow, the greatest pathologist and one of the leading anthropologists of Germany, had much to do with the inspiring of Haeckel's Monistic views in the fifties. Like several other prominent German thinkers, Virchow subsequently abandoned the positive Monistic position for one of agnosticism and scepticism, and a long and bitter conflict ensued. It is hardly too much to say that Virchow's ultra-timid reserve in regard to the evolution of man and other questions has died with him. Apart from one or two less prominent anthropologists, and the curious distinction drawn by Dr. A. R.

Wallace, science has accepted the fact of evolution, and has, indeed, accepted the main lines of Haeckel's ancestral tree of the human race.

In any case, Haeckel had the splendid revenge of surviving his old teacher and almost lifelong opponent. Berlin had for years been dominated by the sceptical temper of Virchow and Du Bois-Reymond. The ardent evolutionist and opponent of Catholicism was impatient of a reserve that he felt to be an anachronism in science and an effective support of reactionary ideas. It was, therefore, with a peculiar satisfaction that he received the invitation, after Virchow's death, to address the Berlin public. Among the many and distinguished honours that have been heaped upon him in the last ten years this was felt by him to hold a high place. He could at last submit freely, in the capital of his country, the massive foundations and the imposing structure of a doctrine which he holds to be no less established in science than valuable in the general cause of progress.

The lectures are reproduced here not solely because of the interest aroused in them by the "Jesuit" telegram. They contain a very valuable summary of his conclusions, and include the latest scientific confirmation. Rarely has the great biologist written in such clear and untechnical phrases, so that the general reader will easily learn the outlines of his much-discussed Monism.

JOSEPH McCABE.

PREFACE

In the beginning of April, 1905, I received from Berlin a very unexpected invitation to deliver a popular scientific lecture at the Academy of Music in that city. I at first declined this flattering invitation, with thanks, sending them a copy of a printed declaration, dated 17th July, 1901, which I had made frequent use of, to the effect that "I could not deliver any more public lectures, on account of the state of my health, my advanced age, and the many labours that were still incumbent on me."

I was persuaded to make one departure from this fixed resolution, firstly, by the pressing entreaties of many intimate friends at Berlin. They represented to me how important it was to give an account myself to the educated Berlin public of the chief evolutionary conclusions I had advocated for forty years. They pointed out emphatically that the increasing reaction in higher circles, the growing audacity of intolerant orthodoxy, the preponderance of Ultramontanism, and the dangers that this involved for freedom of thought in Germany, for the university and the school, made it imperative to take vigorous action. It happened that I had just been following the interesting efforts that the Church has lately made to enter into a peaceful compromise with its deadly enemy, Monistic science. It has decided to accept to a certain extent, and to accommodate to its

creed (in a distorted and mutilated form) the doctrine of evolution, which it has vehemently opposed for thirty years. This remarkable change of front on the part of the Church militant seemed to me so interesting and important, and at the same time so misleading and mischievous, that I chose it as the subject of a popular lecture, and accepted the invitation to Berlin.

After a few days, when I had written my discourse, I was advised from Berlin that the applications for admission were so numerous that the lecture must either be repeated or divided into two. I chose the latter course, as the material was very abundant. In compliance with an urgent request, I repeated the two lectures (17th and 18th April); and as demands for fresh lectures continued to reach me, I was persuaded to add a "farewell lecture" (on 19th April), in which I dealt with a number of important questions that had not been adequately treated.

The noble gift of effective oratory has been denied me by Nature. Though I have taught for eighty-eight terms at the little University of Jena, I have never been able to overcome a certain nervousness about appearing in public, and have never acquired the art of expressing my thoughts in burning language and with appropriate gesture. For these and other reasons, I have rarely consented to take part in scientific and other congresses; the few speeches that I have delivered on such occasions, and are issued in collected form, were drawn from me by my deep interest in the great struggle for the triumph of truth. However, in the three Berlin lectures—my

last public addresses—I had no design of winning my hearers to my opinions by means of oratory. It was rather my intention to put before them, in connected form, the great groups of biological facts, by which they could, on impartial consideration, convince themselves of the truth and importance of the theory of evolution.

Readers who are interested in the evolution-controversy, as I here describe it, will find in my earlier works (*The History of Creation*, *The Evolution of Man*, *The Riddle of the Universe*, and *The Wonders of Life*) a thorough treatment of the views I have summarily presented. I do not belong to the amiable group of "men of compromise," but am in the habit of giving candid and straightforward expression to the convictions which a half-century of serious and laborious study has led me to form. If I seem to be a tactless and inconsiderate "fighter," I pray you to remember that "conflict is the father of all things," and that the victory of pure reason over current superstition will not be achieved without a tremendous struggle. But I regard *ideas* only in my struggles: to the *persons* of my opponents I am indifferent, bitterly as they have attacked and slandered my own person.

Although I have lived in Berlin for many years as student and teacher, and have always been in communication with scientific circles there, I have only once before delivered a public lecture in that city. That was on "The Division of Labour in Nature and Human Life" (17th December, 1868). I was, therefore, somewhat gratified to be able to speak there again (and for

the last time), after thirty-six years, especially as it was in the very spot, the hall of the Academy of Music, in which I had heard the leaders of the Berlin University speak fifty years ago.

It is with great pleasure that I express my cordial thanks to those who invited me to deliver these lectures, and who did so much to make my stay in the capital pleasant; and also to my many hearers for their amiable and sympathetic attention.

ERNST HAECKEL.

JENA, *9th May*, 1905.

CHAPTER I

THE CONTROVERSY ABOUT CREATION

EVOLUTION AND DOGMA

EXPLANATION OF PLATE I

GENEALOGICAL TREE OF THE VERTEBRATES

THE genetic relationship of all vertebrates, from the earliest acrania and fishes up to the apes and man, is proved in its main lines by the concordant testimony of paleontology, comparative anatomy, and embryology. All competent and impartial zoologists now agree that the vertebrates are all descended from a *single* stem, and that the root of this is to be sought in extinct pre-Silurian *Acrania* (1), somewhat similar to the living lancelet. The *Cyclostoma* (2) represent the transition from the latter to the *Fishes* (3); and the *Dipneusts* (4) the transition from these to the *Amphibia* (5). From the latter have been developed the *Reptiles* (6) on the one hand, and the *Mammals* (7) on the other. The most important branch of this most advanced class is the *Primates* (8); from the half-apes, or lemurs, a direct line leads, through the baboons, to the anthropoid apes, and through these on to man. (*Cf.* the tables on pp. 115-120). Further information will be found in chapters xxiv.-xxvii. of the *History of Creation*, and chapters xxi.-xxiii. of the *Evolution of Man*.

LAST WORDS ON EVOLUTION

CHAPTER I

THE CONTROVERSY ABOUT CREATION

EVOLUTION AND DOGMA

THE controversy over the idea of evolution is a prominent feature in the mental life of the nineteenth century. It is true that a few great thinkers had spoken of a natural evolution of all things several thousand years ago. They had, indeed, partly investigated the laws that control the birth and death of the world, and the rise of the earth and its inhabitants; even the creation-stories and the myths of the older religions betray a partial influence of these evolutionary ideas. But it was not until the nineteenth century that the idea of evolution took definite shape and was scientifically grounded on various classes of evidence; and it was not until the last third of the century that it won general recognition. The intimate connection that was proved to exist between all branches of knowledge, once the continuity of historical development was realised, and the union of them all through the Monistic philosophy, are achievements of the last few decades.

The great majority of the older ideas that thoughtful men had formed on the origin and nature of the world and their own frame were far removed from the notion of "self-development." They culminated in more or less obscure creation-myths, which generally put in the foreground the idea of a personal Creator. Just as man has used intelligence and design in the making of his weapons and tools, his houses and his boats, so it was thought that the Creator had fashioned the world with art and intelligence, according to a definite plan. Among the many legends of this kind the ancient Semitic story of creation, familiar to us as the Mosaic narrative, but drawn for the most part from Babylonian sources, has obtained a very great influence on European culture owing to the general acceptance of the Bible. The belief in miracles, that is involved in these religious legends, was bound to come in conflict, at an early date, with the evolutionary ideas of independent philosophical research. On the one hand, in the prevalent religious teaching, we had the supernatural world, the miraculous, teleology: on the other hand, in the nascent science of evolution, only natural law, pure reason, mechanical causality. Every step that was made by this science brought into greater relief its inconsistency with the predominant religion.[1]

[1] The word "evolution" is still used in so many different ways in various sciences that it is important to fix it in the general significance which we here give it. By "evolution," in the widest sense, I understand the unceasing "mutations of substance," adopting Spinoza's fundamental conception of substance; it unites inseparably in itself

If we glance for a moment at the various fields in which the idea of evolution is scientifically applied we find that, firstly, the whole universe is conceived as a unity; secondly, our earth; thirdly, organic life on the earth; fourthly, man, as its highest product; and fifthly, the soul, as a special immaterial entity. Thus we have, in historical succession, the evolutionary research of cosmology, geology, biology, anthropology, and psychology.

The first comprehensive idea of cosmological evolution was put forth by the famous critical philosopher. Immanuel Kant, in 1755, in the great work of his earlier years, *General Natural History of the Heavens, or an Attempt to Conceive and to Explain the Origin of the Universe mechanically, according to the Newtonian Laws.* This remarkable work appeared anonymously, and was dedicated to Frederick the Great, who, however, never saw it. It was little noticed, and was soon entirely forgotten, until it was exhumed ninety years afterwards by Alexander von Humboldt. Note particularly that on the title-page stress is laid on the *mechanical* origin of the world and its explanation on Newtonian principles; in this way the strictly Monistic character of the whole cosmogony and the absolutely

"matter and force (or energy)," or "nature and mind" (=the world and God). Hence the science of evolution in its broader range is "the history of substance," which postulates the general validity of "the law of substance." In the latter are combined "the law of the constancy of matter" (Lavoisier, 1789) and "the law of the conservation of energy" (Robert Mayer, 1842), however varied may be the changes of *form* of these elements in the world-process. *Cf.* Chapter XII. of *The Riddle.*

universal rule of natural law are clearly expressed. It is true that Kant speaks much in it of God and his wisdom and omnipotence; but this is limited to the affirmation that God created once for all the unchangeable laws of nature, and was henceforward bound by them and only able to work through them. The Dualism which became so pronounced subsequently in the philosopher of Koenigsberg counts for very little here.

The idea of a natural development of the world occurs in a clearer and more consistent form, and is provided with a firm mathematical basis, forty years afterwards, in the remarkable *Mécanique Céleste* of Pierre Laplace. His popular *Exposition du Système du Monde* (1796) destroyed at its roots the legend of creation that had hitherto prevailed, or the Mosaic narrative in the Bible. Laplace, who had become Minister of the Interior, Count, and Chancellor of the Senate, under Napoleon, was merely honourable and consistent when he replied to the emperor's question, "What room there was for God in his system?": "Sire, I had no need for that unfounded hypothesis." What strange ministers there are sometimes![1] The shrewdness of the

[1] Certain orthodox periodicals have lately endeavoured to deny this famous atheistical confession of the great Laplace, which was merely a candid deduction of his splendid cosmic system. They say that this Monistic natural philosopher acknowledged the Catholic faith on his death-bed; and in proof of this they offer us the later testimony of an Ultramontane priest. We need not point out how uncertain is the love of truth of these heated partisans. When testimony of this kind tends to "the good of religion" (*i.e.*, their own good), it is held to be

Church soon recognised that the personal Creator was dethroned, and the creation-myth destroyed, by this Monistic and now generally received theory of cosmic development. Nevertheless it maintained towards it the attitude which it had taken up 250 years earlier in regard to the closely related and irrefutable system of Copernicus. It endeavoured to conceal the truth as long as possible, or to oppose it with Jesuitical methods, and finally it yielded. If the Churches now silently admit the Copernican system and the cosmogony of Laplace and have ceased to oppose them, we must attribute the fact; partly to a feeling of their spiritual impotence, partly to an astute calculation that the ignorant masses do not reflect on these great problems.

In order to obtain a clear idea and a firm conviction of this cosmic evolution by natural law, the eternal birth and death of millions of suns and stars, one needs some mathematical training and a lively imagination, as well as a certain competence in astronomy and physics. The evolutionary process is much simpler, and more readily grasped in geology. Every shower of rain or wave of the sea, every volcanic eruption and every pebble, gives us a direct proof of the changes that are constantly taking place

a pious work (*pia fraus*). On the other hand, it is interesting to recall the reply of a Prussian Minister of Religion, Von Zedlitz, 120 years ago, to the Breslau Consistory, when it urged that "those who believe most are the best subjects." He wrote in reply: "His majesty [Frederick the Great] is not disposed to rest the security of his State on the stupidity of his subjects."

on the surface of our planet. However, the historical significance of these changes was not properly appreciated until 1822, by Karl von Hoff of Gotha, and modern geology was only founded in 1830 by Charles Lyell, who explained the whole origin and composition of the solid crust of the earth, the formation of the mountains, and the periods of the earth's development, in a connected system by natural laws. From the immense thickness of the stratified rocks, which contain the fossilised remains of extinct organisms, we discovered the enormous length—running into millions of years—of the periods during which these sedimentary rocks were deposited in water. Even the duration of the *organic* history of the earth—that is to say, the period during which the plant and animal population of our planet was developing—must itself be put at more than a hundred million years. These results of geology and paleontology destroyed the current legend of the six days' work of a personal Creator. Many attempts were made, it is true, and are still being made, to reconcile the Mosaic supernatural story of creation with modern geology.[1] All these efforts of believers are in vain. We may say, in fact, that it is precisely the study of geology, the reflection it entails on the enormous periods of evolution, and

[1] See, for instance, *Moses and Geology, or Harmony of the Bible with Science*, by Samuel Kinns (1882). In this work the pious Biblical astronomer executes the most incredible and Jesuitical manœuvres in order to bring about an impossible reconciliation between science and the Biblical narrative.

the habit of seeking the simple mechanical causes of their constant changes, that contribute very considerably to the advance of enlightenment. Yet in spite of this (or, possibly, because of this), geological instruction is either greatly neglected or entirely suppressed in most schools. It is certainly eminently calculated (in connection with geography) to enlarge the mind, and acquaint the child with the idea of evolution. An educated person who knows the elements of geology will never experience *ennui*. He will find everywhere in surrounding nature, in the rocks and in the water, in the desert and on the mountains, the most instructive stimuli to reflection.

The evolutionary process in organic nature is much more difficult to grasp. Here we must distinguish two different series of biological development, which have only been brought into proper causal connection by means of our biogenetic law (1866); one series is found in embryology (or ontogeny), the other in phylogeny (or race-development). In Germany "evolution" always meant embryology, or a part of the whole, until forty years ago. It stood for a microscopic examination of the wonderful processes by means of which the elaborate structure of the plant or animal body is formed from the simple seed of the plant or the egg of the bird. Until the beginning of the nineteenth century the erroneous view was generally received that this marvellously complicated structure existed, completely formed, in the simple ovum, and that the various organs had merely to grow and to

shape themselves independently by a process of "evolution" (or unfolding), before they entered into activity. An able German scientist, Caspar Friedrich Wolff (son of a Berlin tailor), had already shown the error of this "pre-formation theory" in 1759. He had proved, in his dissertation for the doctorate, that no trace of the later body, of its bones, muscles, nerves, and feathers, can be found in the hen's egg (the commonest and most convenient object for study), but merely a small round disk, consisting of two thin superimposed layers. He had further showed that the various organs are only built up gradually out of these simple elements, and that we can trace, step by step, a series of real new growths. However, these momentous discoveries, and the sound "theory of epigenesis" that he based on them, were wholly ignored for fifty years, and even rejected by the leading authorities. It was not until Oken had re-discovered these important facts at Jena (1806), Pander had more carefully distinguished the germinal layers (1817), and finally Carl Ernst von Baer had happily combined observation and reflection in his classical *Animal Embryology* (1828), that embryology attained the rank of an independent science with a sound empirical base.

A little later it secured a well-merited recognition in botany also, especially owing to the efforts of Matthias Schleiden of Jena, the distinguished student who provided biology with a new foundation in the "cell theory" (1838). But it was not until the middle of the nineteenth century that people generally recognised

that the ovum of the plant or animal is itself only a simple cell, and that the later tissues and organs gradually develop from this "elementary organism" by a repeated cleavage of, and division of labour in, the cells. The most important step was then made of recognising that our human organism also develops from an ovum (first discovered by Baer in 1827), in virtue of the same laws, and that its embryonic development resembles that of the other mammals, especially that of the ape. Each of us was, at the beginning of his existence, a simple globule of protoplasm, surrounded by a membrane, about $\frac{1}{120}$ of an inch in diameter, with a firmer nucleus inside it. These important embryological discoveries confirmed the rational conception of the human organism that had been attained much earlier by comparative anatomy: the conviction that the human frame is built in the same way, and develops similarly from a simple ovum, as the body of all other mammals. Even Linné had already (1735) given man a place in the mammal class in his famous *System of Nature.*

Differently from these embryological facts, which can be directly observed, the phenomena of phylogeny (the development of species), which are needed to set the former in their true light, are usually outside the range of immediate observation. What was the origin of the countless species of animals and plants? How can we explain the remarkable relationships which unite similar species into genera and these into classes? Linné answers the question very simply with the belief

in creation, relying on the generally accepted Mosaic narrative: "There are as many different species of animals and plants as there were different forms created by God in the beginning." The first scientific answer was given in 1809 by the great French scientist, Lamarck. He taught, in his suggestive *Philosophie Zoologique*, that the resemblances in form and structure of groups of species are due to real affinity, and that all organisms descend from a few very simple primitive forms (or, possibly, from a single one). These primitive forms were developed out of lifeless matter by spontaneous generation. The resemblances of related groups of species are explained by *inheritance* from common stem-forms; their dissimilarities are due to *adaptation* to different environments, and to variety in the action of the modifiable organs. The human race has arisen in the same way, by transformation of a series of mammal ancestors, the nearest of which are ape-like primates.

These great ideas of Lamarck, which threw light on the whole field of organic life, and were closely approached by Goethe in his own speculations, gave rise to the theory that we now know as transformism, or the theory of evolution or descent. But the far-seeing Lamarck was—as Caspar Friedrich Wolff had been fifty years before—half a century before his time. His theory obtained no recognition, and was soon wholly forgotten.

It was brought into the light once more in 1859 by the genius of Charles Darwin, who had been born in the very year that the *Philosophie Zoologique* was

published. The substance and the success of his system, which has gone by the name of Darwinism (in the wider sense) for forty-six years, are so generally known that I need not dwell on them. I will only point out that the great success of Darwin's epoch-making works is due to two causes: firstly, to the fact that the English scientist most ingeniously worked up the empirical material that had accumulated during fifty years into a systematic proof of the theory of descent; and secondly, to the fact that he gave it the support of a second theory of his own, the theory of natural selection. This theory, which gives a causal explanation of the transformation of species, is what we ought to call "Darwinism" in the strict sense. We cannot go here into the question how far this theory is justified, or how far it is corrected by more recent theories, such as Weismann's theory of germ-plasm (1844), or De Vries's theory of mutations (1900). Our concern is rather with the unparalleled influence that Darwinism, and its application to man, have had during the last forty years on the whole province of science; and at the same time, with its irreconcilable opposition to the dogmas of the Churches.

The extension of the theory of evolution to man was, naturally, one of the most interesting and momentous applications of it. If all other organisms arose, not by a miraculous creation, but by a natural modification of earlier forms of life, the presumption is that the human race also was developed by the transformation of the most man-like mammals, the primates of Linné—the apes and lemurs. This natural inference, which Lamarck

had drawn in his simple way, but Darwin had at first explicitly avoided, was first thoroughly established by the gifted zoologist, Thomas Huxley, in his three lectures on *Man's Place in Nature* (1863). He showed that this "question of questions" is unequivocally answered by three chief witnesses—the natural history of the anthropoid apes, the anatomic and embryological relations of man to the animals immediately below him, and the recently discovered fossil human remains. Darwin entirely accepted these conclusions of his friend eight years afterwards, and, in his two-volume work, *The Descent of Man and Sexual Selection* (1871), furnished a number of new proofs in support of the dreaded "descent of man from the ape." I myself then (1874) completed the task I had begun in 1866, of determining approximately the whole series of the extinct animal ancestors of the human race, on the ground of comparative anatomy, embryology, and paleontology. This attempt was improved, as our knowledge advanced, in the five editions of my *Evolution of Man.* In the last twenty years a vast literature on the subject has accumulated. I must assume that you are acquainted with the contents of one or other of these works, and will turn to the question, that especially engages our attention at present, how the inevitable struggle between these momentous achievements of modern science and the dogmas of the Churches has run in recent years.

It was obvious that both the general theory of evolution and its extension to man in particular must

meet from the first with the most determined resistance on the part of the Churches. Both were in flagrant contradiction to the Mosaic story of creation, and other Biblical dogmas that were involved in it, and are still taught in our elementary schools. It is creditable to the shrewdness of the theologians and their associates, the metaphysicians, that they at once rejected Darwinism, and made a particularly energetic resistance in their writings to its chief consequence, the descent of man from the ape. This resistance seemed the more justified and hopeful as, for seven or eight years after Darwin's appearance, few biologists accepted his theory, and the general attitude amongst them was one of cold scepticism. I can well testify to this from my own experience. When I first openly advocated Darwin's theory at a scientific congress at Stettin in 1863, I was almost alone, and was blamed by the great majority for taking up seriously so fantastic a theory, "the dream of an after-dinner nap," as the Göttinger zoologist, Keferstein, called it.

The general attitude towards Nature fifty years ago was so different from that we find everywhere to-day, that it is difficult to convey a clear idea of it to a young scientist or philosopher. The great question of creation, the problem how the various species of plants and animals came into the world, and how man came into being, did not exist yet in exact science. There was, in fact, no question of it.

Seventy-seven years ago Alexander von Humboldt delivered, in this very spot, the lectures which afterwards

made up his famous work, *Cosmos, the Elements of a Physical Description of the World.* As he touched, in passing, the obscure problem of the origin of the organic population of our planet, he could only say resignedly: "The mysterious and unsolved problem of how things came to be does not belong to the empirical province of objective research, the description of what *is*." It is instructive to find Johannes Müller, the greatest of German biologists in the nineteenth century, speaking thus in 1852, in his famous essay, "On the Generation of Snails in Holothurians": "The entrance of various species of animals into creation is certain—it is a fact of paleontology ; but it is *supernatural* as long as this entrance cannot be perceived in the act and become an element of observation." I myself had a number of remarkable conversations with Müller, whom I put at the head of all my distinguished teachers, in the summer of 1854. His lectures on comparative anatomy and physiology—the most illuminating and stimulating I ever heard—had captivated me to such an extent that I asked and obtained his permission to make a closer study of the skeletons and other preparations in his splendid museum of comparative anatomy (then in the right wing of the buildings of the Berlin University), and to draw them. Müller (then in his fifty-fourth year) used to spend the Sunday afternoon alone in the museum. He would walk to and fro for hours in the spacious rooms, his hands behind his back, buried in thought about the mysterious affinities of the vertebrates, the "holy enigma" of which was so forcibly impressed

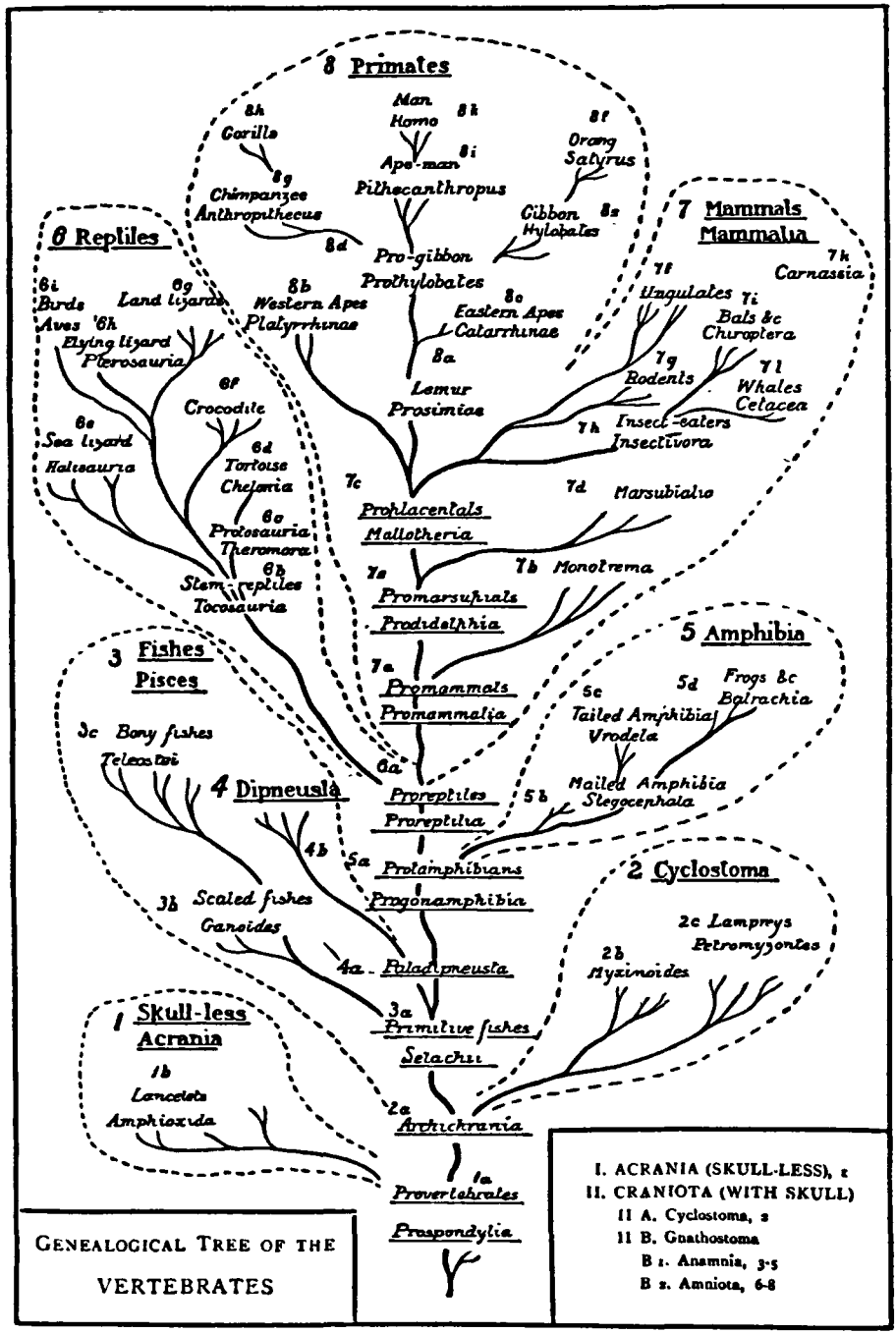
by the row of skeletons. Now and again my great master would turn to a small table at the side, at which I (a student of twenty years) was sitting in the angle of a window, making conscientious drawings of the skulls of mammals, reptiles, amphibians, and fishes.

I would then beg him to explain particularly difficult points in anatomy, and once I ventured to put the question: "Must not all these vertebrates, with their identity in internal skeleton, in spite of all their external differences, have come originally from a common form?" The great master nodded his head thoughtfully, and said: "Ah, if we only knew that! If ever you solve that riddle, you will have accomplished a supreme work." Two months afterwards, in September, 1854, I had to accompany Müller to Heligoland, and learned under his direction the beautiful and wonderful inhabitants of the sea. As we fished together in the sea, and caught the lovely medusæ, I asked him how it was possible to explain their remarkable alternation of generations; if the medusæ, from the ova of which polyps develop to-day, must not have come originally from the more simply organised polyps? To this precocious question, I received the same resigned answer: "Ah, that is a very obscure problem! We know nothing whatever about the origin of species."

Johannes Müller was certainly one of the greatest scientists of the nineteenth century. He takes rank with Cuvier, Baer, Lamarck, and Darwin. His insight was profound and penetrating, his philosophic judgment

comprehensive, and his mastery of the vast province of biology was enormous. Emil du Bois-Reymond happily compared him, in his fine commemorative address, to Alexander the Great, whose kingdom was divided into several independent realms at his death. In his lectures and works Müller treated no less than four different subjects, for which four separate chairs were founded after his death in 1858—human anatomy, physiology, pathological anatomy, and comparative anatomy. In fact, we ought really to add two more subjects—zoology and embryology. Of these, also, we learned more from Müller's classic lectures than from the official lectures of the professors of those subjects. The great master died in 1858, a few months before Charles Darwin and Alfred R. Wallace made their first communications on their new theory of selection in the Journal of the Linnæan Society. I do not doubt in the least that this surprising answer of the riddle of creation would have profoundly moved Müller, and have been fully admitted by him on mature reflection.

To these leading masters in biology, and to all other anatomists, physiologists, zoologists, and botanists up to 1858, the question of organic creation was an unsolved problem; the great majority regarded it as insoluble. The theologians and their allies, the metaphysicians, built triumphantly on this fact. It afforded a clear proof of the limitations of reason and science. A miracle only could account for the origin of these ingenious and carefully designed organisms; nothing



GENEALOGICAL TREE OF THE VERTEBRATES

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less than the Divine wisdom and omnipotence could have brought man into being. But this general resignation of reason, and the dominance of supernatural ideas which it encouraged, were somewhat paradoxical in the thirty years between Lyell and Darwin, between 1830 and 1859, since the natural evolution of the earth, as conceived by the great geologist, had come to be universally recognised. Since the earlier of these dates the iron necessity of natural law had ruled in inorganic nature, in the formation of the mountains and the movement of the heavenly bodies. In organic nature, on the contrary, in the creation and the life of animals and plants, people saw only the wisdom and power of an intelligent Creator and Controller; in other words, everything was ruled by mechanical causality in the inorganic world, but by teleological finality in the realm of biology.

Philosophy, strictly so called, paid little or no attention to this dilemma. Absorbed almost exclusively in metaphysical and dialectical speculations, it looked with supreme contempt or indifference on the enormous progress that the empirical sciences were making. It affected, in its character of "purely mental science," to build up the world out of its own head, and to have no need of the splendid material that was being laboriously gathered by observation and experiment. This is especially true of Germany, where Hegel's system of "absolute idealism" had secured the highest regard, particularly since it had been made obligatory as "the royal State-philosophy

of Prussia"—mainly because, according to Hegel, "in the State the Divine will itself and the monarchical constitution alone represent the development of reason; all other forms of constitution are lower stages of the development of reason." Hegel's abstruse metaphysics has also been greatly appreciated because it has made so thorough and consistent a use of the idea of evolution. But this pretended "evolution of reason" floated far above real nature in the pure ether of the absolute spirit, and was devoid of all the material ballast that the empirical science of the evolution of the world, the earth, and its living population, had meantime accumulated. Moreover, it is well known how Hegel himself declared, with humorous resignation, that only *one* of his many pupils had understood him, and this one had misunderstood him.

From the higher standpoint of general culture the difficult question forces itself on us: What is the real value of the idea of evolution in the whole realm of science? We are bound to answer that it varies considerably. The facts of the evolution of the individual, or of ontogeny, were easy to observe and grasp: the evolution of the crust of the earth and of the mountains in geology seemed to have an equally sound empirical foundation; the physical evolution of the universe seemed to be established by mathematical speculation. There was no longer any serious question of *creation*, in the literal sense, of the deliberate action of a personal Creator, in these great

provinces. But this made people cling to the idea more than ever in regard to the origin of the countless species of animals and plants, and especially the creation of man. This transcendental problem seemed to be entirely beyond the range of natural development; and the same was thought of the question of the nature and origin of the soul, the mystic entity that was appropriated by metaphysical speculation as its subject. Charles Darwin suddenly brought a clear light into this dark chaos of contradictory notions in 1859. His epoch-making work, *The Origin of Species*, proved convincingly that this historical process is not a supernatural mystery, but a physiological phenomenon; and that the preservation of improved races in the struggle for life had produced, by a natural evolution, the whole wondrous world of organic life.

To-day, when evolution is almost universally recognised in biology, when thousands of anatomic and physiological works are based on it every year, the new generation can hardly form an idea of the violent resistance that was offered to Darwin's theory and the impassioned struggles it provoked. In the first place, the Churches at once raised a vigorous protest; they rightly regarded their new antagonist as the deadly enemy of the legend of creation, and saw the very foundations of their creed threatened. The Churches found a powerful ally in the dualistic metaphysics that still claims to represent the real "idealist philosophy" at most universities. But most

dangerous of all to the young theory was the violent resistance it met almost everywhere in its own province of empirical science. The prevailing belief in the fixity and the independent creation of the various species was much more seriously menaced by Darwin's theory than it had been by Lamarck's transformism. Lamarck had said substantially the same thing fifty years before, but had failed to convince through the lack of effective evidence. Many scientists, some of great distinction, opposed Darwin because either they had not an adequate acquaintance with the whole field of biology, or it seemed to them that his bold speculation advanced too far from the secure base of experience.

When Darwin's work appeared in 1859, and fell like a flash of lightning on the dark world of official biology, I was engaged in a scientific expedition to Sicily and taken up with a thorough study of the graceful radiolarians, those wonderful microscopic marine animals that surpass all other organisms in the beauty and variety of their forms. The special study of this remarkable class of animals, of which I afterwards described more than 4,000 species, after more than ten years of research, provided me with one of the solid foundation-stones of my Darwinian ideas. But when I returned from Messina to Berlin in the spring of 1860, I knew nothing as yet of Darwin's achievement. I merely heard from my friends at Berlin that a remarkable work by a crazy Englishman had attracted great attention, and that it turned upside down all previous ideas as to the origin of species.

I soon perceived that almost all the experts at Berlin—chief amongst them were the famous microscopist, Ehrenberg; the anatomist, Reichert; the zoologist, Peters; and the geologist, Beyrich—were unanimous in their condemnation of Darwin. The brilliant orator of the Berlin Academy, Emil du Bois-Reymond, hesitated. He recognised that the theory of evolution was the only natural solution of the problem of creation; but he laughed at the application of it as a poor romance, and declared that the phylogenetic inquiries into the relationship of the various species had about as much value as the research of philologists into the genealogical tree of the Homeric heroes. The distinguished botanist, Alexander Braun, stood quite alone in his full and warm assent to the theory of evolution. I found comfort and encouragement with this dear and respected teacher, when I was deeply moved by the first reading of Darwin's book, and soon completely converted to his views. In Darwin's great and harmonious conception of Nature, and his convincing establishment of evolution, I had an answer to all the doubts that had beset me since the beginning of my biological studies.

My famous teacher, Rudolf Virchow, whom I had met at Würtzburg in 1852, and was soon associated with in the most friendly relations as special pupil and admiring assistant, played a very curious part in this great controversy. I am, I think, one of those elderly men who have followed Virchow's development, as man and

thinker, with the greatest interest during the last fifty years. I distinguish three periods in his psychological metamorphoses. In the first decade of his academic life, from 1847 to 1858, mainly at Würtzburg, he effected the great reform of medicine that culminated brilliantly in his cellular pathology. In the following twenty years (1858-1877) he was chiefly occupied with politics and anthropology. He was at first favourable to Darwinism, then sceptical, and finally rejected it. His powerful and determined opposition to it dates from 1877, when, in his famous speech on "The Freedom of Science in the Modern State," he struck a heavy blow at that freedom, denounced the theory of evolution as dangerous to the State, and demanded its exclusion from the schools. This remarkable metamorphosis is so important, and has had so much influence, yet has been so erroneously described, that I will deal with it somewhat fully in the next chapter, especially as I have then to treat one chief problem, the descent of man from the ape. For the moment, I will merely recall the fact that in Berlin, the "metropolis of intelligence," as it has been called, the theory of evolution, now generally accepted, met with a more stubborn resistance than in most of our other leading educational centres, and that this opposition was due above all to the powerful authority of Virchow.

We can only glance briefly here at the victorious struggle that the idea of evolution has conducted in the last three decades of the nineteenth century. The violent resistance that Darwinism encountered nearly everywhere in its early years was paralysed towards the

end of the first decade. In the years 1866-1874 many works were published in which not only were the foundations of the theory scientifically strengthened, but its general recognition was secured by popular treatment of the subject. I made the first attempt in 1866, in my *General Morphology*, to present connectedly the whole subject of evolution and make it the foundation of a consistent Monistic philosophy; and I then gave a popular summary of my chief conclusions in the ten editions of my *History of Creation*. In my *Evolution of Man* I made the first attempt to apply the principles of evolution thoroughly and consistently to man, and to draw up a hypothetical list of his animal ancestors. The three volumes of my *Systematic Phylogeny* (1894-1896) contain a fuller outline of a natural classification of organisms on the basis of their stem-history. There have been important contributions to the science of evolution in all its branches in the Darwinian periodical, *Cosmos*, since 1877; and a number of admirable popular works helped to spread the system.

However, the most important and most welcome advance was made by science when, in the last thirty years, the idea of evolution penetrated into every branch of biology, and was recognised as fundamental and indispensable. Thousands of new discoveries and observations in all sections of botany, zoology, protistology, and anthropology, were brought forward as empirical evidence of evolution. This is especially true of the remarkable progress of paleontology, comparative anatomy, and embryology, but it applies also

to physiology, chorology (the science of the distribution of living things), and œcology (the description of the habits of animals). How much our horizon was extended by these, and how much the unity of our Monistic system gained, can be seen in any modern manual of biology. If we compare them with those that gave us extracts of natural history forty or fifty years ago, we see at once what an enormous advance has taken place. Even the more remote branches of anthropological science, ethnography, sociology, ethics, and jurisprudence, are entering into closer relations with the theory of evolution, and can no longer escape its influence. In view of all this, it is ridiculous for theological and metaphysical journals to talk, as they do, of the failure of evolution and "the death-bed of Darwinism."

Our science of evolution won its greatest triumph when, at the beginning of the twentieth century, its most powerful opponents, the Churches, became reconciled to it, and endeavoured to bring their dogmas into line with it. A number of timid attempts to do so had been made in the preceding ten years by different free-thinking theologians and philosophers, but without much success. The distinction of accomplishing this in a comprehensive and well-informed manner was reserved for a Jesuit, Father Erich Wasmann of Luxemburg. This able and learned entomologist had already earned some recognition in zoology by a series of admirable observations on the life of ants, and the captives that they always keep in their homes, certain very small

insects which have themselves been curiously modified by adaptation to their peculiar environment. He showed that these striking modifications can only be rationally explained by descent from other free-living species of insects. The various papers in which Wasmann gave a thoroughly Darwinian explanation of the biological phenomena first appeared (1901-1903) in the Catholic periodical, *Stimmen aus Maria-Laach*, and are now collected in a special work entitled, *Modern Biology and the Theory of Evolution.*

This remarkable book of Wasmann's is a masterpiece of Jesuitical sophistry. It really consists of three entirely different sections. The first third gives, in the introduction, what is, for Catholics, a clear and instructive account of modern biology, especially the cell-theory, and the theory of evolution (chapters i.-viii.). The second third, the ninth chapter, is the most valuable part of the work. It has the title: "The Theory of Fixity or the theory of Evolution?" Here the learned entomologist gives an interesting account of the results of his prolonged studies of the morphology and the œcology of the ants and their captives, the myrmecophilæ. He shows impartially and convincingly that these complicated and remarkable phenomena can only be explained by evolution, and that the older doctrine of the fixity and independent creation of the various species is quite untenable. With a few changes this ninth chapter could figure as a useful part of a work by Darwin or Weismann or some other evolutionist. The succeeding chapter (the last third) is flagrantly

inconsistent with the ninth. It deals most absurdly with the application of the theory of evolution to man. The reader has to ask himself whether Wasmann really believes these confused and ridiculous notions, or whether he merely aims at befogging his readers, and so preparing the way for the acceptance of the conventional creed.

Wasmann's book has been well criticised by a number of competent students, especially by Escherich and Francé. While fully recognising his great services, they insist very strongly on the great mischief wrought by this smuggling of the Jesuitical spirit into biology. Escherich points out at length the glaring inconsistencies and the obvious untruths of this "ecclesiastical evolution." He summarises his criticism in the words: "If the theory of evolution can really be reconciled with the dogmas of the Church only in the way we find here, Wasmann has clearly proved that any such reconciliation is impossible. Because what Wasmann gives here as the theory of evolution is a thing mutilated beyond recognition and incapable of any vitality." He tries, like a good Jesuit, to prove that it does not tend to undermine, but to give a firm foundation to, the story of supernatural creation, and that it was really not Lamarck and Darwin, but St. Augustin and St. Thomas of Aquin, who founded the science of evolution. "God does not interfere directly in the order of Nature when he can act by means of natural causes." Man alone constitutes a remarkable exception; because "the human soul, being a spiritual entity, cannot be derived

from matter even by the Divine omnipotence, like the vital forms of the plants and animals" (p. 299).

In an instructive article on "Jesuitical Science" (in the Frankfort *Freie Wort*, No. 22, 1904), R. H. Francé gives an interesting list of the prominent Jesuits who are now at work in the various branches of science. As he rightly says, the danger consists "in a systematic introduction of the Jesuitical spirit into science, a persistent perversion of all its problems and solutions, and an astute undermining of its foundations; to speak more precisely, the danger is that people are not sufficiently conscious of it, and that they, and even science itself, fall into the cleverly prepared pit of believing that there is such a thing as *Jesuitical science*, the results of which may be taken seriously."[1]

While fully recognising these dangers, I nevertheless feel that the Jesuit Father Wasmann, and his colleagues, have—unwittingly—done a very great service to the

[1] The eel-like sophistry of the Jesuits, which has been brought to such a wonderful pitch in their political system, cannot, as a rule, be met by argument. An interesting illustration of this was given by Father Wasmann himself in his controversy with the physician, Dr. Julian Marcuse. The "scientific" Wasmann had gone so far in his zeal for religion as to support a downright swindle of a "miraculous cure" in honour of the "Mother of God of Oostacker" (the Belgian Lourdes). Dr. Marcuse succeeded in exposing the whole astounding story of this "pious fraud" (*Deutsche Stimmen*, Berlin, 1903, iv. Jahrg., No. 20). Instead of giving a scientific refutation, the Jesuit replied with sophistic perversion and personal invective (Scientific [?] Supplement to *Germania*, Berlin, 1902, No. 43, and 1903, No. 13). In his final reply, Dr. Marcuse said: "I have accomplished my object—to let thoughtful people see once more the kind of ideas that are found in the world of dead and literal faith, which tries to put the crudest superstition and reverence for the myth of miraculous cures in the place of science, truth and knowledge" (*Deutsche Stimmen*, 1903, v. Jahrgang, No. 3).

progress of pure science. The Catholic Church, the most powerful and widespread of the Christain sects, sees itself compelled to capitulate to the idea of evolution. It embraces the most important application of the idea, Lamarck and Darwin's theory of descent, which it had vigorously combated until twenty years ago. It does, indeed, mutilate the great tree, cutting off its roots and its highest branch; it rejects spontaneous generation or archigony at the bottom, and the descent of man from animal ancestors above. But these exceptions will not last. Impartial biology will take no notice of them, and the religious creed will at length determine that the more complex species have been evolved from a series of simpler forms according to Darwinian principles. The belief in a supernatural creation is restricted to the production of the earliest and simplest stem-forms, from which the "natural species" have taken their origin; Wasmann gives that name to all species that are demonstrably descended from a common stem-form; in other words, to what other classifiers call "stems" or "phyla." The 4,000 species of ants in his system, which he believes to be genetically related, are comprised by him in one "natural species." On the other hand, man forms one isolated "natural species" for himself, without any connection with the other mammals.

The Jesuitical sophistry that Wasmann betrays in this ingenious distinction between "systematic and natural species" is also found in his philosophic "Thoughts on Evolution" (chap. viii.), his distinction between philosophic and scientific evolution, or between

evolution in one stem and in several stems. His remarks (in chap. vii.) on "the cell and spontaneous generation" are similarly marred by sophistry. The question of spontaneous generation or archigony—that is to say, of the first appearance of organic life on the earth, is one of the most difficult problems in biology; one of those in which the most distinguished students betray a striking weakness of judgment. Dr. Heinrich Schmidt, of Jena, has lately written an able and popular little work on that subject. In his *Spontaneous Generation and Professor Reinke* (1903), he has shown to what absurd consequences the ecclesiastical ideas lead on this very question. The botanist Reinke, of Kiel, is now regarded amongst religious people as the chief opponent of Darwinism; for many conservatives this is because he is a member of the Prussian Herrenhaus (a very intelligent body, of course!). Although he is a strong evangelical, many of his mystic deductions agree surprisingly with the Catholic speculations of Father Wasmann. This is especially the case with regard to spontaneous generation. They both declare that the first appearance of life must be traced to a miracle, to the work of a personal deity, whom Reinke calls the "cosmic intelligence." I have shown the unscientific character of these notions in my last two works, *The Riddle of the Universe*, and *The Wonders of Life*. I have drawn attention especially to the widely distributed monera of the chromacea class—organisms of the simplest type conceivable, whose whole body is merely an unnucleated, green, structureless globule of plasm

(Chroococcus); their whole vital activity consists of growth (by forming plasm) and multiplication (by dividing into two). There is little theoretical difficulty in conceiving the origin of these new simple monera from inorganic compounds of albumen, or their later transformation into the simplest nucleated cells. All this, and a good deal more that will not fit in his Jesuitical frame, is shrewdly ignored by Wasmann.

In view of the great influence that Catholicism still has on public life in Germany, through the Centre party, this change of front should be a great gain to education. Virchow demanded as late as 1877 that the dangerous doctrine of evolution should be excluded from the schools. The Ministers of Instruction of the two chief German States gratefully adopted this warning from the leader of the progressive party, forbade the teaching of Darwinian ideas, and made every effort to check the spread of biological knowledge. Now, twenty-five years afterwards, the Jesuits come forward, and demand the opposite. They recognise openly that the hated theory of evolution is established, and try to reconcile it with the creed! What an irony of history! And we find much the same story when we read the struggles for freedom of thought and for the recognition of evolution in the other educated countries of Europe.

In Italy, its cradle and home, educated people generally look upon the papacy with the most profound disdain. I have spent many years in Italy, and have never met an educated Italian of such

bigoted and narrow views as we usually find amongst educated German Catholics—represented with success in the Reichstag by the Centre party. It is proof enough of the reactionary character of German Catholics that the Pope himself describes them as his most vigorous soldiers, and points them out as models to the faithful of other nations. As the whole history of the Roman Church shows, the charlatan of the Vatican is the deadly enemy of free science and free teaching. The present German Emperor ought to regard it as his most sacred duty to maintain the tradition of the Reformation, and to promote the formation of the German people in the sense of Frederick the Great. Instead of this we have to look on with heavy hearts while the Emperor, badly advised and misled by those in influence about him, suffers himself to be caught closer and closer in the net of the Catholic clergy, and sacrifices to it the intelligence of the rising generation. In September, 1904, the Catholic journals announced triumphantly that the adoption of Catholicism by the Emperor and his Chancellor was close at hand.[1]

The firmness of the belief in conventional dogmas,

[1] While these pages are in the press the journals announce a fresh humiliation of the German empire that will cause great grief. On the 9th of May the nation celebrated the centenary of the death of Friedrich Schiller. With rare unanimity all the political parties of Germany, and all the German associations abroad, came together to do honour to the great poet of German idealism. Professor Theobald Ziegler delivered a very fine address at Strassburg University. The Emperor, who happened to be in the town, was invited, but did not attend; instead of doing so, he held a military parade in the vicinity.

which hampers the progress of rational enlightenment in orthodox Protestant circles as well as Catholic, is often admired as an expression of the deep emotion of the German people. But its real source is their confusion of thought and their credulity, the power of conservative tradition, and the reactionary state of political education. While our schools are bent under the yoke of the creeds, those of our neighbours are free. France, the pious daughter of the Church, gives anxious moments to her ambitious mother. She is breaking the chains of the Concordat, and taking up the work of the Reformation. In Germany, the birthplace of the Reformation, the Reichstag and the Government vie with each other in smoothing the paths for the Jesuits, and fostering, instead of suppressing, the intolerant spirit of the sectarian school. Let us hope that the latest episode in the history of evolution, its recognition by Jesuitical science, will bring about the reverse of what they intend—the substitution of rational science for blind faith.

A few days afterwards he sat at table with the German Catholic cardinals and bishops, amongst them being the fanatical Bishop Benzler, who declared that a Christian cemetery was desecrated by the interment of a Protestant. At these festive dinners German Catholics always give the first toast to the Pope, the second to the Emperor; they rejoice at present that the Emperor and Pope are *allies*. But the whole history of the papacy (a pitiful caricature of the ancient Catholic faith) shows clearly that they are natural and irreconcilable enemies. Either emperor must rule *or* pope.

CHAPTER II

THE STRUGGLE OVER OUR GENEALOGICAL TREE

OUR APE-RELATIVES AND THE VERTEBRATE-STEM

EXPLANATION OF PLATE II

SKELETONS OF FIVE ANTHROPOID APES

THESE skeletons of the five living genera of anthropomorpha are reduced to a common size, in order to show better the relative proportions of the various parts. The human skeleton is $\frac{1}{20}$th natural size, the gorilla $\frac{1}{18}$th, the chimpanzee $\frac{1}{7}$th, the orang $\frac{1}{7}$th, the gibbon $\frac{1}{3}$th. Young specimens of the chimpanzee and orang have been selected, because they approach nearer to man than the adult. No one of the living anthropoid apes is nearest to man in all respects; this cannot be said of either of the African (gorilla and chimpanzee) or the Asiatic (orang and gibbon). This anatomic fact is explained phylogenetically on the ground that none of them are direct ancestors of man; they represent divergent branches of the stem, of which man is the crown. However, the small gibbon is nearest related to the hypothetical common ancestor of all the anthropomorpha to which we give the name of Prothylobates. Further information will be found in my *Last Link* and *Evolution of Man* (chap. xxiii.).

CHAPTER II

THE STRUGGLE OVER OUR GENEALOGICAL TREE

OUR APE-RELATIVES AND THE VERTEBRATE-STEM

In the previous chapter I tried to give you a general idea of the present state of the controversy in regard to evolution. Comparing the various branches of thought we found that the older mythological ideas of the creation of the world were driven long ago out of the province of inorganic science, but that they did not yield to the rational conception of natural development until a much later date in the field of organic nature. Here the idea of evolution did not prove completely victorious until the beginning of the twentieth century, when its most zealous and dangerous opponent, the Church, was forced to admit it. Hence the open acknowledgment of the Jesuit, Father Wasmann, deserves careful attention, and we may look forward to a further development. If his force of conviction and his moral courage are strong enough, he will go on to draw the normal conclusions from his high scientific attainments and leave the Catholic Church, as the prominent Jesuits, Count Hoensbroech and the able geologist, Professor Renard of Ghent, one of the workers on the deep-sea deposits in the *Challenger* expedition.

have lately done. But even if this does not happen, his recognition of Darwinism, in the name of Christian belief, will remain a landmark in the history of evolution. His ingenious and very Jesuitical attempt to bring together the opposite poles will have no very mischievous effect; it will rather tend to hasten the victory of the scientific conception of evolution over the mystic beliefs of the Churches.

You will see this more clearly if we go on to consider the important special problem of the "descent of man from the ape," and its irreconcilability with the conventional belief that God made man according to His own image. That this ape or pithecoid theory is an irresistible deduction from the general principle of evolution was clearly recognised forty-five years ago, when Darwin's work appeared, by the shrewd and vigilant theologians; it was precisely in this fact that they found their strongest motive for vigorous resistance. It is quite clear. *Either* man was brought into existence, like the other animals, by a special creative act, as Moses and Linné taught (an "embodied idea of the Creator," as the famous Agassiz put it so late as 1858); *or* he has been developed naturally from a series of mammal ancestors, as is claimed by the systems of Lamarck and Darwin.

In view of the very great importance of this pithecoid theory, we will first cast a brief glance at its founders and then summarise the proofs in support of it. The famous French biologist, Jean Lamarck, was the first scientist definitely to affirm the descent of man from

the ape and seek to give scientific proof of it. In his splendid work, fifty years in advance of his time, the *Philosophie Zoologique* (1899), he clearly traced the modifications and advances that must have taken place in the transformation of the man-like apes (the primate forms similar to the orang and the champanzee); the adaptation to walking upright, the consequent modification of the hands and feet, and later, the formation of speech and the attainment of a higher degree of intelligence. Lamarck's remarkable theory, and this important consequence of it, soon fell into oblivion. When Darwin brought evolution to the front again fifty years afterwards, he paid no attention to the special conclusion. He was content to make the following brief prophetic observation in his work: "Light will be thrown on the origin and the history of man." Even this innocent remark seemed so momentous to the first German translator of the work, Bronn, that he suppressed it. When Darwin was asked by Wallace whether he would not go more fully into it, he replied: "I think of avoiding the whole subject, as it is so much involved in prejudice; though I quite admit that it is the highest and most interesting problem for the thinker."

The first thorough works of importance on the subject appeared in 1863. Thomas Huxley in England, and Carl Vogt in Germany, endeavoured to show that the descent of man from the ape was a necessary consequence of Darwinism, and to provide an empirical base for the theory by every available argument. Huxley's

work on *Man's Place in Nature* was particularly valuable. He first gave convincingly, in three lectures, the empirical evidence on the subject—the natural history of the anthropoid apes, the anatomical and embryological relations of man to the next lowest animals, and the recently discovered fossil human remains. I then (1866) made the first attempt to establish the theory of evolution comprehensively by research in anatomy and embryology, and to determine the chief stages in the natural classification of the vertebrates that must have been passed through by our earlier vertebrate ancestors. Anthropology thus becomes a part of zoology. In my *History of Creation* I further developed these early evolutionary sketches, and improvements were made in the successive editions.

In the meantime, the great master, Darwin, had decided to deal with this chief evolutionary problem in a special work. The two volumes of his *Descent of Man* appeared in 1871. They contained an able discussion of sexual selection, or the selective influence of sexual love and high psychic activities connected therewith, and their significance in regard to the origin of man. As this part of Darwin's work was afterwards attacked with particular virulence, I will say that, in my opinion, it is of the greatest importance, not only for the general theory of evolution, but also for psychology, anthropology, and æsthetics.

My own feeble early efforts (1866), not only to establish the descent of man from the nearest related apes, but also to determine more precisely

the long series of our earlier and lower vertebrate ancestors, had not at all satisfied me. In particular, I had had to leave unanswered in my *General Morphology* the very interesting question: from which invertebrate animals the vertebrate stem originally came. A clear and unexpected light was thrown on it some time afterwards by the astounding discoveries of Kowalevsky, which revealed an essential agreement in embryonic development between the lowest vertebrate (Amphioxus) and a lowly tunicate (Ascidia). In the succeeding years, the numerous discoveries in connection with the formation of the germinal layers in different animals so much enlarged our embryological outlook that I was able to prove the complete homology of the two-layered *gastrula* (a cup-shaped embryonic form) in all the tissue-forming animals (*metazoa*) in my *Monograph on the Sponges*. From this I inferred, in virtue of the biogenetic law, the common descent of all the metazoa from one and the same gastrula-shaped stem-form, the *gastræa*. This hypothetical stem-form, to which man's earliest multicellular ancestors also belong, was afterwards proved by Monticelli's observations to be still in existence. The evolution of these very simple tissue-forming animals from still simpler unicellular forms (*protozoa*) is shown by the corresponding processes that we witness in what is called the segmentation of the ovum or gastrulation, in the development of the two-layered germ from the single cell of the ovum.

Encouraged by these great advances of modern

phylogeny, and with the support of many new discoveries in comparative anatomy and embryology, in which a number of distinguished observers were at work, I was able in 1874 to venture on the first attempt to trace continuously the whole story of man's evolution. In doing so, I took my stand on the firm ground of the biogenetic law, seeking to give a phylogenetic cause for each fact of embryology. My *Evolution of Man*, which made the first attempt to accomplish this difficult task, was materially improved and enlarged as new and important discoveries were made. The latest edition (1903 [1904 in English]) contains thirty chapters distributed in two volumes, the first of which deals with embryology (or ontogeny), and the second with the development of species (or phylogeny).

Though I was quite conscious that there were bound to be gaps and weak points in these first attempts to frame a natural anthropogeny, I had hoped they would have some influence on modern anthropology, and especially that the first sketches of a genealogical tree of the animal world would prove a stimulus to fresh research and improvement. In this I was much mistaken. The dominant school of anthropology, especially in Germany, declined to suffer the introduction of the theory of evolution, declaring it to be an unfounded hypothesis, and described our carefully prepared ancestral trees as mere figments. This was due, in the first place, to the great authority of the founder and president (for

many years) of the German Anthropological Society, Rudolf Virchow, as I briefly pointed out in the previous chapter. In view of the great regard that is felt for this distinguished scientist, and the extent to which his powerful opposition prevented the spread of the theory, it is necessary to deal more fully with his position on the subject. I am still further constrained to do this because of the erroneous views of it that are circulating, and my own fifty years' acquaintance with my eminent teacher enables me to put them right.

Not one of Virchow's numerous pupils and friends can appreciate more than I do his real services to medical science. His *Cellular Pathology* (1858), his thorough application of the cell-theory to the science of disease, is, in my opinion, one of the greatest advances made by modern medicine. I had the good fortune to begin my medical studies at Würzburg in 1852, and to spend six valuable terms under the personal guidance of four biologists of the first rank—Albert Kölliker, Rudolf Virchow, Franz Leydig and Carl Gegenbaur. The great stimulus that I received from these distinguished masters in every branch of comparative and microscopic biology was the starting-point of my whole training in that science, and enabled me subsequently to follow with ease the higher intellectual flight of Johannes Müller. From Virchow especially I learned, not only the analytic art of careful observation and judicious appreciation of the detailed facts of anatomy, but also the synthetic conception of the whole human frame, the

profound conviction of the *unity* of our nature, the inseparable connection of body and mind, to which Virchow gave a fine expression in his classic essay on "The Efforts to bring about Unity in Scientific Medicine" (1849). The leading articles which he wrote at that time for the Journal of Pathological Anatomy and Physiology, which he had founded, contain much new insight into the wonders of life, and a number of excellent general reflections on their significance—pregnant ideas that we can make direct use of for Monistic purposes. In the controversy that broke out between empirical rationalism and materialism and the older vitalism and mysticism, he took the side of the former, and fought together with Jacob Moleschott, Carl Vogt, and Ludwig Büchner. I owe the firm conviction of the unity of organic and inorganic nature, of the mechanical character of all vital and psychic activity, which I have always held to be the foundation of my Monistic system, in a great measure to Virchow's teaching and the exhaustive conversations I had with him when I was his assistant. The profound views of the nature of the cell and the independent individuality of these elementary organisms, which he advanced in his great work *Cellular Pathology*, remained guiding principles for me in the prolonged studies that I made thirty years afterwards of the organisation of the radiolaria and other unicellular protists; and also in regard to the theory of the cell-soul, which followed naturally from the psychological study of it.

His life at Würtzburg was the most brilliant period

of Virchow's indefatigable scientific labours. A change took place when he removed to Berlin in 1856. He then occupied himself chiefly with political and social and civic interests. In the last respect he has done so much for Berlin and the welfare of the German people that I need not enlarge on it. Nor will I go into his self-sacrificing and often thankless political work as leader of the progressive party; there are differences of opinion as to its value. But we must carefully examine his peculiar attitude towards evolution, and especially its chief application, the ape-theory. He was at first favourable to it, then sceptical, and finally decidedly hostile.

When the Lamarckian theory was brought to light again by Darwin in 1859, many thought that it was Virchow's vocation to take the lead in defending it. He had made a thorough study of the problem of heredity; he had realised the power of adaptation through his study of pathological changes; and he had been directed to the great question of the origin of man by his anthropological studies. He was at that time regarded as a determined opponent of all dogmas; he combated transcendentalism either in the form of ecclesiastical creeds or anthropomorphism. After 1862 he declared that "the possibility of a transition from species to species was a necessity of science." When I opened the first public discussion of Darwinism at the Stettin scientific congress in 1863, Virchow and Alexander Braun were among the few scientists who would admit the subject to be important and deserving

of the most careful study. When I sent to him in 1865 two lectures that I had delivered at Jena on the origin and genealogical tree of the human race, he willingly received them amongst his *Collection of Popular Scientific Lectures.* In the course of many long conversations I had with him on the matter, he agreed with me in the main, though with the prudent reserve and cool scepticism that characterised him. He adopts the same moderate attitude in the lecture that he delivered to the Artisans' Union at Berlin in 1869 on "Human and Ape Skulls."

His position definitely changed in regard to Darwinism from 1877 onward. At the Scientific Congress that was then held at Munich I had, at the pressing request of my Munich friends, undertaken the first address (on 18th September) on "Modern Evolution in Relation to the whole of Science." In this address I had substantially advanced the same general views that I afterwards enlarged in my *Monism*, *Riddle of the Universe*, and *Wonders of Life.* In the ultramontane capital of Bavaria, in sight of a great university which emphatically describes itself as Catholic, it was somewhat bold to make such a confession of faith. The deep impression that it had made was indicated by the lively manifestations of assent on the one hand, and displeasure on the other, that were at once made in the Congress itself and in the Press. On the following day I departed for Italy (according to an arrangement made long before). Virchow did not come to Munich until two days afterwards, when he

delivered (on 22nd September, in response to entreaties from people of position and influence) his famous antagonistic speech on "The Freedom of Science in the Modern State." The gist of the speech was that this freedom ought to be restricted; that evolution is an unproved hypothesis, and ought not to be taught in the school because it is dangerous to the State: "We must not teach," he said, "that man descends from the ape or any other animal." In 1849, the young Monist, Virchow, had emphatically declared this conviction, "that he would never be induced to deny the thesis of the unity of human nature and its consequences"; now, twenty-eight years afterwards, the prudent Dualistic politician entirely denied it. He had formerly taught that all the bodily and mental processes in the human organism depend on the mechanism of the cell-life; now he declared the soul to be a special immaterial entity. But the crowning feature of this reactionary speech was his compromise with the Church, which he had fought so vigorously twenty years before.

The character of Virchow's speech at Munich is best seen in the delight with which it was at once received by the reactionary and clerical papers, and the profound concern of all Liberal journals, either in the political or the religious sense. When Darwin read the English translation of the speech he—generally so gentle in his judgments—wrote: "Virchow's conduct is shameful, and I hope he will some day feel the shame." In 1878, I made a full reply to it in my *Free Science and Free*

Teaching, in which I collected the most important press opinions on the matter.[1]

From this very decided turn at Munich until his death, twenty-five years afterwards, Virchow was an indefatigable and very influential opponent of evolution. In his annual appearances at congresses he has always contested it, and has obstinately clung to his statement that "it is quite certain that man does not descend from the ape or any other animal." To the question: "Whence does he come, then?" he had no answer, and retired to the resigned position of the Agnostic, which was common before Darwin's time: "We do not know how life arose, and how the various species came into the world." His son-in-law, Professor Rabl, has tried to draw attention once more to his earlier conception, and has declared that even in later years Virchow often recognised the truth of evolution in private conversation. This only makes it the more regrettable that he always said the contrary in public. The fact remains that ever since the opponents of evolution, especially the reactionaries and clericals, have appealed to the authority of Virchow.

The wholly reactionary system that this led to has been well described by Robert Drill (1902) in his *Virchow as a Reactionary*. How little qualified the great pathologist was to appreciate the scientific

[1] The manuscript letter in which the gentle Darwin expresses so severe a judgment on Virchow is printed in my Cambridge lecture, *The Last Link*. My answer to Virchow's speech is contained in the second volume of my *Popular Lectures*, and has lately appeared in the *Freie Wort* (April, 1905).

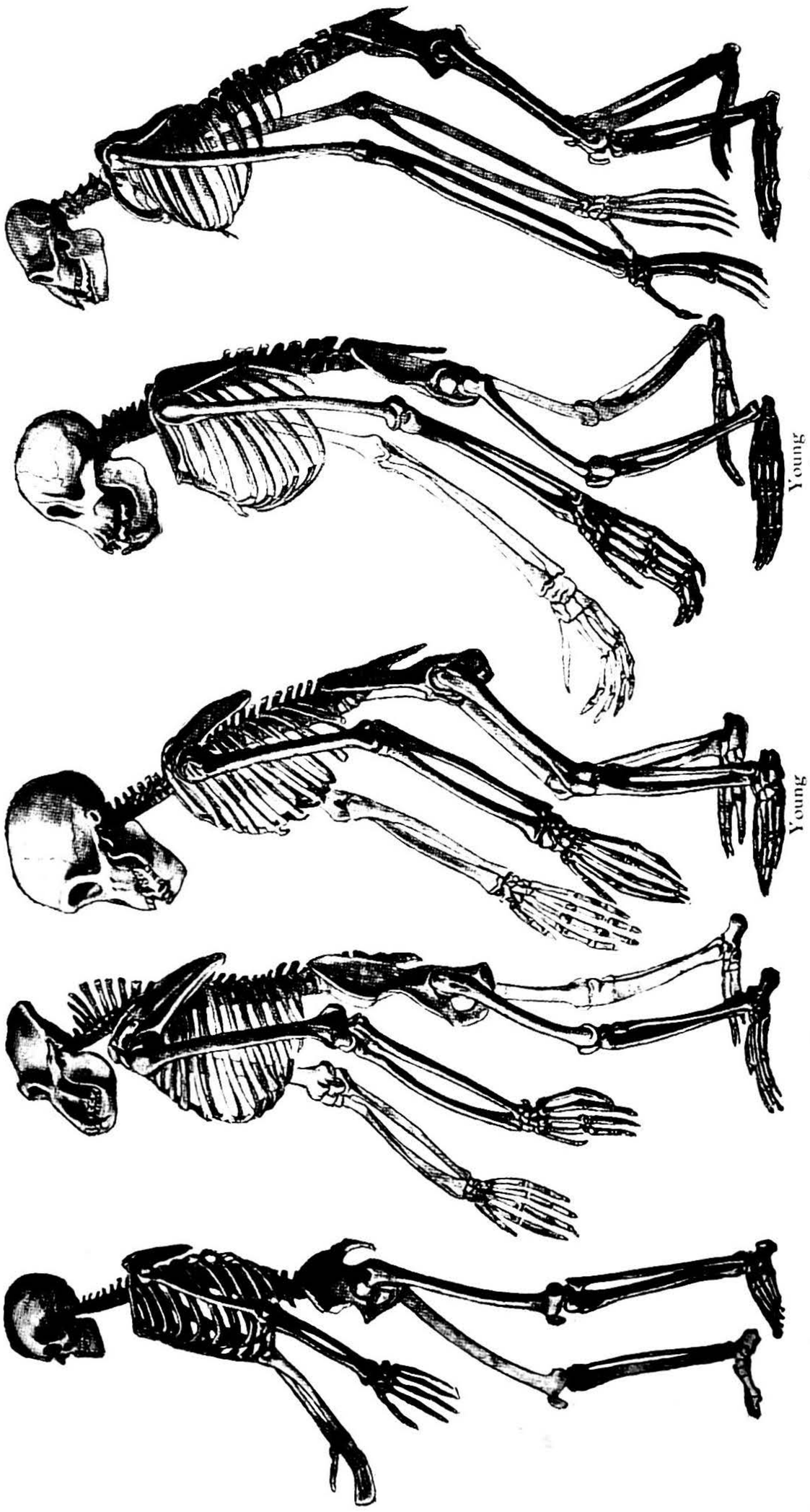
bases of the pithecoid theory is clear from the absurd statement he made, in the opening speech of the Vienna Congress of Anthropologists, in 1894, that man might just as well be claimed to descend from a sheep or an elephant as from an ape. Any competent zoologist can see from this the little knowledge Virchow had of systematic zoology and comparative anatomy. However, he retained his authority as president of the German Anthropological Society, which remained impervious to Darwinian ideas. Even such vigorous controversialists as Carl Vogt, and such scientific partisans of the ape-man of Neanderthal as Schaafhausen, could make no impression. Virchow's authority was equally great for twenty years in the Berlin Press, both Liberal and Conservative. The *Kreutzzeitung* and the *Evangelische Kirchenzeitung* were delighted that "the learned progressist was conservative in the best sense of the word as regards evolution." The ultramontane *Germania* rejoiced that the powerful representative of pure science had, "with a few strokes of his cudgel, reduced to impotence" the absurd ape-theory and its chief protagonist, Ernst Haeckel. The *National-Zeitung* could not sufficiently thank the free-thinking, popular leader for having lifted from us for ever the oppressive mountain of the theory of simian descent. The editor of the *Volks-Zeitung*, Bernstein, who has done so much for the spread of knowledge in his excellent popular manuals of science, obstinately refused to admit

articles that ventured to support the erroneous ape-theory "refuted" by Virchow.

It would take up too much space to attempt to give even a general survey of the remarkable and enormous literature of the subject that has accumulated in the last three decades in the shape of thousands of learned treatises and popular articles. The greater part of these works have been written under the influence of conventional religious prejudice, and without the necessary acquaintance with the subject, that can only be obtained by a thorough training in biology. The most curious feature of them is that most of the authors restrict their genealogical interests to the most manlike apes, and do not deal with their origin, or with the deeper roots of our common ancestral tree. They do not see the wood for the trees. Yet it is far easier and safer to penetrate the great mysteries of our animal origin, if we look at the subject from the higher standpoint of vertebrate phylogeny and go deeper into the earlier records of the evolutionary history of the vertebrates.

Since the great Lamarck established the idea of the vertebrate at the beginning of the nineteenth century (1801), and his Parisian colleague, Cuvier, shortly afterwards recognised the vertebrates as one of his four chief animal groups, the natural unity of this advanced section of the animal world has not been contested. In all the vertebrates, from the lowest fishes and amphibians up to the apes and

SKELETONS OF FIVE ANTHROPOID APES.



$\frac{1}{20}$ MAN (Homo) — $\frac{1}{18}$ GORILLA — $\frac{1}{7}$ CHIMPANZEE (Anthropithecus) Young — $\frac{1}{5}$ ORANG (Satyrus) Young — $\frac{1}{6}$ GIBBON (Hylobates)

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man, we have the same type of structure, the same characteristic disposition and relations of the chief organs; and they differ materially from the corresponding features in all other animals. The mysterious affinities of the vertebrates induced Goethe, 140 years ago, long before Cuvier, to make prolonged and laborious studies in their comparative anatomy at Jena and Weimar. Just as he had, in his *Metamorphosis of Plants*, established the unity of organisation by means of the leaf as the common primitive organ, he, in the metamorphosis of the vertebrates, found this common element in the vertebral theory of the skull. And when Cuvier established comparative anatomy as an independent science, this branch of biology was developed to such an extent by the classic research of Johannes Müller, Carl Gegenbaur, Richard Owen, Thomas Huxley, and many other morphologists, that Darwinism found its most powerful weapons in this arsenal. The striking differences of external form and internal structure that we find in the fishes, amphibians, reptiles, birds, and mammals, are due to *adaptation* to the various uses of their organs and their environments. On the other hand, the astonishing agreement in their typical character, that persists in spite of their differences, is due to *inheritance* from common ancestors.

The evidence thus afforded by comparative anatomy is so cogent that anyone who goes impartially and attentively through a collection of skeletons can

convince himself at once of the morphological unity of the vertebrate stem. The evolutionary evidence of comparative ontogeny, or embryology, is less easy to grasp and less accessible, but not less important. It came to light at a much later date, and its extreme value was only made clear, by means of the biogenetic law, some forty years ago. It shows that every vertebrate, like every other animal, develops from a single cell, but that the course of its embryonic development is peculiar, and characterised by embryonic forms that are not found in the invertebrates. We find in them especially the *chordula*, or chorda-larva, a very simple worm-shaped embryonic form, without limbs, head, or higher sense-organs; the body consists merely of six very simple primitive organs. From these are developed steadily the hundreds of different bones, muscles, and other organs that we afterwards distinguish in the mature vertebrate. The remarkable and very complex course of this embryonic development is essentially the same in man and the ape, and in the amphibians and fishes. We see in it, in accordance with the biogenetic law, a new and important witness to the common descent of all vertebrates from a single primitive form, the *chordæa*.

But, important as these arguments of comparative embryology are, one needs many years' study in the unfamiliar and difficult province of embryology before one can realise their evolutionary force. There are, in fact, not a few embryologists (especially of the modern school of experimental embryology) who do

not succeed in doing so. It is otherwise with the palpable proofs that we take from a remote science, paleontology. The remarkable fossil remains and impressions of extinct animals and plants give us directly the historical evidence we need to understand the successive appearance and disappearance of the various species and groups. Geology has firmly established the chronological order of the sedimentary rocks, which have been successively formed of mud at the floor of the ocean, and has deduced their age from the thickness of the strata, and determined the relative date of their formation. The vast period during which organic life has been developing on the earth runs to many million years. The number is variously estimated at less than a hundred or at several hundred million years.[1] If we take the smaller number of 200 million years, we find them distributed amongst the five chief periods of the earth's organic development in such a way that the earlier or archeozoic period absorbs nearly one half. As the sedimentary rocks of this period, chiefly gneisses and crystalline schists, are in a metamorphosed condition, the fossil remains in them are unrecognisable. In the next succeeding strata of the paleozoic period we find the earliest remains of fossilised vertebrates, Silurian primitive fishes (selachii) and ganoids. These are followed, in the Devonian system,

[1] In his presidential speech at the last meeting of the British Association, Professor Darwin said: "It does not seem unreasonable to suppose that 500 to 1,000 million years may have elapsed since the birth of the moon." [Trans]

by the first dipneust fishes (a transitional form from the fishes to the amphibia). In the next, the Carboniferous system, we find the first terrestrial or four-footed vertebrates — amphibians of the order of the stegocephala. A little later, in the Permian rocks, the earliest amniotes, lowly, lizard-like reptiles (tocosauria), make their appearance; the warm-blooded birds and mammals are still wanting. We have the first traces of the mammals in the Triassic, the earliest sedimentary rocks of the mesozoic age; these are of the monotreme sub-class (pantotheria and allotheria). They are succeeded by the first marsupials (prodidelphia) in the Jurassic, the ancestral forms of the placentals (mallotheria), in the Cretaceous. See p. 115.

But the richest development of the mammal class takes place in the next or Tertiary age. In the course of its four periods—the eocene, oligocene, miocene, and pliocene—the mammal species increase steadily in number, variety, and complexity, down to the present time. From the lowest common ancestral group of the placentals proceed four divergent branches, the legions of the carnassia, rodents, ungulates, and primates. The primate legion surpasses all the rest. In this Linné long ago included the lemurs, apes, and man. The historical order in which the various stages of vertebrate development make their successive appearance corresponds entirely to the morphological order of their advance in organisation, as we have learned it from the study of comparative anatomy and embryology.

These paleontological facts are among the most important proofs of the descent of man from a long series of higher and lower vertebrates. There is no other explanation possible except evolution for the chronological succession of these classes, which is in perfect harmony with the morphological and systematic distribution. The anti-evolutionists have not even attempted to give any other explanation. The fishes, dipneusts, amphibians, reptiles, monotremes, marsupials, placentals, lemurs, apes, anthropoid apes, and ape-men (pithecanthropi), are inseparable links of a long ancestral chain, of which the last and most perfect link is man. (*Cf.* the tables pp. 116-118.)

One of the paleontological facts I have quoted, namely, the late appearance of the mammal class in geology—is particularly important. This most advanced group of the vertebrates comes on the stage in the Triassic period, in the second and shorter half of the organic history of the earth. It is represented only by low and small forms in the whole of the mesozoic age, during the domination of the reptiles. Throughout this long period, which is estimated by some geologists at 8-11, by others at 20 or more, million years, the dominant reptile class developed its many remarkable and curious forms; there were swimming marine reptiles (halisauria), flying reptiles (pterosauria), and colossal land reptiles (dinosauria). It was much later, in the Tertiary period, that the mammal class attained the wealth of large and advanced placental forms that secured its predominance over this more recent period.

The many and thorough investigations made during the last few decades into the ancestral history of the mammals have convinced all zoologists who were engaged in them that they may be traced to a common root. All the mammals, from the lowest monotremes and marsupials to the ape and man, have a large number of striking characteristics in common, and these distinguish them from all other vertebrates: the hair and glands of the skin, the feeding of the young with the mother's milk, the peculiar formation of the lower jaw and the ear-bones connected therewith, and other features in the structure of the skull; also, the possession of a knee-cap (*patella*), and the loss of the nucleus in the red blood-cells. Further, the complete diaphragm, which entirely separates the pectoral cavity from the abdominal, is only found in the mammals; in all the other vertebrates there is still an open communication between the two cavities. The monophyletic (or single) origin of the whole mammalian class is therefore now regarded by all competent experts as an established fact.

In the face of this important fact, what is called the "ape-question" loses a good deal of the importance that was formerly ascribed to it. All the momentous consequences that follow from it in regard to our human nature, our past and future, and our bodily and psychic life, remain undisturbed whether we derive man directly from one of the primates, an ape or lemur, or from some other branch, some unknown lower form, of the mammalian stem. It is important to point this out,

because certain dangerous attempts have been made lately by Jesuitical zoologists and zoological Jesuits to cause fresh confusion on the matter.

In a richly illustrated and widely read work that Hans Kraemer published a few years ago, under the title, *The Universe and Man*, an able and learned anthropologist, Professor Klaatsch of Heidelberg, deals with "the origin and development of the human race," and admirably describes the primitive history of man and his civilisation. However, he denounces the idea of man's descent from the ape as "irrational, narrow-minded, and false"; he grounds this severe censure on the fact that none of the living apes can be the ancestor of humanity. But no competent scientist had ever said anything so foolish. If we look closer into this fight with windmills, we find that Klaatsch holds substantially the same view of the pithecoid theory as I have done since 1866. He says expressly: "The three anthropoid apes, the gorilla, chimpanzee, and orang, seem to diverge from a common root, which was near to that of the gibbon and man." I had long ago given the name of *archiprimas* to this single hypothetical root-form of the primates, which he calls the "primatoid." It lived in the earliest part of the Tertiary period, and had probably been developed in the Cretaceous from older mammals. The very forced and unnatural hypothesis by means of which Klaatsch goes on to make the primates depart very widely from the other mammals, seems to me to be quite untenable, like the similar hypothesis that Alsberg,

Wilser, and other anthropologists who deny our pithecoid descent, have lately advanced.

All these attempts have a common object—to save man's privileged position in Nature, to widen as much as possible the gulf between him and the rest of the mammals, and to conceal his real origin. It is the familar tendency of the *parvenu*, which we so often notice in the aristocratic sons of energetic men who have won a high position by their own exertions. This sort of vanity is acceptable enough to the ruling powers and the Churches, because it tends to support their own fossilised pretensions to a "Divine image" in man and a special "Divine grace" in princes. The zoologist or anthropologist who studies our genealogy in a strictly scientific spirit takes no more notice of these tendencies than of the *Almanach de Gotha*. He seeks to discover the naked truth, as it is yielded by the great results of modern science, in which there is no longer any doubt that man is really a descendant of the ape—that is to say, of a long extinct anthropoid ape. As has been pointed out over and over again by distinguished supporters of this opinion, the proofs of it are exceptionally clear and simple—much clearer and simpler than they are in regard to many other mammals. Thus, for instance, the origin of the elephants, the armadilloes, the sirena, or the whales, is a much more difficult problem than the origin of man.

When Huxley published his powerful essay on "Man's Place in Nature" in 1863, he gave it a frontispiece showing the skeletons of man and the four living

anthropoid apes, the Asiatic orang and gibbon, and the African chimpanzee and gorilla. Plate II. in the present work differs from this in giving two young specimens of the orang and the chimpanzee, and raising their size to correspond with the other three skeletons. Candid comparison of these five skeletons shows that they are not only very like each other generally, but are *identical* in the structure, arrangement, and connection of all the parts. The same 200 bones compose the skeleton in man and in the four tailless anthropoid apes, our nearest relatives. The same 300 muscles serve to move the various parts of the skeleton. The same hair covers the skin; the same mammary glands provide food for the young. The same four-chambered heart acts as central pump of the circulation; the same 32 teeth are found in our jaws; the same reproductive organs maintain the species; the same groups of neurona or ganglionic cells compose the wondrous structure of the brain, and accomplish that highest function of the plasm which we call the soul, and many still believe to be an immortal entity. Huxley has thoroughly established this profound truth, and by further comparison with the lower apes and lemurs he came to formulate his important pithecometra principle: "Whatever organ we take, the differences between man and the anthropoid apes are slighter than the corresponding differences between the latter and the lower apes." If we make a superficial comparison of our skeletons of the anthropomorpha, we certainly notice a few salient differences in the size of the various parts; but these are purely quantitative, and

are due to differences in growth, which in turn are caused by adaptation to different environments. There are, as is well known, similar differences between human beings; their arms are sometimes long, sometimes short; the forehead may be high or low, the hair thick or thin, and so on.

These anatomic proofs of the pithecoid theory are most happily supplemented and confirmed by certain recent brilliant discoveries in physiology. Chief amongst these are the famous experiments of Dr. Hans Friedenthal at Berlin. He showed that the human blood acts poisonously on and decomposes the blood of the lower apes and other mammals, but has not that effect on the blood of the anthropoid apes.[1]

From previous transfusion experiments it had been learned that the affinity of mammals is connected to a certain extent with their chemical blood-relationship. If the living blood of two nearly related animals of the same family, such as the dog and the fox, or the rabbit and the hare, is mixed together, the living blood-cells of each species remain uninfluenced. But if we mix the blood of the dog and the rabbit, or the fox and the hare, a struggle for life immediately takes place between the two kinds of blood-cells. The watery fluid or serum destroys the blood-cells of the rodent, and *vice versâ*. It is the same with specimens of the blood of the various primates. The blood of the lower apes and lemurs, which are close to the common root of the primate stem,

[1] See account of similar experiments in the *Lancet*, 18th January, 1902 [Trans.]

has a destructive effect on the blood of the anthropoid apes and man, and *vice versâ*. On the other hand, the human blood has no injurious effect when it is mixed with that of the anthropoid apes.

In recent years these interesting experiments have been continued by other physiologists and physicians, such as Professor Uhlenhuth at Greifswald and Nuttall at London, and they have proved directly the blood-relationship of various mammals. Nuttall studied them carefully in 900 different kinds of blood, which he tested by 16,000 reactions. He traced the gradation of affinity to the lowest apes of the New World; and Uhlenhuth continued as far as the lemurs. By these results the affinity of man and the anthropoid apes, long established by anatomy, has now been proved physiologically to be in real "blood-relationship."[1]

Not less important are the embryological discoveries of the deceased zoologist, Emil Selenka. He made two long journeys to the East Indies, in order to study on the spot the embryology of the Asiatic anthropoid apes, the orang and gibbon. By means of a number of embryos that he collected he showed that certain remarkable peculiarities in the formation of the placenta, that had up to that time been considered as exclusively human, and regarded as a special distinction of our species, were found in just the same way in the closely related anthropoid apes,

[1] Wasmann meets these convincing experiments with mere Jesuitical sophistry. Of the same character is his attack on my *Evolution of Man*, and on the instructive work of Robert Wiedersheim, *Man's Structure as a Witness to his Past*.

though not in the rest of the apes. On the ground of these and other facts, I maintain that the descent of man from extinct Tertiary anthropoid apes is proved just as plainly as the descent of birds from reptiles, or the descent of reptiles from amphibians, which no zoologist hesitates to admit to-day. The relationship is as close as was claimed by my former fellow-student, the Berlin anatomist, Robert Hartmann (with whom I sat at the feet of Johannes Müller fifty years ago), in his admirable work on the anthropoid apes (1883). He proposed to divide the order of primates into two families, the *primarii* (man and the anthropoid apes), and *simianæ* (the real apes, the catarrhine or eastern, and the platyrrhine or western apes).

Since the Dutch physician, Eugen Dubois, discovered the famous remains of the fossil ape-man (*pithecanthropus erectus*) eleven years ago in Java, and thus brought to light "the missing link," a large number of works have been published on this very interesting group of the primates. In this connection we may particularly note the demonstration by the Strassburg anatomist, Gustav Schwalbe, that the previously discovered Neanderthal skull belongs to an extinct species of man, which was midway between the pithecanthropus and the true human being — the *homo primigenus*. After a very careful examination, Schwalbe at the same time refuted all the biassed objections that Virchow had made to these and other fossil discoveries, trying to represent them as pathological abnormalities. In all the important relics of

fossil men that prove our descent from anthropoid apes Virchow saw pathological modifications, due to unsound habits, gout, rickets, or other diseases of the dwellers in the diluvial caves. He tried in every way to impair the force of the arguments for our primate affinity. So in the controversy over the pithecanthropus he raised the most improbable conjectures, merely for the purpose of destroying its significance as a real link between the anthropoid apes and man.

Even now, in the controversy over this important ape-question, amateurs and biassed anthropologists often repeat the false statement that the gap between man and the anthropoid ape is not yet filled up and the "missing link" not yet discovered. This is a most perverse statement, and can only arise either from ignorance of the anatomical, embryological, and paleontological facts, or incompetence to interpret them aright. As a fact, the morphological chain that stretches from the lemurs to the earlier western apes, from these to the eastern tailed apes, and to the tailless anthropoid apes, and from these direct to man, is now uninterrupted and clear. It would be more plausible to speak of missing links between the earliest lemurs and their marsupial ancestors, or between the latter and their monotreme ancestors. But even these gaps are unimportant, because comparative anatomy and embryology, with the support of paleontology, have dissipated all doubt as to the *unity of the mammalian stem*. It is ridiculous to expect paleontology to furnish

an unbroken series of positive data, when we remember how scanty and imperfect its material is.

I cannot go further here into the interesting recent research in regard to special aspects of our simian descent; nor would it greatly advance our object, because all the general conclusions as to man's primate descent remain intact, whichever way we construct hypothetically the special lines of simian evolution. On the other hand, it is interesting for us to see how the most recent form of Darwinism, so happily described by Escherich as "ecclesiastical evolution," stands in regard to these great questions. What does its astutest representative, Father Erich Wasmann, say about them? The tenth chapter of his work, in which he deals at length with "the application of the theory of evolution to man," is a masterpiece of Jesuitical science, calculated to throw the clearest truths into such confusion and so to misrepresent all discoveries as to prevent any reader from forming a clear idea of them. When we compare this tenth chapter with the ninth, in which Wasmann represents the theory of evolution as an irresistible truth on the strength of his own able studies, we can hardly believe that they both came from the same pen—or, rather, we can only understand when we recollect the rule of the Jesuit Congregation: "The end justifies the means." Untruth is permitted and meritorious in the service of God and his Church.

The Jesuitical sophistry that Wasmann employs in order to save man's unique position in Nature, and to prove that he was immediately created by God,

culminates in the antithesis of his two natures. The "purely zoological conception of man," which has been established beyond question by the anatomical and embryological comparison with the ape, is said to fail because it does not take into account the chief feature, his "mental life." It is "psychology that is best fitted to deal with the nature and origin of man." All the facts of anatomy and embryology that I have gathered together in my *Evolution of Man* in proof of the series of his ancestors are either ignored or misconstrued and made ridiculous by Wasmann. The same is done with the instructive facts of anthropology, especially the rudimentary organs, which Robert Wiedersheim has quoted in his *Man's Structure as a Witness to his Past.* It is clear that the Jesuit writer lacks competence in this department; that he has only a superficial and inadequate acquaintance with comparative anatomy and embryology. If Wasmann had studied the morphology and physiology of the mammals as thoroughly as those of the ants, he would have concluded, if he were impartial, that it is just as necessary to admit a monophyletic (or single) origin for the former as for the latter. If, in Wasmann's opinion, the 4,000 species of ants form a single "natural system"—that is to say, descend from one original species—it is just as necessary to admit the same hypothesis for the 6,000 (2,400 living and 3,600 fossil) species of mammals, including the human species.

The severe strictures that I have passed on the

sophisms and trickery of this "ecclesiastical evolution" are not directed against the person and the character of Father Wasmann, but the Jesuitical system which he represents. I do not doubt that this able naturalist (who is personally unknown to me) has written his book in good faith, and has an honourable ambition to reconcile the irreconcilable contradictions between natural evolution and the story of supernatural creation. But this reconciliation of reason and superstition is only possible at the price of a sacrifice of the reason itself. We find this in the case of all the other Jesuits—Fathers Cathrein, Bräun, Besmer, Cornet, Linsmeier, and Muckermann—whose ambiguous "Jesuitical science" is aptly dealt with in the article of R. H. Francé that I mentioned before (No. 22 of the *Freie Wort*, 16th February, 1904, Frankfort).

This interesting attempt of Father Wasmann's does not stand alone. Signs are multiplying that the Church militant is about to enter on a systematic campaign. I heard from Vienna on the 17th of February, that on the previous day (which happened to be my birthday), a Jesuit, Father Giese, had, in a well-received address, admitted not only evolution in general, but even its application to man, and declared it to be reconcilable with Catholic dogmas—and this at a crowded meeting of "catechists"! It is important to note that in a new Catholic cyclopædia, Benziger's *Library of Science*, the first three volumes (issued at Einsiedeln and Cologne, 1904) deal very fully and ably with the chief problems of evolution: the first with

the formation of the earth, the second with spontaneous generation, the third with the theory of descent. The author of them, Father M. Gander, makes most remarkable concessions to our theory, and endeavours to show that they are not inconsistent with the Bible or the dogmatic treatises of the chief fathers and schoolmen. But, though there is a profuse expenditure of sophistical logic in these Jesuitical efforts, Gander will hardly succeed in misleading thoughtful people. One of his characteristic positions is that spontaneous generation (as the development of organised living things by purely material processes) is inconceivable, but that it might be made possible "by a special Divine arrangement." In regard to the descent of man from other animals (which he grants), he makes the reserve that the soul must in any case have been produced by a special creative act.

It would be useless to go through the innumerable fallacies and untruths of these modern Jesuits in detail, and point out the rational and scientific reply. The vast power of this most dangerous religious congregation consists precisely in its device of accepting one part of science in order to destroy the other part more effectively with it. Their masterly act of sophistry, their equivocal "probabilism," their mendacious "reservatio mentalis," the principle that the higher aim sanctifies the worst means, the pernicious casuistry of Liguori and Gury, the cynicism with which they turn the holiest principles to the gratification of their ambition, have impressed on the Jesuits that black

character that Carl Hoensbroech has so well exposed recently.

The great dangers that menace real science, owing to this smuggling into it of the Jesuitical spirit, must not be undervalued. They have been well pointed out by Francé, Escherich, and others. They are all the greater in Germany at the present time, as the Government and the Reichstag are working together to prepare the way for the Jesuits, and to yield a most pernicious influence on the school to these deadly enemies of the free spirit of the country. However, we will hope that this clerical reaction represents only a passing episode in modern history. We trust that one permanent result of it will be the recognition, in principle, even by the Jesuits, of the great idea of evolution. We may then rest assured that its most important consequence, the descent of man from other primate forms, will press on victoriously, and soon be recognised as a beneficent and helpful truth.

CHAPTER III

THE CONTROVERSY OVER THE SOUL

THE IDEAS OF IMMORTALITY AND GOD

EXPLANATION OF PLATE III

EMBRYOS OF THREE MAMMALS AT THREE CORRESPONDING STAGES OF DEVELOPMENT

THE embryos of man (M), the anthropoid ape (gibbon, G), and the bat (rhinolophus, B) can hardly be distinguished in the earlier stage (the upper row), although the five cerebral vesicles, the gill-clefts, and the three higher sense-organs are already visible. On the curved dorsal surface we see the sections of the primitive vertebræ. Even later, when the two pairs of limbs have appeared in the form of roundish fins (the middle row), the differences are not great. It is not until a further development of the limbs and head has taken place (lowest row) that the characteristic forms are clearly seen. It is particularly notable that the primitive brain, the organ of the mind, with its five cerebral vesicles, is the same in all.

CHAPTER III

THE CONTROVERSY OVER THE SOUL

THE IDEAS OF IMMORTALITY AND GOD

THOUGH it was my original intention to deliver only two lectures, I have been moved by several reasons to add a supplementary one. In the first place, I notice with regret that I have been compelled by pressure of time to leave untouched in my earlier lectures, or to treat very inadequately, several important points in my theme; there is, in particular, the very important question of the nature of the soul. In the second place, I have been convinced by the many contradictory press-notices during the last few days that many of my incomplete observations have been misunderstood or misinterpreted. And, thirdly, it seemed advisable to give a brief and clear summary of the whole subject in this farewell lecture, to take a short survey of the past, present, and future of the theory of evolution, and especially its relation to the three great questions of personal immortality, the freedom of the will, and the personality of God.

I must claim the reader's patience and indulgence even to a greater extent than in the previous chapters, as the subject is one of the most difficult and obscure

that the human mind approaches. I have dealt at length in my recent works, *The Riddle of the Universe* and *The Wonders of Life*, with the controversial questions of biology that I treat cursorily here. But I would like to put before you now, in a general survey, the powerful arguments that modern science employs against the prevailing superstition in regard to evolution, and to show that the Monistic system throws a clear light on the great questions of God and the world, the soul and life.

In the previous chapters I have tried to give a general idea of the present state of the theory of evolution and its victorious struggle with the older legend of creation. We have seen that even the most advanced organism, man, was not brought into being by a creative act, but gradually developed from a long series of mammal ancestors. We also saw that the most man-like mammals, the anthropoid apes, have substantially the same structure as man, and that the evolution of the latter from the former can now be regarded as a fully established hypothesis, or, rather, an historical fact. But in this study we had in view mainly the structure of the body and its various organs. We touched very briefly on the evolution of the human mind, or the immaterial soul that dwells in the body for a time, according to a venerable tradition. To-day we turn chiefly to the development of the soul, and consider whether man's mental development is controlled by the same natural laws as that of his body, and whether it also is inseparably bound up with that of the rest of the mammals.

At the very threshold of this difficult province we

encounter the curious fact that there are two radically distinct tendencies in psychology at our universities to-day. On one side we have the metaphysical and professional psychologists. They still cling to the older view that man's soul is a special entity, a unique independent individuality, which dwells for a time only in the mortal frame, leaving it and living on as an immortal spirit after death. This dualistic theory is connected with the doctrine of most religions, and owes its high authority to the fact that it is associated with the most important ethical, social, and practical interests. Plato gave prominence to the idea of the immortality of the soul in philosophy long ago. Descartes at a later date gave emphasis to it by ascribing a true soul to man alone and refusing it to the animals.

This metaphysical psychology, which ruled alone for a considerable period, began to be opposed in the eighteenth, and still more in the nineteenth, century by *comparative psychology*. An impartial comparison of the psychic processes in the higher and lower animals proved that there were numerous transitions and gradations. A long series of intermediate stages connects the psychic life of the higher animals with that of man on the one side, and that of the lower animals on the other. There was no such thing as a sharp dividing line, as Descartes supposed.

But the greatest blow was dealt at the predominant metaphysical conception of the life of the soul thirty years ago by the new methods of *psychophysics*. By means of a series of able experiments the physiologists, Theodor Fechner and Ernst Heinrich Weber of Leipsic, showed

that an important part of the mental activity can be measured and expressed in mathematical formulæ just as well as other physiological processes, such as muscular contractions. Thus the laws of physics control a part of the life of the soul just as absolutely as they do the phenomena of inorganic nature. It is true that psychophysics has only partially realised the very high expectations that were entertained in regard to its Monistic significance; but the fact remains that a part of the mental life is just as unconditionally ruled by physical laws as any other natural phenomena.

Thus *physiological psychology* was raised by psychophysics to the rank of a physical and, in principle, exact science. But it had already obtained solid foundations in other provinces of biology. Comparative psychology had traced connectedly the long gradation from man to the higher animals, from these to the lower, and so on down to the very lowest. At the lowest stage it found those remarkable beings, invisible with the naked eye, that were discovered in stagnant water everywhere after the invention of the microscope (in the second half of the seventeenth century) and called "infusoria." They were first acurately described and classified by Gottfried Ehrenberg, the famous Berlin microscopist. In 1838 he published a large and beautiful work, illustrating on 64 folio pages the whole realm of microscopic life; and this is still the base of all studies of the protists. Ehrenberg was a very ardent and imaginative observer, and succeeded in communicating his zeal for the study of microscopic organisms to his pupils. I still recall with pleasure the

stimulating excursions that I made fifty years ago (in the summer of 1854) with my teacher, Ehrenberg, and a few other pupils — including my student-friend, Ferdinand von Richthofen, the famous geographer — to the Zoological Gardens at Berlin. Equipped with fine nets and small glasses, we fished in the ponds of the Zoological Gardens and in the Spree, and caught thousands of invisible micro-organisms, which then richly rewarded our curiosity by the beautiful forms and mysterious movements they disclosed under the microscope.

The way in which Ehrenberg explained to us the structure and the vital movements of his infusoria was very curious. Misled by the comparison of the real infusoria with the microscopic but highly organised rotifers, he had formed the idea that all animals are alike advanced in organisation, and had indicated this erroneous theory in the very title of his work: *The Infusoria as Perfect Organisms: a Glance at the Deeper Life of Organic Nature.* He thought he could detect in the simplest infusoria the same distinct organs as in the higher animals—stomach, heart, ovaries, kidneys, muscles, and nerves—and he interpreted their psychic life on the same peculiar principle of equally advanced organisation.

Ehrenberg's theory of life was entirely wrong, and was radically destroyed in the hour of its birth (1838) by the cell-theory which was then formulated, and to which he never became reconciled. Once Matthias Schleiden had shown the composition of all the plants,

tissues, and organs from microscopic cells, the last structural elements of the living organism, and Theodor Schwann had done the same for the animal body, the theory attained such an importance that Kölliker and Leydig based on it the modern science of tissues, or histology, and Virchow constructed his cellular pathology by applying it to diseased human beings. These are the most important advances of theoretical medicine. But it was still a long time before the difficult question of the relation of these microscopic beings to the cell was answered. Carl Theodor von Siebold had already maintained (in 1845) that the real infusoria and the closely related rhizopods were *unicellular organisms*, and had distinguished these *protozoa* from the rest of the animals. At the same time, Carl Naegeli had described the lowest algæ as "unicellular plants." But this important conception was not generally admitted until some time afterwards, especially after I brought all the unicellular organisms under the head of "protists" (1872), and defined their psychic functions as the "cell-soul."

I was led to make a very close study of these unicellular protists and their primitive cell-soul through my research on the radiolaria, a very remarkable class of microscopic organisms that float in the sea. I was engaged most of my time for more than thirty of the best years of my life (1856-87) in studying them in every aspect, and if I came eventually to adopt a strictly Monistic attitude on all the great questions of biology, I owe it for the most part to my innumerable observations

and uninterrupted reflections on the wonderful vital movements that are disclosed by these smallest and frailest, and at the same time most beautiful and varied, of living things.

I had undertaken the study of the radiolaria as a kind of souvenir of my great master, Johannes Müller. He had loved to study these animals (of which only a few species were discovered for the first time in the year of my birth, 1834) in the last years of his life, and had in 1855 set up the special group of the rhizopods (protozoa). His last work, which appeared shortly after his death (1858), and contained a description of 50 species of radiolaria, went with me to the Mediterranean when I made my first long voyage in the summer of 1859. I was so fortunate as to discover about 150 new species of radiolaria at Messina, and based on these my first monograph of this very instructive class of protists (1862). I had no suspicion at that time that fifteen years afterwards the deep-sea finds of the famous *Challenger* expedition would bring to light an incalculable wealth of these remarkable animals. In my second monograph on them (1887), I was able to describe more than 4,000 different species of radiolaria, and illustrate most of them on 140 plates. I have given a selection of the prettiest forms on ten plates of my *Art-forms in Nature.*

I have not space here to go into the forms and vital movements of the radiolaria, of the general import of which my friend, Wilhelm Bölsche, has given a very attractive account in his various popular works. I must

restrict myself to pointing out the general phenomena that bear upon our particular subject, the question of the mind. The pretty flinty skeletons of the radiolaria, which enclose and protect the soft unicellular body, are remarkable, not only for their extraordinary gracefulness and beauty, but also for the geometrical regularity and relative constancy of their forms. The 4,000 species of radiolaria are just as constant as the 4,000 known species of ants; and, as the Darwinian Jesuit, Father Wasmann, has convinced himself that the latter have all descended by transformation from a common stem-form, I have concluded on the same principles that the 4,000 species of radiolaria have developed from a primitive form in virtue of adaptation and heredity. This primitive form, the stem-radiolarian (*Actissa*) is a simple round cell, the soft living protoplasmic body of which is divided into two different parts, an inner central capsule (in the middle of which is the solid round nucleus) and an outer gelatinous envelope (*calymma*). From the outer surface of the latter, hundreds and thousands of fine plasmic threads radiate; these are mobile and sensitive processes of the living internal substance, the plasm (or protoplasm). These delicate microscopic threads, or pseudopodia, are the curious organs that effect the sensations (of touch), the locomotion (by pushing), and the orderly construction of the flinty house; at the same time, they maintain the nourishment of the unicellular body, by seizing infusoria, diatoms, and other protists, and drawing them within the plasmic body, where they are digested and

assimilated. The radiolaria generally reproduce by the formation of spores. The nucleus within the protoplasmic globule divides into two small nuclei, each of which surrounds itself with a quantity of plasm, and forms a new cell.

What is this plasm? What is this mysterious "living substance" that we find everywhere as the material foundation of the "wonders of life"? Plasm, or protoplasm, is, as Huxley rightly said thirty years ago, "the physical basis of organic life"; to speak more precisely, it is a chemical compound of carbon that alone accomplishes the various processes of life. In its simplest form the living cell is merely a soft globule of plasm, containing a firmer nucleus. The inner nuclear matter (called caryoplasm) differs somewhat in chemical composition from the outer cellular matter (or cytoplasm); but both substances are composed of carbon, oxygen, hydrogen, nitrogen, and sulphur; both belong to the remarkable group of the albuminates, the nitrogenous carbonates that are distinguished for the extraordinary size of their molecules and the unstable arrangement of the numerous atoms (more than a thousand) that compose them.

There are, however, still simpler organisms in which the nucleus and the body of the cell have not yet been differentiated. These are the *monera*, the whole living body of which is merely a homogeneous particle of plasm (the chromacea and bacteria). The well-known bacteria which now play so important a part as the causes of most dangerous infectious

diseases, and the agents of putrefaction, fermentation, etc., show very clearly that organic life is only a chemical and physical process, and not the outcome of a mysterious "vital force."

We see this still more clearly in our radiolaria, and at the same time they show us unmistakably that even the psychic activity is such a physico-chemical process. All the different functions of their cell-soul, the sense-perception of stimuli, the movement of their plasm, their nutrition, growth, and reproduction, are determined by the particular chemical composition of each of the 4,000 species; and they have all descended, in virtue of adaptation and heredity, from the common stem-form of the naked, round parent-radiolarian (*Actissa*).

We may instance, as a peculiarly interesting fact in the psychic life of the unicellular radiolaria, the extraordinary power of memory in them. The relative constancy with which the 4,000 species transmit the orderly and often very complex form of their protective flinty structure from generation to generation can only be explained by admitting in the builders, the invisible plasma-molecules of the pseudopodia, a fine "plastic sense of distance," and a tenacious recollection of the architectural power of their fathers. The fine, formless plasma-threads are always building afresh the same delicate flinty shells with an artistic trellis-work, and with protective radiating needles and supports always at the same points of their surface. The physiologist, Ewald

Hering (of Leipsic), had spoken in 1870 of memory as "a general function of organised matter." I myself had tried to explain the molecular features of heredity by the memory of the plasma-molecules, in my essay on "The Perigenesis of the Plastidules" (1875). Recently one of the ablest of my pupils, Professor Richard Semon (of Munich; 1904), made a profound study of "Mneme as the principle of constancy in the changes of organic phenomena," and reduced the mechanical process of reproduction to a purely physiological base.

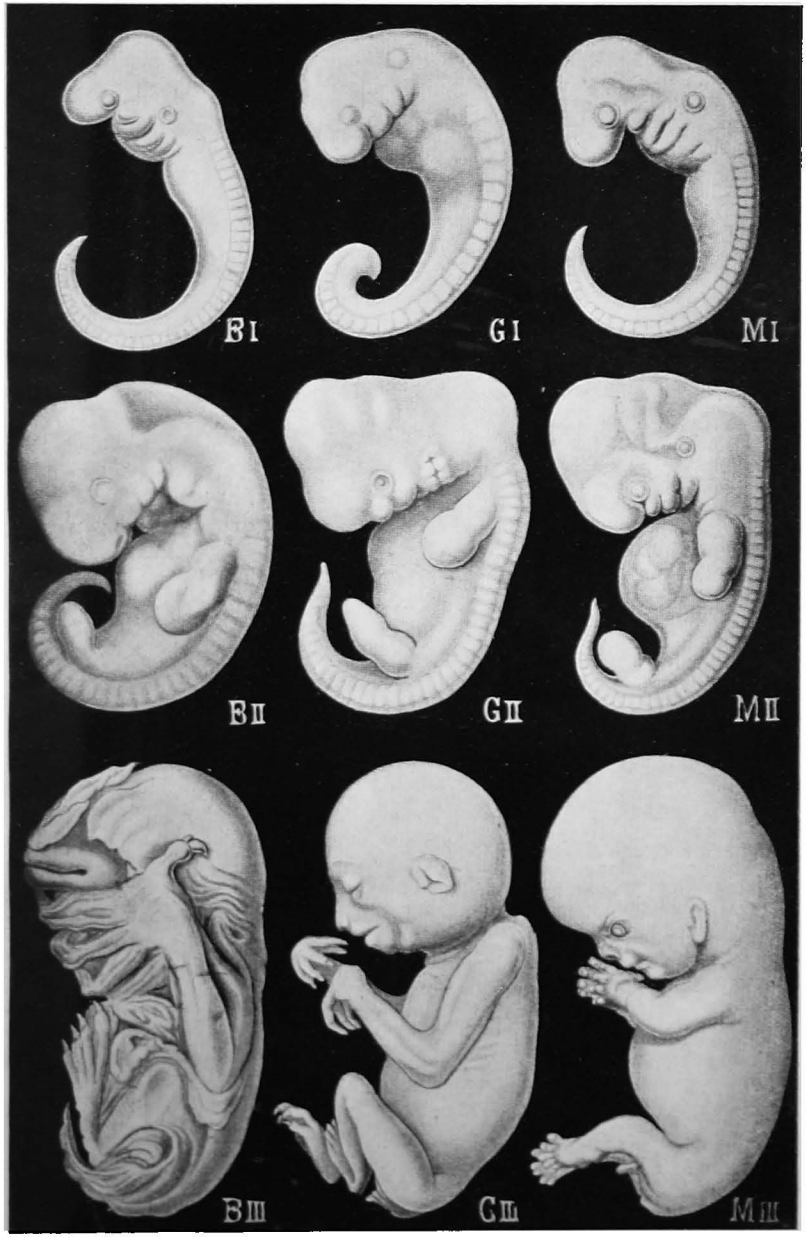
From the cell-soul and its memory in the radiolaria and other unicellular protists, we pass directly to the similar phenomenon in the ovum, the unicellular starting-point of the individual life, from which the complex multicellular frame of all the histona, or tissue-forming animals and plants, is developed. Even the human organism is at first a simple nucleated globule of plasm, about $\frac{1}{125}$ inch in diameter, barely visible to the naked eye as a tiny point. This stem-cell (*cytula*) is formed at the moment when the ovum is fertilised, or mingled with the small male spermatozoon. The ovum transmits to the child by heredity the personal traits of the mother, the sperm-cell those of the father; and this hereditary transmission extends to the finest characteristics of the soul as well as of the body. The modern research as to heredity, which occupies so much space now in biological literature, but was only started by Darwin in 1859, is directed immediately to the visible material processes of impregnation.

The very interesting and important phenomena of impregnation have only been known to us in detail for thirty years. It has been shown conclusively, after a number of delicate investigations, that the individual development of the embryo from the stem-cell or fertilised ovum is controlled by the same laws in all cases. The stem-cell divides and subdivides rapidly into a number of simple cells. From these a few simple organs, the germinal layers, are formed at first; later on the various organs, of which there is no trace in the early embryo, are built up out of these. The biogenetic law teaches us how, in this development, the original features of the ancestral history are reproduced or recapitulated in the embryonic processes; and these facts in turn can only be explained by the unconscious memory of the plasm, the "*mneme* of the living substance" in the germ-cells, and especially in their nuclei.

One important result of these modern discoveries was the prominence given to the fact that the personal soul has a beginning of existence, and that we can determine the precise moment in which this takes place; it is when the parent cells, the ovum and spermatozoon, coalesce. Hence what we call the soul of man or the animal has not pre-existed, but begins its career at the moment of impregnation; it is bound up with the chemical constitution of the plasm, which is the material vehicle of heredity in the nucleus of the maternal ovum and the paternal spermatozoon. One cannot see how a being that thus has a beginning of existence can afterwards prove to be "immortal."

EMBRYOS OF THREE MAMMALS

(At three corresponding stages of development).



B = BAT (Rhinolophus) G = GIBBON (Hylobates) M = MAN (Homo)

To face page 96. SEE PAGE 84.

Further, a candid examination of the simple cell-soul in the unicellular infusoria, and of the dawn of the individual soul in the unicellular germ of man and the higher animals, proves at once that psychic action does not necessarily postulate a fully formed nervous system, as was previously believed. There is no such system in many of the lower animals, or any of the plants, yet we find psychic activities, especially sensation, irritability, and reflex action everywhere. All living plasm has a psychic life, and in this sense the psyche is a partial function of organic life generally. But the higher psychic functions, particularly the phenomena of consciousness, only appear gradually in the higher animals, in which (in consequence of a division of labour among the organs) the nervous system has assumed these functions.

It is particularly interesting to glance at the central nervous system of the vertebrates, the great stem of which we regard ourselves as the crowning point. Here again the anatomical and embryological facts speak a clear and unambiguous language. In all vertebrates, from the lowest fishes up to man, the psychic organ makes its appearance in the embryo in the same form—a simple cylindrical tube on the dorsal side of the embryonic body, in the middle line. The anterior section of this "medullary tube" expands into a club-shaped vesicle, which is the beginning of the brain; the posterior and thinner section becomes the spinal cord. The cerebral vesicle divides, by transverse constrictions, into three, then four, and eventually five vesicles. The most important of these is the first, the *cerebrum*, the

organ of the highest psychic functions. The more the intelligence develops in the higher vertebrates, the larger, more voluminous, and more specialised does the cerebrum become. In particular, the grey mantle or cortex of the cerebrum, its most important part, only attains in the higher mammals the degree of quantitative and qualitative development that qualifies it to be the "organ of mind" in the narrower sense. Through the famous discoveries of Paul Flechsig eleven years ago we were enabled to distinguish eight fields in the cortex, four of which serve as the internal centres of sense-perception, and the four that lie between these are the thought-centres (or association-centres) of the higher psychic faculties—the association of impressions, the formation of ideas and concepts, induction and deduction. This real organ of mind, the *phronema*, is not yet developed in the lower mammals. It is only gradually built up in the more advanced, exactly in proportion as their intelligence increases. It is only in the most intelligent forms of the placentals, the higher ungulates (horse, elephant), the carnivores (fox, dog), and especially the primates, that the phronema attains the high grade of development that leads us from the anthropoid apes direct to the savage, and from him to civilised man.

We have learned a good deal about the special significance of the various parts of the brain, as organs of specific functions, by the progress of the modern science of experimental physiology. Careful experiments by Goltz, Munk, Bernard, and many other physiologists,

have shown that the normal consciousness, speech, and the internal sense-perceptions, are connected with definite areas of the cortex, and that these various *parts of the soul* are destroyed when the organic areas connected with them are injured. But in this respect Nature has unconsciously given us the most instructive experiments. Diseases in these various areas show how their functions are partially or totally extinguished when the cerebral cells that compose them (the *neurona* or ganglionic cells) are partially or entirely destroyed. Here again Virchow, who was the first to make a careful microscopic study of the finest changes in the diseased cells, and so explain the nature of the disease, did pioneer work. I still remember very well a spectacle of this kind (in the summer of 1855, at Würzburg), which made a deep impression on me. Virchow's sharp eye had detected a small suspicious spot in the cerebrum of a lunatic, though there seemed to be nothing remarkable about it on superficial examination. He handed it to me for microscopic examination, and I found that a large number of the ganglionic cells were affected, partly by fatty degeneration and partly by calcification. The luminous remarks that my great teacher made on these and similar finds in other cases of mental disorder, confirmed my conviction of the unity of the human organism and the inseparable connection of mind and body, which he himself at that time expressly shared. When he abandoned this Monistic conception of the psychic life for Dualism and Mysticism twenty years afterwards (especially after his Munich speech in 1877), we must attribute

this partly to his psychological metamorphosis, and partly to the political motives of which I spoke in the last chapter.

We find another series of strong arguments in favour of our Monistic psychology in the individual development of the soul in the child and the young animal. We know that the new-born child has as yet no consciousness, no intelligence, no independent judgment and thought. We follow the gradual development of these higher faculties step by step in the first years of life, in strict proportion to the anatomical development of the cortex with which they are bound up. The inquiries into the child-soul which Wilhelm Preyer began in Jena twenty-five years ago, his careful "observations of the mental development of man in his early years," and the supplementary research of several more recent physiologists, have shown, from the ontogenetic side, that the soul is not a special immaterial entity, but the sum-total of a number of connected functions of the brain. When the brain dies, the soul comes to an end.

We have further proof in the stem-history of the soul, which we gather from the comparative psychology of the lower and higher mammals, and of savage and civilised races. Modern ethnography shows us in actual existence the various stages through which the mind rose to its present height. The most primitive races, such as the Veddahs of Ceylon, or the Australian natives, are very little above the mental life of the anthropoid apes. From the higher savages we pass by a complete gradation of stages to the most civilised

races. But what a gulf there is, even here, between the genius of a Goethe, a Darwin, or a Lamarck, and an ordinary philisthine or third-rate official. All these facts point to one conclusion: the human soul has only reached its present height by a long period of gradual evolution; it differs in degree, not in kind, from the soul of the higher mammals; and thus it cannot in any case be immortal.

That a large number of educated people still cling to the dogma of personal immortality in spite of these luminous proofs, is owing to the great power of conservative tradition and the evil methods of instruction that stamp these untenable dogmas deep on the growing mind in early years. It is for that very reason that the Churches strive to keep the schools under their power at any cost; they can control and exploit the adults at will, if independent thought and judgment have been stifled in the earlier years.

This brings us to the interesting question: What is the position of the "ecclesiastical evolution" of the Jesuits (the "latest course of Darwinism"), as regards this great question of the soul? Man is, according to Wasmann, the image of God and a unique, immaterial being, differing from all other animals in the possession of an immortal soul, and therefore having a totally different origin from them. Man's immortal soul is, according to this Jesuit sophistry, "spiritual and sensitive," while the animal soul is sensitive only. God has implanted his own spirit in man, and associated

it with an animal soul for the period of life. It is true that Wasmann believes even man's body to have been created directly by God; but, in view of the overwhelming proofs of our animal descent, he leaves open the possibility of a development from a series of other animals, in which case the Divine spirit would be breathed into him in the end. The Christian Fathers, who were much occupied with the introduction of the soul into the human embryo, tell us that the immortal soul enters the soulless embryo on the fortieth day after conception in the case of the boy, and on the eightieth day in the case of the girl. If Wasmann supposes that there was a similar introduction of the soul in the development of the race, he must postulate a moment in the history of the anthropoid apes when God sent his spirit into the hitherto unspiritual soul of the ape.

When we look at the matter impartially in the light of pure reason, the belief in immortality is wholly inconsistent with the facts of evolution and of physiology. The ontogenetic dogma of the older Church, that the soul is introduced into the soulless body at a particular moment of its embryonic development, is just as absurd as the phylogenetic dogma of the most modern Jesuits, that the Divine spirit was breathed into the frame of an anthropoid ape at a certain period (in the Tertiary period), and so converted it into an immortal soul. We may examine and test this belief as we will, we can find in it nothing but a piece of mystic superstition. It is maintained solely by the great power of tradition and

the support of Conservative governments, the leaders of which have no personal belief in these "revelations," but cling to the practical conviction that throne and altar must support each other. They unfortunately overlook the circumstance that the throne is apt to become merely the footstool to the altar, and that the Church exploits the State for its own, not the State's, good.

We learn further, from the history of this dogma, that the belief in immortality did not find its way into science until a comparatively late date. It is not found in the great Monistic natural philosophers who, six centuries before the time of Christ, evinced a profound insight into the real nature of the world. It is not found in Democritus and Empedocles, in Seneca and Lucretius Carus. It is not found in the older Oriental religions, Buddhism, the ancient religion of the Chinese, or Confucianism; in fact, there is no question of individual persistence after death in the Pentateuch or the earlier books of the Old Testament (which were written before the Babylonian Exile). It was Plato and his pupil, Aristotle, that found a place for it in their dualistic metaphysics; and its agreement with the Christian and Mohammedan teaching secured for it a very widespread acceptance.

Another psychological dogma, the belief in man's free-will, is equally inconsistent with the truth of evolution. Modern physiology shows clearly that the will is never really free in man or in the animal, but determined by the organisation of the brain; this in turn

is determined in its individual character by the laws of heredity and the influence of the environment. It is only because the *apparent* freedom of the will has such a great practical significance in the province of religion, morality, sociology, and law, that it still forms the subject of the most contradictory claims. Theoretically, determinism, or the doctrine of the necessary character of our volitions, was established long ago.

With the belief in the absolute freedom of the will and the personal immortality of the soul is associated, in the minds of many highly educated people, a third article of faith, the belief in a personal God. It is well known that this belief, often wrongly represented as an indispensable foundation of religion, assumes the most widely varied shapes. As a rule, however, it is an open or covert anthropomorphism. God is conceived as the "Supreme Being," but turns out, on closer examination, to be an idealised man. According to the Mosaic narrative, "God made man to his own image and likeness," but it is usually the reverse; "Man made God according to his own image and likeness." This idealised man becomes creator and architect and produces the world, forming the various species of plants and animals like a modeller, governing the world like a wise and all-powerful monarch, and, at the "Last Judgment," rewarding the good and punishing the wicked like a rigorous judge. The childish conceptions of this extramundane God, who is set over against the world as an independent being, the personal creator, maintainer, and ruler of all things, are quite incompatible

with the advanced science of the nineteenth century, especially with its two greatest triumphs, the law of substance and the law of Monistic evolution.

Critical philosophy, moreover, long ago pronounced its doom. In the first place, the most famous critical thinker, Immanuel Kant, proved in his *Critique of Pure Reason* that absolute science affords no support to the three central dogmas of metaphysics, the personal God, the immortality of the soul, and the freedom of the will. It is true that he afterwards (in the course of his dualistic and dogmatic metamorphosis) taught that we must *believe* these three great mystic forces, and that they are indispensable postulates of practical reason; and that the latter must take precedence over pure reason. Modern German philosophy, which clamours for a "return to Kant," sees his chief distinction in this impossible reconciliation of polar contradictions. The Churches, and the ruling powers in alliance with them, accord a welcome to this diametrical contradiction, recognised by all candid readers of the Königsberg philosopher, between the two reasons. They use the confusion that results for the purpose of putting the light of the creeds in the darkness of doubting reason, and imagine that they save religion in this way.

Whilst we are engaged with the important subject of religion, we must refute the charge, often made, and renewed of recent years, that our Monistic philosophy and the theory of evolution that forms its chief foundation destroy religion. It is only opposed to

those lower forms of religion that are based on superstition and ignorance, and would hold man's reason in bondage by empty formalism and belief in the miraculous, in order to control it for political purposes. This is chiefly the case with Romanism or Ultramontanism, that pitiful caricature of pure Christianity that still plays so important a part in the world. Luther would turn in his grave if he could see the predominance of the Roman Centre party in the German Empire to-day. We find the papacy, the deadly enemy of Protestant Germany, controlling its destiny, and the Reichstag submitting willingly to be led by the Jesuits. Not a voice do we hear raised in it against the three most dangerous and mischievous institutions of Romanism—the obligatory celibacy of the clergy, the confessional, and indulgences. Though these later institutions of the Roman Church have nothing to do with the original teaching of the Church and pure Christianity; though their immoral consequences, so prejudicial to the life of the family and the State, are known to all, they exist just as they did before the Reformation. Unfortunately, many German princes foster the ambition of the Roman clergy, making their "Canossa-journey" to Rome, and bending the knee to the great charlatan at the Vatican.

It is also very regrettable that the increasing tendency to external show and festive parade at what is called "the new court" does grave injury to real and inner religion. We have a striking instance of this external religion in the new cathedral at Berlin, which many

would have us regard as "Catholic,' not Protestant and Evangelical. I often met in India priests and pilgrims who believed they were pleasing their God by turning prayer-wheels, or setting up prayer-mills that were set in motion by the wind. One might utilise the modern invention of automatic machines for the same purposes, and set up praying automata in the new cathedral, or indulgence-machines that would give relief from lighter sins for one mark [shilling], and from graver sins for twenty marks. It would prove a great source of revenue to the Church, especially if similar machines were set up in the other churches that have lately been erected in Berlin at a cost of millions of marks. It would have been better to have spent the money on schools.

These observations on the more repellent characters of modern orthodoxy and piety may be taken as some reply to the sharp attacks to which I have been exposed for forty years, and which have lately been renewed with great violence. The spokesmen of Catholic and Evangelical beliefs, especially the Romanist *Germania* and the Lutheran *Reichsbote*, have vied with each other in deploring my lectures as "a desecration of this venerable hall," and in damning my theory of evolution —without, of course, making any attempt to repute its scientific truth. They have, in their Christian charity, thought fit to put sandwich-men at the doors of this room, to distribute scurrilous attacks on my person and my teaching to those who enter. They have made a generous use of the fanatical calumnies that the court

chaplain, Stöcker, the theologian, Loofs, the philologist, Dennert, and other opponents of my *Riddle of the Universe*, have disseminated, and to which I make a brief reply at the end of that work. I pass by the many untruths of these zealous protagonists of theology. We men of science have a different conception of truth from that which prevails in ecclesiastical circles.[1]

As regards the relation of science to Christianity, I will only point out that it is quite irreconcilable with the mystic and supernatural Christian beliefs, but that it fully recognises the high ethical value of Christian morality. It is true that the highest commands of the Christian religion, especially those of sympathy and brotherly love, are not discoveries of its own; the golden rule was taught and practised centuries before the time of Christ. However, Christianity has the distinction of preaching and developing it with a fresh force. In its time it has had a beneficial influence on the

[1] I may remind those who think that the hall of the Musical Academy is "desecrated" by my lectures, that it was in the very same place that Alexander von Humboldt delivered, seventy-seven years ago (1828), the remarkable lectures that afterwards made up his *Cosmos*. The great traveller, whose clear mind had recognised the unity of Nature, and had, with Goethe, discovered therein the real knowledge of God, endeavoured to convey his thoughts in popular form to the educated Berlin public, and to establish the universality of natural law. It was my aim to establish, as regards the organic world, precisely what Humboldt had proved to exist in inorganic nature. I wanted to show how the great advance of modern biology (since Darwin's time) enables us to solve the most difficult of all problems, the historical development of plants and animals in humanity. Humboldt in his day earned the most lively approval and gratitude of all free-thinking and truth-seeking men, and the displeasure and suspicion of the orthodox and conservative courtiers at Berlin.

development of civilisation, though in the Middle Ages the Roman Church became, with its Inquisition, its witch-drowning, its burning of heretics, and its religious wars, the bloodiest caricature of the gentle religion of love. Orthodox *historical* Christianity is not directly destroyed by modern science, but by its own learned and zealous theologians. The enlightened Protestantism that was so effectively advocated by Schleiermacher in Berlin eighty years ago, the later works of Feuerbach, the inquiries into the life of Jesus of David Strauss and Ernest Renan, the lectures recently delivered here by Delitzsch and Harnack, have left very little of what strict orthodoxy regards as the indispensable foundations of historical Christianity. Kalthoff, of Bremen, goes so far as to declare that all Christian traditions are myths, and that the development of Christianity is a necessary outcome of the civilisation of the time.

In view of this broadening tendency in theology and philosophy at the beginning of the twentieth century, it is an unfortunate anachronism that the Ministers of Public Instruction of Prussia and Bavaria sail in the wake of the Catholic Church, and seek to instil the spirit of the Jesuits in both lower and higher education. It is only a few weeks since the Prussian Minister of Worship made a dangerous attempt to suppress academic freedom, the palladium of mental life in Germany. This increasing reaction recalls the sad days of the eighteenth and nineteenth centuries, when thousands of the finest citizens of Germany migrated to North America, in order to develop their mental powers in

a free atmosphere. This selective process formed a blessing to the United States, but it was certainly very injurious to Germany. Large numbers of weak and servile characters and sycophants were thus favoured. The fossilised ideas of many of our leading jurists seem to take us back sometimes to the Cretaceous and Jurassic periods, while the palæozoic rhetoric of our theologians and synods even goes back to the Permian and Carboniferous epochs.

However, we must not take too seriously the anxiety that this increasing political and clerical reaction causes us. We must remember the vast resources of civilisation that are seen to-day in our enormous international intercourse, and must have confidence in the helpful exchange of ideas between east and west that is being effected daily by our means of transit. Even in Germany the darkness that now prevails will at length give place to the dazzling light of the sun. Nothing, in my opinion, will contribute more to that end than the unconditional victory of the idea of evolution.

Beside the law of evolution, and closely connected with it, we have that great triumph of modern science, the law of substance—the law of the conservation of matter (Lavoisier, 1789), and of the conservation of energy (Robert Mayer, 1842). These two laws are irreconcilable with the three central dogmas of metaphysics, which so many educated people still regard as the most precious treasures of their spiritual life — the belief in a personal God, the

personal immortality of the soul, and the liberty of the human will. But these great objects of belief, so intimately bound up with numbers of our treasured achievements and institutions, are not on that account driven out of the world. They merely cease to pose as truths in the realm of pure science. As imaginative creations, they retain a certain value in the world of poetry. Here they will not only, as they have done hitherto, furnish thousands of the finest and most lofty motives for every branch of art — sculpture, painting, or music—but they will still have a high ethical and social value in the education of the young and in the organisation of society. Just as we derive artistic and ethical inspiration from the legends of classical antiquity (such as the Hercules myth, the *Odyssey* and the *Iliad*) and the story of William Tell, so we will continue to do in regard to the stories of the Christian mythology. But we must do the same with the poetical conceptions of other religions, which have given the most varied forms to the transcendental ideas of God, freedom, and immortality.

Thus the noble warmth of art will remain, together with—not in opposition to, but in harmony with—the splendid light of science, one of the most precious possessions of the human mind. As Goethe said: "He who has science and art has religion; he who has not these two had better have religion." Our Monistic system, the "connecting link between religion and science," brings God and the world into unity in the sense that Goethe willed, the sense that Spinoza clearly

expressed long ago and Giordano Bruno had sealed with his martyrdom. It has been said repeatedly of late that Goethe was an orthodox Christian. A few years ago a young orator quoted him in support of the wonderful dogmas of the Christian religion. We may point out that Goethe himself expressly said he was "a decided non-Christian." The "great heathen of Weimar" has given the clearest expression to his Pantheistic views in his noblest poems, *Faust*, *Prometheus*, and *God and the World*. How could so vigorous a thinker, in whose mind the evolution of organic life ran through millions of years, have shared the narrow belief of a Jewish prophet and enthusiast who sought to give up his life for humanity 1,900 years ago?

Our Monistic god, the all-embracing essence of the world, the Nature-god of Spinoza and Goethe, is identical with the eternal, all-inspiring energy, and is one, in eternal and infinite substance, with space-filling matter. It "lives and moves in all things," as the Gospel says. And as we see that the law of substance is universal, that the conservation of matter and of energy is inseparably connected, and that the ceaseless development of this substance follows the same "eternal iron laws," we find God in natural law itself. The will of God is at work in every falling drop of rain and every growing crystal, in the scent of the rose and the spirit of man.

APPENDIX

EVOLUTIONARY TABLES

I.—GEOLOGICAL AGES AND PERIODS

Ages in the Organic History of the Earth.	Periods of Geology.	Vertebrate Fossils.	Approximate length of Paleontological Periods.
I. Archeozoic age (primordial) Age of invertebrates	1. Laurentian 2. Huronian 3. Cambrian	No fossil remains of vertebrates	52 million years Sedimentary strata 63,000 ft. thick
II. Paleozoic age (primary) Age of fishes	4. Silurian 5. Devonian 6. Carboniferous 7. Permian	Fishes Dipneusts Amphibia Reptiles	34 million years Sedimentary strata 41,200 ft. thick
III. Mesozoic age (secondary) Age of reptiles	8. Triassic 5. Jurassic 10. Cretaceous	Monotremes Marsupials *Mallotheria* Pro-placentals	11 million years Sedimentary strata 12,200 ft. thick
IV. Cenozoic age (tertiary) Age of mammals	11. Eocene 12. Oligocene 13. Miocene 14. Pliocene	*Prosimiæ* Lemurs *Cynopitheca* Baboons *Anthropoides* Man-like apes *Pithecanthropi* Ape-men	3 million years 3,600 ft. thick
V. Anthropozoic age (quaternary) Age of man	15. Glacial 16. Post-glacial	Pre-historic man Savage and civilised man	300,000 years Sedimentary strata little thickness

2A.—MAN'S GENEALOGICAL TREE—*First Half*

EARLIER ANCESTRAL SERIES, WITHOUT FOSSIL REMAINS, BEFORE THE SILURIAN PERIOD

Chief Stages.	Ancestral Stem-Groups.	Living Relatives of our Ancestors.	Paleontology.	Ontogeny.	Morphology.
Stages 1—5: PROTIST-ANCESTORS Unicellular organisms	1. MONERA (Plasmodoma) without nuclei	1. CHROMACEA (*Chroococcus*) *Phycochromacea*	O	!?	I
	2. ALGARIA Unicellular algæ with nuclei	2. PAULOTOMEA *Palmellacea* *Eremosphaera*	O	!?	I
1—2: Plasmodomous Protophyta	3. LOBOSA Unicellular (Amœboid) Rhizopods	3. AMŒBINA *Amœba* *Lecocyta*	O	!!	II
3—5: Plasmophagous Protozoa	4. INFUSORIA (Unicellular)	4. FLAGELLATA *Euflagellata* *Zoomonades*	O	?	II
	5. BLASTÆADES Multicellular cell-colonies	5. CATALLACTA *Magosphaera* *Volvocina* *Blastula?*	O	!!!	III
Stages 6—11: INVERTEBRATE METAZOA-ANCESTORS 6—8: Cœlenteria, without anus or body-cavity	6. GASTRÆADES with two germinal layers	6. GASTRULA *Hydra, Olynthus, Orthonectida*	O	!!!	III
	7. PLATODES I. *Platodaria* (without nephridia)	7. CRYPTOCŒLA (*Convoluta*) (*Proporus*)	O	?	I
	8. PLATODES II. *Platodinia* (with nephridia)	8. RHABDOCŒLA (*Vortex*) (*Monotus*)	O	?	I
9—11: Vermalia, with anus and body-cavity	9. PROVERMALIA *Rotatoria* Primitive worms	9. GASTROTRICHA *Trochozoa* *Trochophora*	O	?	I
	10. FRONTONIA (*Rhynchelminthes*) Snouted worms	10. ENTEROPNEUSTA *Balanoglossus* *Cephalodiscus*	O	?	I
	11. PROCHORDONIA Worms with chorda	11. COPELATA *Appendicaria*	O	!!	II
Stages 12—15: MONORRHINA-ANCESTORS Earliest vertebrates, without jaws or pairs of limbs, with single nostril	12. ACRANIA I. (Prospondylia)	12. LARVÆ OF AMPHIOXUS	O	!!!	II
	13. ACRANIA II. Later skull-less animals	13. LEPTOCARDIA Amphioxus (Lancelet)	O	!	III
	14. CYCLOSTOMA I. (Archicrania)	14. LARVÆ OF PETROMYZON	O	!!!	II
	15. CYCLOSTOMA II. Later round-mouthed animals	15. MARSIPOBRANCHIA Myxinoides Petromyzontes	O	!	II

2B.—MAN'S GENEALOGICAL TREE—*Second Half*

LATER ANCESTRAL SERIES, WITH FOSSIL REMAINS, BEGINNING IN THE SILURIAN

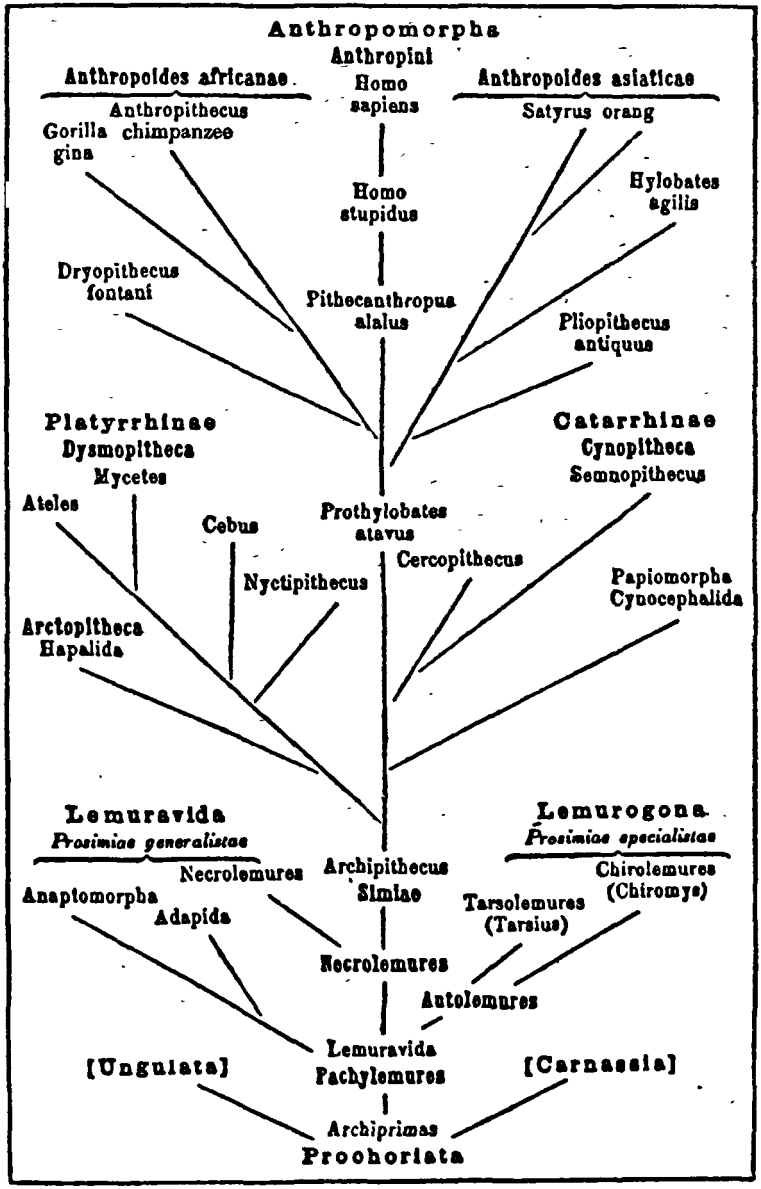
Geological Periods.	Stem-Groups of Ancestors.	Living Relatives of our Ancestors.	Palæontology.	Ontogeny.	Morphology.
Silurian	16. SELACHII Primitive fishes *Proselachii*	16. NOTIDANIDES Chlamydoselachus Heptanchus	I	! !	III
Silurian	17. GANOIDES Plated fishes *Proganoides*	17. ACCIPENSERIDES Sturgeon, Polypterus	II	!	II
Devonian	18. DIPNEUSTA *Paladipneusta*	18. NEODIPNEUSTA Ceratodus, Protopterus	I	! !	II
Carboniferous	19. AMPHIBIA *Stegocephala*	19. PHANEROBRANCHIA and Salamandrina (Proteus, Triton)	III	! ! !	III
Permian	20. REPTILIA *Proreptilia*	20. RHYNCOCEPHALIA Primitive lizards Hatteria	III	! !	II
Triassic	21. MONOTREMA *Promammalia*	21. ORNITHODELPHIA Echnida Ornithorhyncus	I	! ! !	III
Jurassic	22. MARSUPIALIA *Prodidelphia*	22. DIDELPHIA Didelphys, Perameles	I	! !	II
Cretaceous	23. MALLOTHERIA *Prochoriata*	23. INSECTIVORA Erinaceida (Ictopsida+)	III	!	
Older Eocene	24. LEMURAVIDA Earlier lemurs Dent. 3, 1, 4, 3	24. PACHYLEMURES (*Hypopsodus*+) (*Adapis*+)	III	? ?	II
Later Eocene	25. LEMUROGONA Later lemurs Dent. 2, 1, 4, 3	25. AUTOLEMURES (*Eulemur*) (*Stenops*)	II	! ?	II
Oligocene	26. DYSMOPITHECA Western apes Dent. 2, 1, 3, 3	26. PLATYRRHINÆ (*Anthropops*+) (*Homunculus*+)	I	!	II
Older Miocene	27. CYNOPITHECA Baboons (tailed)	27. PAPIOMORPHA (*Cynocephalus*)	I	!	III
Later Miocene	28. ANTHROPOIDES Anthropoid apes (tailless)	28. HYLOBATIDA Hylobates Satyrus	I	! !	III
Pliocene	29. PITHECANTHROPI Ape-like men (alali = speechless)	29. ANTHROPITHECA Chimpanzee Gorilla	II	! ! !	III
Pleistocene	30. HOMINES (loquaces = with speech)	30. WEDDAHS Australian natives	I	! ! !	III

3.—CLASSIFICATION OF THE PRIMATES.

N.B.—* indicates extinct forms, † living groups, ‡ the hypothetical stem-form. *Cf. History of Creation*, chap. xxvii. ; *Evolution of Man*, chap. xxiii.

Orders.	Sub-Orders.	Families.	Genera.
I PROSIMIAE Lemurs (Hemipitheci) The orbits imperfectly separated from the temporal depression by a bony arch. Womb double or two-horned. Placenta diffuse, indeciduate (as a rule). Cerebrum relatively small, smooth, or little furrowed.	1. LEMURAVIDA (*Palalemures*) Early lemurs (generalists) Originally with claws on all or most fingers: later transition to nails. Tarsus primitive.	1. PACHYLEMURES* (*Hypopsodina*) Dent. $44=\frac{3}{3}\cdot\frac{1}{1}\cdot\frac{4}{4}\cdot\frac{3}{3}$ Primitive dentition	*Archiprimas*‡ *Lemuravus** Early Eocene *Pelycodus** Early Eocene *Hypopsodus** Late Eocene
		2. NECROLEMURES (*Anaptomorpha*) Dent. $40=\frac{2}{2}\cdot\frac{1}{1}\cdot\frac{4}{4}\cdot\frac{3}{3}$ Reduced dentition	*Adapis** *Plesiadapis** Necrolemur*
	2. LEMUROGONA (*Neolemures*) Modern lemures (specialists) All fingers usually have nails (except the second toe). Tarsus modified	3. AUTOLEMURES† (*Lemurida*) Dent. $36=\frac{2}{2}\cdot\frac{1}{1}\cdot\frac{3}{3}\cdot\frac{3}{3}$ Specialised dentition	*Eulemur* *Hapalemur* *Lepilemur* *Nycticebus* *Stenops* *Galago*
		4. CHIROLEMURES† (*Chiromyida*) Dent. $18=\frac{1}{1}\cdot\frac{0}{0}\cdot\frac{1}{0}\cdot\frac{3}{3}$ Rodent dentition	*Chiromys* (Claws on all fingers except first)
II SIMIAE Apes (*Pitheci* or *simiales*) Orbits completely separated from the temporal depression by a bony septum. Womb simple, pear-shaped. Placenta discoid, deciduate. Cerebrum relatively large and much furrowed.	3. PLATYRRHINAE Flat-nosed apes *Hesperopitheca* Western apes (American) Nostrils lateral, with wide partition 3 premolars	5. ARCTOPITHECA† Dent. $32=\frac{2}{2}\cdot\frac{1}{1}\cdot\frac{3}{3}\cdot\frac{2}{2}$ Nail on hallux only	*Hapale* *Midas*
		6. DYSMOPITHECA† Dent. $36=\frac{2}{2}\cdot\frac{1}{1}\cdot\frac{3}{3}\cdot\frac{3}{3}$ Nails on all fingers	*Callithrix* *Nyctipithecus* *Cebus* *Mycetes* *Ateles*
	4. CATARRHINAE Narrow-nosed apes *Eopitheca* Eastern apes (Arctogoea) Europe, Asia, and Africa. Nostrils forward, with narrow septum 2 premolars Nails on all fingers	7. CYNOPITHECA† Dent. $32=\frac{2}{2}\cdot\frac{1}{1}\cdot\frac{2}{2}\cdot\frac{3}{3}$ Generally with tail and cheek-pouches Sacrum with 3 or 4 vertebræ	*Cynocephalus* *Cercopithecus* *Inuus* *Semnopithecus* *Colobus* *Nasalis*
		8. ANTHROPOMORPHA† Dent. $32=\frac{2}{2}\cdot\frac{1}{1}\cdot\frac{2}{2}\cdot\frac{3}{3}$ No tail or cheek-pouches Sacrum with 5 vertebræ	*Hylobates* *Satyrus* *Phopithecus** *Gorilla* *Anthropithecus* *Dryopithecus** *Pithecanthropus** *Homo*

4.—GENEALOGICAL TREE OF THE PRIMATES



EXPLANATION OF GENEALOGICAL TABLE I

CHRONOMETRIC REDUCTION OF BIOGENETIC PERIODS

THE enormous length of the biogenetic periods (*i.e.*, the periods during which organic life has been evolving on our planet) is still very differently estimated by geologists and paleontologists astronomers and physicists, because the empirical data of the calculation are very incomplete and admit great differences of estimate. However, most modern experts aver that their length runs to 100 and 200 million years (some say double this, and even more). If we take the lesser figure of 100 millions, we find this distributed over the five chief periods of organic geology very much as is shown on Table I. In order to get a clearer idea of the vast duration of these evolutionary periods, and to appreciate the relative shortness of the "historical period," Dr. H. Schmidt (Jena) has reduced the 100,000,000 years to a day. In this scheme the twenty-four hours of "creation-day" are distributed as follows over the five evolutionary periods:

I. Archeozoic period (52 million years)	= 12h. 30m.
II. Paleozoic period (34 million years)	= 8h. 7m.
III. Mesozoic period (11 million years)	= 2h. 38m.
IV. Cenozoic period (3 million years)	= 43m.
V. Anthropozoic period (0·1-0·2 million years)	= 2m.

If we put the length of the "historic period" at 6,000 years, it only makes *five seconds* of "creation-day"; the Christian era would amount to *two* seconds.

POSTSCRIPT

EVOLUTION AND JESUITISM

THE relation of the theory of evolution to the teaching of the Jesuits is in many respects so important and so liable to misunderstanding that I have felt it very desirable to make it clear in the present work. I have, I think, clearly showed that the two doctrines are diametrically and irreconcilably opposed, and that the attempt of the modern Jesuits to reconcile the two antagonists is mere sophistry. I wrote with special reference to the works of the learned Jesuit, Father Erich Wasmann, not only because that writer deals with the subject more ably and comprehensively than most of his colleagues, but because he is more competent to make a scientific defence of his views on account of his long studies of the ants and his general knowledge of biology. He has made a vigorous reply to my strictures in an "open letter" to me, which appeared on 2nd May, 1905, in the Berlin (or Roman) *Germania*, and in the *Kölnische Volkszeitung*.

The sophistical objections that Wasmann raises to my lectures, and his misleading statement of the most important problems, oblige me to make a brief reply in this

"Postscript." It will be impossible, of course, to meet all his points here, and convince him of their futility. Not even the clearest and most rigorous logic makes a man a match for a Jesuit; he adroitly employs the facts themselves for the purpose of concealing the truth by his perverse misstatements. It is vain to hope to convince my opponent by rational argument, when he believes that religious faith is "higher than all reason." A good idea can be formed of his position from the conclusion of the eleventh chapter of his work, *Modern Biology and the Theory of Evolution* (p. 307). "There can never be a real contradiction between natural knowledge and supernatural revelation, because both have their origin in the same Divine spirit." This is a fine comment on the incessant struggle that "natural science" is compelled to maintain against "supernatural revelation," and that fills the whole philosophical and theological literature of the last half century.

Wasmann's orthodox position is shown most clearly by the following statement: "The theory of evolution, to which I subscribe as a scientist and a philosopher, rests on the foundations of the Christian doctrine which I hold to be the only true one: 'In the beginning God created the heavens and the earth.'" Unfortunately, he does not tell us how he conceives this "creation out of nothing," and what he means by "God" and "heavens." I would recommend him to consult Troelslund's excellent work, *The Idea of Heaven and of the World.*

Almost at the same time that I was delivering my

lectures at Berlin, Wasmann was giving a series of thoroughly Jesuitical lectures on the subject at Lucerne. The Catholic Lucerne journal, *Vaterland*, describes these lectures as "a work of emancipation" and "a critical moment in the intellectual struggle." It quotes the following sentence: "At the highest stage of the theistic philosophy of evolution is God, the omnipotent creator of heaven and earth; next to him, created by him, is the immortal soul of man. We reach this conclusion, not only by faith, but by inductive and strictly scientific methods. The system that is reared on the theistic doctrine of evolution is the sole rational and truly scientific system; the atheistic position is irrational and inscientific."

In order to see the untruth of this and the succeeding statements of the modern Jesuits, we have to remember that the Churches—both Protestant and Catholic—have vigorously combated the theory of evolution with all their power for thirty years, ever since the first appearance of Darwinism. The shrewd clergy saw more clearly than many of our naïve philosophers that Darwin's theory of descent is the inevitable key-stone of the whole theory of evolution, and that "the descent of man from other mammals" is a rigorous deduction from it. As Karl Escherich well says: "Hitherto we read in the faces of our clerical opponents only hatred, bitterness, contempt, mockery, or pity in regard to the new invader of their dogmatic structure, the idea of evolution. Now (since Wasmann's apostasy) the assurances of the Catholic journals, that the Church has

admitted the theory of evolution for decades, make us smile. Evolution has now pressed on to its final victory, and these people would have us believe that they were never unfriendly to it, never shrieked and stormed against it. How, they say, could anyone have been so foolish, when the theory of evolution puts the wisdom and power of the creator in a nobler light than ever. We find a similar diplomatic retreat in the popular work of the Jesuit, Father Martin Gander, *The Theory of Descent* (1904): "Thus the modern forms of matter were not immediately created by God; they are effects of the formative forces, which were put by the creator in the primitive matter, and gradually came into view in the course of the earth's history, when the external conditions were given in the proper combination." That is a remarkable change of front on the part of the clergy.

We see the astonishing system of the Jesuits, and of the papacy of which they are the bodyguard, not only in this impossible jumble of evolution and theology, but also in other passages of Wasmann, Gander, Gutberlet, and their colleagues. The serious dangers that threaten our schools, and the whole of our higher culture, from this Jesuitical sham-science, have been well pointed out lately by Count von Hoensbroech in the preface to his famous work, *The Papacy in its Social and Intellectual Activity* (1901). "The papacy," he says, "in its claim to a Divine authority, transmitted to it by Christ, endowed with infallibility in all questions of faith and morals, is the greatest, the most fatal, the most successful

error in the whole of history. This great error is girt about by the thousands of lies of its supporters; this error and these lies work for a system of power and domination, for ultramontanism. The truth can but struggle against it. . . . Nowhere do we find so much and such systematic lying as in Catholic science, and in the history of the Church and the papacy; nowhere are the lies and misrepresentations more pernicious than here; they have become part and parcel of the Catholic religion. The facts of history tell plainly enough that the papacy is anything but a Divine institution; that it has brought more curses and ruin, more bloody turmoil and profanation, into humanity's holiest of holies, religion, than any other power in the world."

This severe judgment on the papacy and Jesuitism is the more valuable as Count von Hoensbroech was himself in the service of the Jesuit Congregation for forty years, and learned thoroughly all its tricks and intrigues. In making them public, and basing his charges on numerous official documents, he has done great service to the cause of truth and civilisation. I was merely repeating his well-founded verdict when, at the close of my first lecture, I described the papacy as the greatest swindle the world has ever submitted to.

A curious irony of Fate gave me an opportunity, the same evening, to experience in my own person the correctness of this verdict. A Berlin reporter telegraphed to London that I had fully accepted the new theory of Father Wasmann, and recognised the

error of Darwinism; that the theory of evolution is not applicable to man on account of his mental superiority. This welcome intelligence passed from London to America and many other countries. The result was a flood of letters from zealous adherents of the theory of evolution, interrogating me as to my unintelligible change of front. I thought at first that the telegram was due to the misunderstanding or the error of a reporter, but I was afterwards informed from Berlin that the false message was probably due to a deliberate corruption by some religious person who thought to render a service to his faith by this untruth. He had substituted "supported" for "refuted," and "error" for "truth."

The struggle for the triumph of truth, in which I have had the most curious experiences during the last forty years, has brought me a number of new impressions through my Berlin lectures. The flood of calumnies of all kinds that the religious press (especially the Lutheran *Reichsbote* and the Catholic *Germania*) poured over me exceeded any that had gone before. Dr. Schmidt gave a selection from them in the *Freie Wort* (No. 4, p. 144). I have already pointed out, in the Appendix to the popular edition of the *Riddle of the Universe* [German edition], what unworthy means are employed by my clerical and metaphysical opponents for the purpose of bringing my popular scientific works into disrepute. I can only repeat here that the calumniation of my person does not move me, and does not injure the

cause of truth which I serve. It is just this unusually loud alarm of my clerical enemies that tells me my sacrifices have not been in vain, and that I have put the modest key-stone to the work of my life—"The advancement of knowledge by the spread of the idea of evolution."

THE END

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