

**R.R. Kale Memorial Lecture**

**PATENTING LIFE**

**Madhav Gadgil**

**Centre for Ecological Sciences  
Indian Institute of Science  
Bangalore 560012**

**Wkhale Institute of Politics & Economics  
ne**

**November 25, 1995.**

***Not publish or perish, but patent and prosper,  
should become the guiding philosophy of the  
Council of Scientific and Industrial Research.***

***-- R.A. Mashelkar (1995)***

I greatly appreciate this invitation to deliver the 1995 Kale Memorial Lecture. It is indeed a privilege to follow in the footsteps of such great men as Dr. B.R. Ambedkar. A charming passage in his book "Buddha and his Dhamma" describes the birth of Gautam Buddha in a grove of Sal trees. This is apt for Sal is the tree of life for the tribals of eastern India. And, for modern chemical industry it is an excellent source of oil for manufacture of soap. I thought of Sal when a French industrial consultant visited me the day I received the invitation to deliver this lecture and asked if I could help in a survey of plant based cosmetics of India.

## **Gene Hunters**

The firm this gentlemen represented is engaged in gene hunting. This activity is now called biodiversity prospecting; looking for new species of plants, animals, fungi, bacteria, with uses that may turn a tidy profit for industry, for we are continually adding to the already incredibly long list of living organisms put to human use. Humans are remarkable for the variety of foods they consume; grass seeds and pith of palm trees, mushrooms and grasshoppers, crabs and whales. They use bones and horns, cotton and wood as structural material. And they use an incredible variety of plants and animals for their flavour, their scent, to tan leather and to poison fish, to cure themselves and their livestock of multiplicity of diseases. Humans husband a wide range of organisms, bacteria that curdle milk and yeasts that ferment beer, silk-worms that spin silk and pigs that furnish pork, jasmines that produce flowers and mangoes that yield fruit. There are myriads of varieties of such domesticated organisms, often valued for some special attribute.

Modern technology has added altogether new dimensions to the range of creatures of value to people. In Australia occurs a species of frogs that rears its brood in its own stomach. Very likely they have some special chemical devices for keeping their enzymes from digesting their own young. A Japanese pharmaceutical company has a hunch that these chemicals could help provide clues for developing drugs to treat stomach ulcers. It has therefore applied for patent rights over these chemicals.

## **Patenting Knowledge**

The Oxford English Dictionary defines a patent as a license to manufacture, sell or deal in an article or a commodity to the exclusion of other persons; adding that in modern times it is a grant from a government to a person or persons conferring for a certain definite time the exclusive privilege of making, using or selling some new invention. The oldest English usage of the word patent in this sense dates from 1588, when one G. Longe stated that "Dollyne and Carye obtained the patent for making of glass in England in 1566-67, the ninth year of the Queen's regime for 21 years ensuing which the patent was fully expired a year

ago". Patent is then a particular form of monopoly, of control over some skill, or a process, or a product to the exclusion of others. Knowledge is power, and humans have attempted to establish monopoly over it in many different ways over the ages. In many tribal societies knowledge of medicinal uses of plants and animals is a monopoly of one or few medicinemen, who keep it to themselves during their lifetime and pass it on to a select individual in their last days. In the more advanced society of Mahabharata, the Kshatriyas attempted to monopolise the techniques of archery, so that the tribal Ekalavya had to sacrifice the thumb of his right hand for having mastered the technique by watching Dronacharya teach Arjuna and other princes.

This form of monopoly over knowledge is now termed trade secret, as opposed to copyrights and patents. In the latter cases the pertinent information is available to the public, but the state throws its weight behind certain claimants to grant them exclusionary rights. In particular, a patent is for a limited period, and is accepted only when the applicant agrees to disclose full details of the new technique or design so that another person skilled in the art can practice it on payment of some specified compensation, or freely on expiry of the period of protection. Trade secrets are ancient, copyrights and patents gradually came into being in Europe as people of that continent slowly gained an edge over others in scientific knowledge and technical skills beginning with the sixteenth century.

## **Chemicals of Life**

Products of living organisms of utility to humans may be broadly classified into two categories; those produced in bulk and those produced in small quantities. The former include staple foods, carbohydrates, starches, sugars, fats, proteins. They include structural materials such as cellulose and lignin. The second category that may be termed specialty chemicals, includes molecules produced by living organisms in smaller quantities, often to attract or repel other organisms. The scent of jasmines is produced to attract insect pollinators, the aroma of musk to attract females. The flavour of pepper or cardamom serves to repel insects. Indeed most chemicals people use as drugs to cure diseases are produced by the plants concerned to combat insects, snails and such like predators. Plants and animals belonging to complex, species rich biological communities are involved in a variety of intricate interactions amongst each other, interactions that are often mediated by chemicals that attract or repel other creatures. Tropical rain forests and coral reefs represent two such communities whose members are therefore rich sources of specialty chemicals of value to people. The biological communities of colder regions are much simpler and therefore poorer in species producing such chemicals.

Almost all drugs used in olden days to combat diseases were such specialty chemicals. We now know that even Chimpanzees use such plant compounds as therapeutic agents. Evidently their use by humans is as old as our species, over one lakh years. These specialty chemicals such as alkaloids are far more varied from species to species than the bulk chemicals like starches or lignin. Over thousands of years therefore human communities, especially those living in or close to the species rich tropical forests have learnt to put a diversity of plant and animal species to uses as drugs, as flavouring agents, as spices. Amongst hunter-gatherer societies, each tribe may encounter a slightly different set of plants and animals, especially in the species diverse tropics and may develop its own distinctive set of practices of usage of such organisms. A fraction of such uses especially as drugs would undoubtedly depend on psychological factors alone and have no larger validity; another fraction may depend much more on physiological factors and have more universal application. As larger scale agricultural societies emerged they absorbed the more universally valid practices from the tribal traditions, and created systems that replaced the tribal trade secrets with more universally accessible, codified information. Especially powerful systems developed in India and China, the two advanced civilizations of the warmer latitudes.

### **Systems of Classification**

Spices and drugs were the two major attractions that brought Europeans to our part of the world. Encountering a new rich world of plants and animals over vast stretches of the earth, the Europeans were highly motivated to systematise their rapidly growing knowledge of the diversity of tropical life and its manifold uses. Van Rheedee, a Dutch official in Malabar in the late 17th century was an important actor in this endeavour. He was much impressed by the rich Ayurvedic traditions of Kerala and took the help of Ety Achyuthan and three other Vaidyas to record the treatment of various diseases with the help of herbal remedies. To aid in correct identification of the plants from which the drugs were derived, he described them, classifying them with the help of the system used by the Kerala physicians. The result was "Hortus Malabaricus"- published between 1678 and 1703, a landmark in the history of modern botany. It was this monumental work that fifty years later inspired the Swedish naturalist, Carl Linneaus to devise his system of classification of living organisms, a system that is universally followed today. In this system, every distinct species of plant and animal has a unique name, and a unique place in a hierarchy of taxonomic categories. This is an important advance, for the older systems like Ayurveda are not so fully standardized and therefore open to confusion. For instance, Ayurvedic pharmacopeia extensively uses the plant Shankhapushpi. But in different parts of the country, Shankhapushpi denotes as many as seven distinct, very different species of plants.

## **Seeds of Change**

Humans have long traditions of exploiting, plundering, exterminating populations and resources of other human groups that they conquer. Many such episodes marked the European expansion over the rest of the globe over the last five centuries. Two major factors governed the form of such interactions; extent of technological advantage enjoyed by the Europeans, and the local ecological setting. In regions such as temperate north America, Argentina and Australia the ecological setting was conducive to the spread of European agriculture based on wheat, cattle and sheep. At the same time, the inhabitants were at considerable technological disadvantage. The Europeans then simply pushed the native peoples off the land, often exterminating them. The ecological setting of the tropics on the contrary, was hostile to European agriculture and people. These complex biological communities harboured many parasites responsible for human diseases, diseases that kept European populations at bay. Foremost amongst these was malaria. Only the natives of a region of Peru in South America knew of an effective remedy; quinine extracted from cinchona. For years they denied this knowledge to the unwelcome European invaders. But finally it was forced from them in 1700 A.D. when the daughter of the Spanish Governor came down with malaria. Now the Spanish themselves wanted to maintain a monopoly over cinchona, and deny its cure to their British competitors. But despite all precautions an enterprising official of the East India Company, Clements Markham, managed to smuggle a few seeds out of Peru in 1860, and establish extensive cinchona plantations in the Nilgiris.

The tropics were a source of a wealth of other plant material as well; potato and maize, tomatoes and chillies, cocoa and cloves, oil palm and rubber. Different European powers desperately attempted to create and maintain monopolies over many of these. Thus the rulers of Brazil were determined to retain their hold over natural rubber. Again another British agent, Henry Wickham managed to smuggle out some planting material in 1876 to create the thriving rubber estates of Malaysia.

Indeed exploration, documentation, systematic propagation and introduction to new regions of the wealth of tropical plants was vital to the European strategy of dealing with the tropics; regions they could never fully take over themselves. This interest fuelled biological explorations, systematic descriptions of plant and animals, floras and faunas, collection of plant and animal specimens in herbaria and museums and development of botanical and zoological gardens all over the world. The Howra Botanical Garden, the Alipore Zoo, the Indian Museum, all located at Calcutta, the 19th century capital of British India were important links in this endeavour. Indians served as field guides, local collectors, helpers. Their knowledge of uses of plants, animals, minerals was meticulously recorded in the Wealth of India series of publications. But Europe remained at the centre of development of all this

knowledge. All Indian plant and animal specimens were lodged at the Kew Herbarium and the Natural History Museum in London. Almost all the scientific literature was published from Europe. Even the British scientists working in India, scientists like Ronald Ross who made important discoveries in elucidating the role of mosquitoes in transmission of malaria were meted out stepmotherly treatment.

### **European Monopoly**

There was a systematic discouragement of Indians gaining access to this newly emerging, systematised knowledge of the natural world. Jagdish Chandra Bose was a victim, as was J.N. Tata who died before his dream of an Indian Institute of Science could materialize. J.N. Tata was a Parsi, and Parsis were reputed to be amongst the world's finest ship builders. In fact the British government had to make special efforts to put down the ship builders of Surat to ensure that they did not outcompete British shipyards. J.N. Tata had developed the technologically most sophisticated industry, steel production, of his times and wanted to establish an Institute of Science to promote indigenous technological development. Lord Curzon, the then Governor-General of India did his utmost to scuttle the project; it finally came into being some years after J.N. Tata's death. In its initial years the Indian Institute of Science did catalyse the growth of modern chemical and electrical industries in the Mysore state. This was not at all to the liking of its British dominated Governing Council. The Governing Council organized a special review that discouraged pursuit of applied science at the Institute. Its faculty then shifted gear to focus on basic research. This was very much suited to the high caste dominated culture of the Indian scientific community. It is a culture very different from J.N.Tata's with its traditions of excellence in shipbuilding. For Indian higher castes have relegated such artisanal activities to lower castes, and look down on them. For them applied science in the service of manufacture or crop or animal production is second rate. But given the many limitations Indian Scientific community has always lagged behind in the basic science. In any case unlike China, India does not have traditions of technological innovations. So the Indian scientific community has little innovative basic research to its credit. It has by and large pursued imitative science dancing to the tunes set by Britishers and Americans, and has no noteworthy innovations, neither basic, nor applied to manufacture or cultivation to its credit.

### **Diversity of Life**

The Linnean system of classification was the first major advance in biology triggered by the exposure of Europeans to the tremendous variation of living organisms of the tropical world. Charles Darwin was a witness to such variation as the naturalist aboard Beagle, a vessel commissioned to map the sea coast and sea floor to facilitate European shipping. Darwin demonstrated that such variation gradually emerged as a result of high rates of

multiplication of living organisms, accompanied by survival and propagation of variants well adapted to their particular local conditions. This process has been termed natural selection, as opposed to artificial selection or selective breeding of cultivated plants and domesticated animals at the hand of man, or more often woman. But Darwin left open the question of the source of heritable variation amongst living organisms. His contemporary, Johann Gregor Mendel, focussed on this problem and founded genetics, the science of heredity. These twofold advances made possible an understanding of the great range of natural variation of life, and more systematic manipulation of this variation through breeding in the early twentieth century.

### **Pasteur's Patent**

European interest in navigation led to Darwin's encounter with the varied life of tropics. This interest also promoted the development of lenses to fabricate better and better telescopes. The same lenses were used to observe minute organisms invisible to the naked eye, leading to the discovery of the microbial world by Anton van Leeuwenhoek in 1683. In Leeuwenhoek's time it was believed that fleas were produced from dust and weavils from grain. He demonstrated that like other larger animals these minute and despised creatures too came from eggs and were endowed with as great perfection in its kind. But it was Louis Pasteur, a contemporary of Darwin and Mendel in the late 19th century, who conclusively ruled out ongoing production of life from non-living matter. He demonstrated the role of microorganisms in a number of diseases, as also in fermentation of beer, wine and production of buttermilk. He established the practice of vaccination on a scientific foundation, although vaccination against smallpox is believed to have been practiced earlier in India. To Louis Pasteur goes the distinction of being awarded the first patent over living organisms – over a culture of yeast in 1873.

### **Patenting Plant Varieties**

Genetics, the study of laws of heritable variation, made great strides in years following 1910, principally through the work of the American biologist, Thomas Hunt Morgan. That put selective breeding, practiced for millennia by women and men on a systematic footing, greatly improving our ability to deliberately mould the characters of living organisms. These advances led to the granting of patents, for the first time in the United States in 1930, for new and distinct varieties of sexually propagated plants. This excluded patenting of tuber propagated plants and plants found in an uncultivated state. These early plant patents granted the right to exclude others from asexually reproducing the plant and selling or using the plant so produced.

## **Synthetic Molecules**

Louis Pasteur, recipient of the first patent over a living organism, was also an accomplished chemist. In 1840's he clarified the difference between two forms of tartaric acid. The century that followed saw remarkable advances in our understanding of carbon containing organic chemicals, and the ability of science to manipulate and synthesize them. These advances have enabled chemists to manufacture many specialty chemicals produced by living organisms. One such is the molecule responsible for the fragrance of sandalwood, greatly prized at least since the time of Gautam Buddha two thousand five hundred years ago. Extraction of sandalwood oils using modern techniques was one of the chemical industries promoted by the Indian Institute of Science in its early years of applied work. It was undercut by a synthetic process discovered by the Germans. Such synthetic compounds could be patented, bringing in tidy profits to the chemical industry. In fact, today the sandalwood incense stick industry of Mysore is heavily dependent on aromatic compounds imported from Germany. Chemists can of course patent not only compounds produced entirely through laboratory syntheses, but also extracted from natural sources. One such is azadirachtin, an alkaloid extracted from neem, and used as an insecticide. Now manufacture of both the synthetic scent of sandal and the pesticidal extract of neem are based on uses and properties known and practiced in India by thousands of people over centuries. But these are also products of the art of man, and therefore patentable under the regime now long prevalent in the industrial world.

## **Manipulating Life**

The 1950's witnessed the great triumph of modern biology brought about by a fusion of the growing understanding of laws of heredity and of the chemistry of life. This resulted in the elucidation of the chemical structure of the hereditary material, DNA. The four decades that have followed have brought to us fuller and fuller understanding of how the machinery of life functions, and how the instructions for running this machinery are coded in genes, the elements of heredity. With this understanding have come growing abilities of manipulating all manners of living organisms, of identifying genes responsible for specific activities such as production of insulin, making any number of copies of these genes, and inserting such genes at will in the hereditary material of very different organisms. We can thus create entirely new living entities; for instance tobacco plants carrying a bacterial gene for the production of toxins against insects, or bacteria carrying the human gene for the production of insulin.

There have been other significant advances in manipulating living organisms. Cancer is the outcome of cells going on dividing without any check. We can now take ordinary cells from a man, a woman or an animal, and get them to grow on an artificial medium without limit like cancerous cells. Cells thus cultured are immortal; and in theory at least, such

immortality is now within reach for all genetic material. We as yet do not know enough to put this genetic material to work to reconstruct full animals, but that is also possible with plants. We can take a small number of cells from any specific plant, say a coconut tree yielding 500 nuts per year, culture them, multiply such cultures indefinitely, and produce thousands of coconut seedlings with the genetic ability to produce 500 nuts.

## **Information Revolution**

Last forty years have also witnessed yet another technological revolution. This is the electronic, the computer, the communication revolution. This has made possible collection, manipulation, interpretation, and instantaneous transmission of enormous amounts of information. So we can now screen thousands of different plants or animals for specialty chemicals of interest, for instance, alkaloids with anti-cancer activity in a very short time. We can also take an organism, make large number of copies of its genes, and then determine the particular sequence of basic constituents of genetic material, the nucleotide bases adenine, thymine, cytosine and guanine which governs its functions. More and more of this can be done automatically, with the help of computer-aided scientific instrumentation.

## **Chemicalised Agriculture**

These exciting developments in understanding and manipulation of life in the post-world war II - world have been taking place in an increasingly chemicalised world. In part, the Second World War was fought over the control of tropical colonies by the European powers and the newly emerging Asian power of Japan. Malaria had always kept these imperial powers at bay in the tropical jungles. It was a serious problem for the fighting forces, and the response was the development of such effective, persistent chemical insecticides as DDT. Following the second world war these chemical insecticides were widely deployed to control agricultural pests. They were complemented by the use of chemical fertilizers. So products of chemical industry came to replace organic manure and plant based pest control agents, permitting initially an enormous increase in agricultural productivity. These opportunities have been cashed with the aid of modern high yielding crop varieties; varieties initially put together using classical plant breeding techniques by bringing together genetic resources from all over the world. Thus were developed high yielding dwarf varieties of rice and wheat capable of profiting from high levels of nutrient inputs from synthetic fertilisers, coupled to assured water supply through irrigation. The genetic variation that provided the raw material for this breeding effort was largely collected by Government-funded agencies, the breeding programmes too were financed by Governments, Inter-governmental agencies and philanthropic foundations. The philosophy that underlay such effort was that these crop genetic resources were a common heritage of mankind.

## **Pattambi Rice**

Tropical countries like India of course contributed a great deal to this genetic resource base. India has many species of wild rice and prior to green revolution harboured an estimated fortyfive thousand varieties of rice under cultivation. One such cultivar came from Pattambi in Kerala, and this genetic material was maintained in the rice germ plasm collection at the International Rice Research Institute in Philippines. The modern chemicalised agriculture creates large stretches of genetically uniform populations of a few high yielding strains of crops like rice, conditions that are very much conducive to outbreaks of crop pests and diseases. A few years ago, rice production over vast areas of southeast Asia became threatened by an outbreak of an insect pest, the brown plant hopper. It so turned out that the Pattambi rice variety harboured a gene that conferred resistance to this pest. It was incorporated into the high yielding variety through classical breeding methods, and thereby contributed to rice production worth hundred of crores of rupees.

## **Common Heritage**

India has not only thus contributed valuable genes to new crop varieties world over, it has benefitted from crop varieties based in genetic material from other parts of the world. On the balance, we have gained even more than we have given. But all this has been done under a regime that treated this material as common heritage, and the breeding programmes as a publicly funded effort towards common goals. Of course private commercial interests have greatly benefitted through the resultant spread of chemicalised agriculture. For such chemicalised agriculture is far more dependent on inputs from the industrial sector – pesticides, growth hormones, fertilizers, tractors. But initially private commercial interests had little direct involvement in the production and marketing of plant varieties, despite the patent like protection offered to the plant varieties in the Unites States since 1930. Here private breeders depended for profits more on production of varieties of maize or chicken that yield well only in the hybrid form. So the private farmer or poultry breeder cannot breed high yielding strains from his own material, the parental lines of the hybrid being under control of the commercial breeders. But as the publicly sponsored effort progressed, private breeders - seed companies - stepped in. If they sell pure, rather than hybrid lines, then farmers can raise seeds for their own use, exchange, or sell them. Farmers have of course been doing this for millennia. But seed companies cannot profit from such a system. So they have lobbied for and succeeded in extending patent like protection to seeds in U.S.A. and Europe as well. Under such a regime the farmer can sell his wheat, or rice grains as food. But he cannot sell it as seed material. Other stringent restrictions are also being imposed on use of his own farm produced seed material for the next crop, or for exchange with farmers. The commercial seed companies are also motivated to monopolise germ plasm collections, currently held with

public institutions such as our own National Bureau of Plant Genetic Resources or the International Rice Research Institute.

## **Made by Man**

With time, the dangers of the modern chemicalized way of life have begun to surface. The Minamata disaster in Japan in 1960's, involving serious birth defects to children whose mothers had consumed fish and shellfish from a bay heavily polluted with heavy metal residues led to strong citizen's protests. Protests in United States and Europe followed beginning with 1970's. The chemicalized world is increasingly dependent on energy and chemical production based on petroleum. Transporting petroleum products around leads to accidental oil spills. The first patenting in modern times of a living organism, other than seeds, was that of a genetically modified organism, a synthetic plasmid injected bacterium, *Pseudomonas* capable of degrading crude oil. This patent was awarded to an ex-patriate Indian, Anand Chakraborty by the U.S. Supreme Court in 1980. While awarding the patent, the U.S. Supreme court remarked that the U S Congress intended the statutory subject matter of the Patent Act to 'include anything under the sun that is made by man'. Gradually this 'made by man' has come to embrace wider and wider meaning, including microorganisms found in nature and isolated in laboratory culture without any other genetic manipulations. Patents have also been awarded on cultured cell lines and man-made animal forms such as genetically modified mice and oysters with additional copies of genetic material. Patents are also being awarded on simple information – such as the sequence of nucleotide bases in a particular segment of human genetic material. Notable in this context is the recent patent on a human cell line isolated from a tribal population of Papua New Guinea, awarded by U.S. Patent Office to Gadusek, an American scientist working with National Institute of Health. This cell line could be of considerable commercial value in diagnosing certain diseases.

## **Products of Life**

There is a growing interest in the products of living organisms, not only as sources of drugs for treatment of human diseases, but in a multiplicity of other applications aimed at reducing the use of synthetic chemicals. Thus Germans have banned the use of synthetic dyes for textiles, spurring a renewed interest in vegetable dyes whose use had largely disappeared in face of competition from cheaper synthetics. The ongoing search for neem based pesticides is similarly an expression of interest in doing away with synthetic pesticides. And cosmetic products based on plants are coming back, bringing to India people such as the French industrial consultant I mentioned at the beginning of this lecture. Of course, all such specialty chemicals based on living organisms would also be patented.

## **Changing World Order**

The fifty years since the end of World War II have thus seen momentous changes in the world around us, impelled, to a significant degree by the communication revolution. The resultant coming together of the world is accompanied by startling changes in the world order as well. Colonialism was liquidated soon after World War II, dictatorships have begun to give way to a democratic order in recent decades. But this has not meant an end to the highly inequitable distribution of access to the resources of the earth. Colonial powers of yesteryears - U.S.A., U.K., France, Japan are amongst the dominant industrial powers of today. But they can no longer claim access to a lion's share of the resources of the earth as a right of conquest. Their dominant position is now dependent on the strength of their economy, and their technological superiority. The patenting regime is an important device for maintenance of this domination, and is therefore being steadily strengthened.

## **Biodiversity Convention**

Many of the most promising technologies of the future are based on manipulation of living organisms and their products. The diversity of living organisms is an important raw material for these technologies and industrial countries are interested in maintaining easy and cheap access to these resources. They are also concerned that the ongoing changes in the world may lead to a decimation of potentially valuable genetic resources. These twin concerns found their expression in the U.N. Conference on Environment and Development, held at Rio de Janeiro in June 1992. What the industrial countries wanted from this conference was an assurance from the tropical developing countries that they would make more serious efforts at conserving the diversity of living organisms that is their heritage, and would continue to permit free access to these resources to the technology driven industrial corporations of the developed world. The tropical developing countries saw in these negotiations opportunities for asserting their rights over their own genetic resources and demanding substantial returns for granting access to these resources. India, Malaysia and Brazil argued forcefully for such an arrangement and achieved a measure of success. The result was the Convention on Biological Diversity, in force since December 1993, ratified to date by 127 countries.

## **Sovereign Resources**

This convention accepts the sovereign rights of each country over its genetic resources. Thus the Pattambi variety of rice with its gene conferring resistance to brown plant hopper is our property. So would be the genetic resources of neem, if India can establish itself as the country of origin of that plant. Any genes unique to Indian human populations may also be treated in a similar fashion, though the Convention on Biological Diversity does not specifically mention humans. But there is an impression that Indian carriers of AIDS are much

less susceptible to severe symptoms when compared to Europeans, and Indian population may indeed carry genes of value in combating the disease. Of course, there are many difficulties. Pattambi genes are already incorporated in widely distributed high yielding varieties of rice, neem is cultivated in many parts of the world, and people of Indian origin occur almost everywhere. Other resources, for instance, medicinal plants like *Tinospora cordifolia* not only occur in India, but also in Sri Lanka and China, and are used not only in Ayurveda, but in Chinese traditional medicine as well. So taking advantage of a country's sovereign resources is not a simple, straight forward matter.

### **A Megadiversity Country**

Yet there are definite possibilities of a country like India benefitting from its heritage of genetic resources. If all the countries of the world are ranked by the number of species of various groups of organisms known to occur within their limits, India turns out to occupy 10<sup>th</sup> or 11<sup>th</sup> position for most groups of plants and animals, be they flowering plants, snails, frogs or birds. Our neighbours China and Indonesia are higher on most counts, others like Myanmar and Malaysia are close on our heels. India is also a minor centre of origin of many husbanded plants and animals. Mung and til, pepper and cardamom, humped bull and chicken were probably domesticated in India. Rice may have been first domesticated in China, but India has rich germplasm of both wild relatives of rice and tens of thousands of cultivars. Even chillies, introduced to India only at the time of Akbar have diversified into many varieties, such as the Byadgi variety of Karnataka famous for its bright red colour; from which is extracted a chemical, capsicane. India is also a part of the world with highest levels of diversity of human genes.

### **Cashing on Genetic Wealth**

India then may have significant levels of genetic wealth which may be of considerable commercial interest. But can we turn this wealth into tangible returns ? That calls for access to very sophisticated technology. India could develop this technology on its own, acquire it through technical collaborations, joint ventures, or merely sell the raw genetic material in return for some financial considerations. The pharmaceutical giant Merck is following the last route in Costa Rica, a central American tropical country rich in biological resources. Merck has purchased a whole island in Costa Rica with rights over all genetic resources. It has also a contract with a Costa Rican scientific institute INBIO to prepare alcohol extracts of species belonging to particular groups of organisms such as spiders or parasitic wasps. Merck then further processes these extracts to assess them for the presence of biologically active compounds of potential application. Merck is paying a fee for receiving the alcohol extracts and promises to pay royalties if any product is put to commercial use. Merck has also made a grant to Costa Rica to help in its conservation efforts. But Costa Ricans are only serving as

skilled labourers in this effort. Patents for any commercial product developed will rest with Merck. This route is apt to yield little returns, and no long range building of technical capabilities to the country of origin of such genetic resources.

### **Importing Technology**

At the other end is the route of developing high level technologies taking advantage of our indigenous genetic resources on our own. This is not a route open to us in the immediate future. Indian industry has so far almost entirely relied on importing technology to turn tidy profits in a protected market. It invests little in research and development. At the same time the Indian scientific establishment, even in avowedly applied laboratories of the Council for Scientific and Industrial Research has done little to build bridges with industry. They have merely been content to get state support to publish a little to receive minor recognition from the British or American scientific community. Of course, there are honourable exceptions. One such is the team of synthetic organic chemists led by A.V. Rama Rao at the Indian Institute of Chemical Technology in Hyderabad. This team specialized in finding alternative, more economical routes of production for pharmaceutical compounds with a ready market. The Indian pharmaceutical industry, which only has to abide by a process, not a product patent has thrived by absorbing such new processes and marketing the chemical abroad. But in spite of such exceptions, neither the Indian industry with a few possible exceptions such as Ranbaxy's, nor the Indian scientific community is today in a position to develop high tech products based on indigenous genetic resources on our own.

### **High Cost - Low Quality**

That leaves the third route of collaboration with multinational corporations in research and development, as well as production. This is now inevitable given the increasing integration of global economy and the key role of continually advancing technologies in industrial production. In any event the Indian record of the times during which we kept the multinational corporations at bay is dismal. It merely permitted our industry and our government to elaborate a high cost-low quality economy unable to stand up to global competition. It is then necessary that we permit the entry of multinational corporations and learn to work with them to our advantage. This is entirely possible, for all said and done, India has available highly trained scientific and technical manpower which costs far less than elsewhere in the world.

### **Organising Collaborations**

Provisions of the Convention on Biological Diversity would further help us in this regard. For this conventions stipulates that research and development efforts for products based on genetic resources should be preferably located in the country of origin, and that pertinent technologies should be transferred to both public and private sector industries in the

countries of origin on special concessional terms. We ought now to concentrate on ways and means of turning these provisions to our advantage. This would primarily have to come through positive, promotional, not negative, regulatory measures.

## **Regulatory Measures**

An important reason for this is that negative, regulatory measures simply will not work. A fair amount of our genetic material is already in the hands of industrial countries. Another large fraction is shared with neighbouring countries such as Pakistan, China, Bangladesh, Nepal, Bhutan, Sri Lanka and Myanmar. These countries may not all co-operate with us in maintaining a monopolistic hold on these resources. Thirdly given our large trade in biological produce, it is very difficult to control ongoing export of genetic resources. If we want to sell Basmati rice to U.K., there is no way to prevent a U.K. based company from using this material to isolate the chemical compound responsible for the delicate aroma, or the gene responsible for the production of the compound. Finally, genetic resources need to be taken out in small quantities, and to prevent their smuggling out is well high impossible. After all, Peru could not prevent cinchona seeds from being smuggled out, nor could Brazil prevent rubber seeds leaving the country.

## **Monitoring System**

Today there is no system at all of monitoring the use of genetic resources within the country or its export abroad. Some of our medicinal herbs have already yielded important commercial drugs, e.g. reserpine, used in the treatment of high blood pressure derived from Sarpangandhi, *Rauwolfia serpentina* or taxol, an important anti-cancer drug from *Taxus baccata*. In both these cases the concerned plant material has been rapidly depleted through overcollection of wild plants. Hundreds of others are used as sources of Ayurvedic drugs, cosmetics, dyes without any record. Others are being exported for unknown purposes. For instance, I have been told that *Drosera*, a tiny insect-eating plant of Western Ghats is collected and exported to Japan. Perhaps the Japanese are interested in its unusual enzymes. Nobody has an idea. So we do need a system of monitoring the use of India's genetic resources and taking good care of them. But this should be a people-friendly, simple system; not a heavy handed bureaucratic one. Such a user-friendly system of monitoring the use of genetic resources has to be complemented by our persuading the international community to introduce a system of recording the imports of genetic resources in all countries. Such a system for recording imports and exports already exists for some special biological materials such as ivory, it needs to be enlarged to cover the broader range of genetic resources.

## **Patent Specifications**

We also need to persuade the international community to properly reconcile provisions of the GATT agreement with those of the Convention on Biological Diversity. GATT agreement includes a section on patent and patent-like protection called TRIPS - or Trade Related Aspects of Intellectual Property Rights. India has signed GATT and is therefore committed to agree to these provisions. These include patenting of microorganisms, plant varieties and microbiological processes. It is likely that in near future these provisions would be extended further, and that we would be forced to agree. I strongly believe therefore that the best course of action for us is to go along with these provisions and lobby for their modification to our advantage.

One such modification would be to include information on country/ies of origin and common public knowledge in the specification accompanying any patent application. This would make it mandatory, for instance, to acknowledge in a patent application for a pesticide based on neem that India is the country of origin of neem and that Indians have long been using the plant for its pesticidal properties. If such an acknowledgement is compulsory, we can take advantage of the patent by asking that further research on neem by that company be located in India, and that the technology be transferred to competent Indian companies on concessional terms, perhaps through joint ventures. The companies should agree to do so, for R and D effort in India ought to be very economical for the company as well. There may be some reluctance to transfer technology on concessional terms. That is the reason why U.S.A. is still not a party to the Convention on Biological Diversity, though all other industrial countries including Japan, Germany, France, U.K., Sweden and Switzerland are. But this is a matter of further negotiation and persuasion.

## **Information System**

Above all, India should concentrate on building a user-friendly, transparent information system on its wealth of genetic resources. We are at an advantage in such an endeavour because of all tropical countries, India has a high level of competence in the concerned scientific fields, such as taxonomy, ecology, genetics, biochemistry, as well as in computer science and informatics. We of course have to reckon with the tendency of every organisation to guard its turf and keep information close to its chest. The state forest departments, for instance, have far less reliable information than they ought to have on the wild plant resources, and are extremely reluctant to share what information they do have. This culture of control and command of the government agencies would obviously have to give way to a culture of share and inform. But if we learn to work together and freely share information, India could put together a system of information on a variety of its genetic resources; medicinal plants, wild relatives of cultivated plants, cultivars, land races of domesticated animals, even human

population genetic variation, that could attract Indian and foreign entrepreneurs to take advantage of the opportunity to develop a variety of biodiversity based enterprises in India. India would be in a far better position to take advantage of its indigenous genetic resources with such a facilitatory, rather than any regulatory approach.

## **Conserving Biodiversity**

There are two other important issues that I must briefly touch upon before I close. These are issues of long term conservation of our genetic resources in conjunction with their sustainable use, and of sharing in benefits of the use of these resources. Admittedly, our record in this context is rather poor. Our forest wood and coastal and freshwater fishery resources have been grossly overexploited and depleted, as have populations of medicinal herbs. There have been some programmes of conservation of genetic resources of cultivated crops in collections maintained at agricultural research stations, but none for maintenance of livestock germplasm. In all programmes of development of natural resources the tribals, the shepherds, the artisanal fisherfolk, the marginal farmers have invariably been the losers. There is now a realisation that these people living close to nature have played a significant role over the centuries in creation of genetic diversity of crops and livestock and conservation of diversity of wild populations through practices such as protection to sacred ponds and forests, to sacred plants and animals, to birds breeding at heronaries. It is these people in day to day contact with nature in pursuit of their livelihoods who also have a rich wealth of knowledge of the living diversity and its manifold uses such as medicinal herbs, or sources of vegetable dyes or fish poisons. The Convention on Biological Diversity obliges us to respect these traditions, this knowledge, and involve the indigenous communities, especially their womenfolk as partners in conservation efforts and as beneficiaries from the commercial utilization of genetic resources.

## **Benefit Sharing**

There have been suggestions that such benefit sharing should be based on payment of some royalty, say by seed companies to farmers who have contributed to the maintenance of cultivars, or by pharmaceutical companies to tribals whose use of a medicinal herb provided the clue for further commercial developments. Dr. M.S. Swaminathan has in fact suggested a fairly elaborate institutional structure for operationalizing such a scheme.

I believe this to be completely impractical. Consider the utilization of the gene conferring resistance to brown plant hopper from the Pattambi cultivar of rice. This particular gene would be used in combination with several other genes derived from many different sources. Indeed any particular high yielding variety of rice may be derived from 10 to 20 different cultivars coming from as many countries. How is the royalty to be apportioned

amongst these different sources ? Furthermore, how is this royalty to be shared amongst the different village communities, or farmers who had traditionally cultivated the Pattambi strain? Perhaps these issues might be resolved. But it is impossible to identify any individuals or communities as appropriate beneficiaries of royalties flowing from the use of neem as a pesticide. It is therefore necessary to devise a simpler, more workable system for proper sharing of benefits flowing from biodiversity based enterprises.

## **Global Fund**

The funds to serve the purpose of equitable sharing of benefits could come from a cess imposed by each country on sale of seeds, drugs, pesticides, cosmetics or other biodiversity based products. A fraction of this cess could be retained by the country's government, while a fraction may be deposited into a global biodiversity conservation fund. The quantum of money available globally for conservation of biodiversity would thus grow with the growth of biodiversity based enterprises, and be freed of pressures by any one national government. These funds could be distributed amongst the various countries in proportion to their involvement as countries of origin of biological materials as evident from the specifications of the various patents being worked at any point of time.

## **Positive Incentives**

The funds thus coming to each country for supporting conservation should not be simply appropriated by the governments, but must flow to people at the grassroots to reward for their active participation in efforts at conservation of biological diversity, as well as their practical knowledge of uses and management of this diversity. Such a system of rewards would have to be based on a transparent system of decentralized monitoring of levels of biological diversity as well as knowledge of its utilization and management all over the country. This monitoring system would also serve as a major input for the information system to promote biodiversity based enterprises in the country. This would ensure that people would share in benefits flowing from biodiversity based enterprises in proportion to the levels of biological diversity on their own farms and within limits of their own villages, and in proportion to their own knowledge of sustainable use of biodiversity. This would be just, it would promote positive efforts at conservation of biological diversity, it would promote enterprise, it is workable. I have elsewhere suggested in some detail how such an effort might be organised by linking it to the Panchayat Raj institutions and to the educational system.

## **In Conclusion**

To sum up, I believe that patenting of life is here to stay. The multi-national corporations are also here to stay. They are here to stay because of the high cost-low quality economy that we nurtured over the four decades that we kept patents and multinationals out.

There is nothing to be gained therefore through lamenting that the order has changed. Instead we must now focus on taking full advantage of our indigenous wealth of genetic resources, and on taking the benefits that could flow therefrom to our people. This would be possible only if we usher in a democratic culture of inform and share in place of a bureaucratic culture of control and command. The sooner we get down to this task, the better..

### **Acknowledgements**

Permit me to conclude by again thanking the Gokhale Institute, and all of you for this opportunity to develop my ideas on this exciting theme. I have been greatly helped in this process by my interactions with Dr. K.P.S. Chauhan, N.S. Gopalakrishnan, Ashish Kothari, and Dr. M.S. Swaminathan, and above all with my two young colleagues, Preston Devasia and P.R. Seshagiri Rao. It has indeed been a privilege to pay my tribute to the memory of the late Rao Bahadur R.R. Kale, a public spirited lawyer and scholar, and the founder of this Institute, by exploring this legal and scientific issue of great public significance.

Thank you.