

CHAPTER I

THE MYSTERY OF LIFE

ASTRONOMERS tell us that the strangest thing of all in this vast unfathomable and mysterious universe is the fact that there has appeared on the crust of an insignificant planet whirling around a third-rate sun, a curious state of matter known as life. A long series of apparently random and fortuitous events has led up to this unusual and unexpected appearance, such a series which can have occurred but rarely during the long ages of time, and is likely to be equally rare in the ages to come. Regarded in its relation to the universe, life on earth is probably unique, since there appears to be little or no opportunity for its repetition elsewhere in the peculiar form in which we know it. It is conceivable, however, that in other planets or elsewhere, other fortunate associations and combinations of matter may have led and may still lead to other and completely different manifestations of the mysterious creative power known as life. Even on our own planet the vast majority of people live through their lives quite unconscious of the myriad forms of living organisms that live, move and have their being around

them. To most people, man and the larger animals, fishes, birds, insects, trees and flowering plants make up the sum total of living creatures. They are almost unaware of the smaller organisms, except those which make their presence felt by causing disease, and they are entirely ignorant of the great hordes of microscopic and ultra-microscopic living organisms which make their homes in the earth, water and air or live parasitically in the bodies of animals and plants.

To modern science it is these minute creatures which have the greatest interest and show the greatest need of study and research. To medical workers their discovery represents the solution of many of their difficulties about diseases, for there are few illnesses which cannot be traced back to the attacks of microscopic and ultra-microscopic organisms. To the agriculturist their study is of the utmost value in facilitating the growth of crops and the treatment and choice of soils. To the biologist they show the path by which evolution has proceeded from the lowliest forms and point the way to a knowledge of the origin of life itself.

The lowliest creatures in the scale of life are so small that the most refined ultra-microscopes are unable to show them to us. The finest filters yet made are unable to stop their passage and so isolate them for study and examination. One may well ask how their existence can be proved in these circumstances,

BORDERLAND OF LIFE AND MATTER 3

but although they themselves are invisible to us the effect of their actions can be seen and studied. The smallest filter-passer known is called the bacteriophage, and its presence is discovered by the fact that it attacks and devours or breaks up living bacteria—organisms themselves microscopic but large enough to be seen and studied with the aid of a good microscope. Much discussion centres around these bacteriophages. Some scientists believe they are living organisms of the most primitive description, others believe them to be chemical ferments which have attained the power of self-reproduction. Whatever they may be it is evident that here we are dealing with half-alive particles which are on the borderland between Life and Matter.

Passing up from the bacteriophage is a series of ultra-microscopic organisms known as viruses. Around these is centred some of the most absorbing work of the present day, for it is these viruses which give rise to so many of our most deadly and difficult diseases. Foot-and-mouth disease in cattle and swine, distemper in dogs, smallpox, typhus, yellow and trench fever, rabies, measles and influenza in Man, mosaic and other diseases of the potato, tobacco and other plants, all show the presence of these organisms in affected individuals. Although these viruses are larger than the bacteriophage, they are still too small to be filterable and are known collectively as 'filter-passers'.

One extraordinary thing about them is that tissues taken from plants or animals suffering from a virus disease usually show curious bodies in their cells. These are collectively known as 'inclusion bodies', and the wonderful thing about them is that whatever the disease, whether in Man, animal or plant, these bodies are very similar in appearance. They apparently arise from the streaming together of innumerable small particles, but whether these are aggregations of virus organisms or the effects of cell degeneration brought about by the organisms is difficult to determine. The most important fact about them is their striking similarity under widely differing conditions, showing the relationship of the virus organisms as a whole. Recent research in potato viruses show that one well-defined disease may be due to the combination of two or three different viruses, and the combinations and recombinations of these interacting systems can produce various types of diseases. If this can be demonstrated in the virus diseases of Man it may solve many of the problems of the day. The difficulty of isolating viruses owing to their passing through the finest of laboratory filters has been a great stumbling-block for preventive medicine, since it has not been possible to test and experiment with them as has been done with the larger disease-causing organisms. In the potato experiments it was dis-

MINUTE ORGANISMS

5

covered that certain kinds of aphids (greenfly) feeding on the diseased plants could absorb one type of virus, leaving behind the others, and then being placed on other plants infect them with a different disease caused by the presence of the one virus alone instead of in combination with the others of the original disease. In other words, what could not be done by elaborate filtering experiments in the laboratories was performed naturally by these little creatures, but precisely how or why is at present unknown.

That all viruses are harmful can hardly be believed, but in their present state of invisibility one can only detect their presence by the mischief they do and the beneficent ones no doubt pass unnoticed. Arguing from analogy, however, one would expect that there are many harmless or helpful kinds just as there are good, bad and indifferent bacteria, the organisms immediately above them in size.

The bacteria and cocci present another series of minute precellular organisms, larger than the viruses but still so small that they are invisible except through powerful microscopes. They are, however, easily filterable, and it is therefore possible to grow cultures of them and examine their actions and reactions so that diseases which are associated with them are comparatively easy to investigate. On the other hand, the good offices of beneficent bacteria have been dis-

covered and their necessity in many cases to life and growth, so that it has been made possible to cultivate them and increase their good work.

Up to this point the minute organisms of which we have been speaking are so tiny that they consist of the merest specks of living material. We now reach another vast world of living creatures, still microscopic, but having a definite organisation of form and structure. These are the one-celled plants and animals which swarm everywhere. They have attained the definite step of having a complete cell and, although so minute, their shapes and appendages are often extraordinarily complex and beautiful. Most complex of all are the Protozoa, some of which cause us to gasp with astonishment at the marvellous range of variation that can be achieved by a single cell. Some even bear beautifully shaped shells, and stars and rays and feathery filaments float from them. The Flagellates are noteworthy in being partly animal in their characteristics and partly vegetable. They have caused no little perturbation in the realms of biology, for the botanists claim them as plants and the zoologists claim them as animals, with the result that many of them bear two names, one given them by the botanists and one by the zoologists.

The Fungi are another interesting group with innumerable forms. They are usually looked on as

plants, but they exude digestive juices like animals and live as parasites on plants and animals or decaying matter. Some of the very large ones are well known by their visible fructifications—the mushrooms and toadstools for instance. Many of the Fungi are extraordinarily destructive, for they cause much damage to their hosts. When they are parasitic on plants they are known as mildews, rusts and other diseases, and in animals and Man they cause ringworm. On the other hand, many of them are very useful, and one family—the yeasts—is almost indispensable to Man in his production of food and drinks.

Ascending the scale of life we find that the next step is caused by the joining together of several cells. At first these cell colonies and the creatures which they form are extremely primitive, but as we get higher and higher we find them becoming more and more complex. Gradually the cells become more and more differentiated. In the more primitive types each cell behaves more or less as its neighbour, but as the number of cells increases this system of each cell for itself becomes impracticable and unworkable. So, gradually, various groups of cells take on a special function, and these specialisations go on increasing until in the higher animals we find a remarkable degree of specialisation. In these highly developed creatures and in Man himself we find that special

groups of cells are concerned with separate functions, the cells of the lungs are busy using the oxygen breathed in from the air, the cells of the stomach in assimilating the food eaten, the cells of the brain in receiving messages through the nerves and controlling the actions of the body and so on. Each group of cells has its own special work, and so long as the body is in health will carry it on. Each of these colonies, however, is entirely dependent on the others, for, in attaining its high degree of specialisation it is now cut off from the possibility of maintaining life on its own account. If the heart cells cease to function properly all the cells in the body must suffer; if the stomach cells are unable to deal with the food properly it will be felt by every other cell in the body. Any default on the part of any one of these specialised cell groups instantly reacts on them all, for they are so completely interdependent that any failure of a single part brings discomfort all round. In order to function properly themselves they must receive constant supplies of nutriment and be able to exude waste and impurities freely, and these necessities can only be accomplished when all the organs are working smoothly. The failure of one organ will cause starvation or waste clogging in the others, throwing them out of gear, and in extreme cases the death of the individual is the result.

The gradual building up of these complex bodies of the higher animals and plants is indeed a marvellous adaptation and adjustment to environment. Through the long ages evolution gradually advanced, building up more and more complex forms, until to-day its greatest culmination is Man. Man and Mind, for with Man came the greatest power that has yet arisen, the Conceptual Mind or Intellect which enables Man to look forward, to plan and to think for the future, and to reflect on and benefit by his memories of the past.

To-day we can see spread out before us the great story of Evolution. It is written in the rocks, in the fossils of long dead things, and in the hordes of life which inhabit the world to-day. Some 2000 million years ago our planet first became separated from the sun. For about half that length of time it pursued its lonely course and then by a series of happy combinations and developments Life became possible and the first minute organisms made their appearance, probably resembling in size and simplicity the bacteriophage of to-day. Gradually organisms increased in complexity and a divergence of forms arose, many to fall by the way as not being fitted to their environment. Such were the gigantic reptiles which appeared some 300 million years ago. Their huge bodies needed enormous quantities of food, and their tiny heads

made them, in spite of their size, an easy prey to the little mammals, with their quick bodies and active brains, which were just beginning to make themselves felt. Among these were the little Tarsioids, whose descendants were to make such an impression upon the world when after long ages they had become Man.

Some 10 million years ago a great genus known as the *Dryopithecus* roamed through the old world. These were pre-human anthropoids, and from them evolved on the one hand Mankind, with its intellect and conceptual mind, and on the other the great apes, the gorillas, the chimpanzees, the orang-outangs and the gibbons. Thus from this generalised genus or family arose the potentialities of the Mind of Man, and for the next 10 million years this was gradually increasing in power and scope.

The great new force which had evolved in the world first became manifest in the aptitude of its possessors to use tools and to utilise the products of nature for their own life and comfort. At first its development was extremely slow, for long ages the ancestors of modern Man roamed the earth little better than the animals around them. But burning feebly within them was the divine flame of intellect which was to lift them far above the rest of their fellow denizens of the earth.