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Another field in which considerable advance has been made is that of divers' clothing. Two-way stretch nylon, proofed with neoprene, is being used to give a supple suit with maximum protection properties. Despite much research, it is still thought that the standard diving woollen undergarments are the best for protection against cold.

Capt. Shelford went on to predict further developments. He foresaw a time when all suits would be of rubber- or neoprene-proofed 'Terylene' fabrics fitted with light-weight ball-race shoulder and waist joints. The special copper helmet inside which the diver rotates his head may be replaced by a comparatively tight-fitting helmet rotating and elevating at the neck joints so that its volume and buoyancy can be greatly reduced. There could be considerable development in the open-circuit aqualung set if new materials, allowing for greater charging pressures, were allowed by the authorities for the construction of cylinders. Capt. Shelford ended by saying that he had no doubt that industry would supply any equipment which the scientist needed to provide for deeper and deeper depths.

The last part of the meeting was devoted to the showing by M. Frederic Dumas of three films. The first, in black and white, was of some of the experiences of cave diving. The film started by giving an insight into the organization required before such a project could be undertaken, how the interest of the local population was aroused and how the morale of the divers was maintained in the local cafés. In the caves themselves the pictures were most fascinating. particularly when attempts were made to find the sources and direction of flow of the water.

The second film, in colour, was an account of an exploration for oil in the Persian Gulf carried out for the Kuwait Oil Company. Fine seascapes and pictures of fish and animal life were shown. A cage for protection against sharks was a reminder of one of the special hazards in this sort of work.

The third film, again in colour, showed the discovery and investigations of some Roman galleons sunk in the Mediterranean. Marble pillars and other portions of buildings which were being transported in the galleon when it sank were in a remarkable state of preservation. Later, the film showed how an underwater swimmer can help in tunny fishing. This looked particularly hazardous, but M. Dumas assured his audience that this was not so.

During the subsequent short discussion members of the audience gave accounts of the work of their own sub-aqua clubs, endorsing the warnings that Dr. Taylor gave earlier on. Questions were asked about the reported failure of some men to carry out quite simple tasks at shallow depths, when nitrogen narcosis could be ruled out. It was suggested that this was probably due to apprehension and anxiety.

H. J. TAYLOR

THE ORIGINS OF LIFE

MOSCOW SYMPOSIUM

THE Academy of Sciences of the U.S.S.R. acted as generous host to the first of the specialist symposia that the International Union of Biochemistry has decided to arrange in years when there is no international congress. The symposium was organized by Prof. A. I. Oparin ; it was on "The Origin of Life on the Earth", and this is also the title of the new edition of a book by him that Dr. Ann Synge has recently translated into English.

About sixty papers were circulated, read in summary, and then discussed during three and a half well-filled days. This was certainly the most ambitious attack on the problem that has as yet been made, but, contrary to the claim that was often made at the symposium, it was by no means the first serious scientific attack on it. At the end of last century and the beginning of this one the British Association dealt with the subject regularly. Huxley, Tyndall, Schafer and others had a clearer grip on the nature of the problem than most contemporary writers. They also often have priority. If participants in future symposia on biopoesis would read the old literature we might be spared the embarrassment of hearing eminent scientists portentously making suggestions that were familiar 50–80 years ago.

There is now general agreement that life can arise from non-living matter but there is disagreement about how often it does so. The possible points of view are set out in Table 1. Possibilities 1 and 2 are not now often advocated, but 1 will soon become amenable to experimental test when astronauts set out to look for what Haldane calls "astroplankton". Possibility 5 was effectively disproved during last century, not so much by the work of Pasteur as by the existence of the food-canning industry. That leaves 3 and 4. Many people advocate 3 because they claim that the biochemical uniformity of present-day life, and the preponderant use in proteins of amino-acids of only one of the two antipodal series, suggests a common origin. This point of view was maintained at the symposium by R. L. M. Synge ; but it does not seem to me to pay sufficient attention to the operation of food chains in Nature. If any group of organisms started to use one antipodal series it would be advantageous for any other group, even slightly dependent on the first, to come into line. And there are obvious advantages in using one series only. Though biopoesis is probably a rare event it is probably not a unique

Table 1. BIOPOETIC THEORIES

	No. of biopoeses	General character
1	None	Life has always pervaded space and an apparent origin is simply a transfer from place to place
2	One	Creation by divine intervention
3	One	Evolution on Earth by the action of inevitable, normal processes
4	Several	Repeated co-ordination of eobionts or sub-vital units
5	Innumerable	Classical and medieval idea that life appeared whenever there was a suitable environment

one. Disproof of this point of view will be difficult. It is hard to experiment on rare events and, as Darwin long ago pointed out, any new intruder into the living domain would now be immediately used as food by a longer established organism.

The Moscow discussion, like most similar discussions, got bogged down from time to time in metaphysics about the nature of life. In spite of official adherence to a Marxist materialist philosophy, a surprisingly large proportion of the Russian participants appeared to be Platonic Idealists. They realized that they could neither define nor unequivocally recognize 'life', but they were none the less certain that there was such an entity to be recognized. This was also the attitude of many members of the group from the United States. Even the 'cold war' cannot contend with Idealism. My attitude, which might be labelled Empirical Nihilism, is that the statement that a system is or is not alive is a statement about the speaker's attitude of mind rather than about the system, and that no question is scientifically relevant unless the questioner has an experiment in mind by which the answer could be approached. When we are concerned with extreme states, such as the higher plants and animals on one hand and rocks and chemicals on the other, there is little uncertainty. It is when the borderline is being considered, as with viruses or some metabolically active fragments from cells, that definition could be useful and is impossible.

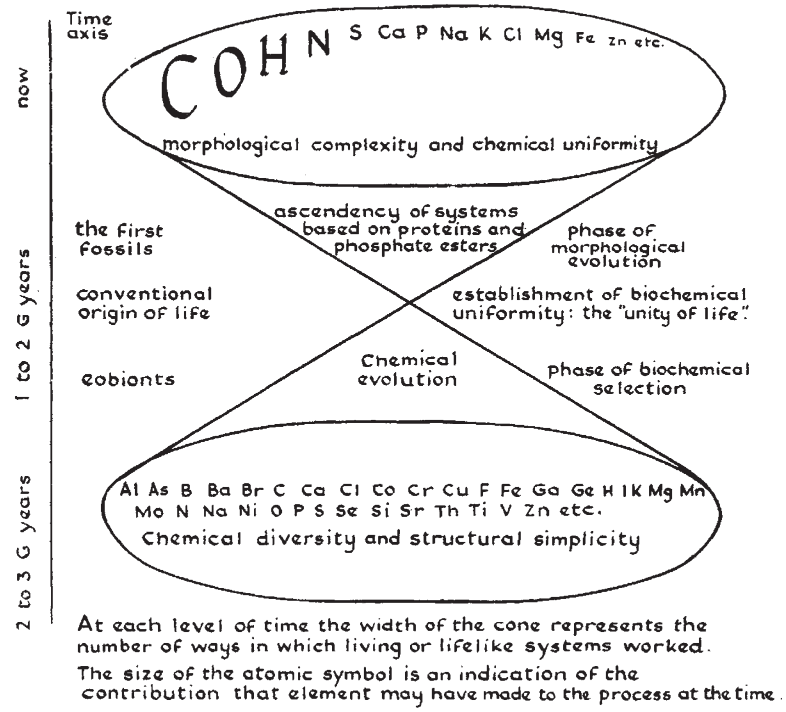

Fig. 1

But the history of science offers many examples of useful discussions on ill-defined or undefinable themes. The Moscow symposium was another. The first few papers were on the chemical nature of Earth's probiotic atmosphere and surface; they demonstrated that there is no basis for dogmatism. Of particular interest was the revival by P. N. Kropotkin of the idea that petroleum could have a non-biological origin. The case that was made out was so convincing, although the idea has been condemned by most authorities for half a century, as to suggest that many other possibilities that are now neglected might be re-investigated. There were then several papers on the types of synthesis that proceed when mixtures of the various substances that have been postulated in the primitive environment are exposed, in the laboratory, to energy sources as diverse as heat, electromagnetic radiation and radioactivity. These demonstrate, what most biochemists have been prepared to assume, that there is no difficulty in postulating a chemically complex 'probiotic soup'. If a theory of biopoesis demands the presence initially of any particular type of chemical compound it would be foolhardy to deny the possibility of its synthesis. It is good to have our assumptions justified; but the main value of this type of experimentation now seems to lie in the possibility that these syntheses may have industrial applications.

The greater part of the symposium was taken up with papers the relevance of which depended on the assumption that life can only exist as a result of the activities of proteins, nucleic acids, high-energy phosphates or whatever type of compound is at the moment fashionable. Undoubtedly all the present-day organisms that have been studied contain all these substances; they also contain fats, carbohydrates and so on. In these circumstances it seems invidious to pick any one as the *sine qua non* of life. We are not even justified in assuming that there was any single type of substance in this unique position. It is just as likely that primitive forms of life, or eobionts, made use of many different mechanisms, and that the mechanisms we see now are the end result of an immense process of evolution and selection. Proteins may be the most efficient rather than the only vehicle for living. On this view a detailed discussion of the contemporary metabolic behaviour of amino-acids, nucleic acids or proteins may have no more to do with the origins of life than a study of the mechanism of a cigarette lighter has with the origins of fire making. Extending this type of scepticism, there is also no reason for the general assumption that life has, at all epochs, been predominantly the affair of the carbon compounds. Small, atypical regions, in which elements that no longer play a large part quantitatively were concentrated, may have been the sites of biopoesis.

This outlook is illustrated crudely in Fig. 1. There are two cones set apex to apex and the diameter of a cone (the abscissa) at any level of time (the ordinate) represents the number of different ways in which systems with living or lifelike properties worked. The lower cone represents an immense chemical diversity narrowing down as a result of biochemical selection to give a few forms of life operating on a more restricted group of efficient chemical mechanisms. From that point on there has been little or no increase in biochemical complexity but there has been the immense increase in morphological complexity with which we are familiar and of which fossils give evidence. The great difficulty of discussions on the origins of life is that they are attempts to describe events long before the beginning of the fossil record ; metaphorically, they are attempts to see through the apices of the double cones.

Two courses are open. One is an intensification of geochemical studies, and if they are to be useful it is important that they should not be conceived narrowly but keep all the biopoetic possibilities in mind. The other is to follow the course of evolution backwards to see if the apparent direction, in the period about which we have evidence, can be used to give hints about the period before that. M. Florkin attempted this for aspects of the metabolism of complex molecules, and I did so for some of the elements. Florkin showed how often a substance that seems perfectly adapted for one role appears in more primitive organisms filling an entirely different one. Thus oxytocin exerts uterine control in mammals but controls water metabolism in amphibians. Furthermore, as evolution proceeds there is good evidence for biochemical simplification. Haldane, who unfortunately was not at the symposium, has already argued that the only exception to this generalization is protein synthesis, which seems to get more elaborate in the higher organisms. If this is indeed so, and if we follow the logic of the generalization, it suggests that proteins, far from being the original essential vehicles of life, are a relatively recent innovation. The efficiency given by proteins may have made them dominant. Thus it is the vertebrates that use them for nearly all purposes, structural as well as catalytic. As we descend the evolutionary scale their structural and protective functions are increasingly taken over by polysaccharides and matrices loaded with mineral crystals. The use of the elements suggests a similar trend. It is primitive organisms and not the most highly developed that have the most catholic approach to biochemistry and use vanadium, selenium, the halogens, aluminium, silicon and so on, most readily. That is why I give all these elements an equal status with the contemporary bio-elements on the base of the lower cone of Fig. 1.

If this approach to the problems of biopoesis is valid it follows that the most relevant contributions that comparative biochemistry could make would come from a detailed study of the most primitive contemporary organisms and of those organisms which, although able to live in an environment free from other metabolizing systems, nevertheless have extremely limited synthetic capacity. The first group includes such things as sponges, ferns and liverworts ; a study of their peculiarities would give us more information about the range of activities of which the now extinct forms of life may have been capable. The second group includes those saprophytic bacteria that need the most elaborate media for growth, for they probably have the smallest range of intrinsic metabolic ability and so would give us information about how small a group of co-ordinated metabolic activities is needed to satisfy at least some of our æsthetic requirements for a living system. It is unfortunate therefore that most attention was devoted at the symposium to viruses and autotrophic bacteria. The former are irrelevant because they do too little and only exist by courtesy of the synthetic mechanisms of a highly evolved host ; the latter because they do too much. They are indeed able to carry out almost all the general biochemical operations. All these capacities could scarcely have developed simultaneously in an early form of life. It is more probable that they are a response to the competitive stresses of more recent times.

Argument about evolution presents many intellectual pitfalls for the imprudent. J. D. Bernal fell into some of them with consequent inversion. This was the position in which, according to Engels, Marx found Hegel. Marx put Hegel on his feet and put posterity in his debt by making the Dialectic useful : I would like to perform a like service for my friend. In the course of making some valuable points about the relationships that will necessarily exist between particles as systems get more complex, he erected the principle of "structural conservatism or inertia" and resurrected L. J. Henderson's old illusions about the "Fitness of the Environment". "Inertia" only amounts to the fact that, when selection has operated efficiently enough to give an organism mechanisms or structures well adapted to the circumstances in which it lives, any change is likely to be a change for the worse. This is a consequence of having achieved reasonable success and it obtrudes itself of necessity in the activities of organisms with a long evolutionary history. The concept of "Fitness" led Henderson towards God ; Bernal is a Materialist so it only leads him into trouble. The proposition is that the chemical and physical properties of water, carbon dioxide, etc., are uniquely fitted to give organisms a comfortable environment : and the argument seems plausible until we realize that that is why organisms have evolved with the properties we know. The environment selects those that fit it. It is no accident that the environment suits proteins ; had it been different another group of substances would have assumed the dominant role that proteins have in this one. Thus in an environment of liquid ammonia and methane, such as is postulated by some on Jupiter, there would be less need to have macromolecular catalysts, like proteins, because Brownian movement would not be joggling the catalyst's elbow all the time. The reactions there on which life, if any, depends will be slow, but the universe does not seem to be short of time. If Jovial scientists are not very thoughtful they have probably concluded that nothing resembling life can exist on Earth except perhaps in the middle of Antarctica where the sort of molecules that evolution may have selected on Jupiter could be stable. The basic illusion is to assume that ours is the only way of living.

The symposium was valuable because it gave an opportunity for discussion and produced some papers with new relevant information and points of view, and some that may not have been strictly relevant but were sound. It also produced some new nonsense and some nonsense that was not even new ; the paper by W. M. Stanley, with the modest title "On the Nature of Viruses, Genes and Life", was outstanding in the last category ; he decided that multiplication was an infallible index of the living or non-living status of a system.

Now that the initial step has been taken, it is very much to be hoped that further symposia will be held on themes related to the origins of life. They will produce no succinct answers to the more general questions ; but they are essential if the problem is to be defined and if people working in all the different relevant sciences are to see the bearing that their work has on it.

N. W. PIRIE