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War conditions having rendered it impracticable to hold an Ordinary Meeting on March 18th, 1944, the Paper for that date was circulated to subscribers and is here published, together with the written discussion elicited.

CURRENT THEORIES OF THE ORIGIN OF LIVING ORGANISMS

By Douglas Dewar, B.A., F.Z.S.

THAT men of science have not yet discovered how the world of life originated is shown by the number of theories of its origin now in the field. These theories fall into two categories: Evolutionist and Creationist.

Evolutionist Theories.

According to evolutionist theories all plants and animals are the modified descendants of microscopic organisms that evolved from inorganic matter millions of years ago.

1. The theory of monophyletic evolution is that all living organisms are modified descendants of a common ancestor. This to-day seems to be the most widely-held of the theories of origin.

2. The theory of polyphyletic evolution is that the living organisms of to-day are modified descendants of a number of primal species, all of microscopic size. Some adherents of this theory postulate less than ten of these, others put the number much higher, thousands or hundreds of thousands. The adherents of this theory seem to be increasing in number.

3. The theory of Hologenesis was formulated in 1918 by the Italian Rosa ("Ologenesi. Nuova teoria dell' Evoluzione"). It is that, millions of years ago in most parts of the world, inorganic matter gave birth simultaneously to myriads of microscopic organisms, each having the property of evolving. For many generations their descendants resembled the parent forms, until, at what Rosa called the period of maturation, each of these, instead of producing offspring like itself, gave birth to two daughter species, differing both from the mother and one another. Each of these daughter species followed the same course as the parent species, and after a time their descendants split up into two daughter species. And this process continued. According to Rosa, a periodic splitting up or dichotomy is a property of living organisms. In some species this dichotomy occurs comparatively often and the daughter species do not differ greatly from the parent. In other species the dichotomy is much less

frequent, but the resulting species differ greatly from the parent form and from one another. Sooner or later a time comes when a species loses its power of splitting up and it may then persist unchanged through many geological ages, its range becoming less and less extensive until it dies out. This theory has been formulated in order to account for some features of the geological record which other evolution theories fail to do. It has not many adherents. It assumes that living organisms are endowed with certain properties for which there is no evidence.

Creationist Theories.

According to creationist theories all the main types of plants and animals, simple and complex, were created in their present form and have undergone little modification since they were created.

4. The theory of successive creations is that there have been a number of creative acts at various times, and that the later creations have replaced largely or entirely the earlier ones. At one time this theory was held by most palaeontologists; but D'Orbigny seems to have been the only one to state the theory in detail. In 1852 he wrote: "A first creation appeared with the Silurian stage. After the annihilation of this by some geological cause, a second creation took place in the Devonian stage; and successively 27 times distinct creations have come to re-people the whole earth with plants and animals after each geological perturbation which had destroyed the whole of living nature." That what appear to be the same species occur in successive creations presented a difficulty. This and the enunciation of Darwin's theory of evolution, so simple and specious, caused the younger geologists of that time to discard the theory of successive creations for that of evolution. But, as the more we learn about the fossils, the greater become the objections to evolutionist theories, a reaction has recently set in, especially on the continent of Europe, and the theory of successive creations is again coming into favour. As evolutionists in England are apt to ignore the views of creationists, let us notice some that have been expressed within the last ten years.

The French zoologists L. Vialleton ("L'Origine des Êtres Vivants" (1930)) and J. Lefèvre ("Manuel Critique de Biologie", (1938)) liken the panorama of life, as shown by the fossils, to a set-piece firework of which the various parts explode successively. The emanations from the first part go off and fill the scene for a

time; then another part, hitherto dormant, explodes and its emanations cover the debris of the first part, and so on. A new explosion does not prolong its predecessors; it comes from another engine. The continuity of the successive outbursts is not evolutionary, although all emanate from one firework. Everything happens as if this firework has been so constructed that each part goes off at the desired moment.

The Belgian Zoologist Maurice Thomas writes (*Revue des Questions Scientifiques* (1940)): "Life seems to have taken on new forms whenever it seemed good and has done so at the beginning of each geological period. The laws of heredity show that an organism can reproduce in its lineage only similar individuals capable of very limited variation. The transformist philosophy can clear these limits only by a perilous leap into the realm of philosophy. As it still constitutes one of the great trends of thought, we may, *purely from a desire to conciliate and to take account of the fact that it still constitutes one of the great currents of human thought*, accord the rights of citizenship to transformism, while flatly refusing to allow it the scientific character claimed by its adherents to the exclusion of other theories of living beings."

The Swedish botanist Heribert Nilsson asserts ("Hereditas," vol. 24 (1938)) that the completely distinct land floras of the various geological ages cannot be explained by evolution. "The postulated ancestors of new floras cannot be found." "Mendel has given us an entirely new concept of the constitution of species and of variation. Species should be regarded as the syntheses of the biological ground elements which are as constant as the atoms of Chemistry. With Lamarck, Darwin and de Vries we get no farther, Cuvier and Mendel point surely to the path leading to a new full comprehension of the constitution of species . . . In what mighty synthesis the biological ground elements were constituted we know not, but there is visible proof that in this synthesis the flora of, so to speak, a great geological slice of the earth was completely built up at one stroke, both higher and lower species. This is also in accord with the finding of the exact sciences: if the components be present, complicated end products are formed as easily as simple ones. In this connection time means nothing."

The French Geologist Paul Lemoine writes ("Encyclopédie Française," Tome V (1937)): "The theory of evolution is impossible." Like H. Nilsson he believes that the classes or families of living organisms correspond to the families of chemical

compounds, that biological classifications reflect, not evolution, but families of allied chemical constitution. He writes: "Only some 80,000 combinations have been realised by chance in nature during the present epoch: many others were realised in past epochs. Probably when man discovers how to originate life, he will be able to realise a vast number of new types and will not leave it to nature to cause new types to appear by chance as has happened in the past. He will create living organisms, not only of existing or extinct types, but new ones endowed with the qualities he desires."

The English Palaeontologist L. Merson Davies writes ("The Bible and Modern Science," 2nd edn.) (p. 68): "There is a totally indefinite GAP between the first two verses of Genesis . . . the language of the second verse further implies that it does not at all refer to a primitive creation of the world. . . . There was at LEAST one creation before our own, and it ended under the effects of a PENAL disaster more complete even than the Deluge of Noah, since no survivors of any sort remained." He shows that if this disaster were the prolonged freezing of the earth resulting from the blanketing of the sun it would leave no geological traces. As regards the difficulty mentioned above of the fossils of some animals of a later creation being indistinguishable from those of an earlier one, he writes: "Let us beware . . . of the danger of arguing from the evidences of very ancient forms of life similar to our own, to the very great age of our own creation. The correspondences between those forms and our own (as the fathers of palaeontology stoutly held from the first) may be purely analogical: and it is certain that we can never prove them to be anything else. 'Descent,' as Dr. Bather remarked, 'is not a corollary of succession.'"*

5. The theory of one great creation is that all the main types of plants and animals came into being as the result of one creative act and have undergone little or no modification since they were created.

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* The botanist J. C. Willis has formulated what seems to me to be a theory of successive creations, but he describes it as a theory of evolution. He writes ("The Course of Evolution" (1940), p. 191): "The family, consisting probably of one genus and one species, is probably first created by a single mutation, whilst later ones are usually less marked than the first and give rise to further genera and species." He considers that the facts of palaeontology can be explained easily "only by the concept . . . that mutations on the whole were larger the farther back in the past one goes from species through genera to family and class."

Can a class which springs ready-made from another class correctly be called a product of evolution?

It is incumbent on the adherents of this theory to show that it is *prima facie* compatible with the late appearance in the rocks of the known fossils of many types of plants and animals, such as the flowering plants and mammals.

Some adherents of this theory have attempted to do this by asserting that geologists are mistaken in their belief that the deposition of the sedimentary rocks was a process extending over millions of years. These creationists contend that practically all these rocks were laid down in a few months in one huge flood—Noah's flood. This theory was formulated when the science of geology was in its infancy. Later it was discarded, but was revived recently with the object of harmonising the geological record with one interpretaton of the account of creation in the first chapter of Genesis. It is impossible to accept this theory for many reasons, of which one is: the thickness of the sedimentary rocks is far too great for them to have been deposited in a single flood; another is: the fossils are so segregated and arranged in the rocks that all cannot have been laid down in one deluge.

Without question the deposition of the sedimentary rocks extended over a period of millions of years. In face of this, is the theory of one creation tenable? It is submitted that it is.

All theories of evolution and of successive creations are based on the assumption that the fossils found in the rocks of each geological period include representatives of ALL the classes of plants and animals existing in the period, that the absence of fossils of a class in the known rocks of a period denotes that the class in question had not then come into existence. These assumptions seem unjustified for two reasons:

First, most of the marine rocks known to us contain much terrigenous material, and the distance to which this can be carried by currents is limited. The bulk of the marine deposits accessible to us seem to have been formed within two or three hundred miles of the shore and, in consequence, the fossils they hold are of *organisms which lived near land.* Further, there is evidence that most rocks devoid of terrigenous matter, *e.g.*, chalk and some limestones, were laid down near land. Thus the known marine fossils represent, not all classes of sea plants and animals, but merely those living near the coasts.

Secondly, most of the ancient land rocks have disappeared because all rocks exposed to the atmosphere are subjected to continual weathering. No land deposit can persist longer than a few million years unless it become submerged beneath the sea

and there protected from sub-aerial denudation. A rock laid down on low ground or near the sea has a fair chance of eventually becoming submerged; one formed at high elevations has not. In consequence *almost all the older fossiliferous land rocks that still exist were laid down at low elevations and the fossils they hold are those of lowland plants and animals.* It is doubtful whether any high level deposits formed before the Tertiary epoch exist to-day. Thus the early land fossils represent, not all classes of plants and animals, but merely those of the lowlands.

The absence of fossils of any class of organism in the known rocks of any period, such as fossils of flowering plants in the Triassic, may denote that these plants did not then exist, or merely that none of them lived in the areas where the known Triassic rocks were laid down. According to the theory of one creation the latter is the correct explanation.

In brief this theory is that all the main types of living beings were brought into existence by one creative act in considerable numbers, each type in the parts of the earth that were then best suited to its habits. For example, flowering plants and mammals and birds among vertebrates, being adapted to cool or cold conditions, were created in the polar regions and elsewhere on tablelands and hills, and the bony fishes in the polar seas and open oceans. Pteridosperms, among plants and reptiles and amphibia among vertebrates, being adapted to a hot or a warm climate were created in the tropics and elsewhere on lowlands, and the cartilaginous fishes in tropical and coastal seas. In the long course of the history of the earth this distribution underwent great changes in consequence of what Joly describes as "great cycles of world-transforming events" which caused the extinction of many kinds of animals and plants and a vast amount of migration culminating in the survival of only the types now living and their present geographical distribution.

In each of these cycles of world-transforming events, writes Joly ("The Surface History of the Earth," p. 85): "the succession of events is the same. The continents sink relatively to the ocean. The waters flow in over the lower levels, vast areas become covered by transgressional seas. These seas persist over very long periods—fluctuate in area—advance and retreat many times, but always still advancing until at length a time is reached when retreat overtakes advance, and little by little the land advances again. And now a strange climax is attained. Just when the seas have been most enduring mountains begin to rise . . . the uplift may amount to many thousands of feet.

Then succeeds comparative repose. Evidence of cold climatic conditions often attends the period of greatest continental elevation. These conditions generally pass away after some thousands of years, telling of renewed sinkings of the land, and this period of very slow sinking endures over millions of years, approximating ever more to the time when once more the seas shall flood the continents, and so the cycle of events begins all over again. This extraordinary history is no myth. It has been traced in many parts of the world."

The cold periods mentioned by Joly have probably exercised a more profound effect on the life of the earth than have the advances and retreats of the sea. It is my belief that these cold periods have been interruptions of a secular cooling of the climate of the earth. This is not the view of some authorities, but it is supported by such facts as: fossils of corals occur in Cambrian rocks of Alaska (Lat. 65° N.), in the Silurian of the New Siberian Islands and the Carboniferous of Siberia. Fossils of amphibia occur in the Devonian rocks of Greenland, those of reptiles in the Permian of the North of Scotland, and in the Triassic of Spitzbergen. Fossils of the mudfish Ceratodus, now confined to the tropics, occur in the Jurassic rocks of Spitzbergen. The fossils further show that a rich flora flourished in Greenland in the Cretaceous period, and that turtles, crocodiles and palms lived in England in the Eocene period. Large areas of the Arctic and Antarctic regions now ice-bound formerly supported a rich flora and fauna.

Whether or not there has been a secular cooling of the earth is immaterial to the theory of one great creation, but the cold periods are of the greatest importance to it. A considerable fall of temperature in a locality results in either the extinction or the emigration of all the local plants and animals unable to tolerate the fall. Those in the warmest parts are killed off, there being no warmer place to which they can move. These cycles explain the fact that the fossils show that every locality has been occupied by successive floras and faunas, each of which generally lacks some components of its predecessor and has new components which are clearly not modified descendants of those of its predecessor in that locality, unless modified beyond recognition. Often no species or genus is common to the two. Thus, to quote the French palaeontologist, Arambourg, "the idea of migration is forced upon us, because at certain epochs faunas not descended from those they replace in the locality appear suddenly. This fact is very marked in marine faunas. These, so to speak,

DIAGRAM I.—*Periods during which the classes of animals are known to have existed.*

Period or System	Protozoa		Coelenterata		Vermes	Echinodermata					Molluscoidea	Mollusca		Arthropoda			Vertebrata				
	Foraminifera	Radiolaria	Hydrozoa	Anthozoa (Corals)	Spongiae	Gephyrea	Chaetopoda	Holothuroidea	Echinoidea	Asteroidea	Cystoidea	Blastoidea	Crinoidea	Brachiopoda	Polyzoa	Cephalopoda	Gastropoda	Lamellibranchiata	Arachnida	Crustacea	Insecta	Aves	Mammalia	Reptilia	Amphibia	Pisces
Present																										
Tertiary Epoch																										
Upper Cretaceous																										
Middle Cretaceous																										
Lower Cretaceous																										
Upper Jurassic																										
Middle Jurassic																										
Lower Jurassic																										
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Upper Devonian																										
Middle Devonian																					(b)				(b)	
Lower Devonian																										
Upper Silurian																										
Middle Silurian																										
Lower Silurian																										
Upper Ordovician																										
Middle Ordovician																										
Lower Ordovician																										
Upper Cambrian																										
Middle Cambrian																	(a)									
Lower Cambrian																										

NOTES.

The vertical lines represent the duration of each class of Animal as shown by the known fossils. The dotted portions indicate that some authorities do not admit the existence of the Class in question during the period they represent. The lines are drawn parallel, because there is no fossil evidence that any Class is derived from any other. Each is sharply differentiated from the others at the time of its earliest known fossil.

(*a*) Fossils of the Lamellibranchs Fordilla and Modioloides occur in Lower Cambrian deposits; some authorities, however, deem these to be the shells of Branchiopod Crustaceans.

(*b*) Fossils of Insects and Amphibia occur in the Fern Ledges of New Brunswick, Canada, which biologists on account of the fossils they hold deem to be Carboniferous, but, on geological grounds, Bailey and Matthew consider them to be Upper Silurian (Trans. Royal Soc. Canada, Series 3, vol. 12 (1918/1919).

The reason for the differences of opinion regarding the date of rocks is that, as "a fossil out of place would be fatal to the evolution theory," when a fossil is found in too early a rock the adherents of the theory have either (1) to dispute the nature of the fossils, as at (*a*) above, or (2) (in the case of a human fossil, assert that it was intrusively buried. Or (3) dispute the date previously assigned to the rock containing the fossil as in (*b*) above, or (4) believe that the species evolved precociously.

As rocks are dated to a considerable extent by the nature of the fossils they hold, it is probable that some are really older and others younger than the geological period to which they are assigned.

faunic waves which roll in in the course of stratigraphic history generally coincide with the great phenomena of the relative displacements of seas and continents." These new types must be either immigrants or new creations. It is here contended that they were all immigrants from the open seas or from higher ground.

Let us now briefly survey the fossil record and see which of the above five theories best accords with it. Diagram I, which deals with animals, shows that in none of the rocks laid down during the immense stretch of time before the Cambrian Period have any unquestionable fossils been found, despite the fact that these rocks occur in all parts of the world, are of great thickness, often underlie the Cambrian rocks, and are in many cases undisturbed or modified and well-suited to hold fossils. By contrast, the Cambrian rocks everywhere are well stocked with fossils which represent all the great groups (phyla) that compose the animal kingdom. This is the strongest possible evidence of the creation of a great marine fauna at the beginning of the Cambrian Period. As the rocks of this period and the next, the Ordovician, and practically all the Silurian period, were laid down in the sea, the fossils they hold are of marine animals and plants. If the evolution theory be true, then all Major Evolution took place before the earliest known fossil was laid down, which seems incredible. Nor is this all, the Cambrian fossils include those of nearly all the classes and most of the sub-classes of animals, also those of the only class of marine plants (see Diagram II). Thus, if there have been successive creations, all except the first have been minor ones, limited to the creation of Classes and smaller groups. Of the 23 Classes of animals which have marine representatives, fossils of no fewer than 17 occur in Cambrian rocks. Of the 6 Classes of which no fossils have been found in these rocks four almost certainly existed in the Cambrian period: the Blastoidea, Crinoidea, Echinoidea and Polyzoa.

The Blastoidea (now extinct) were either never a large class or always lived mainly in the open sea, for, in all, fossils of only some 25 genera have been found, of which two (one in Russia and one in the U.S.A.) occur in Ordovician rocks.

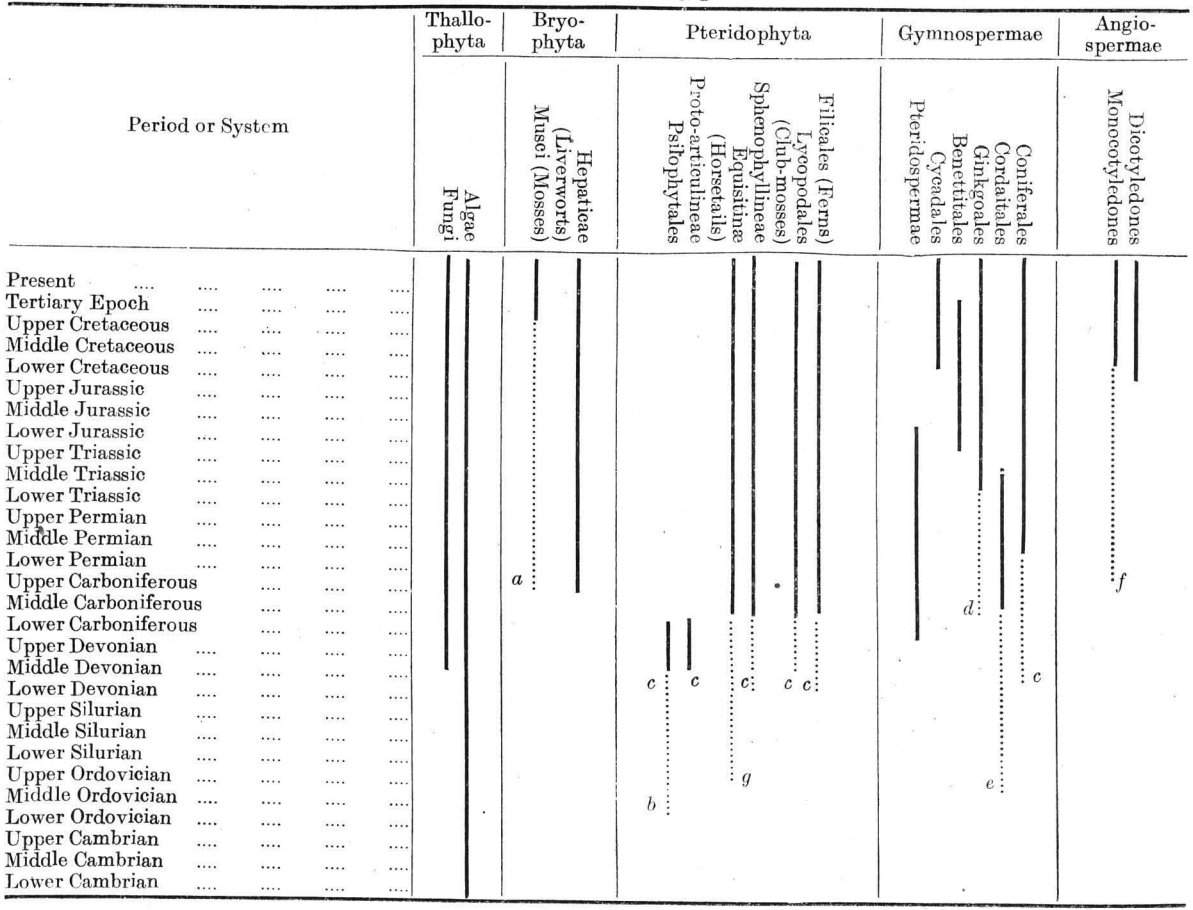
Only a few fossils of Echinoidea (sea-urchin group) have been found in pre-Carboniferous rocks, viz., of one genus in Ordovician, three genera in Silurian, and four in Devonian. The main emigration to coastal seas occurred in the Jurassic period. Thus originally both these Classes seem to have been denizens of the

open oceans, and this explains the failure to find their fossils in Cambrian rocks. Of the Polyzoa (sea-mats) and Crinoidea (sea-lilies) no fossils have been reported from Cambrian rocks, but in Ordovician rocks fossils have been found of some 400 species of Polyzoa, representing 17 families, and of nearly as many species of Crinoids, representing 14 families. This means either that these two Classes came into existence early in the Ordovician period, or that at that time they migrated in numbers into coastal waters. Probably the latter is the correct explanation, because in a number of similar cases of such sudden appearance of a group a solitary fossil has been found in a rock of an earlier period. For example, until recently the earliest known fossils of amphibia were those in Carboniferous deposits, but a Devonian rock had been discovered bearing the impression of what appears to be the footprint of an amphibian. Quite recently two skulls of amphibia have been found fossil in Upper Devonian rocks.

The earliest known fossils of marine reptiles and mammals have been found respectively in Triassic and early Tertiary (Eocene) rocks.

Is it possible that these Classes of large animals can have existed during the whole of the Primary era, without any of their fossils having been found in the rocks of that long period? It is submitted that this may be answered in the affirmative, but as these animals belong to classes of which the great majority of the members are dwellers on land, it will be convenient to survey the land fossils before attempting to show how this is possible. Before passing on to the land flora and fauna, a few general remarks on the Cambrian fauna are desirable. Prof. W. K. Brooks wrote of the Cambrian species ("The Foundations of Zoology," p. 216): they "outline the whole fauna of the modern sea-floor. Far from showing us the simple unspecialised ancestors of modern animals, they are most intensely modern themselves in the zoological sense, and they belong to the same order of nature as that which prevails at the present day. . . Nothing brings home more vividly to the zoologist a picture of the diversity of the Lower Cambrian fauna and of its intimate relation to the fauna on the bottom of the modern ocean than the thought that he would have found on the old Cambrian shore the same opportunity to study the embryology and anatomy of pteropods and gastropods and lamellibranchs, of crustacea and medusae, echinoderms and brachiopods, that he now has at a marine laboratory." In the Cambrian coastal seas lived molluscs having shells like those of mussels, limpets and whelks,

DIAGRAM II.—*Periods during which the classes of plants are known to have existed.*



NOTES.

(*a*) Some authorities deem *Muscites polytrichaceus* and *M. bertrandi* from an Upper Carboniferous deposit in France to be Mosses.

(*b*) W. C. Darrah found a fossil in a Cambrian deposit in Sweden which he considers to be the shoot of a land plant.

(*c*) Fossils of Psilophytales, Equisitinae, Spenophyllineae, Cordaitales and Filicales occur in the Fern Ledges of New Brunswick. (See note (*b*), Diagram I.)

(*d*) *Psygomophyllum* from the Upper Devonian of Bear Island may the impression of the leaf of a Ginkgo.

(*e*) Fossils *Dadoxylon hendricksi* occur in deposits in Cornwall deemed to be Upper Ordovician and Lower Devonian by the Geological Survey.

(*f*) The fossil *Angiospermum americanum* from a Carboniferous deposit in the U.S.A. is held by its discoverer, Dr. Noe, to be part of the stem of a monocotyledonous flowering plant. Seward and others consider it to be that of a Pteridosperm very like the Maize plant.

(*g*) The fossil *Buthrotrepis harknessi* found in an Ordovician deposit in England is deemed by its discoverer, Nicholson, to be a sea-weed, but Sir J. Dawson considers it to be an Equisetum and he changed its name to *Protoannula harknessi*.

That six Classes of plants have become extinct as opposed to only two of animals may be ascribed to the fact that the sea is less affected than the surface of the earth by climatic changes resulting from geological disturbances.

also protozoans, lamp-shells, jelly fish, annelids and echinoderms (sea-lilies, sea-cucumbers, starfish and brittle stars) which no one not an expert is able to distinguish from forms now living. This, I think, may be said of corals, although some authorities place the Cambrian forms in an extinct order. Some Cambrian crustaceans are almost indistinguishable from living ones, but no fossils of shrimps, crabs and lobsters have been found in Cambrian rocks and the majority of the Cambrian crustacea belong to an extinct order, Trilobita. Trilobites varied in length from ¼ inch to 20 inches and must have looked like large wood lice. Some were able to curl the body as wood lice do. As regards fishes, the Cambrian rocks have yielded only one or two fragmentary fossils, and these indicate that the fishes they represent were unlike any now living. Fossils of the Teleosts (bony fishes), which form the greater part of the fish population today, have not been found in any rocks laid down before the Cretaceous period. Table I shows how the late appearance of these fishes, marine reptiles and mammals and lobsters and crabs is accounted for on the theory of one creation. Fossil shrimps occur in Upper Devonian deposits. These may have lived in lakes.

Unless the Fern Ledges of New Brunswick, Canada, are of the Silurian period, the earliest known rocks laid down on land or in fresh-water are Lower Devonian. Although the Silurian rocks are marine, fossils of a millipede and three species of scorpion have been found in them—remains of creatures washed out to sea. As the existence on land in the Silurian period of so advanced an animal as a scorpion is embarrassing for the evolution theory, some of its supporters assert that these Silurian scorpions lived in the sea and later changed their gills into lung-books and came to live on land without undergoing any change in appearance !

Unless the Fern Ledges be Devonian, fossils of land animals in the known Devonian rocks are very few : they are two or three insects—spring-tails ; some millipedes and (found recently in Greenland) two species of amphibians of the extinct order Stegocephalia. Fossils are more plentiful in deposits in lakes and lagoons ; they are of some molluscs and crustaceans and many fish. One of the Crustaceans is *Esteria* which still lives in saline springs in deserts. The fishes represent five sub-classes—the extinct Ostracoderms and Arthrodira, and the existing Elasmobranchs, Ganoids and Dipnoi (lung-fishes). The only sub-class not represented is the Teleostei (bony fishes) which today con-

stitute the majority of fishes. On the other hand the Devonian plant fossils are abundant. As Diagram 2 shows, all the great groups of plants existed in the Devonian Period, and, of the 18 classes which constitute the vegetable kingdom 10 or perhaps 11 occur in the Devonian rocks, as opposed to 12 now existing, which include 6 of the sub-classes known to have existed in the Devonian period: algae, fungi, Equisetums (horse-tails), Lycopodiums (club-mosses), Filicales (ferns) and Gymnosperms. But no fossils have been found of liverworts, mosses and flowering plants, which to-day form the greater part of the flora. The Devonian fungi and algae differed little from those now living; the ferns were like those of to-day but more robust; the club-mosses and horse-tails were mostly much bigger than any now living, some were tall trees. The Gymnosperms differed from the pines of our time in that their seeds were in catkins and not in cones, and their leaves were broader than pine "needles." The branches, like those of our pines, were all near the summit of the trunk. Of the known Devonian organisms, Dr. J. W. Evans writes: "The vegetation, like the animal life, was probably confined to streams, lakes and marshes, while the high ground was left unprotected by vegetation." It is true that the known Devonian fossils are only those of plants and animals that lived in low-lying localities, but the inference that none existed elsewhere seems unjustified, if only because these Devonian plants represent no fewer than ten classes. Some authorities maintain that the known Devonian deposits were laid down in lakes, but Gregory and Barrett are probably right in suggesting ("General Stratigraphy," p. 100) that they were deposited by rivers that carried much water at some seasons and little in others; these, on emerging from narrow gorges, spread coarse sands and pebble beds in low strips of coast land. Changes in the course of such rivers gave rise to lakes. As these disappeared by seepage or evaporation their fish buried themselves in the mud and died there, hence the tangled masses of their fossils which occur in such rocks as those of Dura Den in Fifeshire; a slab exhibited in the Museum at South Kensington holds the remains of over one hundred fishes. The fact that beds of shingle rivers are not the resorts of many animals may be the explanation of the paucity of animal fossils in the Devonian rocks now existing.

The Carboniferous rocks were deposited under very different conditions, in swamps near the sea in great deltas. Geikie suggests that some of these swamps were analogous to the man-

grove swamps of to-day; the trees grew seaward, dropping their roots into shallow waters and gradually forming a belt of swamp jungle several miles broad. Throughout both Devonian and Carboniferous periods the land seems to have sunk, very slowly in the Carboniferous so that generally the silt from the rivers kept pace with the subsidence. At times when the subsidence was less slow than usual the many intercalated marine strata were formed. In Carboniferous times the climate seems to have been moist and hot and very favourable to life in the coastal areas. The flora, save being more luxuriant, differed little from the Devonian. Animal fossils are abundant. They include those of all the three extinct orders of amphibia, a variety of spiders that spun webs to catch their insect prey, and no fewer than 12 orders of insects, including dragon-flies, may-flies and cockroaches. Many were very large; one dragon-fly had a wing expanse of 28 inches. Fossils of insect larvae of nearly 120 species have been found, nearly all of which were aquatic. Except possibly in rocks formed quite at the close of the period no fossils of Carboniferous land reptiles are known. This was because fossils of these animals rarely occur in the same deposits as those of plants and Carboniferous land rocks are rich in fossil plants.

At the close of the Carboniferous period one of the great cycles of world-transforming events turned swamps into relatively dry and hilly regions or into arid wastes in which inland seas like the Caspian replaced estuaries and fresh water lakes. (Seward.)

These upheavals, which ushered in the Permian period, involved a fall in temperature which caused much migration and extinction of plants and animals. The land vegetation became impoverished. Many Carboniferous families of animals became extinct: nine of insects which were replaced by five new families, nine families of amphibia were replaced by seven new ones.

A feature of the Permian rocks is that they hold hundreds of thousands of fossils of reptiles. The manner in which these fossils appear upon the scene, which may be taken as typical, has an important bearing on the origins of new groups of animals. The following figures are based on Zittel's "Textbook of Palaeontology." Fossils of 42 genera, representing 13 families and 3 orders of land reptiles (turtles are excluded) are recorded from rocks of the Lower Permian period; 4 in South Africa, 2 in Russia, 4 in Germany, 2 in France and 30 in the U.S.A. Usually all the genera of a given family appear in the same

continent, but there are exceptions, thus the Poliosauridae turn up in the form of 7 genera in the U.S.A., 2 in France and 2 in South Africa. Often a family extends its range in course of time. Of these 13 Lower Permian families 8 seem to have become extinct in it, 2 persisted into the Trias, the others died out in the latter part of the Permian. In the Middle Permian rocks fossils of 77 new genera occur belonging to Lower Permian families, and 66 genera belonging to new families; most of these have been found in South Africa; all became extinct in the Permian period, save one which lasted till the Upper Trias.

Let us notice how these facts bear on the various theories of origins. Most evolutionists believe that the reptiles originated in one locality from a single species of amphibian. The descendants of this common ancestor gradually developed into full-fledged reptiles, which became divided up into species, genera, families and orders. All this evolution and the dispersal from the place of origin to South Africa, Russia, France and the United States must have taken a very long time, during which a great many fossils were laid down. As none of these have been found, the diffusion must have occurred without any of the animals entering coastal areas. This I cannot believe. The difficulty as regards migration does not present itself to polyphyletic evolutionists or to Rosa, because, according to them, reptiles may have arisen from amphibia in several parts of the world. Those who believe in successive creations may hold that there were successive creations of reptiles, the first being early in the Permian period, or that there was only one creation early in the Permian, and the reptilian groups which first appear in later rocks are immigrants. The former view means that a number of families became extinct very shortly after their creation. According to the theory of one great creation, the reptiles, along with other land organisms, were created long before the Permian period, each in a locality of such latitude or altitude that the climate was best suited to its constitution at the time of creation. The lack of their fossils in known Devonian and Carboniferous rocks is because these rocks were deposited in localities unsuited to reptiles for various reasons such as not providing proper food or the sun's rays were so powerful as to cook eggs on the ground. The geological disturbances at the end of the Carboniferous period both lowered the temperature and rendered the coastal tracts suitable for reptiles; in consequence those then living nearest to the sea migrated to the coastal tracts; these immigrants provided the known Lower

Permian fossils. But the early extinction of these reptiles suggests that even their new habitat was too cold for them, they soon died out and their places were taken by immigrants from farther afield. Subsequent changes in environmental conditions have led to further extinctions and migrations. Thus the successions of faunas and floras in the known land rocks may be accounted for.

After the Permian period the climate improved. Fossils are abundant in Triassic and very abundant in Jurassic rocks. The vertebrate fossils are mostly of reptiles, of which new orders appear successively including bipedal and quadrupedal Dinosaurs and Pterodactyls. The known Triassic and Jurassic fossils include some isolated teeth and parts of jaw bones believed to be those of aplacental mammals, which seem to have been carried from a distance by rivers. The Stegocephalia became extinct in the Triassic period and the earlist known fossils of modern amphibians—frogs and tailed forms—occur in Upper Jurassic rocks. In these last the earliest known fossils of birds have been found—those of the extinct Archaeopteryx. The Upper Triassic rocks contain the earliest known fossils of three classes of plants: Cycads, Maiden-hair Trees and the extinct Benettitales, also of two fragments of flowering plants, proving that these existed at that time.

The Cretaceous period is marked by the world-transforming event that brought about the great Cenomanian transgression of the sea. The accompanying fall in temperature caused the extinction of a host of plants and the great majority of land and marine reptiles. The plants thus killed off were rapidly replaced by Flowering Plants, and the reptiles more tardily by placental mammals, the earliest known fossils of which occur in Upper Cretaceous rocks. In the Lower Cretaceous rocks of Greenland and Western Siberia occur, mixed with many types of Jurassic plants, fossils of about twenty kinds of Flowering Plants, including those of the poplar, plane, cinnamon and breadfruit. The sudden spread of the Flowering Plants was rapid. The fossils of the Middle Cretaceous deposits of the U.S.A. and Portugal show that they constituted 30 and 35 per cent. of the local flora. In the Upper Cretaceous deposits of New Jersey and Dakota the percentages were 70 and 90. In the latter have been found fossils of 132 species of Flowering Plant representing 64 families.

What may be the earliest known fossils of mosses also occur in Cretaceous rocks (see Diagram II). In the Upper Cretaceous rocks of Europe and North America a few fossils of birds have

been found; these, like Archaeopteryx but unlike any birds now living, had teeth; some were aquatic, others flightless. They seem to have become extinct by the end of the Cretaceous period. In the Eocene of North America and Europe occur the earliest known fossils of toothless birds; these fossils include those of the owl, falcon, sandpiper, rail, quail and woodpecker.

The earliest known fossils of placental mammals occur in the Upper Cretaceous of Asia—these represent Insectivora and Carnivora. Little is known of the early Tertiary rocks of Asia, but those of Europe and North America indicate that, as in the case of flowering plants, a great many placental mammals have migrated from the far north. In the Palaeocene four new orders of placental mammals make their first appearance, and in the Eocene several orders now extinct, and even- and odd-toed hoofed animals, bats, rodents and primates, and, in N. America, Edentates. Sometimes a family appears simultaneously in both Europe and North America, *e.g.*, the horse, tapir, pig, rhinoceros, cat and dog families.

The late appearance of the flowering plants and the mosses in the known rocks necessitates that of the placental mammals, butterflies and birds owing to the fact these animals are directly or indirectly dependent on flowering plants for their food.* As to man, he cannot exist in any part of the earth devoid of grain-bearing and fruit-giving plants. The original home of most of the grain plants now living seems to have been in the far north, for to-day these constitute nearly one-fourth of the Arctic flowering plants, one-twelfth of the English and one-twenty-third of the South African.

The rocks of the Eocene period are the latest in which fossils of orders make their first appearance. This suggests that the Eocene is the earliest period of which the rocks laid down at high elevations have been preserved. New families, however, appear in the later rocks; some of these are immigrants from the north. The known fossils of Eocene horses are of small four-toed species. These are followed by those of larger three-toed species, and

* This does not apply to fish-eating birds. Birds' eggs are more liable than those of reptiles to be destroyed by the heat of the sun's rays. Therefore birds which nest on the ground, as many sea birds do, may originally have been confined to high latitudes, or have been based on islands far from the equator. To-day in hot climates birds that nest on the sand take precautions to prevent eggs being overheated. The terns near Ghazipur on the Ganges, after April, lay their eggs on moist sand. Young Indian Skimmers lie up in hollows scratched by themselves, and often throw sand on their backs. Swallow-plovers nest by creeping plants, in the shade of which the young lie up.

TABLE

FACTS ABOUT GROUPS OF MARINE ANIMALS OF

Name of Group	Period in which First-known Fossils First Appear	Localities in which Earliest-known Fossils Occur
Teleostei .... (Bony Fishes)	Lower Cretaceous	Europe, Brazil, Queensland ....
Chelonia (Turtles)	Upper Triassic	Wurtemburg, Scotland (Nairn) ? ....
Pythonomorpha	Upper Cretaceous	England, France, Belgium, Holland, N. Germany, N. Italy, Morocco, Nigeria, S. Africa, U.S.A., New Zealand
Thalattosauria	Upper Triassic	California ....
Champsosauridae....	Upper Cretaceous	N. America, France, Belgium, Timor ....
Ichthyosauria	Middle Triassic	Nevada, Spitzbergen ....
Plesiosauria	Upper Triassic	England, Germany ....
Mesosauria	Upper Carboniferous	S. Africa ....
Nothosauria	Lower Triassic	Franconian Silesia, Saxony, Thuringia ....
Cetacea	Middle Eocene	Alabama, Egypt ....
Sirenia	Middle Eocene	Jamaica, Egypt, Italy ....
Pinnipedia	Miocene	Europe, U.S.A..... ....
Crustacea—		
Lobsters	Upper Trias	Europe ....
Crabs	Middle Jurassic	Europe ....

NOT

Some authorities deem these rocks (Beaufort Beds) to be Middle Permian.

A. Original habitat was the open ocean or sea bed far from land. As various world-transforming events killed off groups of animals in the coastal seas immigrants from the open sea replaced them. This explanation can apply only to animals that do not have to come to land to breed, such as fishes, Ichthyosauria, Plesiosauria (?), Pythonomorpha (?), Cetacea, Sirenia, lobsters and crabs.

B. The original habitat was the polar seas; later falls in temperature caused late migration equatorwards.

C. Originally based on a large island or small continent which later became submerged. The submergence caused some of the marine animals based on them to resort to existing continents for breeding purposes.

III.

WHICH FOSSILS APPEAR LATE IN THE KNOWN ROCKS.

In Earliest Period Fossils occur of		Latest Period in which Fossils occur	All the known Fossils are of		Suggested reasons of late appearance in the known Rocks
Families	Genera		Families	Genera	
4	6	Still	Living	—	A, perhaps D in case of fresh-water forms.
2	3	Still	Living	—	C or D.
4	15	Up. Cret.	4	15	C ?
1	2	Up. Trias	1	2	D ?
1	2	Up. Cret.	1	3	A or B.
3	7 or 8	Up. Cret.	5	21	A.
1	3	Up. Cret.	4	25–35	A ?
1	2	Permian	1	3	A ? or C ?
1	10	Up. Trias	1	21	D.
1	3	Still	Living	—	A.
1	3	Still	Living	—	A or D.
3	6	Still	Living	—	B.
1	4	Still	Living	—	A or D.
1	5	Still	Living	—	A.

ES.

D. Original habitats were fresh water lakes at high elevations. Subsequent fall in temperature led to migrations to coastal lakes, lagoons and the sea.

Owing to the paucity of the known fossils it is not yet possible to make definite pronouncements regarding the causes of the late appearance of the fossils of some groups, particularly of Thalattosauria, Champsosauridae, Mososauria, lobsters and crabs. Fossils of Crustacea (other than of bivalves of which fossils occur in Cambrian and other early rocks) are comparatively scarce, and a considerable fraction of these are so fragmentary as to render it difficult to determine the group to which they belong. Accidents of a kind that result in the fossilisation of most kinds of Crustacea are very rare. Of the 30 genera of lobsters of which fossils are recorded in Zittel's Palaeontology 11 occur in one deposit—the Jurassic limestone of Solenhofen (Germany).

finally the living one-toed genus. This does not necessarily mean that the one-toed is descended from a four-toed horse. It may be that the three- and the one-toed species are later immigrants which followed the southward movement of the type of grass on which each fed.

A fact which has a bearing on the present and past distribution of land animals and plants is that, although most parts of each continent have been under the sea at some periods, certain areas have always been above water since Cambrian times, *e.g.*, Brazil, parts of Canada and the U.S.A., and of Russia, Siberia, China, Malaya and much of Africa. There remains for consideration the late appearances in the rocks of the fossils of the bony fishes (Teleosts) and marine reptiles and mammals (see Table I).

These, it is submitted, present great and real difficulties to theories of evolution, and minor ones, more real than apparent, to theories of successive creations and more apparent than real to the theory of one creation. According to the last, animals whose young are born in the water—fishes, Ichthyosauruses, Plesiosaurians, whales and Sirenia—were created in the oceans far from land; later world-transforming events drove some sections of them into coastal waters. The late appearance of marine animals that have to come on to the land to breed—turtles and some extinct reptiles—is because these were created in the polar regions or elsewhere in lakes at considerable altitudes or on islands which have become submerged; and this may have been so in the case of the Sirenia. That the Teleosts were originally confined to the open ocean is indicated by (1) the fact that their earliest known fossils occur in considerable variety in widely-separated localities (see Table I) and (2) two waves of immigration to coastal areas, one as the result of the Cenomanian transgression in the Cretaceous period and the other as the result of the Montian transgression at the beginning of the Eocene period. The first drove into the coastal seas of Europe and the U.S.A. seventeen families, mostly of fishes of which the air-bladder is connected with the gullet; the second caused an influx of thirty-two families of which the air-bladder is not so connected. The available data for the groups that come ashore to lay eggs or breed are at present insufficient to justify pronouncements as to their centres of origin. They suggest a northern early home for the turtles and an arctic one for the seals. We may, however, notice that, as the existence of a marine reptile as early as the Carboniferous is not in accord with evolutionary concepts, some authorities would relegate to the Middle

Permian the deposits in which the earliest known Mesosaurs occur. Still more unfavourable to evolution theories is the fact that the earliest known members of each group of marine reptiles and mammals exhibit, fully developed, all the peculiarities of the group, and no fossils intermediate between any of them and the hypothetical land ancestor have been found.

From the foregoing it is clear that the creation theories explain the fossil record far better than do those of evolution, and, as the latter involve impossible transformations, they ought to be abandoned. As between the theory of one creation and that of several, the former is the more simple, but it is far from being proved; indeed, the fossil record is such that it may never be proved. However, if it be correct, discovery after discovery will be made of fossils of flowering plants, bony fishes, placental mammals, land reptiles and turtles and other groups in rocks considerably older than those in which any of their fossils have been found up to date. Each new discovery of this nature will add to the evidence in favour of the theory; but, so long as biology is dominated by transformist philosophy, each of these discoveries is likely to be challenged.

Written Communications

Dr. L. R. Wheeler wrote: Though present evolutionists commonly assume that abiogenesis must have occurred, this is not true of all. Dr. J. Gray* criticised this assumption violently in 1933. Bower, botanist, and MacBride, zoologist, believed in the divine creation of the first organisms, which was always taught by Darwin† and Wallace.‡

I doubt whether such a believer in polyphyletic evolution as Berg supposed that primal species were all of microscopic size; anyhow, though he did not expressly teach creation, he too, attacked abiogenesis vigorously (§, last ch. and p. 2). Rosa's Hologenesis theory has few adherents indeed.

It seems an over-simplification to say that all creationist theories involve the creation of all the main types of organisms in their

* Gray, J. (1933); The Mechanical View of Life; Adv. of Sci.

† Darwin, C. (1859); Origin of Species; last paras.

‡ Wallace, A. R. (1889); Darwinism, p. 474, etc., Macmillan (*cf.* World of Life, 1914; Chapman & Hall).

§ Berg, L. S. (1926); Nomogenesis; Constable.

present form or very near it. Wallace's evolutionism involved at least three major creational actions ; Ramsbottom has shown clearly that Linnæus ultimately believed in evolution from species to genera as well as in the creation of primal species* ; I myself believe in creation-mutations + evolution within families and/or genera, etc.

Thomas, the Belgian zoologist, does not allow for the appearance of new " good " species among plants through polyploidy (auto- or allo-), which British botanists regard as absolutely certain (*cf.*, † among much other evidence).

I agree that Dr. J. C. Willis' (*op. cit.*) theory of " evolution " through—or mainly through—large mutations implies, or is at least congruent with, successive creations, and the evidence he marshals against Darwinian struggle and selectionism is very impressive—for plants only. His theory, based on life-long experience, supports the view that creation need not always be *ab initio, ex nihilo,* but may go on from what the Creator had already created and " saw that it was good " (*cf.* notes on p. 10).

I am glad that millions of years are recognised as necessary for the deposition of sedimentary rocks, and it may well be that some classes of organisms have existed during a geological period and not yet been found among its fossils. But in a previous paper Mr. Dewar argues from the absence of fossils of intermediate forms that such forms never existed on the earth.‡ Is it logical to adopt an entirely opposite conclusion here (and on p. 11) with regard to the total absence of fossils of certain important classes from vast geological periods, especially as such classes are—or have become—adapted to widely different habitats ?

I do not think the simultaneous creation of " all the main types of living beings " possible (despite the vagueness of the term " type ") because of the vast numbers of genera, etc., involved and the limited land areas available for them. A sample of this immensity of genera is given in this paper, pp. 16-17. To me it is incredible that these swarms of extinct reptiles and of other organisms existed simultane-

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* Ramsbottom, J. (1938) ; Linnæus and the Species Concept ; *Proc. Linn. Soc.*, 150, Pt. 4.

† Stern, F. C., and Sprague, T. A. (1944) ; papers in *Proc. Linn. Soc.*, 155, Pt. 2.

‡ Dewar, D. (1942) ; *What Animal Fossils Tell Us,* Trans. Vic. Inst. LXXIV.

ously with all the genera that died out before their time and with all those that lived on to the present day.

Further, there is in successive creational and/or evolutionary theories evidence of Design in Nature which does not exist if all types of organisms were produced together at one time (*cf.* *). This is a philosophical argument. The absence of evidence for simultaneous creation is surely a scientific one. Cold periods can hardly be considered as interruptions to cooling, though warm periods would be ; the former are iutensifications of a process which scientists are agreed has occurred on the Earth.

Granted that the Cambrian fauna was very rich, it was admittedly marine. There remains the possibility or probability of the further production of all the great phyla of the Plant Kingdom except the sub-phylum Algæ, of the most important, if not all, classes of Vertebrates, and of the Class Insecta, which outnumbers all the other animal classes put together. These events, including the appearance of all flying animals, should not be regarded as minor ones. Further, the appearance of the Mind-cum-Soul of Man is, as Wallace said,† a creatiou of the highest importance. I think it quite incredible that this dates from Cambrian times.

What is truly said about the Cretaceous and Eocene periods later supports the views of our great botanists and some zoologists that great mutations—of the nature of fresh creations—produced these enormously important branches of the Realm of Life (*cf.* ‡).

Genesis i. is not the only portion of the Bible that deals with organic creation. Progressive creation is indicated in many passages, *e.g.*, Psalm civ—" He bringeth forth grass for the cattle ; and green herb for the service of men " ; at least an evolutionary interpretation is possible, *cf.* Psalm xcv, 5.

Eskimo Man exists on fish and flesh without grain or fruits§; the Masai used to feed on meat and milk, but these are certainly derived from grasses, etc.

The Sirenia live in the fossil-producing sea or river areas ; whales

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* Dewar, D. (1942) ; What Animal Fossils Tell Us ; *Trans. Vict. Inst.* LXXIV

† Wheeler, L R (1942) ; Co-Operation for Existence ; *Hibbert Journal*, July.

‡ Wheeler, L. R. (1944) ; Survival ; Biological and Human ; *Hibbert Journal*, April (in the press).

§ Encyclopaedia Brit. (1930) ; art.—Eskimo ; 8,710b.

often get stranded on land. It would be strange if these orders had existed since the Cambrian without leaving early fossils.

Still, even on Mr. Dewar's hypothesis, a great deal of subsidiary evolution or adaptation must have occurred in such a class as the Teleostei, which he suggests were originally confined to the open ocean, for many bony fishes are now exclusively fresh-water animals or haunt the sea bottom at all sorts of depths, or frequent shallow water near shores.

So, fortunately, there is no hard and fast line between his or other creational hypotheses and belief in evolution or mutation to some extent. But for various reasons, some indicated briefly above, I do not think his conclusion of a solitary creative instant, or even epoch, followed by many millions of uncreative years, is acceptable. And it is out of keeping with the time proportions of Genesis i, however thoroughly we believe that with God a thousand years are but as yesterday. But this paper contains many instructive ideas and useful criticisms of atheistic evolutionary theories.

Recent relevant criticisms of selectionism are given in a Royal Society Discussion.*

Lt.-Col. L. M. DAVIES, D.Sc., Ph.D., F.R.S.E., F.G.S., wrote: Mr. Dewar well stresses the difficulty to evolution afforded by the nature and abundance of the oldest known fossils. According to evolutionists, life began in shallow coastal waters; and animals slowly adapted themselves, by extremely prolonged processes, to life at a distance from the coast, *e.g.*, on the bottoms of the great ocean depths or in the surface waters of the main oceans far from land. Yet among the earliest fossils known to us are types which seem to be fully adapted to both of these. Thus, we find highly specialised Trilobites (*Eodiscus*, *Goniodiscus*, etc.), with relatively huge cephalon and pygidium and greatly reduced thorax, which are unlike less specialised Trilobites in being devoid of all traces of eyes, and apparently adapted for life in the perpetual darkness of abyssal depths; and we also find Pteropods (*Hyolithes*) with perfect swimming organs, as fully suited for life in surface waters as their counterparts are to-day. Where are the ancestries connecting,

* Royal Society (1936-7); Discussion on . . . Natural Selection; *Proc. R. Soc. B*, CXXI, p. 43 seq.

through prolonged ages, these extreme members of totally different phyla with their supposed common progenitors of shallow-water origin ? There are many rocks in which the ancestries should be found if they ever existed, for we have masses of pre-Cambrian sediments (*e.g.*, the huge Cuddapah series of India) which are quite unmetamorphosed and undisturbed, and perfectly suited to have preserved remains of life. Yet the required ancestries simply are not there. Life bursts upon us, in the closely succeeding Cambrian ; and it is highly differentiated and specialised life from the first.

As Mr. Dewar has indicated, I believe in *at least two* separate and successive creations, not in one creation. But my reasons for doing so are Scriptural. I believe that the Bible talks of several creations. I cannot go into that matter here, but it is discussed in my book.

I have no personal objection, of course, to the idea of only one creation (if it can be reconciled with Scripture, which I strongly doubt), and I am interested in Mr. Dewar's able arguments on its behalf. But I find it difficult to picture a Cambrian world containing all types to which the rocks bear witness, in addition to ones now existing ; and it is difficult to account for the non-appearance through vastly long ages of now ubiquitous types, like grasses and toothless birds, if they were in existence all the while. These purely physical objections may not be fatal ones, however ; and the fact that so experienced a naturalist as Mr. Dewar can argue for its possibility shows how little science can *prove*, one way or the other, regarding the distant past. We all ultimately walk by faith, not sight ; but how few realise the fact !

Mr. O. R. Barclay, B.A., wrote : Mr. Dewar's paper is most interesting and contains much useful information. There is, however, one distinction which he has not made and which seems to be basic in the question.

Leaving aside questions of interpretation, there are three main *biological* problems involved in any consideration of evolution :

(1) Are types of organisms absolutely rigid or are they capable of change in the course of time ?

(2) If they change, how far can such changes go ?

(3) If they change, by what machinery do these changes come about ?

The first of these may be termed the problem of " Descent with Modification." The second the problem of " The Extent of Descent with Modification " ; and the third that of " The Machinery of Descent with Modification." These three problems are quite distinct and it is due to a confusion of the first two that a good deal of the trouble seems to have arisen recently.

As far as I can see, Mr. Dewar, together with nearly all biologists, would say that Descent with Modification seems to have taken place, at least on a very small scale ; *e.g.*, the races of man are all derived from Adam and Eve by descent (with, obviously enough, some modification). But on the question of " The Extent of Descent with Modification " Mr. Dewar's position is not clear. Some conservative Christians would limit it to a process within the Species, others draw the line at the Family, and still others at the Phylum, etc. Now these units (Species, Family, etc.) are all quite arbitrary, human ideas, and Mr. Dewar avoids the terms in this context, and says : ". . . all the main *types* . . . have undergone little or no modification since they were created."

It would be very interesting to know where Mr. Dewar draws the line, and whether he does not think that in any case it is a very arbitrary and uncertain thing to do. It is a matter of what he means by " type." It seems to me that there are very good reasons for accepting " Descent with Modification," and I am quite unable to put an exact limit to this process. It does not seem to me to be contrary to Scripture to say that it *may* have extended to a whole Phylum, all the members of that Phylum being, therefore, derived by descent (with modification) from a common ancestor. Mr. Dewar's wide knowledge makes his view on this question of considerable value.

Dr. PHILIP G. FOTHERGILL wrote : Mr. Dewar puts the case for special creationism extremely well in his various writings and in this paper the palæontological evidence seems to support his thesis. But this evidence as presented seems to me to be mainly negative, aimed at showing the invalidity of the current evolutionary theory. We can assume that the great groups of organisms, unicellular animals, unicellular plants, algæ, fungi, pteridophyta, gymnosperms, angiosperms, fishes, reptiles, birds, mammals and Man have each

to their own group their characteristic mode of life, and. with Paul Lemoine, we can believe that the members of these groups have a similar, or allied, chemical constitution. Perhaps such large groups as these were created at one time by the fiat of the Creator. It is easy to hold to this view if we interpret "time" in its newer physical sense—the sense of relativity in which space and time are parts of the same general nature (space-time), which our human intellect on account of its limitations separates into two categories. But, excluding this newer as yet little appreciated concept, as biologists, we deal only with perceptual space and time, and physical space and time. Hence, it would seem that we must allow for *some* sort of evolution within these great groups of organisms because we can trace within them series of changes which logically indicate that some kind of *progressive differentiation* has occurred.

Mr. Dewar cannot here appeal to the theory of successive creations because he has already cast his vote in favour of one creation only. It seems to me, then, that he is forced to postulate the creation at one time, not only of the large clear-cut divisions of living things, but also of each genus, or even species (in the biological sense). It is incumbent upon him, then, to explain the *resemblances* between organisms which some biologists believe indicate the reality of evolutionary sequences. For instance, among the flowering plants especially, the gradations from one genus to another are often very small—the same habit persists, but morphological changes are often so slight that a disputed type will be put in one genus by one man, in another by someone else and yet a third will create a new genus for it.

In this connection Mr. Dewar could possibly appeal to the environment by saying that, as many different kinds of things were created at one time suited to certain environments, then those put in a similar environment must of necessity show many structural similarities. The *differences* then require explanation. This appeal could not, however, apply in the following case. The bryophyta and pteridophyta have totally different habits; from, say, Marchantia, on the one hand, to a Tree Fern, on the other, is a large jump. Yet in their reproduction they show many features in common—they both belong to the archegoniatæ and so possess archegonia and antheridia. They live also in totally different habitats and they show alternation of generations characterised by chromosomal

differences. In one case the gametophyte is the important generation, while in the other the sporophyte is the main one.

In some cases the evidence of the rocks does contradict that obtained from other lines of evolutionary enquiry. For instance, as evolutionists we consider that the mosses are more primitive than the ferns, but palæontology does not at present support this view, for mosses appear much later in the rocks than the ferns. Nevertheless in the palæontological records, viewed as a whole, there does seem to be an increase in the complexity of the form, structure and organisation of animals and plants, if only because man, the mammals, reptiles, angiosperms and gymnosperms appear much later than the lower organisms. Within the phyla themselves there are many fairly clear-cut evolutionary lines, but few of them are perfectly continuous. In many cases these evolutionary lines, as Mr. Dewar shows in his diagrams, run parallel down to the dim beginnings of living things and never seem to anastomose. Cats are always cats, dogs are always dogs; there are no intermediates. Another point here is that a new fossil as it is found can be at once put into an existing phylum.

Many palæontologists, like H. F. Fairfield Osborn, will agree that palæontology shows unmistakably that the various major groups of organisms run back to remote ages as a series of parallel lines with no convergence anywhere. Hence we can only conclude that the major groups have always existed together since the origin of living things. They all show simultaneous development each along its own special line. To explain this Osborn brings in the principle of aristogenesis, or the idea of adaptive reaction and interaction of internal and external energy systems. Mr. Dewar concludes, however, that evolutionary hypotheses must be discarded and that of special creationism substituted, and he limits special creation to one major act whereby all these large groups were created at one time. Are there any other possible alternatives? A. H. Clark* provides us with another explanation which is just as feasible as Dewar's appeal to special creation. To solve this difficulty of distinct phyla existing from earliest times he appeals to embryology and brings in the hypothesis of primogenesis.

* "Zoogenesis," *Jour. Wash. Acad. Scs.*, 19, 1929, 219-231, and other papers.

Clark assumes that the first living things were unicellular—we know that living things start life as single cells which then divide; the daughter cells may or may not become separated. Primitive cells also after division would have to remain attached or separate. Those that separated became the protozoa, while from the attached ones were developed the metazoa. Those that remain attached may adhere irregularly or regularly. The irregular masses of cells could give rise to the sponges. Embryology provides us with a clue as to what could happen to those primitive cells which remained adhering in a regular order. If the divisions continued regularly a hollow ball of cells would result resembling a blastula. If one wall of this collapses a symmetrical gastrula would be produced. If the gastrula stage persists to adult life, then we get a coelenterate type of animal. As Clark says: "The appearance of the protozoans, the sponges and the coelenterates was presumably simultaneous. Each is the logical outcome of a special type of cell division."

Finally, all other animals that we know pass through a gastrula stage in their ontogenetic development. Hence primitive gastrulæ could give rise simultaneously to various forms of higher animals. Clark then accounts for the existence of the parallel evolutionary lines in a perfectly reasonable way which finds its parallel in the development of an embryo from the fertilised cell. All these kinds of cell division could take place simultaneously given the original creation of a primitive cell. Environmental factors may possibly have determined the exact method by which these cells would divide—roughly, those in water would tend to become protozoa, sponges and coelenterates, while those on land would tend to become metazoa.

Dr. A. Morley Davies wrote: As I have had no opportunity to refer to scientific literature my criticism of Mr. Dewar's views is general.

His preliminary survey of Evolutionist and Creationist theories is a useful summary. I am glad that he has tracked down the original of the Hologenesis theory, as I know of no English translation of Rosa's book.

There are two other theories which Mr. Dewar might add in any further expansion of his paper.

Among Creationist theories there is P. H. Gosse's, which I have described pretty fully in my book "Evolution and its Modern Critics."

Among Evolutionist theories is one which I heard propounded at a lecture by Professor Przibram, of Vienna, some years back. He is an ardent Lamarckian, but the most remarkable—to my mind fantastic—deduction which he made was that every species had a separate ancestral line from the beginning of life.

Mr. Dewar, in his support of Single Creation, is returning to an early view of Cuvier's, at a date before William Smith had founded stratigraphy on a palæontological basis (or before Smith's views had gained general acceptance). Cuvier accounted for differences in successive faunas by extinction followed by migration from some other habitat. He abandoned the idea when he realised that it demanded an improbably large number of original habitats from which faunal migration should take place.

Mr. Dewar tries to overcome this objection by suggesting possible habitats from which no fossil evidence can be got, and grounds for believing in periodical extinctions and migrations. I admire his ingenuity in using the arguments put forward by evolutionists to explain the imperfections in the record as arguments for the One Creation Theory, but I am not shaken in my evolutionist views. It seems a greater strain on credibility to suppose that successive migrations of portions of enormous faunas should mimic so closely an evolutionary succession. I admit that it is an imperfectly evolutionary succession, but I feel that a succession of migratory portions of a fauna would have a vastly larger number of evolutionary anomalies. To consider Mammalia only, for instance: if all mammals living and extinct lived together in upland regions from the Cambrian to the Trias, in surroundings to which they were perfectly adapted, is it likely that when at last migration took place it was only the most primitive orders which migrated and survived in a new habitat? (The view that these small Mesozoic mammals migrated on floating wood which would not support larger mammals is hardly consonant with the idea of an original upland home; besides, the smallest of the higher mammals, such as mice and shrews, would equally be able to travel on floating wood.) And if these primitive mammals were the easiest to adapt themselves to

new conditions, and could survive through the later Jurassic, Cretaceous and Paleocene periods, why should they become extinct just as the presumably less adaptive higher mammals were at last following them into their habitats ?

Similar difficulties arise at every point in the sequence of Tertiary mammalian faunas. And parallel difficulties in the case of all other phyla. If the extinction of successive faunas is due to the arrival of more advanced competitors, how did all these faunas manage to survive for such enormous periods when they all lived together in some unknown habitat ?

Author's Reply.

Dr. Fothergill's contribution to the discussion is interesting and valuable. In his view we must allow *some* sort of evolution within the great groups of organisms because we can trace within them a series of changes which logically indicate that some kind of progressive differentiation has occurred. I agree that the fossils suggest that in the course of time some species have undergone change, but—and this is important—the changes to which the fossils appear to testify are small, and I would describe them as differentiation rather than evolution. In the hands of the breeder the jungle fowl, Gallus bankiva, has undergone differentiation into several breeds, but this, in my view, is not evolution. Curiously enough the best examples of changes to which the fossils bear witness are furnished by animals on the verge of becoming extinct, as though they assumed strange forms in an unavailing effort to adapt themselves to increasingly unfavourable conditions, *e.g.*, Micraster, Zaphrentes, Gryphea, Inoceramus, etc., some account of which I have given in my "More Difficulties of the Evolution Theory." The larger changes that transformists imagine to have taken place, such as the supposed transformation of Eohippus into Equus and Moeritherium into Elephas, are on a footing very different from that of Micraster cor-bovis into M. cor-anguineus. Here transitional fossils exist. But there are no known fossils transitional between Equus and Elephas and any other known genera. That Equus is derived from Eohippus and Elephas from Moeritherium is theory unsupported by fossil evidence. The most that can be said is : If Equus be derived from a small four-toed horse, Eohippus

is as likely to be that Eocene ancestor as any other known genus. Fully twenty different pedigrees have been drawn up of the supposed genetic intermediaries between these two genera.

The point at issue is the extent to which animals and plants have changed in form since their origin. The transformists assert that it is almost limitless. In my view it is very limited. Dr. Fothergill says that in plants the gradation from one genus to another is often very small. I agree; but from this it does not follow that such transition has in fact taken place. Moreover, this is not the case with families; these are sharply divided. Dr. Willis, for this reason, believes that each plant family was created by a single mutation ("The Course of Evolution," p. 191). This is a theory of successive creations. As to whether such mutations have occurred, all that can be said at present is that no breeder scientific or practical has produced a new family of plant or animal. Nor have they produced a new genus. In the case of animals the fossils give but little support to the view that a genus often becomes gradually changed into a new one. As regards mammals we read (Zittel's "Textbook of Palæontology," vol. III (1925), p. 295): "It is particularly surprising to find in Europe at least the origin of a new genus from geologically older genera exceptional." Yet fossils of a large proportion of living genera occur in Miocene deposits; that is, on the present system of dating rocks, more than 20 million years ago; yet not one of these in all this long period seems to have thrown off a new genus. In this connection it is interesting to notice that Dr. F. E. Zeuner writes ("Monograph on Troides Butterflies," *Trans. Z.S.*, Lond. (1943), p. 174): "One will be fairly close to the mark if one accepts a period of 500,000 to 1 million years as the time for the evolution of a good species." As the earliest known fossils were laid down (on this computation) 600 million years ago, this means that since the beginning of Cambrian time no living species can have had more than 600 or 1,200 ancestral species. We know that no fewer than nine of the living genera of whales were in existence in the Miocene period. According to the transformists all these 9 genera have evolved from a single genus of ancestral whale, which in turn gradually evolved from a Cretaceous land mammal. Thus there cannot have been more than 50 or 100 species linking any of these nine living genera with its hypothetical

land ancestor. If the transformation were gradual these intermediate species would be numbered by hundreds. Facts such as these seem effectively to dispose of the idea of evolution by very small steps. They plainly indicate creation in some form.

Osborn's assertion: "Palæontology shows unmistakably that the various major groups of organisms run back to remote ages as a series of parallel lines" is precisely what the theory of a single creation asserts. Although Dr. A. H. Clark's idea as to how the different phyla originated does credit to his imagination it is on a par with Rudyard Kipling's account of the way in which the elephant got its trunk. Could anything be more fantastic than the notion that a protozoan (one-celled animal) gradually evolved into a Metazoon (many-celled animal)?

In reply to Dr. Morley Davies, I did not mention Gosse's theory as I deem it too fantastic to merit notice. It is that the fossils represent, not animals and plants that ever existed. but organisms projected in the mind of God before He created the actual animals and plants. I am grateful to Dr. Davies for stating Przibram's views, of which I was not aware. His theory, like those of Sergi, Berg, Haack, Belogolovy, Kleinschmidt and others, seems to come within the second of my categories of evolution theories.

To Dr. Davies' question as to the likelihood of the most primitive orders being always the first to migrate I would reply that, in my view, the farther we go back in time the more must the conditions of existence, such as climate and food, have differed from those of the present time; in consequence in any given locality the older the fauna the more different it should be from that of to-day; this is what we find. But are we justified in asserting that the earlier members of any class are more primitive than the existing ones? for example, are the known Paleocene placental mammals of North America more primitive than those that now live in that continent? I think not, because the known fossils of that period are all so fragmentary, consisting mostly of more or less complete jaws. Thus teeth are almost all we have to go on. Evolutionists assert that the most primitive placental animal had on each side of each jaw three incisor teeth, one canine, four pre-molars and three molars, or 44 teeth in all. This dental formula is thus represented: 3.1.4.3. But, as the Insectivore Necrolestes has four incisor teeth on each side of each

jaw, it seems to me that the " primitive " formula should be 4.1.4.3. No known Paleocene placental mammal has so many teeth. As regards incisors, some have only two, and one genus one, on each side of each jaw. Again some Paleocene placental mammals have only three or two pre-molars, and a few only two molars. According to the evolution theory all such creatures have lost a number of teeth and so are not primitive. Moreover, one of them (Coryphodon) had the canines so greatly developed as to merit the name of tusks. Clearly, then, until we know more about the anatomy of these early mammals it is premature to call them all " primitive " and to base an argument on this. Moreover, I submit that the evolutionist is treading on very thin ice when he adduces the known fossils of placental mammals as evidence for evolution. Mammals of sorts are believed to have been in existence in the latter part of the Triassic period, but no fossil of a placental mammal has been found in any deposit earlier than the late Cretaceous, where fossils of Insectivora and Carnivora first appear, but by the middle of the Eocene period the following orders had made their appearance in the known rocks: Primates, Edentates, odd- and even-toed Ungulates, Chiroptera, Cetacea, Sirenia, Rodentia, Hyracoidea, Proboscidea and eight extinct orders of placentals. If all these be derived from a common ancestor that lived in the Cretaceous period, it is a case of " explosive evolution " that ceased as abruptly as it began, since none of these orders has evolved appreciably since its appearance in the known rocks. Either this must have happened, or they were created in the Eocene period, or they migrated then to the localities in which their earliest known fossils occur. The last seems the most probable explanation of the phenomenon, and in that case the issue between the evolutionist and the creationist is how and when they originated.

Dr. Davies says that the order of the appearance of the great groups points—albeit imperfectly—to an evolutionary succession. But this does not apply to the greatest groups of all, the phyla, because these all appear simultaneously in the Cambrian. And within the phyla it applies only to the vertebrates, the classes of which make their appearance in the following order: fishes, amphibia, reptiles, mammals, birds. As no one thinks that birds are derived from mammals, the transformist has to believe that reptiles

gave rise to both mammals and birds, and so have achieved in the comparatively short time of their existence more than the fishes or the amphibia who have been longer in existence. Within the vertebrate classes the appearances of the orders do not fit in comfortably with the evolution concept. The egg-laying mammals—the Monotremata—are the most primitive, but they appear much later than either the Marsupialia or Placentalia. Bats are more highly evolved in the direction of flight than are the flying squirrels, phalangers and lemurs, but they appeared long before these last; similarly the more highly evolved whales and sea-cows appear in the rocks earlier than the less-evolved seals and walruses. So it is in the other classes; the turtles appear before the lizards, the frogs before the salamanders; the sharks and great Arthrodira (the only fishes that could move the head on the body) appear before the bony fishes (Teleosts).

The other phyla exhibit also many evolutionary anomalies. Of the land Arthropods the earliest to appear are the very highly developed scorpions and web-making spiders. The Cephalopods are admittedly the highest class of the Phylum Mollusca, nevertheless their fossils occur in the earliest known fossiliferous rocks. So do those of another highly developed order, the Pteropoda. As regards the latter some transformists assert that the Cambrian Pteropods are not really Pteropods, but an "early assay in Pteropod specialisation"! Thus the successions of the various groups of animals as shown by the known fossil record present plenty of difficulties to the evolutionist.

As regards extinction, in my view, much more of this has been caused by earth-transforming events than by competition with more advanced organisms.

Dr. Wheeler points out that many evolutionists (even Darwin, to the great disgust of many of his followers) have acknowledged one or more acts of creation. Notwithstanding this I deem Darwin, Wallace and Berg evolutionists; it is open to those who do not go the whole hog to call themselves limited evolutionists. If asked where I would draw the line between evolutionists and creationists, I should suggest that those who believe that a new natural family cannot originate gradually by the accumulation of small variations should be termed creationists, while those who believe that new

families, orders and classes have originated by the accumulation of variations or small mutations should be regarded as evolutionists. Applying this test, both Dr. Wheeler and Dr. Willis are creationists. If a member of family A arose by a sudden mutation of a member of family B I should deem family A to have been a special creation.

Dr. Wheeler asks: Is it logical to suggest, on the one hand, that some classes have existed during a geological period and yet have not been found among its fossils, and, on the other hand, that fossils of intermediate forms are absent because they never existed? I think it is, because I suppose that the flowering plants and placental mammals were originally confined to highlands of which the early rocks have been destroyed with the fossils they held. This cannot apply to such creatures as whales and ichthyosauruses, which, according to the evolutionist, are derived from land animals, because their supposed transformation must have take place at the margins of the oceans, *i.e.*, in the very areas where most of the existing fossiliferous rocks were laid down. Of course, it is open to the evolutionist to say that these marine creatures all evolved in the shallow seas surrounding large islands far from any continent, which have become submerged, and that is why no transitional fossils have been found. But, even if such islands did exist, there remains the insuperable difficulty that these supposed transformations involve the existence of impossible animals. I have repeatedly challenged evolutionists —and I here repeat the challenge—to draw or describe the skeleton of a *possible* creature mid-way between a whale or a sea-cow, on the one hand, and a land quadruped, on the other. I extend the challenge to a half-way creature between a seal and a bat, on the one hand, and an ordinary land mammal, on the other. Dr. Wheeler points out that the Sirenia (Sea-cows) live in the fossil-producing sea or river areas and whales get stranded on land, and he remarks "it would be strange if these orders had existed since the Cambrian without leaving fossils." This is a formidable difficulty both of the one-creation and of the evolution theory. As regards the latter the difficulty may be thus stated: The whale-bone whales constitute a sub-order of the Cetacea which appears suddenly in the Miocene in the form of eight genera in several parts of the world. No fossils have been found linking any of these genera with the hypothetical ancestor of all the whales. Between this last and each of these

genera of whales a line of some 20 successive species must have intervened, making in all some 80 intermediate species, the evolution of which must have occupied from 10 to 20 million years (see above). In the Eocene two sub-orders of Cetacea—the Archeoceti and the Odontoceti—make their first appearance, the former in the form of four genera (one of which, Zeugledon, being represented by eight species). The latter appears in the form of two genera. Assuming a line of 12 successive species linking each of these six Eocene genera with the ancestral species of whale, we get about 36 intermediate species of which the evolution occupied from 5 to 12 million years. Not a single fossil has been found of the above 116 intermediate species. Fully 200 successive species must have existed linking this ancestral whale with the last of its land ancestors, and the evolution of these would occupy from 100 to 200 million years and would mean that the last land ancestor existed at some time between the middle Carboniferous and the middle Triassic period. But not a single fossil has been found of these 316 (probably many more) hypothetical intermediate species. The same applies to the sea-cows to a lesser extent.

The difficulty to the one-creation theory presented by the late appearance of the Sirenia and Whales is somewhat lessened by the recent discovery off the Chalumna River in South Africa of the fringe-finned ganoid fish Latimeria chalumnæ. This fish is five feet long and belongs to a family of fish, the Coelacanthidæ, represented by a number of fossils in Devonian, Carboniferous, Triassic and Jurassic rocks and two fossils in Cretaceous rocks. No fossil of this family has been found in any later rock. Before the above fish was caught it was believed that the family had become extinct in the Cretaceous period. Apparently the family has existed throughout the Tertiary period without leaving any record in the rocks known to us. Despite this the theory of one creation is an unverified hypothesis, and must remain such until a number of classes of animals and plants yield us fossils in much earlier rocks than those in which they have hitherto been found.

Dr. Wheeler takes exception to my remarks about Major Evolution. I use this term to describe the changes supposed to have given origin to the phyla or great groups of animals. As all these are represented in the Cambrian rocks and no new phyla have

appeared since them, all Major Evolution, if such occurred, ended before the Cambrian period.

I do not agree with Dr. Wheeler that the earth is not large enough to hold simultaneously all the genera of organisms now living and those that lived in the past; I think it could have accommodated even all the species. Consider the birds and mammals. There are not more than 28,000 species of living birds; assuming as many extinct species existed we get 56,000. Four hundred and ten living species of bird (one seventieth of the total number) have been recorded from Britain, of which the area is 87,000 square miles. An area 70 times as great, *i.e.*, one rather less than that of South America, could accommodate 56,000 species. As to mammals, about 13,000 species of these now exist; assuming that the extinct species number 52,000 we get a total of 65,000. Allowing an exclusive area of 500 square miles for each species, the 65,000 could be accommodated in an area of 32½ million square miles. The land surface of the earth is about 55½ million square miles. As a number of different species live in the same area the actual range of each species would be more than 500 square miles. Of course, were all species past and present living at the same time the average population of each species would be smaller than it is to-day.

I am obliged to Dr. Wheeler for pointing out that Eskimo man is able to subsist entirely on fish and flesh. But he is dependent on dogs and boats and complicated tools to enable him to secure his food. In other words, he is civilised. When I said that man cannot exist in any part of the world devoid of grain-bearing and fruit-giving plants I was speaking of uncivilised man without special adaptations to very abnormal conditions.

In reply to Col. Merson Davies, I do not see that the one creation theory as enunciated by me conflicts with the Scriptures. It attempts to account for the distribution of the fossils in the sedimentary rocks. If we accept the days of Genesis i as literal days, then the existing fauna and flora were created some 6000 years ago. In this period very few fossils can have been laid down in comparison with the number embedded in the crust of the earth, and these few fossils must all be of the post-Pleistocene period. As Genesis i, 2, coupled with Isaiah xlv, 18, seems to indicate that an earlier creation was destroyed before the creation of the existing one, then all the

Pleistocene and earlier fossils, including man, are the remains of an earlier creation or earlier creations. I know of nothing in the Bible that suggests that more than one creation preceded the existing one. On the other hand, there is in the Scriptures nothing that negatives the idea of more than one earlier creation.