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THE EARLIEST KNOWN ANIMALS.

BY DOUGLAS DEWAR, B.A., F.Z.S.

THE most striking feature of the geological record is the abundance of fossils in the rocks laid down during the Cambrian and all later periods and the complete lack of *indubitable* fossils in all the earlier rocks—all those laid down in the pre-Cambrian period. Yet in many places these pre-Cambrian rocks seem to be well-fitted to hold and preserve fossils. Examples of such are the Torridon Sandstones of Scotland, 8,000 feet thick, the Green Shales of Brittany, 17,000 feet thick, the Huronian Series of Canada, 18,000 feet thick, the Tindir Group in Alaska, 20,000 feet thick, the Belt Series of North America, 40,000 feet thick, and the Cuddapah Series of India, 20,000 feet thick.

This sudden appearance of fossils in great variety and of high specialisation presented no difficulties to the older geologists, who regarded this as proof of a great creation at the beginning of the Cambrian period. But to the geologists who were induced by Darwin to accept the evolution theory this sudden advent in the rocks of a vast array of fossils presented a most formidable difficulty, because, in the words of Darwin (*Origin of Species*, 6th edn. (1882), p. 286) “if the theory be true, it is indisputable that before the lowest Cambrian stratum was deposited, long periods elapsed, as long as, or probably far longer than, the whole interval from the Cambrian age to the present day, and that during these vast periods the world swarmed with living creatures.”

Darwin admitted the seriousness of this difficulty, because (p. 287), “it does not seem probable that the most ancient beds have been quite worn away by denudation, or that the fossils have been wholly obliterated by metamorphic action.” He, however, took comfort because “only a small portion of the world is known with accuracy.”

He was confident that further geological exploration would bring to light a copious pre-Cambrian fauna. In full confidence that such organisms existed in their millions in the pre-Cambrian

epoch, scores of geologists set themselves to search for fossils of these. This intensive search has continued for seventy years. In his Presidential address to the Royal Society of Canada, in 1938, E. S. Moore said, "A large number of very able geologists are almost wholly engaged in work on these ancient and complex formations, and the literature on the subject is voluminous." This prolonged search, far from removing the difficulty to the evolution theory, has rendered it very much more serious than it was in Darwin's time, because, while it has resulted in the discovering of a great many fossils of Cambrian organisms, the rocks have not yielded a single indubitable fossil from the pre-Cambrian period. Seventy years ago, some 250 species of Cambrian animals were known. Today, the number exceeds 5,000. Every object found in any pre-Cambrian rock, having the remotest resemblance to a plant or an animal has been carefully preserved and minutely examined by experts. As there seems to be no end to the forms that some kinds of rocks, particularly limestones, may take, a few enthusiasts have reported the discovery of what they believe to be fossils and to which they have given names, such as Eozoon, Beltina, Carelozoon, Atikokania, Newlandia, etc., but not one of these has satisfied every expert that it is a fossil or even an organic product. A short account of these finds is given in an Appendix, in order to justify the title of this paper, in view of the belief of evolutionists that the Cambrian fauna was far from being the earliest; indeed, according to them, it is comparatively modern!

The discovery and the naming of these supposed pre-Cambrian fossils has enabled evolutionists who write textbooks to give their readers the impression that animals and plants existed in abundance in pre-Cambrian times. These writers speak of fossils of algæ, worms, foraminifers, etc., without stating that most experts deny the authenticity of these¹.

¹ This does not necessarily denote dishonesty on the part of the author. The discoverer of a supposed pre-Cambrian fossil records his find in a scientific periodical. This is utilised by the writer of a scientific book. Later the fossil in question is re-examined and rejected, and the fact recorded in a scientific journal. The writers of later text-books copy their remarks about this fossil from the first textbook, unaware that the fossil has been discredited. Thus Walcott's rejected fossils recorded by him in 1899, are cited by Depéret in his "Transformations of the Animal World," written more than 40 years ago, and this error is repeated in books published as recently as 1947, for example "L'Evolution Régressive (1943)," by Salet and Lafont, and "Human Destiny" (1947) by Du Noüy.

It is noteworthy that the standard book on Palæontology, the 1937 edition of von Zittel's "Text Book of Palæontology," edited by Professor C. R. Eastman, refers (p. 4) to "the total absence of fossils," in pre-Cambrian rocks.

That some 5,000 species of Cambrian animals have been described does not mean that only this number of fossils have actually been dug up. In the case of many of these species, fossils of thousands of individuals have been collected. These are a minute fraction of those still lying *in situ*. There are millions of these. That this is not exaggeration will be seen from such a fact as that on the hills adjoining the left bank of the Thornton river in N.W. Queensland, there are Cambrian limestone strata 40 feet thick "closely packed with fossils of the echinoderm Cymbionites, weathering out beautifully on the surface." Dr. F. W. Whitehouse gives in volume XII of *The Memoirs of the Queensland Museum*, a photograph of a slab of this limestone $5\frac{1}{2}$ ft. by $3\frac{1}{2}$ ft. in which some 60 complete specimens of this animal are shown, "This limestone," he writes, "with specimens crowded as richly and as well preserved, may be traced continuously around the contour of these hills. Following it is like walking over thickly-strewn embedded marbles." "Twenty-four feet above this rich band occurs the bed, five feet thick, with Peridionites (another genus of echinoderm). This is packed almost as tightly as the other . . . and they . . . too . . . weather out in relief. Between the two horizons are other echinodermal horizons, greatly crowded with ossicles that, however, do not stand out with naturally etched surfaces. Thus, what echinoderm types occur in them is unknown." These are exceptionally rich beds; but Cambrian rocks rich in fossils are known to exist in more than 100 localities in various parts of the earth.

Here then we have, on the one hand, the complete absence of indubitable fossils in all the rocks laid down before the Cambrian period, and on the other hand millions of fossils in the rocks of the Cambrian period and every later period.¹ The natural explanation of this phenomenon is that there was a great creation of marine animals and plants at the beginning of the Cambrian period. Owing to the influence of Darwin modern biologists and palæontologists mostly refuse to accept this explanation, and in consequence biology and geology have not kept pace with the exact sciences. The present predicament of biologists and geologists is just as it was described by A. Heilprin in 1887 (*The Distribution of Animals*, p. 194): "If we attach full weight

¹ Although the rocks of the Cambrian and all later periods abound in fossils, there are in every period some beds in which fossils are scarce or even entirely lacking, but such beds are rarely more than a few hundred feet thick, whereas the unfossiliferous pre-Cambrian beds are thousands of feet thick.

to the imperfection of the geological record, it is not difficult to account for the apparent abrupt appearance of certain animal groups of faunas But there is one special instance which is not so readily accounted for, and which, under any hypothesis, is almost inexplicable. We refer to the sudden appearance of the numerous forms of life which characterise the oldest fossiliferous formation with which we are at present acquainted, the Cambrian, when no unequivocal traces of pre-existing life are anywhere to be met with in the formation next preceding. So absolutely universal is this condition that it almost staggers belief. It cannot rationally be conceived that the varied Cambrian fauna could have come into existence *de se*, without there being a line of progenitors to account for its existence: but, if such progenitors did exist, which was doubtless the case, what has become of their remains? Can it be that all over the world, so far as we know, every fragment of such a pre-Cambrian fauna should have been so completely wiped out as to leave not a determinable vestige behind? It must be confessed this seems very incredible, seeing with what absolute perfection many of the oldest, and in many respects, the most delicate, structures have been preserved through all the vicissitudes of geological time."

In consequence of this obstinate refusal to believe that God has, or could have, created simultaneously all the earlier Cambrian animals, palæontologists have devoted an immense amount of time and labour in a vain search for pre-Cambrian fossils and in inventing fantastic theories to account for the non-discovery of these.¹ Had all this expenditure of time and energy been on more useful work, the biological and palæontological sciences would not have been in their present backward state. Let us hope that the time is at hand when, at long last, biologists and palæontologists will realise that they have been led by Darwin into a *cul-de-sac*, and that, until they turn back towards the road which leads to progress, biology and palæontology will continue to stagnate.

¹ Some of these theories are dealt with on pp. 116-120 of my "More Difficulties of the Evolution Theory," (1938). Here it must suffice to controvert the assertion that there is everywhere unconformity representing a large time lapse between the deposition of pre-Cambrian and Cambrian rocks. This is true of most localities, but in a number there is no apparent break, e.g., in the Kimberley and Adelaide Districts of Australia (*Vide Ency. Brit.* vol. 10, p. 168 and Vol. 2, p. 705), the Lake District of England ("General Stratigraphy" (1931), by Gregory and Barrett), Yukon, Alaska (*U.S.A. Geol. Survey Bull.*, 872 (1937), p. 64).

The Cambrian fossils known to us show that all the phyla or great groups of animals were in existence at that remote period, with the possible exception of the vertebrata, or back-boned animals.¹ Up to date only one fossil has been described from a Cambrian rock which may represent a vertebrate. This was found in a mid-Cambrian deposit in Vermont State, U.S.A. by W. L. Bryant, who named it *Eoichthys howelli*. It is thus described (*The Fifteenth Biennial Report of the Vermont State Geologist*, 1925): "An ellipsoid plate, 3 mm. in length, truncated at one end, ornamented with rows of tubercules which radiate from a point near the truncate border." Bryant believes this fossil to be a scale of an armoured fish. Dr. F. A. Bather, on the other hand, considers it to be part of the integument of a Cystid—an extinct order of Echinoderms. Thus the existence of vertebrates in the Cambrian period has not been proved, but the fossils show that these animals did exist in the Ordovician period. The fossils prove that representatives of all the other great phyla existed in the Cambrian period and that no new Phylum has appeared since the earliest known vertebrate fossil was laid down.

In the Cambrian period the phyla and classes of animals were as sharply separated from one another as they now are. "The Lower Cambrian Crustacea," writes W. K. Brooks (*The Foundations of Zoology*, (1899), (p. 218)) "are as distinct from the Lower Cambrian Echinoderms, or Pteropods, or Lamellibranchs or Brachiopods as they are from those of the present day." If there has been any evolution since the Cambrian period, it has been within each phylum.

Nor is this all. The smaller groups—families, genera and species of the Cambrian period were as sharply defined as they are today. The Cambrian animals, writes Brooks (p. 206), "far from showing us the simple unspecialised ancestors of modern animals, are most intensely modern themselves in the

¹ These fossils are all of marine animals and plants. This is to be expected because all the Cambrian rocks which have been preserved seem to have been laid down on the sea bed. All Cambrian freshwater and land deposits seem to have been weathered out of existence. Thus the Cambrian rocks known to us give no answer to the question: were terrestrial and freshwater organisms in existence in the Cambrian period?

Moreover, all the known Cambrian rocks contain terrigenous matter, therefore they must have been deposited in the sea at no great distance from land, and the fossils they hold must be almost all of animals and plants that lived near the shore. Thus they tell us little, if anything, about organisms which were confined to the open oceans while they were being deposited.

zoological sense, and they belong to the same order of nature as that which prevails to-day."

The above assertions of Brooks have been fully confirmed by the later exploration of the Black Burgess Shales—a Mid-Cambrian formation—in British Columbia. These Shales, very exceptionally, exhibit a number of impressions of the whole body of jelly-fishes, worms and other creatures lacking hard parts, which rarely leave a good record in the rocks, because normally, immediately after death, their soft bodies are decomposed by the action of bacteria. In this case it is thought that the black mud of these shales gave off sulphuretted hydrogen which killed off the local bacteria and so permitted the preservation of these delicate fossils. These are of 79 genera represented by 130 species, some of which have not been found anywhere else. Some of these most ancient animals are so like those now living in the sea that it takes an expert to distinguish between them.

The most interesting of these fossils are those of worms, sea-cucumbers and crustaceans. The only known rocks, apart from these Burgess Shales, which contain fossils of worms other than tracks and burrows made by these creatures in the sand or mud, are the Ordovician Shales of Cincinnati and Ohio, the Upper Jurassic Lithographic Shales at Solenhofen in Bavaria and the Eocene Shales at Monte Bolca in Italy. The worm fossils yielded by the Burgess Shales are of eleven genera representing three classes of worms, all of which are still living—the Gephyrea (segmented worms), the Chaetopoda (bristle-worms) and the Chaetognatha (arrow-worms).

Before the discovery of the Burgess Shales the only fossils of the group of Echinoderms known as *Holothuria* or sea-cucumbers which had been found in rocks of the Primary Epoch consisted of spicules of forms having a calcareous body-covering. These shales have yielded fossils showing the whole body of four species, representing three of the six families composing this class. This shows that the earliest known *Holothurians* were much diversified.

As regards the Crustaceans, fossils of *Trilobites* are not very abundant in these shales, but those of the other classes are numerous. Some of these are very like those now living. Walcott, who has made a special study of these fossils, writes (*Smithsonian, Misc., Coll.* vol 17 (1914), p. 161); "The bivalve carapaces of *Tuzoia* and *Carnarvonina* are so similar to the living

forms of the Nebalicea that there is little question of intimate relationship between them . . . The alimentary canal has been preserved in a number of species. The branched hepatic cæca are beautifully preserved in the shield of Burgessia, Naracia and Molaria. Among recent crustaceans the hepatic cæca are branched in some copepods . . . but none have the beautiful structure found in Burgessia . . . Marella splendens has an apus-like form, but it is evidently a more highly developed form than Apus (now living in our seas). This is shown among other characters by its carapace, long and jointed legs and fewer segments . . . The Burgess shale crustacean fauna was a tremendous surprise to me . . . That Branchiopoda of the order Anostraca lived in Cambrian time is not so surprising, but that they should be perfectly preserved, and closely allied to the living worms, certainly is unexpected."

As our knowledge of the Cambrian fossils grows, it becomes increasingly apparent that the representatives of all the phyla, except the vertebrata, were not less complex in Cambrian time than they are today.

All the known Cambrian animals belong to existing phyla, the majority to existing classes, and a fair percentage to existing orders, but comparatively few are members of the smaller groups now living. The only known Cambrian fossil which is clearly of an existing species is that of the beautiful little spiral-shelled foraminifer, *Spirillina groomi*, now living off the West coast of Ireland, of which a fossil has been found in an Upper Cambrian deposit at Malvern. Fossils of about ten living genera of foraminifera, lampshells and molluscs, and those of perhaps a score of living families are known from Cambrian rocks.

Some of the Cambrian orders and classes have become extinct, and the fossils of new ones have appeared in the later rocks at sundry times.

Further, the relative abundance of the various phyla was not the same in the coastal waters in Cambrian times as it is to-day.

Trilobites afford a striking instance of a great Class which has become extinct. Their fossils constitute more than half the total number found in Cambrian rocks. They died out during the Permian period. They had the appearance of great wood lice; some of them could curl themselves up as wood lice do. They varied in length from about $\frac{1}{4}$ inch to nearly 2 feet. Both

large and small forms occur in the earliest Cambrian rocks. They are called trilobites because longitudinal furrows divided the back of the body into three lobes. They were provided with a head shield and a smaller tail shield. Their legs were biramous, like the abdominal legs of lobsters. There were five pairs of these in the head region and a pair to each body segment. The number of body segments varied from two to 20. Some trilobites had compound eyes and some seem to have been devoid of eyes. They appear to have crawled on the sea bottom or burrowed in the mud. Fully 3,000 species have been described from Cambrian rocks. Their fossils seem to occur in every muddy sediment, but are not confined to rocks of this description.

The Decapods are an order of crustacea, which includes crabs, lobsters and shrimps, but no fossils of this order have been found in any Cambrian rock. The earliest known fossils of this order occur in rocks of the Triassic period. Next to the Crustacea, the Brachiopods (Lampshells) are the most numerous fossils. Over 130 Cambrian genera of these have been described, which is considerably more than double the number of genera now living. To-day, the lampshells form an insignificant part of the fauna.

The foregoing facts raise the question ; Are the animals now living (*a*) modified descendants of those of which the fossils occur in Cambrian rocks, or (*b*) are they later creations, or, (*c*) did they exist in much their present form in the Cambrian period, and no fossils of them have been found because, in some cases, they were confined to localities where the rocks containing their fossils have been eroded out of existence, or, in other cases, the rocks holding their fossils have not been geologically explored for various reasons, such as their being under the sea or covered by ice in the polar regions ?

These questions are dealt with in my paper "Current Theories of the Origin of Living Organisms" (*Jour. Trans. V.I. vol. LXXVI (1944)*), in which I contend that the fossils are definitely against (*a*), and that in the present state of knowledge it is not possible to decide definitely between (*b*) and (*c*). (*c*) seems to be highly improbable unless we bear in mind that the marine fossils we know are almost entirely of organisms which lived in the coastal seas and that probably every rock laid down at elevations a few hundred feet above sea level during the Primary and Secondary epochs has been weathered out of existence with all the fossils it contained.

CAMBRIAN FOSSILS.

<i>Phylum or Class.</i>	<i>Number of Genera of which fossils have been recorded.</i>
Trilobites	644
Other Arthropods	49
Molluscs	77
Brachiopods (Lamp-shells)	134
Bryozoa or Polyzoa (Sea-mats)	2
Echinoderms (Starfish, Sea-urchins, etc.)	39
Worms	41
Sponges	91
Coelenterates (Corals, Medusæ, etc.) ...	30
Radiolaria	3
Foraminifera	9

TOTAL NUMBER OF GENERA ...	1,119

In the above table disputed fossils such as *Eoichthys* are not included, nor are fossils not found earlier than in the Ozarkian System, because most authorities regard this system as transitional between the Cambrian and the Ordovician Systems. If Ozarkian fossils be included, the total number of Cambrian genera is 1,162.

APPENDIX.

Alleged Pre-Cambrian Fossils.

“Certain geologists,” writes C. W. Knight (Article ‘Pre-Cambrian’ in *Encyclopædia Britannica* p. 426), “consider that the evidence for the occurrence of fossils in pre-Cambrian rocks is hardly conclusive. This sparsity of fossils is the main feature which distinguishes the pre-Cambrian from Palæozoic and later eras.”

In the above passage I would substitute “far from” for “hardly” and “total lack” for “sparsity,” for the following reasons:—

1. If the evolution theory be true, the pre-Cambrian seas swarmed with living creatures; in consequence the rocks laid down in the pre-Cambrian should have yielded nearly as many fossils as those that have been found in Cambrian rocks—i.e., scores of thousands of fossils.

2. A search extending over 80 years has yielded nothing approaching a complete fossil.

3. Less than a dozen enthusiasts have described finding what they believe to be fossils of sorts, chiefly in limestones, which exhibit a great variety of structures of inorganic nature.

4. The supposed fossils are not mainly of trilobites and brachiopods which constitute three-fourths of the Cambrian fossils. Walcott has described what he thinks might be a segment of a trilobite and doubtful specimens of parts of brachiopods have been described by F. Chapman.

5. Most of the supposed pre-Cambrian fossils are of groups, such as worms, jelly-fishes and radiolaria, which are not commonly fossilised, while none are of molluscs which are commonly fossilised.

6. Most of the supposed pre-Cambrian fossils occur in rocks far older than the Cambrian and in consequence are overlaid by great thicknesses of rocks which seem to be completely devoid of fossils. This absence of fossils in the overlying rocks militates strongly against the idea that the structures in the earlier beds are fossils.

7. A comparison of the supposed pre-Cambrian fossils or the photographic plates of them with those of Cambrian fossils demonstrates the problematical nature of the former.

For example, compare David's plates of pre-Cambrian fossils (plates XIV-XVIII of Vol. 52 of the *Transactions of the Royal Society of South Australia*, 1928), with Cobbold's plates of Cambrian fossils found at Comley in Shropshire (*Quarterly Journal, Geological Society*, Nos. 261 (1910) and 304 (1920).)

8. Dr. Percy Raymond (who is an evolutionist), devoted his Presidential Address to the Palæontological Society of America, in 1935, to a survey of the objects which have been put forward as pre-Cambrian fossils. He rejects all of them (they include all on the following list except *Brooksella* which has since been discovered), except the burrows, etc., of worms, on which it is impossible to pronounce definitely, and two specimens of *Beltina*, of one of which he says, "there can be little doubt that it is a fragment of an arthropod. Somewhat less satisfactory, but still fairly satisfactory, are the specimens figured from the Algonkian on the continental divide of Alberta. They may, I think, be accepted as evidence of the presence of **Arthropods** in what may be part of the Belt Series. Unfortunately, these

finds cannot be fully accepted until checked by future discoveries." (*Bul. Geo. Soc. Amer.* vol. 46 (p. 378).)

No better specimens of Beltina have been recorded since Raymond gave his address. Raymond's warning is very necessary, on account of the extraordinary forms inorganic concretions may take. A classical example of this is afforded by what appears to be the fossilised leather sole of a child's shoe, size 13, which apparently has a double line of stitches, one line close to the outside edge and the other parallel at a distance of one-third of an inch. The edges of the sole are rounded off smoothly as if cut by an expert cobbler. The right side of the heel seems to be worn more than the left. This object occurs in a rock of the Triassic period.

LIST OF ALLEGED PRE-CAMBRIAN FOSSILS.

ANIMALS.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Archæospherina	Sir W. Dawson, Laurentian Limestone, Canada	Dawson thought that certain singular rounded bodies found by him might be casts of shells of a Foraminifer, allied to Globigerina. Nearly all the authorities deem this to be inorganic and I can find no mention of it in any book written in the past 40 years.
Aspidella....	Billings, Huronian, Newfoundland	These are limpet-shaped objects seen in a deposit "apparently referable to the Huronian." As in the case of Archæospherina, nearly all authorities deem this inorganic. The last mention of this supposed fossil that I have seen is in Dana's "Manual of Geology," published in 1895. He there describes it as "a supposed fossil of uncertain relations."
Atikokania	A. C. Lawson and C. D. Walcott, Steeprock Limestone, Ontario	The discoverers deem this to be a peculiar kind of sponge. Raymond does not accept it as a fossil, and E. S. Moore later searched these rocks diligently for fossils and found nothing that seemed to be indubitably organic. Moore concludes his report (<i>Trans. Roy. Soc. Canada</i>), (1938), p. 15), thus: "However much the writer believes in the existence of life at a very early period in Pre-Cambrian time, he was unable to verify the existence of fossils in this series."

Animals—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Beltina	F. C. Walcott, Belt Series, Montana, U.S.A.	<ol style="list-style-type: none"> 1. Dana and others doubt its organic nature. 2. The deposit holding the Beltinas is overlain by some 5,000 feet of shales and limestones which are completely devoid of fossils. 3. Hundreds of Beltinas have been found, but all are very fragmentary; some deem them bits of the integument or of appendages of an animal; others regard them as parts of a plant (alga). 4. If Beltina be an organism, it is strange, in view of its numbers, that nothing approaching a complete animal or a complete organ has been found. 5. Most of the Beltinas are supposed to be bits of legs. This is true of 14 or 18 of the best specimens figured by Walcott. But, although thousands of fossils of trilobites have been found, nearly all are the complete animal minus the legs, or parts of head, body or tail. For years it was thought Trilobites lacked legs. Recently, Raymond, Walcott and Beecher have found trilobite fossils with legs attached. 6. No fossil of Beltina has been found in any other formation.
Brachiopoda	F. Chapman, Adelaide Series, South Australia.	<p>Sir T. W. E. David (see entry Eurypterids below), asked Chapman to report on the supposed Brachiopods he had collected. Chapman (<i>Trans. Roy. Soc., South Australia</i>, vol. 53 (1929), declared them to be brachiopods of the genera <i>Lingulella</i> and <i>Obolella</i>. Raymond does not accept this verdict.</p>

Animals—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Brachiopoda —cont.	F. Chapman, Suket Shales, Vindhyan Central India	In 1908, H. C. Jones, of the Indian Geological Survey described what he thought might be brachiopods. These were discussed in 1908, 1926, 1927, 1931, 1932 and 1935, and opinions differed. Howell deemed these objects to be parts of plants. Chapman, however, (1935), declared them to be brachiopods and named them <i>Femoria</i> and <i>Protobolella</i> . The pictures of them in his plates are not convincing. The head of the Indian Geol. Survey, Sir L. Femur asked M. S. Sahni to examine these "fossils" and report. He reported that they exhibit NO character that establishes beyond doubt that they are brachiopods. Raymond does not accept them as fossils.
	C. D. Walcott, Grand Canyon Series, Montana	Walcott described in vol. 10 of the <i>Bulletin of the American Geological Society</i> in 1899, what he deemed fragments of fossils of brachiopods, crustaceans, molluscs, bryozoa and tracks of worms. This discovery was at first accepted uncritically, as we have noticed above. But Walcott, although he did a vast amount of good work on early fossils, seems to have allowed his imagination rather free scope, and today, nearly all authorities regard his supposed fossils as inorganic concretions. Thus his supposed brachiopod which he named <i>Cuarua circularis</i> , is not mentioned in Zittel's <i>Palæontology</i> or, so far as I am aware, in any modern textbook. Raymond does not even mention these fossils, and I doubt whether anyone accepts Walcott's supposed segment of a trilobite as such.
Brooksella canyonensis	C. E. Van Gundy, Nankoweat Red Sandstones, Grand Canyon, Arizona	1. Some believe this to be the impression of a jelly-fish in the sandstone. Others assert positively that it is inorganic. The leading authority on medusæ, Dr. G. Stiasny is very doubtful of its being a fossil. He says the furrows it shows do not represent radial canals and the pouches are not stomach pouches. If it be a jelly-fish it is quite unlike any known Cambrian form.

Animals—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Brooksella canyonensis —cont.		2. This object was named Brooksella, because it resembles Brooksella alternata found by Walcott in a mid-Cambrian deposit in Alberta. But Walcott's belief that his find is the impression made by a jelly-fish is not shared by some authorities.
Eozoon canadense	Sir W. Dawson, Grenville Lime- stone, Canada	3. Careful subsequent search for fossils in the deposit in which <i>B. canyonensis</i> was found has revealed none. (<i>Proc. Geo. Soc. Amer.</i> (1936, p. 304), "Science," Aug. 26, 1938, <i>Proc. U.S. Nat. Mus.</i> (1941), vol. 89, No. 104).
Eoozoon bavaricum	In various parts of Europe	For many years nearly all biologists accepted this as a fossil. Some deemed it a coral, others a giant foraminifer. A few asserted it to be an inorganic structure. Then it was shown that it is almost certainly inorganic. Finally it was found that blocks of limestone enveloped in molten lava at Vesuvius have, by the absorption of silicates, developed into typical Eozoon!
Eurypterids	David. Adelaide Series, South Australia	Sir T. W. Egerton David, has described a number of objects deemed by him to be fossils, most of which were found by Howchin, in the Adelaide Series which David believes to be pre-Cambrian, but Howchin regards them as Lower Cambrian. These supposed fossils are very fragmentary, and are believed by David to represent parts of giant eurypterids and polychaete worms, small parasitic brachiopods, radiolaria and other unidentified fossils. Illustrations of these are given on plates XIV-XVIII of vol. 52 (1929), of <i>Trans. Roy. Soc. South Australia</i> , and in <i>Memoirs of fossils of the late pre-Cambrian from the Adelaide Series</i> , by David and Tillyard. The plates are not convincing. David and Tillyard have drawn freely on their imagination. Raymond does not even mention these supposed fossils. In any case David himself admits that the rocks in which these structures occur may

Animals—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Eurypterids — <i>cont.</i>		be basal Lower Cambrian. As these rocks are easily accessible, David expressed the hope that later geologists would find more satisfactory fossils in these deposits. So far no confirmation of David's views has been published.
Foraminifera	Cayeux, Cherts, Brittany	Cayeux found in pre-Cambrian rocks in Brittany what he believed to be fossils of many species of animals. These include six species of foraminifera. Few, if any, experts believe these to be fossils. They are very minute, the largest having a diameter of barely .01 millimetre. Raymond points out that some of the specimens cannot possibly represent foraminifera, because the new chamber is not formed over the principal opening of the preceding one.
Orthoceras	Waterberg Sand- stones, South Africa	This was believed to be a fossil of a Cephalopod Mollusc, but has since proved to be an inorganic concretion.
Radiolaria	Cayeux, Cherts, Brittanny	Cayeux describes 45 species of these supposed radiolarians. As they are only from .001 to .022 millimetres in diameter, they had to be magnified from 1,000 to 2,300 times to enable an artist, who had never seen a radiolarian, to draw them. The smallest known Cambrian radiolarian is 10 times the size of the largest of Cayeux's finds. Rust, who is an authority on Radiolaria, says positively that these are not radiolaria. Rust could not get more than five species of palæozoic radiolaria on 1,000 slides, whereas Cayeux got 41 of his species on one slide! Moreover, Cayeux, although he got so many specimens on to one slide, did not manage to obtain a cross section of any of them.
Sponges	G. F. Matthew, Laurentian, New Brunswick. Cayeux, Cherts, Brittany	H. Rauff asserts (<i>Neues Jahrbuch für Mineralogie</i> (1896), that these supposed spicules of sponges are inorganic, and today no one appears to accept them as fossils.

Animals—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Worms	Murray, Huronian Newfoundland. Walcott, Belt Series, Montana. David, Adelaide Series, South Australia	These supposed fossils of worms are all either tracks or burrows. No one claims to have found any fossil of the actual body or even an appendage of a worm. It is not possible to say definitely whether or not any mark in a rock has been made by an animal.
Xenusion auerswalde	J. F. Pompeckj. A glacial erratic in N. Germany thought to be derived from the Algonkian Dala Sandstone of Central Sweden	The pre-Cambrian age of this Sandstone is doubtful. Frodin asserts that it is of later date. In the "Zoological Record," for 1927, Xenusion is described under the heading "Crustacea" as "an enigmatical fossil organism of uncertain affinities." Zeuner gives a picture of this, and describes it as "a representative of a group intermediate between annelid worms and arthropoda . . . its stratigraphic age is Dala Sandstone, Upper Pre-Cambrian (?) 500-600 million years ago." It is quite unlike any known Cambrian animal. (Pompeckj: <i>Palacon.</i> 26, Berlin (1927), Zeuner <i>Dating the Past</i> (1946), p.350.

NOTE.—The problematic fossil *Ainiktozoon* has not been included in the above list, although it would seem that Dr. A. Morley Davies deems it pre-Cambrian (see pp. 172-3, of "Evolution and its Modern Critics." (1937), because it undoubtedly was found in an Upper Silurian rock. (*Proc. Roy. Soc., Lond. (B)*, 1937, p. 533).

PLANTS.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Algæ Coblenia	C. D. Walcott, Belt Series, Spokana Shales, Montana.	Walcott has described and illustrated these supposed fossils (<i>Smithsonian, Misc. Col.</i> vol. 64 (1916). He believes them to be products of calcareous (blue-green) algæ. They are not fossils because: 1. Their structure is quite unlike a product of any known alga. 2. They occur in shales which are overlaid by strata, over 3,000 feet thick, of unfossiliferous shales and limestones. In fact they occur in the same rocks as <i>Beltina</i> .
Newlandia	C. D. Walcott, Belt Series, Newland Limestones, Montana.	
Camasia		
Weedia		
Kimieyia		
Greysonia		
Copperia		
Gallatinia		

Plants—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Algæ—cont.		<p>If these algæ were so readily fossilised in these shales and limestones, the overlying shales and limestones should contain many fossils. 3. The belief that these are fossils entails the belief that these beds were laid down on land, but no land beds have been found in any Cambrian or Ordovician deposits. All very early land sedimentary rocks appear to have been weathered out of existence. 4. Holtedahl shows that precisely similar concretions have been found in situations that preclude their being made by organisms. 5. Liesegang has shown that such structures can be made artificially in the laboratory.</p>
Archæophyton newberrianum	N. L. Britton, Crystalline Limestone, New Jersey, U.S.A.	<p>Dana writes of this (<i>Manual of Geology</i> (1896), p. 454), "The specimen consists of graphite arranged in narrow parallel stripes with a regularity that suggests organic origin; but the arrangement may well be an effect of the pressure attending metamorphism." Darrah and Walton do not deem it a fossil.</p>
Archæoxylon krasseri	Krausel, near Prague	<p>Krausel deems this part of a conifer-like plant. Seward writes of it: "The weak point is that its pre-Cambrian age has not been proved, and its structure is too imperfect to admit of any satisfactory determination."</p>
Bacteria	<p>Both Walcott and Gruner believe they have discovered the remains of Bacteria. Raymond points out that Walcott "makes no argument in favour of the identification and leaves it to be accepted on faith that an organism without hard parts and less than .001 millimetre in diameter could be preserved in identifiable condition from pre-Cambrian time to the present." This criticism applies with greater force to Gruner's finds which are in much older rocks. Seward writes: "These finds, though worth recording are by no means convincing."</p>

Plants—contd.

Name of fossil.	Name of Discoverer and Locality.	Reasons for rejecting.
Carelozoon jaticulum	Metzger, Jatulian Dolomites, Finland	This supposed fossil is not mentioned by Raymond, presumably because it occurs in dolomite in which, as Adam Sedgwick pointed out, there is no end to the different forms of inorganic structure. These dolomites are overlaid by two unfossiliferous formations—the Rapakivi Granites and the Jotnian Sandstones.
Corycium enigmaticum	Sederholm, Jatulian Dolomites, Finland	This is not noticed by Raymond. It is open to the same objections as Carelozoon. Seward describes it as "a problematical body," and deems it inorganic.

NOTE ON GRAPHITE. It has been contended that the graphite in pre-Cambrian rocks proves that living organisms were in existence. For example, Dr. Julian Huxley and Messrs. H. G., and G. P. Wells write ("The Science of Life," (1938), p. 673): "There exist great beds of carbon in the form of graphite, and these as far as our chemical knowledge goes, must be derived from the remains of living things, most probably aquatic plants." Unfortunately the knowledge of these gentlemen does not go quite far enough. The British Museum Mineralogist Dr. L. J. Spencer writes (Article "Graphite," in *Enc. Brit.*): "Graphite occurs mainly in the older crystalline rocks—gneiss, granulite schist and crystalline limestone—and also sometimes in granite . . . It has also been observed as a product of contact metamorphism in carbonaceous clay slates near their contact with granite, and where igneous rocks have intruded into beds of coal: in these cases the mineral has clearly been derived from organic matter. The graphite found in granite and in veins in gneiss, as well as that contained in meteoric irons cannot have had such an origin . . . The graphite veins in the older crystalline rocks are probably akin to metalliferous veins and the material derived from deep-seated sources; the decomposition of metallic carbides by water and the reduction of hydrocarbon vapours have been suggested as possible modes of origin."

WRITTEN COMMUNICATIONS.

Dr. L. RICHMOND WHEELER: This is a most valuable and learned summary of modern knowledge about the rich Cambrian fauna and the reputed fossils which have been claimed at various times as having been found in pre-Cambrian formations. The strong factual background against which Mr. Dewar's observations and criticisms are set is particularly useful; and we are indebted to him for

rounding off a discussion about animals with a summary of the reasons for rejecting the authenticity of the alleged pre-Cambrian plants.

But, as regards his theory that all organisms were probably created contemporaneously, he has not shed any further light on one outstanding difficulty—that is, the absence of any fossils of fishes from the marine Cambrian formations—apart from one very dubious “ellipsoid plate, 3 mm. in length.”

DR. A. S. MASLEN: From the anti-Evolutionist point of view, Mr. Dewar makes a plausible case for special creation at the beginning of Cambrian times, but how any zoologist and palæontologist can be an opponent of evolution passes my comprehension. It is perfectly true that the pre-Cambrian rocks have yielded next to nothing of indubitable organic origin, in spite of the fact that these rocks have been intensively searched for fossils for very many years in many countries, and through such thicknesses of rock as probably represent as long an interval of time as all the rocks formed since pre-Cambrian times, most of which time may have been really Azoic.

Then, as Dewar says, comes suddenly the well-defined and abundant fauna of the Cambrian representing many families of Invertebrata, some of which are remotely similar to their modern representatives. This sudden appearance has always been an “abominable mystery”!

Geologists, who perforce must be evolutionists, see in this only another example of the imperfection of the palæontological record and consider it reasonable to postulate a long series of ancestors of which there are few or no remains.

As regards plants no certain fossil forms are known before Silurian times, some millions of years later than early Cambrian. So there is the same “sudden” appearance. These earliest known plants belong to relatively low orders, and the higher woody plants appear much later. Ordinary Angiospermic flowering plants are Tertiary only.

So that on fossil evidence the first plants came long after the first animals. In spite of this it seems highly probable that plants really came long before animals as the life of animals depends ultimately on plants.

These are theories suggested to account for the almost complete absence of fossils in the oldest rocks. Both plants and animals may have had entirely soft bodies and thus be incapable of preservation. The absence of hard parts may be due to the almost complete absence of lime salts in pre-Cambrian seas. There is reason to believe that the primordial ocean was fresh and that the salinity (including the lime salts, etc.) was gradually increased by material carried down by rivers from the land areas.

AUTHOR'S REPLY.

In reply to Dr. Wheeler, I agree that the non-discovery of undisputed fossils of fishes in Cambrian rocks is an outstanding difficulty of the One-Creation Theory, as is the fact that only a few fossils of fish plates have been found in Ordovician rocks, and these only in Colorado, Wyoming and South Dakota, while no fish fossils have been found in Lower or Middle Silurian deposits. Upper Silurian fossils are fairly numerous in Spitzbergen, Norway, the Baltic, Scotland, England, Galicia and Portugal. Some of these fossils are of almost complete fish. They represent 4 Orders, 12 families and 29 genera.

A suggested explanation of these facts is that the earliest fishes were confined to fresh water. I doubt this. I attribute this lack of fish fossils to the fact that in the Cambrian, Ordovician and Silurian periods the coastal seas swarmed with trilobites. These probably completely devoured dead fishes before they were buried in the mud; or after burial, since many kinds of trilobites seem to have burrowed in the mud for their food.

It is significant that the Late Silurian marks the beginning of a rapid decline in the Trilobite population. According to the latest edition of Zittel's Palæontology the 22 families of trilobites living at the close of the Ordovician period were reduced to 11 at the end of the Silurian, 5 at the end of the Devonian and 1 at the end of the Carboniferous period.

In reply to Dr. A. S. Maslen, the following are some reasons why I reject the evolution theory: (1) It demands morphological transformations which I regard as impossible, except by miracle, such as the conversion of a land quadruped into a bat or a whale; (2) many animals have habits and instincts which cannot have developed

gradually, *e.g.*, the habit of making a nest like that of a sun bird or an oriole; (3) anatomical characters are so distributed among members of every large group of animals, *e.g.*, Primates, as to preclude all the members of the group being descended from a common ancestor; (4) the sudden appearance of the Cambrian fauna in the rocks; (5) not a single fossil has been discovered really intermediate between any highly specialised animal, such as a bat, or a whale, or a pterodactyl, or a turtle and its supposed generalised ancestor; (6) the evolution theory contravenes the Law of Entropy; (7) the evolution theory purports to explain phenomena which I regard as scientifically inexplicable.

As regards fossil plants. Algæ may occur in Cambrian rocks; they certainly do in Ordovician formations. It is land plants of which no undisputed Cambrian or Ordovician fossils have been found. The sudden appearance of a diversified land flora in Devonian rocks could be accounted for by supposing that these rocks (except possibly the fern ledges of New Brunswick) are the earliest land or fresh-water rocks which have not been weathered out of existence.

The facts that, apart from a doubtful carboniferous plant and two Jurassic fossils, no remains of flowering plants have been recorded before the cretaceous period, and in the rocks of this period their fossils are abundant and much diversified, could be accounted for by supposing that in the early periods of the history of life these plants were confined to high altitudes or high latitudes, and all rocks laid down in such situations have been eroded away or are now covered by ice caps. The fall in temperature which caused the extinction of so many Mesozoic plants permitted the flowering plants to replace those in the lowlands.

In view of the fact that fossils of jelly-fish are not very uncommon in Cambrian and later rocks, it seems to me that, even if no pre-Cambrian animals had hard parts, good impressions of the bodies of many of these should have been discovered by this time.

The abundance of limestones among pre-Cambrian rocks renders it improbable that the seas were devoid of calcium.

I have discussed, in Chapter XV of "More Difficulties of the Evolution Theory" (1938), the various theories advanced by evolutionists to account for the lack, or extreme rarity, of fossils in pre-Cambrian rocks.