EN Tech. J., vol. 4, 1990, pp. 138–140

Comments on One Creationist's Palaeontology

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Near the termination of his article on cellular metabolism, John G. Leslie briefly discussed the fossil record.[1] As a palaeontologist I would like to comment on two aspects of Leslie's discussion — punctuated equilibrium and evolutionary theory — as each relates to the fossil record. The purpose of this paper is **not** to defend either theory. Rather I seek to clarify the concepts of each theory.

Of punctuated equilibrium, Leslie claims that it is untestable as a theory. Leslie defines punctuated equilibrium as the postulate '. . . that a group of organisms remain static until some environmental (or other) force acts on them and a mutated form becomes predominant. The change is rapid and extensive so that few if any transitional forms become fossilized. This is Goldschmidt's hopeful monster or bird out of a reptile egg concept'.[2] I would like to show that not only is punctuated equilibrium testable, but that Leslie's representation of punctuated equilibrium is an inaccurate understanding of the theory.

There is more than a single theory which is labelled 'punctuated equilibrium'. Each of the existing theories, however, possesses a common theoretical core that is both verifiable and falsifiable. The variety of genetic amendments to the core theory produces the present variety of punctuated equilibrium theories. In Leslie's defence, his misrepresentation of punctuated equilibrium is not uncommon. The proponents of punctuated equilibrium have been largely responsible for the confusion about what punctuated equilibrium really is.

Punctuated equilibrium *sensu strictu* is an observation of the fossil record. It is an observation in two parts:

(1) most species in the fossil record show limited to no morphological change throughout a long stratigraphic range ('stasis'), **and**
(2) most species 'appear' and 'disappear' 'suddenly' in the stratigraphic record — lacking morphological intermediates with any other species.

Each of these observations is both verifiable and falsifiable **whether one accepts geologic dating and evolutionary theory or not.** To test the theory one needs only study a number of fossil species or kinds at random. For each species or kind, two 'populations' of fossils should be sampled, one from the lowermost and the other from the uppermost stratigraphic occurrence of the species. If the range of morphological variation of the two populations from most of the species are identical, the first claim of the theory of punctuated equilibrium is verified. If, however, most of the species show a significant difference in the range of morphology of the population pairs, the claim is falsified, and so is the theory of punctuated equilibrium. It turns out that in most studies of multicellular organisms this first claim of punctuated equilibrium is verified. However, for many unicellular organisms, such as for foraminifera,[3] species show morphological change throughout their range. Punctuated equilibrium may thus be largely falsified for the kingdoms Prokaryota and Protoctista.

Another test of this first claim is to examine the fossil record of living species and determine how the morphology of the lowermost fossil 'population' compares to the morphology of the present species. Species which show limited or no variation from the fossil to the living are often called 'living fossils'. If most species with a fossil record are living fossils, then the first claim of punctuated equilibrium is verified. If most of the species with a fossil record show significant change, then punctuated equilibrium is falsified. **The truth is that most species with a fossil record are living fossils.** Leslie included a table which was intended to be an accurate list of living fossils. Leslie's table is entitled 'Animals and Plants that have not changed morphologically since their "supposed" appearance in the geologic record'.[4] There are at least three major types of errors in Leslie's table:

(1) Living species are listed which have no fossil record at all (e.g. *Vampyroteuthis infernalis, Neopilina galathea, Rhizocrinus lofotensis,* and ctenophores). These organisms are representatives of larger groups which are **thought** to be very ancient, and thus **in theory** are living fossils. Yet without a fossil record, they cannot be included in Leslie's table of organisms which 'have not changed morphologically since their "supposed" appearance in the geologic record.'
(2) First appearances are listed with incorrect conventional geologic dates (CGD). For example, *Spirula,* which Leslie lists as first appearing 200 million years ago (ma.), actually exists only in the present and as fossils in the Upper Burdigalian of the Lower Miocene[5] (18.5–16.0ma., CGD[6]); and *Nautilus,* which Leslie lists as first appearing 570 ma., is actually only known back to the Oligocene[7] (38.0 – 24.6 ma.,

CGD[8]). Again these are more recent representatives of groups thought to be more ancient.

(3) Reasonable ranges of living genera are listed which, however, cannot be used as evidence of **no** morphological change because the present species show a different morphology than fossils. An example is the genus *Lingula*. *Lingula* fossils have been claimed from the Ordovician to the present. The Ordovician fossils, however, lack sufficient detail to be certain of generic or even familial designation.[8] Valid *Lingula* are found from the Silurian to the present. Yet, of the living species only one certainly has a known fossil record, *Lingula dumonterieri*,[9] and that is from the Miocene. Though other living species, upon further study, may be found to have fossil records, *Lingula* fossils do have a different morphology than the living individuals.[10] Though all this change **may** be within species (or kind) variation, it is still morphological change, which Leslie claims did not occur.

There are many valid examples of living fossils, and thus the evidence in support of the first claim of punctuated equilibrium is substantial. Leslie's table needs to be carefully re-evaluated before it can ever be accurately used.

To test the second claim of punctuated equilibrium one must study the stratigraphic levels coincident with and immediately preceding the lowermost stratigraphic level of the species range. If morphological intermediates can be found in these levels between most of the species and other similar species, then the second claim of punctuated equilibrium is falsified, as is punctuated equilibrium itself. If, however, most of the species do not show such intermediates, then the second claim of punctuated equilibrium is verified. With the exception of unicellular organisms the fossil record seems to verify this claim as well. Thus the theory of punctuated equilibrium *sensu strictu* is not only testable, but with the exception of protoctistans seems to be valid.

Yet, beyond the palaeontologic theoretical core, punctuated equilibrium is often thought to be much more, even by its co-founders, Stephen Jay Gould and Niles Eldredge. Punctuated equilibrium *sensu latu* includes not only the core theory, but also theories of genetics and population dynamics which have been developed to explain the observations of punctuated equilibrium *sensu strictu.* These theories vary substantially. One such theory is that espoused by Goldschmidt some time ago.[11] Goldschmidt thought it worthy to consider the possibility that single mutations might be able to produce new species. He acknowledged the fact that such successful 'hopeful monsters' had never been seen and were at best highly improbable. However, he felt that large changes in the adult may be produced, among other ways, by means of a small genetic change, such as in a 'rate' or 'regulatory' gene. Though Goldschmidt was condemned for his theory for decades, the importance of regulatory genes is becoming increasingly more realized. In the future it may play an important part in evolutionary genetic theory.[12] In the meantime, to critique punctuated equilibrium by critiquing Goldschmidt's theory as Leslie has done is an unfair criticism of punctuated equilibrium.

For now, however, Goldschmidt's idea is **not** the most accepted genetic mechanism for punctuated equilibrium. By the early 1970s the most popular theory of speciation among evolutionary biologists was Ernst Mayr's peripheral isolate theory of allopatric speciation.[13] Eldredge and Gould felt that if most species did arise by means of Mayr's theory, then the fossil record should show stasis as well as abrupt appearance and extinction. To this observation they gave the name punctuated equilibrium.[14] During the years since punctuated equilibrium's original proposal, Mayr's theory has continued to hold sway as the most popular population genetics mechanism for speciation. In Mayr's theory changes are small in each generation, but because of the dynamics of small, isolated populations in areas of unusually high selection pressure, speciation is thought to occur in only a few thousands or tens of thousands of years in small, obscure localities. Because of their limited geographical range and diminutive numbers, the probability of preservation of these organisms would be extremely low under the conventional understanding of the geologic record. If most species did originate in this manner one would expect to find morphological intermediates only very rarely in such a fossil record. It is this genetic aspect of the theory of punctuated equilibrium *(sensu latu)* which is most difficult to test. Under conventional geological assumptions, it is only potentially verifiable and only falsifiable in a limited sense. One would have to examine closely the few instances of species transition, if any, that were found in the record. If these instances showed that species transitions occurred in large populations and/or in situations of 'normal' selection pressure, then Mayr's peripheral isolate theory does not explain the species transitions under study.

Peter Williamson's study of African molluscs, for example, shows simultaneous change of a wide variety of organisms in only five to fifty thousand years (CGD).[15] Williamson presented the study as a confirmation of punctuated equilibrium *sensu strictu.* It turns out that both claims of punctuated equilibrium *sensu strictu* are verified. Though the study does show stasis and sudden extinction, it also preserves the so-called 'speciation' event, morphological intermediates and all. The morphological change, however, occurs among fossils found from lower to higher layers in contiguous lacustrine deposits over a large area. Conventionally this would be interpreted as a large lake, involving changes among perhaps millions of organisms. It is thus doubtful that this is an example of a small population, so the population dynamic mechanism is not explained by Mayr's theory. The incredibly wide diversity of organisms affected

would seem to indicate that some large environmental change occurred in those East African lakes, which in turn implies that the change may be ecophenotypic (within species reversible change due to an environmental change) and not an example of speciation at all. This is confirmed by the fact that although change is seen, the new morphology becomes extinct immediately after its origin, and the original morphology returns. Unpublished data by Williamson in another area show the same phenomena.[16] It is thus unlikely that Williamson is studying any speciation event at all. Although I feel that Williamson's study is a failed attempt to test for the genetic mechanism for punctuated equilibrium, that mechanism is still potentially testable, even assuming all the conventional geologic assumptions.

Leslie also falls short of an accurate understanding of evolutionary theory. He claims that '. . . if life arose from simple organic compounds to single-celled and then multicellular organisms that there would be a corresponding increase in both complexity and size [of fossil plants and animals]'.[17] Leslie then goes about critiquing this idea. On one level Leslie is correct. If man evolved from inorganic molecules then the net change has been one of an increase in size and complexity. However, evolutionary theory does not predict the direction of change at any single speciation event. There could have been a trend to increased size and complexity followed by a reversal, followed in turn by a change to a new species without a change in size or complexity, followed by a reversal, etc., etc. The fossil record understood conventionally shows examples of each of these.

Leslie also implies that the overwhelming percentage of plants and animals show gigantism in the fossil record. The truth is that it is probably only a minority that show this. Most organisms show no change at all, and many others show the opposite. Horseshoe crabs (Limulids), for example, were very diverse in the past, but none of the fossils approaches the size of the present *Limulus.* Among extinct groups the most consistent change in the fossil record is that of an increase in the size of representatives of a group with higher stratigraphic position. This observation is actually without a genetic/population dynamic mechanism in conventional geology. Unlike Leslie claims, there is mystery as to why it does occur, because it is not an expected deduction from current evolutionary theory.

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10. My research on *Lingula* is not complete. It may turn out that there are more examples of *Lingula* species with fossil records, but there is certain to be very, very few. It should also be noted that species identifications are significantly biased against assigning names of living species to fossils. This is acknowledged, and acknowledged to be a pervasive problem, but until a careful morphological study is done to establish this in a group, different species cannot be taken to indicate morphological identity.
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