CREATIONISM DEFENDED

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Darwinism Defended, by Ruse,[1] is typical of recent books which attack Creationism, and also attack such non-Darwinian views as punctuated equilibrium. In this article, the charges made against Creationism are refuted, and it is shown that, just as Creationists have been saying, Darwinism rests on a shaky foundation indeed. Moreover, recent work is showing more and more that the Darwinian view is untenable.

For many years creationists have been told "creationism is not science, and probably never will be"; but until now evolutionists have not bothered to respond to the scientific arguments presented by creationists. It is for this reason that Michael Ruse's book *Darwinism Defended*[1] is of great interest, since, in his own words, it "is intended to be a refutation of the Creationist position" (p. 303).

The method of attack is to first give a presentation of "orthodox" evolutionary theory, which for Ruse is "Neo-Darwinism"; then to dispose of some challenges to the "orthodox" interpretation — e.g. the view that the principle of natural selection is a tautology, and the theory of 'punctuated equilibria' as an alternative to the gradualist interpretation of the fossil record. The final part of the book is a direct confrontation with creationism.

Naturally, in the space presently available, it is not possible to deal with all of Ruse's arguments, and hence I wish to confine myself to a brief review of a few of the most important topics covered in the book.

Most central to Ruse's concern and obviously to any discussion about evolution is the mechanism of evolution. In this area Ruse reveals himself as a staunch defender of the Darwinian principle of random variation and natural selection as the ultimate cause of all evolutionary change, over and against those in modern biology who believe that the recent developments in molecular biology, systematics and paleontology paint a somewhat different picture — not to mention the creationists, who of course deny the possibility of evolution altogether.

A great deal of time is spent on explaining the fundamentals of population genetics, the meaning of genetic variation and natural selection. Ruse may be surprised about the extent to which creationists will agree with his exposition; creationists have no quarrel with the existence of genetic variation, with the laws of Mendel or Hardy and Weinberg. The point at which Ruse's exposition turns weak is when we get around to asking the question to what extent the existence of microevolution can help us with understanding the mechanism of macroevolution. For him, the answer is clear: Macroevolution is nothing more than scaled-up microevolution. Population genetics is both necessary and sufficient to explain all known aspects of evolution.

Nothing in the book comes anywhere near a proof of this contention. That all is not as simple as it might appear becomes clear in R. C. Lewontin's study, where he freely admits, "It is an irony of evolutionary genetics that, although it is a fusion of Mendelism and Darwinism, it has made no direct contribution to what Darwin obviously saw as the fundamental problem: the origin of species. . . .*we know virtually nothing about the genetic changes that occur in species formation.*"[2] The evolutionary concept postulates that all living beings on this planet have ultimately a common biological origin, and that complex organisms have gradually evolved from more primitive ones. This contention does not logically follow from microevolution as described by population genetics.

Obviously Ruse argues that random mutations provide a sufficient source of new genetic variation for macroevolution to occur. He doesn't think it necessary to provide a quantitative basis for this hypothesis. The reason is obvious: Any quantitative calculation that has been done to see if random mutations could generate enough new biological information for evolution to occur has been overwhelmingly against this hypothesis.[3-5] M. P. Schützenberger from MIT concludes his quantitative study of evolution models by saying: "Thus . . . we believe there is a considerable gap in the neo-Darwinian theory of evolution, and *we believe this gap to be of such a nature that it cannot be bridged within the current conception of biology.*"[6]

Ruse hopes to bridge this gap by the action of selection on random variation: "Natural selection allows the successes, but 'rubs out' the failures. Thus, selection creates complex order, without the need for a designing mind. All of the fancy arguments about a number of improbabilities, having to be swallowed at one gulp, are irrelevant. Selection makes the improbable, actual." (p. 308)[1]

However, the calculations cited *include* the operation of selection. Thus "now we have less excuse for explaining away difficulties by invoking the unobservable effect of astronomical numbers of small variations."[6] Hence macroevolution does not follow even if we accept Ruse's views on microevolution. But it is by no means certain that those are true, either.

The amount of hidden variation is the most central problem of population genetics, and two principal predictions have been made. One is called the *classical theory,* defined by H. J. Muller, M. Kimura, T. H. Jukes and others. It assumes (in a simplified version) that at nearly every locus every individual is homozygous for a 'wild-type' gene; heterozygosity is rare; mutations are mostly deleterious and natural selection acts as a 'cleansing agent' to free the population from genetic defects. The *balance theory* pioneered by T. Dobzhansky and defended by F. J. Ayala and others maintains the opposite: Nearly at every locus every individual is heterozygous. Hence it must be assumed that some sort of 'balancing selection' is in operation

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that maintains the alternate alleles in the population. (Both hypotheses have of course been considerably refined.[2, 7])

The two hypotheses make different predictions about the amount of variation in a population; under the balance hypothesis, there is a great deal of variation in the population, to such an extent that one cannot really speak of a 'wild type' at all; the classical theory, in its most extreme form, predicts that there is very little variation within a population, and according to Lewontin the evolutionary program would be quite hopeless if the classical theory were true.

Naturally, Ruse supports the balance theory. But unfortunately, it is not really known whether or not the balance theory is true. Lewontin cites very strong reasons to reject both the balance and the neo-classical theory.[2] One can almost sense his frustration as he writes, in view of this dilemma: "How can such a rich theoretical structure as population genetics fail so completely to cope with the body of fact?" (p. 267)

For Ruse, the balance theory is a good stick to beat creationists with: "Most particularly, the Creationists fail through ignorance of the incredibly significant implications of the balance hypothesis. A group of organisms is not sitting around, waiting for a good new mutation to occur as the need arises, which mutation will then be cherished by selection. Rather, all the time, there is massive variation within populations, waiting to be drawn upon, as the need arises. . . . Thus selection can create new features, because there is a veritable bank or library of mutations, to draw on." (P. 307 f.)[1]

Although there are some examples which support this statement, as an explanation for the origin of species it is almost certainly false. While it is true that there is a great deal of genetic variation in populations, on the other hand it can be demonstrated with many examples that the amount of variation present is very clearly limited.

In 1800, experiments were conducted in France to increase the amount of sugar in table beets (at the time around 6%). Artificial selection was conducted on a large scale, selecting the sweetest to produce seed for the next crop. By 1878 the average sugar content of the table beets had risen to 17%. However, further selection failed to increase the sugar content from there on; the limits of genetic variation had been reached.

A similar example is the reduction in the number of bristles on the thorax of fruit flies by artificial selection and breeding. In each generation, the number was reduced, until the 20th generation, after which the number remained the same. The limit of variation by artificial selection had been reached, and any experiment involving cross-breeding and artificial selection, even if it proves the existence of great genetic variations, always demonstrates the limits of the potential for variation fairly soon.

In the opinion of the well-known zoologist Pierre Grassé, the limits of variation established by artificial selection are in profound contradiction to the Neo-Darwinian argument.[4] For 10,000 years, the dog has been subjected to artificial selection, revealing a great amount of variation, but not allowing the emergence of a new species. The genetic potential is limited. Grassé applies a similar argument to other domesticated animals (cows, bred for 4000 years; chickens, bred for 4000 years; sheep, bred for 6000 years).

Grassé furthermore argues that artificial selection produces a much greater variety than natural selection. As an example he compares the dog and the jackal which he considers to be closely related. The dog *(Canis familiaris)* and the jackal *(Canis aureus)* are genetically related (in the evolutionary model) and are subject, with some minor differences, to the same kind of mutations. The jackal, however, appears to be very stable genetically, whereas the dog species is divided into numerous races and sub-races. Grassé concludes that this is due to the fact that the dog has been subject to artificial selection whereas the jackal has only been subject to natural selection. The action of natural selection may differ from the way postulated by the Neo-Darwinian view. For example, it is not at all clear to what extent the evolution of enzymes and other molecules is due to natural selection and to what extent it is the result of the chance accumulation of mutations. Lewontin explains that "it has proved remarkably difficult to get compelling evidence for changes in enzymes brought about by selection, not to speak of evidence for adaptive changes . . ."[8]

Quite compatible wtih Grassé's view, but incompatible with Ruse's understanding of the action of natural selection, is the Red Queen hypothesis formulated by Leigh Van Valen. It postulates essentially that the environment is constantly decaying with respect to existing organisms. The function of natural selection then is to enable the organisms to maintain their state of adaptation, rather than, as Neo-Darwinism would have it, to improve it. Van Valen obtained evidence for his hypothesis from paleontological data. He plotted the extinction rates of two classes of marine invertebrates and compared them with the duration of survival of living types. The curves compared very well with the predictions of the Red Queen hypothesis, and contradicted the model that natural selection improves the state of adaptation of the organisms.[8]

This brings us to the subject of paleontology. The dilemma of modern paleontology is described very succinctly and honestly by Stephen Jay Gould: 'The history of most fossil species includes two features inconsistent with gradualism: 1. *Stasis.* Most species exhibit no directional change during their tenure on earth. They appear in the fossil record much the same as when they disappear; morphological change is usually limited and directionless. 2. *Sudden Appearance.* In any local area, a species does not arise gradually by the steady transformation of its ancestors; it appears all at once and "fully formed."[9] Simpson already explained that 'there is in this respect a tendency toward systematic deficiency in the record of the history of life. It is thus possible to claim that such transitions are not recorded because they did not exist, that the changes were not by transition but by sudden leaps in evolution.'[10]

To explain the lack of evidence of gradual transitions in the fossil record, Niles Eldredge and Stephen J. Gould formulated the theory of 'punctuated equilibria.' The main tenets of this theory could be briefly

summarized as follows: (1) Intermediate forms exist only in small populations, which are less likely to leave a trace in the fossil record than large ones. (2) Speciation occurs rapidly in small isolated populations, followed by long periods of stasis. (3) Intermediate forms did not exist in the same place as their ancestors and were hence not likely to be preserved alongside them.[11, 12] Instead of gradual evolutionary change, this theory predicts periods of long stasis interrupted by sudden bursts of rapid evolution — hence punctuated equilibria.

Ruse goes to great lengths to demonstrate that the theory of 'punctuated equilibria' is in conflict with orthodox Darwinian theory, and then, as defender of this orthodoxy, proceeds to attack this new threat.

The attack on the Eldredge/Gould model proceeds along two lines:

(1) 'Gradualists' try to demonstrate that gradual transitions actually do occur in the fossil record.

(2) Critics of the 'punctuated equilibria' approach attempt to show that the mechanism of evolution implied by this theory is implausible.

Considering the fossil evidence certainly makes Ruse somewhat uncomfortable. Nonetheless he argues: "Although it is conceded that there are many gaps in the fossil record, it is countered, nevertheless that there is a sizeable number of well-established gradual changes to be found in the record. Hence, given all the factors making fossilization improbable, Darwinism remains totally plausible." (p. 218)[1]

To use one of his own metaphors, he is "putting on a little bit of a brave face" considering that it becomes apparent from his own words that the "well-established gradual changes" which he quotes are actually quite vigorously disputed. One of the foremost defenders of the "gradualist' approach in recent times has been P. D. Gingerich, a vertebrate palaeontologist at the University of Michigan. Gingerich believes that sequences of fossil mammal teeth which he has analyzed in detail show gradual changes in size which in some branching lineages lead to a new species. Gould and Eldredge have replied that the evolution Gingerich believes to have observed in the genus *Hyopsodus* is too slow to be of any significance.[13] Chris Paul comments that even in Gingerich's best data, *Hyopsodus simplex* and *Hyopsodus miticulus* appear suddenly: "even if Gingerich is correct and his new species can be traced back to their points of origin . . . the fact remains that most appear abruptly in the fossil record, many with no trace at all of an ancestral form."[14] Recently West published a study in which he followed the descendants of Gingerich's *Hyopsodus* through a middle Eocene formation which in evolutionary terms covers at least one million years, and found no evidence of evolutionary change.[15] The implication is that even if *Hyopsodus* did evolve gradually in Gingerich's study site, they manifested prolonged stasis soon afterwards. It appears that Gingerich's results are very tenuous at best.

The words of G. G. Simpson are still true to this day: "Nearly all categories above the level of families appear in the record suddenly and are not led up to by known, gradual, completely continuous transitional sequences."[16]

S. M. Stanley explains the evidence in the following way: "The examination of any well-fossilized invertebrate group will show that many family level transitions have occurred during intervals in the order of 50 My. Thus, documented rates of large-scale evolution are so high that, for phyletic evolution to have played a major role in large-scale transformation, phyletic transitions from genus to genus within about 5 My would have to be commonplace in phylogeny . . . In fact, only rarely has a lineage been found to yield what is considered to be a new genus. On the contrary, an average *species* of marine echinoids, bivalves, gastropods, or brachiopods has survived for at least 5 My without even evolving enough to be regarded as a new species."[17] Furthermore, "The only invertebrate taxon for which phyletic intergeneric transitions have been claimed with any frequency, however, is the *Ammonitina*, and as Hallam noted, taxa of this group are grossly oversplit, so that most lineages treated in this way should actually be assigned to single genera. In fact, many ammonite species exhibit an extraordinary degree of variability. Morphotypes previously regarded as representing discrete genera have been found to occur, with intermediate forms, in single populations."

One frequently cited example of progressive evolution in the fossil record is the progressive decoiling of ammonites during the Cretaceous. This was supposedly the final phase in the evolution of ammonites, in which they began to change their form and structure. As is well-known, ammonites became extinct at the end of the Cretaceous period. However, next to the 'heteromorphous species we also find those with normal shells. The latest explanation postulates that in what could almost be called reverse evolution' coiled shells re-appeared. Uncoiled ammonites are not only known from the Cretaceous, but can also be found in the Jurassic and Triassic formations. The whole gradualistic explanation collapses.[18]

The ammonites are a particularly rich field of disputable gradualistic interpretation (see for example David J. Tyler's recent article on "The Evolution of *Gryphaea Arcuata*"). Another example concerns the development of lobe formations. What started as a wavy structure line at the point where the chambers were separated, progressively changed into a zig-zag line and finally into a complicated pattern — that's the evolutionary model, as recently described in *The New Scientist*. Scheven, however, has demonstrated that "in contradiction to this rule, the Permian genera *Cyclolobus* and *Perrinitis* exhibit the complicated lobe formation, just like the Triassic genera *Ptychites, Sturia, Pinacoceras* and *Rhacophylites,* while *Neolobites* — one of the latest ammonite genera in the Upper Cretaceous — exhibits the most primitive suture lines, and the Cretaceous genera *Engonoceras, Tissotia, Platylenticeras* and *Buchiceras* exhibit the lobe lines of the Triassic Ceratites, as an 'early' stage in the evolutionary sequence."[18] (p. 88) Thus Scheven has disproved one of the most impressive examples of progressive evolution in the fossil record.

Ruse believes that one of the best transitional forms has been preserved in *Archaeopteryx,* 'firmly intermediate between reptiles and birds' (p. 220)[1] He cas-

tigates Stephen Jay Gould and the Creationists alike for not taking it seriously.

Unfortunately for this argument, the days of *Archaeopteryx* as a "missing link" are coming to an end. In a series of studies, L. D. Martin and his co-workers have demonstrated the similarity between *Archaeopteryx* and other Mesozoic birds, and have also compared them to various groups of reptiles. It appears that the pioneering studies by J. H. Ostrom on which the current interpretation of *Archaeopteryx* is based, were mistaken in certain crucial points. "We think that many of these 'coelurosaurian' features are incorrectly identified. This is certainly true of the tarsal region, where *Archaeopteryx* has a pretibial bone, fibula and calcaneum of the *avian* type. In the dentition, *Archaeopteryx* has unserrated teeth with constricted bases and expanded roots like those of other Mesozoic birds."[19] If the phylogeny of birds is as far removed from the currently accepted model as Martin and coworkers claim, then *Archaeopteryx's* status as missing link goes by the board.[20-23]

Stanley's observations on the invertebrate fossil record also apply to vertebrates. Thus Stanley writes that "phyletic evolution will seldom accomplish a genus-level transition within a mammalian lineage spanning 5 My. Even in 20 My, rather little phyletic change is to be anticipated, and, in fact, few mammalian lineages survive as long as this."[17] (p. 129)

An interesting example of the problems gradualists have with the empirical evidence of the fossil record is an interesting fossil bat studied by Glenn L. Jepson from Princeton University. The bat was found in early Eocene deposits in the Green River Formation in Wyoming. The bat was very well preserved and remarkably similar to modern bats. In a public lecture Jepson described the following problem that this fossil poses: If one has a fully developed bat which resembles modern bats very closely (including the highly developed echolocator equipment that modern bats have) in the early Eocene, ie. 60 My old, at a time when the Class Mammalia was in the relatively early stages of its evolution, it follows that the evolutionary precursors of that bat would have had to extend down into the Paleozoic Era. In the evolutionary scheme of things, this would be completely out of the question.[24] (Lubenow 1980).

It appears therefore that on the whole the fossil record would support the model of 'punctuated equilibria' rather than the gradualist model. Indeed, Creationists would go much further than that. The gaps in the fossil record are far too persistent for the Eldredge/Gould model to be adequate. As Anderson and Coffin explain, "The Punctuated Equilibria model would not predict that we would find an abundance of transitional forms. However, even organisms that are evolving in isolated populations would have some probability of fossilization. Occasionally, some fossils would be fossilized and discovered to provide some "stepping stones" in the valleys between the hills of fossil finds.

This prediction is even more reasonable when we realize that it would take numerous species transitions to bridge the gaps between organisms that have evolved major adaptive structures (wings, flippers). According to Steven Stanley of Johns Hopkins University, 'ten or so species-to-species phyletic transitions are insufficient to produce the enormous degree of change that occurred in the origin of such divergent taxa as bats and whales'."[25]

Gradualists generally cite the improbability of fossilization and the resultant incompleteness of the fossil record as an explanation for the absence of transitional forms. "Punctuated equilibria" theorists argue that the fossil record is complete enough to make reliable statements about the course of evolution.

A. B. Shaw (see additional references) has attempted to demonstrate on a statistical basis that for all practical purposes, we can rely on the ranges of fossil species for accurate correlation.

Chris Paul[14] comments, "Although correlation was Shaw's main concern, it follows that if the fossil record is reliable for this purpose, it is probably reliable for other purposes as well. Indeed the very fact that we can correlate, recognize faunal provinces, reconstruct past climatic belts and so on argues strongly that the fossil record is adequate for all our purposes. To cite ludicrously obvious examples, literally millions of Mesozoic and Tertiary fossils are known, yet not one of them is a Trilobite. On the other hand, hundreds of thousands, perhaps millions of Palaeozoic triolobite specimens are known. If this distribution is due to the imperfection of the fossil record, as Lyell once suggested, why are all known trilobites only one part of the record. How did they become unpreservable and where are they now? It is common sense and the simplest hypothesis to assume that trilobites only occur in Palaeozoic rocks because they only existed in the Palaeozoic."

This general argument was supported by Shaw with a more rigorous statistical analysis in which Shaw sought an estimate of the probability that an observed distribution of fossils is due to failure of preservation or collection.

There are other ways of testing the completeness of the fossil record than a large-scale statistical analysis of faunal provinces.

Consider for example known gaps in the fossil record. It occurs sometimes that a species appears at a certain level, then there is a gap and then it reappears. It seems reasonable to assume that the species in question actually existed during the time represented by the gap and that its absence just represents an incompleteness in the fossil record.

As a test of the fossil record of cystoids (extinct Palaeozoic echinoderms), Chris Paul plotted the record at series level of all families known from one or more series. It turns out that on average for every five families known to have existed during any one series representatives of only four have been found! Chris Paul concludes that at this level the fossil record is at least 23% incomplete. Similarly the fossil record of modern groups of amphibians is at least 30% incomplete when the same method is used at epoch level during the Mesozoic and Tertiary.

However: "The incompleteness of the fossil record of cystoid families may be higher than usual for a shelly group. They are relatively rare and their skeletons fall apart very rapidly after death. Rapid burial

is particularly necessary for their preservation, whereas this is less vital to the preservation of ammonites, gastropods, bivalves, brachiopods, etc. The records of these groups may well be nearer the 90% end of the spectrum."[14]

The meaning of this is that even in groups where it is considered that the record is fairly incomplete, it is still 70% complete when a statistical analysis is made.

In the context of the observations made by Stanley and others, such estimates are a strong argument against any gradualistic interpretation of the fossil record.

Paradoxically, the observations by Gingerich, Kellogg, Ozawa[26-28] and others of small gradual changes argue rather *against* a gradualistic interpretation, because of the absence of such a large number of transitional forms required in the gradualistic model. If their gradualistic model is true, and if the fossil record is complete enough to allow us to see such small-scale change as Gingerich, Kellogg and others have claimed to demonstrate, how is it possible then that larger scale change which requires a good number of transitional forms, is completely unrecorded?

Strangely enough, the arguments by Gingerich and others can be used against the gradualistic model, rather than for it, unless the fossil record contains statistical fluctuations so large as to make it completely impossible to decide between alternate theories. This is also the result of a study by David J. Rodabaugh in which he argued on a rigorous statistical basis that given the large number of missing links we can say that the probability that they ever existed is vanishingly small.[29]

Furthermore, consider the 'Cambrian explosion,' ie. the sudden appearance of a great diversity of life forms in the Cambrian without signs of many precursors, when "the entire system of life arose during about 10 percent of its history surrounding the Cambrian explosion some 600 million years ago."[30] Gould successfully demolishes one attempt after another to explain this phenomenon. However, that the model of punctuated equilibria should successfully account for the Cambrian explosion also stretches credulity to its limits. Paleontologist Chris Paul, by no means a creationist, admits that "the Eldredge and Gould model helps to explain the sudden appearance of fossil species, but it is inadequate to explain the simultaneous appearance of many forms of life . . . or, for that matter, the sudden disappearance of many unrelated species."[14] (p. 215) Thus the new theory fails precisely at the points where it counts most.

The second criticism of 'punctuated equilibria' by gradualists concerns their model of speciation. Anderson and Evenson[31] (1978) have done a study on the sizes of the geographic ranges of species of North America terrestrial vertebrates which are considered to have diverged recently. Mark Ridley comments, "Although uncertainty exists about just how recently the pairs of species diverged and about the relation between range and population size, Anderson and Evenson's data does not support Eldredge and Gould's claim that speciating populations are very small."[12] John Maynard Smith has argued that the total rates of mutation are lower in smaller populations, and this may lead to lower rates of evolution.[32]

Naturally, the creationist arguments against the Neo-Darwinian mechanism of evolution apply with a vengeance to the theory of 'punctuated equilibria.' If quantitative calculations make gradual evolution appear inconceivable, rapid evolution is quite impossible.

Eldredge and Gould are aware of this problem and realize that they must find mechanisms of speciation that go beyond Neo-Darwinian microevolution. A change in a chromosome (eg. a translocation or an inversion) within one local population is suggested as a mechanism for rapid speciation. Mark Ridley comments: ". . . even given a correlation between chromosome differences and speciation, it is not obvious which is cause and which effect, nor can we be sure that chromosomal speciation would necessarily produce punctuated evolution."[12] Ruse is quite scathing: "Again, if one looks at some of the proposed chromosome species mechanisms that so excite Gould, one suspects that orthodox evolutionists would like more proof as to their universal nature." (p. 218)[1] More recently, Gould has proposed large mutation as the main cause of punctuated equilibria; this strikes me as a counsel of despair in the absence of a plausible mechanism.

Another concept introduced by Gould and Stanley is the concept of "species selection." They believe that "species play the same role in an evolutionary trend that individual organisms, which do not change evolutionarily during their life, play in the adaptive processes of microevolution."[33] Species selection is said to direct evolutionary trends within clades.

However, species selection does not really address itself effectively to the problems of the mechanism of evolution in the model of "punctuated equilibria," for the following reasons: (1) By definition, species selection does not explain speciation. It is an evolutionary process above the species-level. The problem of speciation hence remains unresolved.

(2) It may also contradict the model of speciation in the 'punctuated equilibria" interpretation. Species selection as a way to explain evolutionary trends within clades obviously only makes sense if the competing species are reasonably closely related. However, the Eldredge/Gould model claims that the speciation occurs rapidly in small isolated populations, and that intermeidate forms did not exist in the same place as their ancestors and were hence not likely to be preserved alongside them. In that case, however, it is hard to see how species selection can take place, because it presupposes that two closely related species compete for the same niche.

Many of the gaps in the fossil record which the theory of 'punctuated equilibria' is supposed to explain are of such a nature that none of the accepted mechanisms of evolution, including the ones proposed by Eldredge, Gould and Stanley, is sufficient to account for rapid evolution on such a scale.

We are hence faced with a remarkable paradox: The paleontological evidence overwhelmingly favors the interpretation of 'punctuated equilibria' over against the 'gradualist' model, whereas the evidence from

population genetics overwhelmingly favors, *if any,* the gradualist model.

For creationists, the answer is clear: Neither model accounts for the fossil record. Only the creation model will do.

Ruse, of course, does not leave us in doubt about his views on creationism: "I believe Creationism is wrong: totally, utterly and absolutely wrong." (P. 305)[1]

This statement does not become true just by repeating it again and again, which is what evolutionists have confined themselves to doing until recently. Ruse devotes the final part of his book to his critique of creationism. Let me briefly touch on some of the main arguments.

Creationists have often argued that the 2nd law of thermodynamics is in contradiction to the concept of evolution. Ruse attacks this argument on the basis that the law only applies to isolated systems. If one reads the technical literature on this subject, eg. by Prigogine, Nicolis and Eigen, one realizes that it is not as simple as Ruse would have us believe. Prigogine is very well aware of the problems the 2nd law causes for evolution; hence his valiant efforts over many decades to find a way to overcome them. Creationists have, of course, dealt quite effectively with Ruse's objections.[34, 35] Of course thermodynamics does apply also in non-isolated systems (albeit in somewhat different form). It is difficult to believe that random forces acting on a system like the pre-biological earth-sun system can produce order. The longer a system is subject to random forces, the more random the distribution of molecules is likely to become. Over time, the system is considerably more likely to approach equilibrium rather than to consistently depart from it. What Ruse would have to show is that the energy influx from the sun causes the earth in its pre-biotic stage to systematically deviate from equilibrium, and that he cannot do.[34, 36] I have written a survey of the various evolutionary self-organization models in theromodynamics advanced in recent times.[37] Hence I am reasonably familiar with the literature in this area. While Ilya Prigogine, Manfred Eigen and others have obtained interesting and useful results, I am not convinced yet that the thermodynamics problem of evolution has been solved or will be solved in the foreseeable future. Creationists argue that the self-organization of matter seems to be against the laws of nature as we know them.

Ruse does not seem to quite understand the second argument from thermodynamics as applied to evolution, which considers the correspondence between entropy in statistical mechanics and information theory. The argument is that the coded order which is present in DNA is not a property of matter itself; it is information given by the arrangement of nucleotides which is not contained in the physico-chemical properties of DNA *per se.* Creationists have argued that the information content of such codes cannot have developed from random processes or 'noise.' Ruse seems to be unaware (p. 307) that an analogue to the 2nd law of thermodynamics exists in information theory.[5, 35, 38, 39]

It would appear that Ruse has overlooked a great deal of creationist literature. The next issue dealt with concerns the origin of life: "We know full well that work on this problem has far to go. But, present progress surely merits detailed treatment, not a back-of-the-hand dismissal. Take the Creationists' claim that Stanley Miller's synthesis of amino acids proves nothing, since amino acids are not living things. Whoever said they were? Miller himself certainly never did want to claim that amino acids are living things. The point is that their synthesis does seem to be an important stage in the natural production of life, and can rightly be respected as such. Take also the Creationists' flat claim that amino acids would not have survived — "protection would not have been available on the primitive earth." At the very least, this claim needs justification. Simply stating your position is no argument." (p. 307)[1]

It appears that Ruse has not considered the detailed analyses of modern theories of chemical evolution given by, for example, D. T. Gish,[36, 40] and A. E. Wilder-Smith.[35, 41] The argument that the amino acids formed by a Miller-type synthesis under primitive earth conditions could not have accumulated in great concentrations because their rate of destruction would be of the same order as their rate of production has been well-supported by empirical calculations.[36] Apparently Ruse hasn't read these technical papers by creationists on this issue.

Again, Ruse says, "it would be nice to see the Creationist take on the question of the horse, which is one of the best documented cases of evolutionary change." (p. 311)[1] Ironically, the horse is discussed in one of the books that he cites.[42] Of course, more thorough treatments of the phylogeny of the horse from a creationist standpoint are available, see for example Cousins,[43] and Scheven.[18]

About the Galapagos finches Ruse writes: "They are nowhere to be found in the Creationist discussion!" (p. 309)[1] He must not have spent much time looking, because a number of creationist discussions on this topic exist.[18, 44, 45]

The question of human footprints in Cretaceous formations in the Paluxy River Bed, Glen Rose, Texas, is discussed. The impression Ruse gives is that they might be misinterpreted dinosaur footprints. It is very clear to anyone who has actually seen the prints (and Ruse must have at least seen photographs of them in the books he cites) that some of the footprints must be human or forgeries. Analysis has shown that a good number of them appear to be genuine and are certainly not carvings.[18] They were not actually discovered by creationists, but rather by a very orthodox paleontologist by the name of R. T. Bird in 1939. Bird described his findings in his publications, but since they didn't fit into his scheme of things, he declined to ascribe any particular interpretation to them. If Ruse had read Creationist literature thoroughly, he would also know that human footprints were discovered in Carboniferous rocks.[46, 47]

If any of these findings are inadmissable or falsely interpreted, this would need to be established and argued rather more conclusively than has been done in the book.

The example of radiometric dating techniques is revealing. Ruse claims that "no proof is offered for the Creationist claim that processes of decay may have

speeded up . . ." (p. 317).[1] The context makes it clear that he is saying that creationists are suggesting that rates of radioactive decay have not been constant, but have not made any attempt to give reasons for this. Quite to the contrary: Creationists have specified both the mechanism of the change in the rate of radioactive decay and *empirical evidence that this actually has occurred.*[48, 49] Ruse may disagree with these theories, but his comment that no attempt has been made to explain the changes in the rate of radioactive decay is plainly false. Furthermore, he seemingly does not think it necessary to deal with examples of discrepancies in radiometric dating results cited in creationist literature. Some of this material is covered in *Scientific Creationism* by H. M. Morris, which Ruse refers to frequently, but apparently has not read thoroughly.

Since Ruse's book is "intended to be a refutation of the Creationist position" it is truly astonishing that among the approximately 290 books and papers cited in his bibliography there are merely six creationist titles! One is left wondering whether he has read a single technical study by creationists on any of the major issues under discussion. The net effect is that to this day the arguments by creationists have remained unanswered, and Ruse's book has not really changed the situation.

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