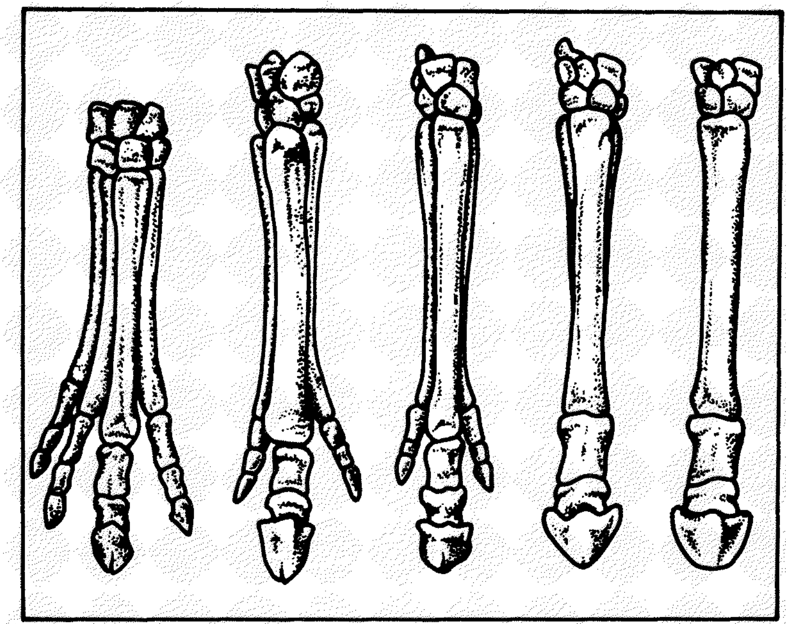
Creation/Evolution



Comparison of the forelimbs of four horse ancestors and the modern horse. Left to right: *Hyracotherium (Eohippus)*, *Mesohippus*, *Merychippus*, *Pliohippus*, and *Equus*.

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About this issue and the next . . .

In this issue, we continue from Issue XIV the discussion of the design argument. William Thwaites leads off with an article about the natural formation of new proteins. "Letters to the Editor" continues the dialogue with responses to material published in previous issues of *Creation/Evolution*. Although we have on hand a new response from Norman Geisler, we chose not to publish it this issue. In this way, we could catch up on some of the letters written in response to his earlier contributions. Dr. Geisler's newest response will appear in the next issue, along with a special article by Hubert Yockey.

Also in this issue, we focus on the fossil record. James S. Monroe writes in detail on the horse series, a series often challenged by creationists. Dr. Monroe not only shows how the creationist challenges are off the mark but makes clear that the horse series is linked to fossil sequences of other perissodactyls. The evidence shows a radiating evolutionary pattern that extends far beyond what creationists could conveniently relabel as "variation within the original created kind."

John Wolf and James S. Mellett provide a scholarly history of "Nebraska Man" that reveals how a "pig's tooth" was mistaken for the tooth of a human ancestor and how the error was discovered. Creationists make much of such corrected errors of evolutionary scientists while asking us not to do likewise with their own corrected errors.

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New Proteins Without God's Help

William M. Thwaites

Creationists seem to be proud of their calculations that supposedly show how thermodynamics and probability prevent the chance formation of biologically useful macromolecules such as enzymes. Their "evidence" usually consists of quotations from such authors as Hubert P. Yockey, who agrees that catalytically active proteins cannot occur by chance. Yockey (1977a and b), looking at fully evolved proteins, says that their information content is too high for their chance formation.

Creationists do their own calculations to show that the chance formation of biologically useful proteins is impossible. These calculations almost always involve the erroneous assumption that each of the many amino acid positions in a protein must be filled by the one particular amino acid suitable for that position. Since there are twenty different amino acids available for each position, the chance of randomly getting a string of 200 amino acids all in the right order is $(1/20)^{200}$. If you plug this expression into a calculator, it will tell you that it equals essentially zero. Thus, the creationists say, you can't get such a protein by a chance ordering of amino acids. As Duane Gish of the Institute for Creation Research (ICR) put it (1976), "The time required for a single catalytically active protein molecule to arise by pure chance would be billions of times the assumed age of the earth."

But proteins, even modern highly evolved specialized proteins, are not built with that degree of specificity. What's more, many proteins show in their structure that they were built of smaller subunit sequences of amino acids (Doolittle, 1981) or they have a simple metalo-organic core that could have functioned alone as a primitive precursor of today's complex enzyme. So the creationist calculations give an answer of zero probability because the creationists make at least two major errors in their assumptions: they assume a degree of specificity that has not been shown to exist in real proteins, and

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they insist that newly formed proteins must be as efficient as their older and highly evolved counterparts.

We've been trying to explain all this to the protein "experts" at ICR for the last seven years. We have told them that new proteins could indeed form from the random ordering of amino acids. We have warned them that their calculations were based on faulty assumptions and soon someone would document the natural formation of a new protein from the random association of amino acids.

Now it has happened! Not one, but two, new proteins have been discovered. In all probability new proteins are forming by this process all the time, but this seems to be the first documentation of this phenomenon. The newly discovered proteins are enzymes that break down some of the byproducts produced during nylon manufacture. Since nylon first came into commercial production in 1940, we know that the new enzymes have formed since that time.

When the enzymes were first discovered about 1975 (Kinoshita, *et al*, 1981), it was at first thought the new enzymes arose through the modification of preexisting enzymes that had similar functions. To test this notion, the discoverers looked to see if the other enzymes in the same organism would react to antibodies made against the new enzymes. But by this criterion the new enzymes were unique. Antibodies against them found nothing similar with which to react among the array of other enzymes in the organism.

Again it was reasoned that if the new enzymes were just old enzymes with minor changes to allow digestion of nylon byproducts, they should retain at least a slight amount of activity with their original substrates. But the new enzymes had no activity on biologically derived molecules having similar chemical structures. So, by this attribute as well, the new enzymes were seen to be unique.

It seemed that if the new enzymes were indeed derived from randomly ordered amino acids, they would be very inefficient compared to the usual highly evolved enzyme, since the new enzymes would not have had billions of years of natural selection to reach a pinnacle of biological perfection. It has been shown that one of the new enzymes (the linear oligomer hydrolase) has about 2% of the efficiency demonstrated by three other enzymes that perform similar reactions with biologically derived substrates (Kinoshita, *et al*). Thus, by this criterion, as well as the others, the enzyme appears to be newly formed.

More recently, another analysis (Ohno, 1984) added further evidence that at least one of the proteins was formed from an essentially random sequence of amino acids. This evidence is a little bit more difficult to understand since its comprehension involves some understanding of how the genetic code works. I'll just have to refer readers who do not have this background to an explanation such as Suzuki, *et. al*, 1976. It appears that the DNA that formed the gene was somewhat unusual since it could be "read" without finding a "stop" word in any of the three "reading frames." It can be shown that such DNA sequences could easily occur through the well-known process of duplication. The DNA sequence suggests that a simple "frame-shift" mutation could have brought about the chance formation of at least this one enzyme. "Frame-shift" mutations are known for forming totally new and essentially random arrays of amino acids since the code is "read" in a new reading frame. Usually the proteins that are formed by frame-shift mutations are totally useless sequences of amino acids that have no structural, antigenic, or enzymatic relationship to the original protein. This time, however, the new protein was useful. Being useful, it was retained by natural selection and was finally discovered by biochemists who noticed a bacterium that could live on industrial waste.

All of this demonstrates that Yockey (1977a and b), Hoyle and Wickramasinghe (1981), the creationists (Gish, 1976), and others who should know better are dead wrong about the near-zero probability of new enzyme formation. Biologically useful macromolecules are not so information-rich that they could not form spontaneously without God's help. Nor is help from extraterrestrial cultures required for their formation either. With this information in hand, we can wonder how creationists can so dogmatically insist that life could not have started by natural processes right here on earth.

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Basic Created Kinds and the Fossil Record of Perissodactyls

James S. Monroe
with illustrations by Daniel G. Warren

"Original kinds have been stable" is a tenet of "scientific" creationism, and scientific evidence can be given to support this tenet. At least, this is the claim of creation "scientists." Evidence usually cited includes probability, thermodynamics, the "impossibility" of beneficial mutations, and the fossil record, all of which are intended to show that evolution from "kind" to "kind" could not have occurred. The intent of this article is to show that the concept of a "basic created kind" is without meaning, especially when applied to fossil animals, and to demonstrate that the fossil record shows all perissodactyls are interrelated, therefore must all be of the same "kind" based on the only logical criterion for assigning fossils to "kinds."

Basic Created Kinds

Creationists conceive of a "basic created kind" as an organism which when created possessed considerable genetic potential for variation. This is commonly cited as "creative forethought" to allow these "kinds" to adapt, within limits, to changing environments (Morris, 1974; Hiebert, 1979). These "basic created kinds" have varied within limits thus accounting for the diversity of modern life forms. Common examples are a basic dog "kind" that gave rise to all varieties of dogs, from jackals to coyotes, a basic finch "kind" to account for Darwin's finches, and a basic horse "kind" that varied to give rise to all modern horses and many, or perhaps all, fossil horses. So variation, or microevolution, is allowed, but creationists emphatically deny that one "kind" could give rise to another "kind" (macroevolution).

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The absolute number of "basic created kinds" would probably be irrelevant to creationists were it not for two things. One is the demonstrated ability to induce variation by artificial selection and controlled experiments. The second, and probably most important, is that the size of Noah's Ark is known, at least approximately, and so the number of kinds must be reduced to something manageable. To accomplish this, aquatic "kinds" are usually not included as passengers on the ark. But this still leaves a space problem, and far too many "kinds" for Noah and his family to care for. Accordingly, "kinds" are further reduced to a dog "kind," a cat "kind," and so on.

The estimates of "basic created kinds" vary enormously. Jones (1973, p. 104) equates "kinds" roughly with the family and concludes (p. 107) that, "The number of animals under Noah's care probably did not exceed 2,000. . . ." These 1000 "kinds" (actually Jones p. 105 argues for 700 kinds) include mostly reptiles, birds and mammals. At the other extreme is Hiebert's (1979, p. 16) conclusion that ". . . species correspond roughly to original created kinds in Genesis chapter one." He does amend this statement by saying biological species ". . . do not always correspond to original kinds."

It is difficult to see how creationists could take either author's concept of a "kind" very seriously, but at least one (Moore, 1983) sees some value in Jones' ideas. Using Jones' concept, it would seem that goats, sheep, musk-ox, bison, wildebeests and gazelles *all* were derived from an ancestral bovid "kind." And of course the okapi and giraffe also must have been derived from a single "kind."

Hiebert simply overloads the ark, even if aquatic kinds are omitted. In addition, Hiebert's formalization of what a "kind" is must surely be too restrictive for most creationists. For example, he insists (p. 114) that new species cannot arise because the chromosome number of each is "rigidly fixed." On p. 113 he argues that more complex animals should show an increasing number of chromosomes if evolution is true, and since there is no such correlation, each organism possessing a different number of chromosomes represents a separately created "kind." The problem is that the basic horse kind of most creationists now has no meaning since the chromosomes vary from 32 in Hartman's zebra, to 46 in Grevy's zebra, to 56 in the onager, to 66 in Przewalski's horse (Gould, 1983, p. 362). Perhaps Hiebert thinks each is a "basic created kind" (he seems to contradict this on p. 60), but it is doubtful that other creationists would agree.

Between Jones' 700 "kinds" and Hiebert's unspecified but undoubtedly large number of "kinds" are somewhat more moderate estimates. Whitcomb and Morris (1961) and LaHaye and Morris (1976) argue for 35,000 and 50,000 animals on the ark respectively. The former estimate seems to be taken from Mayr's list of 17,600 species of mammals, birds, reptiles and amphibians, although Whitcomb and Morris (p. 69) say: ". . . but undoubtedly the number of original 'kinds' was less than this."

Aside from their vague estimates of the number of "kinds," creationists have also left their definition of a "basic created kind" rather vague, a point noted by Judge Overton in the Arkansas decision. This vagueness is probably intentional since any definitive statement invariably leads to problems, as in the case of Hiebert and his criterion of chromosome numbers. Indeed, creationist criteria for "kinds" seem to be variable, depending on the needs of the moment (Awbrey, 1981). The most commonly cited criterion is infertility, but morphology is included when infertility fails (Wysong, 1976, p. 60). Moore (1983 , p. 203) includes both:

> A kind is a distinct group of interbreeding organisms found in a particular geographic area which are (sic) genetically isolated from other recognizably different organisms.

Since infertility sometimes fails (see Kitcher, 1982, p. 151-155) "recognizably different" (morphology) is used. But what does "recognizably different" mean? All would agree that whales and sparrows are "recognizably different" and "genetically isolated." However, most would also probably agree that goats and sheep are "recognizably different," but they can hybridize. Two species of zebras, *Equus burchelli* and *Equus grevyi*, have overlapping ranges but are not known to hybridize (Keast, 1965). And some species of fruit flies are "genetically isolated" yet not "recognizably different." In the final analysis, the concept of a "basic created kind" becomes meaningless; "kinds" are simply whatever creationists want them to be.

But, if these criteria of "genetic isolation" and "recognizably different" are objectively applied, what is the result? Hyenas are certainly dog-like in appearance, have a social structure and habits similar to those of some dogs, but they do not hybridize, so they are "genetically isolated." Nevertheless, if hyenas were derived from an ancestral dog "kind" one would still expect to see some indication of this genetic relationship. In fact, hyenas are more closely related to the viverrids (genet cats, civits and mongooses) and cats: "This has been established from recent studies of chromosome patterns . . ., and especially from fossil evidence. . . ." (Kruuk, 1972, p. 269). Gregory and Hellman (1939, p. 331), Romer (1966, p. 233) and Colbert (1980, p. 345) all note that the late Miocene-early Pliocene genus *Ictitherium* is transitional between viverrids and hyenas.

Gish, in *Evolution: The Fossils Say No!* (1978), gives his views on "basic created kinds," but his discussion is even less informative than those of other creationist writers. Humans are of course a "kind" (p. 32), and gibbons, chimpanzees, and gorillas are also each "kinds" (p. 35). But on p. 47 he lists apes as a "major kind," and also dinosaurs. Based on this statement alone, it would seem that a "major ape kind" gave rise to all other apes. However, Gish's previous discussion (p. 35) muddies this point, for although he states that each ape is a "kind," he further discusses "kinds" within "kinds," whatever that means. So, Gish's concept of a "basic created kind" is confusing at best, yet it appears in a book advertised for use in public schools.

Gish is, however, clear and partly correct on one point. Some animals, although not all that he lists, do appear in the fossil record with all the characteristics of a "kind." Bats are full-fledged bats when they appear in the Eocene, and, so far at least, no intermediates between them and their insectivore ancestors have been found. Creationists are quite fond of this point and use it often. They should derive only slight comfort from this fact, however, since there are numerous well documented examples of evolutionary relationships that go beyond what is accepted as variation within "kinds."

Obviously infertility cannot be the criterion to determine fossil "kinds." Morphology will have to be used, so the question becomes, will creationists apply this criterion objectively and consistently, or will they simply establish arbitrary "kinds" as the need arises? Most likely the latter, because if morphology is applied objectively and consistently, animals as "recognizably different" as hyenas and civits would end up as members of the same "basic created kind."

Perissodactyls

The living perissodactyls are grouped into three families—Equidae, Rhinocerotidae, and Tapiradae, all of which are "reproductively isolated" and "recognizably different." Nevertheless, they are united by several shared characteristics. For example, the cusp pattern of the cheek teeth is similar, a condition referred to as lophodont. The dentition does vary in crown height, being high-crowned (hypsodont) in grazers (equids and one rhinoceros), and low-crowned (brachyodont) in browzers (the tapirs and other rhinoceroses). The digits in the hind foot are reduced to three or one, and the front foot has one, three or four digits. But in all, the plane of symmetry of the foot passes through the third toe. In addition, the calcanium and astragalus, although present in the ankle of all mammals, are uniquely perissodactyl.

There is considerable variation in living and fossil perissodactyls, but most such variation is related to specializations in diet as reflected in the dentition, and skeletal modifications related to locomotion and size. For example, limb element reduction, an adaptation for running, is extreme in horses, while the heavy rhinoceroses and extinct titanotheres have those skeletal modifications related to large size. It seems unlikely that creationists would consider horses, rhinoceroses and tapers to represent variation within a single "created kind," but if perissodactyls are considered in detail, some questions arise.

It seems odd that the Creator saw fit to give zebras perissodactyl teeth and ankles and one toe, while giving Thompson's gazelle and the wildebeest artiodactyl teeth and ankles and two toes. After all, these animals live side by side, eat the same grass, and flee from predators. There are behavioral differences which reduce interspecific competition (Bell, 1971), but overall they seem to have been "designed" to do the same thing. Did the Creator have two plans for plains-dwelling, grazing, running animals? If so, it seems that one plan was inferior to the other since perissodactyls of this type were formerly much more abundant and varied, but now constitute only a small part of the mammalian fauna. Indeed, *all* perissodactyls have declined in abundance and diversity. But we are told that "design" is a strong argument for creation, and that creation was perfect and complete (Morris, 1974). Of course the entire earth, and all upon it, is in a state of decline (the principle of disintegration according to Morris, 1974), but why should this affect perissodactyls and not artiodactyls?

At the family level, modern perissodactyls are quite different one from the other, but does this hold up if each family is traced back in the fossil record? It should according to Gish (1978, p. 47) who claims:

> We would thus expect to find the fossilized remains, for example, of cats, dogs, bears, elephants, cows, horses, bats, dinosaurs, crocodiles, monkeys, apes, and men without evidence of common ancestors. Each major kind at its earliest appearance in the record would possess, fully developed, all the characteristics that are used to define that particular kind.

This prediction is simply not borne out by the fossil record. Creationists will no doubt disagree and gleefully point out that bats and rodents appear abruptly with no evidence of ancestral forms. However, creation "science" is all or nothing, either nothing evolved or everything evolved. With this in mind, let us look at the fossil record of the perissodactyls—horses, tapirs, rhinoceroses, and the extinct titanotheres and chalicotheres.

Horses

The following account is concerned with those equid genera and evolutionary trends that led from *Hyracotherium* to *Equus*. This is not to minimize the fact that horse evolution was actually a complex of diverging lineages, at least after the appearance of *Miohippus* in the late Oligocene. These other lineages are important, interesting, and well documented by fossils, but are peripheral to the main argument advanced in this article. The following account briefly reviews the overall trends in horse evolution, presents a brief description of the "main line" genera, and concludes by addressing those criticisms voiced by creationists.

Some major trends in horse evolution were: 1) increase in size; 2) lengthening of the legs and feet; 3) reduction of lateral toes; 4) molarization of premolars; 5) development of high-crowned, cement-covered cheek teeth; 6) increasing complexity of the enamel pattern of the cheek teeth; and 7) changes in skull proportions to accommodate high-crowned cheek teeth. These trends were not uniform, nor did they all occur simultaneously. For example, horses actually decreased in size slightly in the Eocene, but the "main line" genera increased in size thereafter. Molarization of the premolars largely preceded the reduction of lateral toes. Some trends, however, were interrelated and proceeded at more-or-less the same rate. The change in skull proportions, for example, occurred along with the development of high-crowned cheek teeth.

Horse evolution begins with *Hyracotherium*, first described by Owen (1841) based on specimens from the London Clay. Early North American discoveries were referred to as *Eohippus*, but it eventually became clear that both *Hyracotherium* and *Eohippus* were similar enough to be included in the same genus, so the earlier name applies. Owen did not realize that *Hyracotherium* was related to modern horses, and, in fact, he compared it with some other animals. This is a point exploited by creationists and will be discussed later.

Horse evolution was largely a North American phenomenon. There were Old World Eocene genera, and the European paleotheres diverged from the ancestral equid stock but died out in the Oligocene. Some later Cenozoic genera, especially those in the Miocene and Pliocene, migrated from North America to the Old World and to South America, but *Hyracotherium* to *Equus* evolution was a North American event. The "main line" horse genera are briefly described in the following paragraphs. See Figure 1.

Hyracotherium (Eohippus): This little animal varied from about ten to twenty inches at the shoulder (Simpson, 1951), and served as the ancestral stock for all later horses. *Hyracotherium* is reported from late Paleocene age sediments (Morris, 1968; MacFadden, 1982), but Savage and Russell (1983) note that these specimens are probably early Eocene. In any case, early Eocene specimens are common. The forefoot had four fully functional toes; the fifth toe was smallest, and no vestige of the first metacarpal remained. The hind foot had three toes. In each jaw there were four premolars and three molars, all of which were low-crowned.

Orohippus: The differences between middle Eocene *Orohippus* and *Hyracotherium* are slight.

> *Orohippus* and *Hyracotherium* are very similar to each other in almost all known anatomical characters (Kitts, 1957, p. 1).
>
> The fact that advanced species of *Hyracotherium* and primitive species of *Orohippus* resemble one another so closely clearly indicates that *Hyraco-*

> *therium* was the immediate ancestral form . . . (Kitts, 1957, p. 32).

The main difference between these two genera is that the third and fourth upper premolars of *Orohippus* have four cusps of roughly equal size, and the heel of the third lower molar is relatively shorter than in *Hyracotherium* (MacFadden, 1976). That is, the upper premolars of *Orohippus* were more molariform than in *Hyracotherium*.

Epihippus: *Epihippus* appeared in the late Eocene, and differs little from *Orohippus*. The upper and lower third and fourth premolars were molariform, and the first lower premolar was single-rooted rather than double-rooted as in *Orohippus* and *Hyrocotherium*. According to MacFadden (1976, p. 11): "This degree of premolar molarization is nearly approximated in some advanced specimens of *Orohippus*."

Mesohippus-Miohippus: *Mesohippus* was the early Oligocene descendant of *Epihippus*. It differs from its ancestor in the reduction of metacarpals to three (II, III, and IV), but a small vestige of a fourth remained. The most notable difference was in the second upper premolar which was molariform and thus advanced over the stage in *Epihippus*. Various species of *Mesohippus* vary in size but average about 24 inches at the shoulder.

Mesohippus died out in the middle Oligocene, but not before giving rise to *Miohippus*. In general, species of *Miohippus* were larger than *Mesohippus*, and differed from their ancestor in some other details. For example, a small infold of enamel of the upper molars, the crochet, appeared as an occasional variation, but became a constant feature in many later horses. Also in *Miohippus*, and all later horses, the cannon bone (third metatarsal) was in contact with the ectocuneiform and cuboid, while in earlier forms it only contacted the ectocuneiform. *Miohippus* is not known after the early Miocene.

Parahippus: *Parahippus*, an early to middle Miocene genus, intergrades with *Miohippus* on the one hand, and with its descendant, *Merychippus*, on the other. Molarization of premolars was already completed in *Mesohippus*, but that genus showed the first indication of lengthening of the limbs and feet, a trend also seen in *Parahippus*. The crochet, seen as a variant in some specimens of *Miohippus*, was consistently present on the upper molars of *Parahippus*. The trend toward high-crowned teeth and the addition of cement to the cheek teeth are both first seen in *Parahippus*.

> Cement first appears as a mere film on the teeth of some members but not others in single populations. Gradually it comes to characterize whole populations and, still varying, it increases in average thickness until it reaches an evident optimum about which it fluctuates without further secular change down to recent *Equus* (Simpson, 1953, p. 106-107).

Merychippus: Although later species of *Parahippus* are difficult to distinguish from *Merychippus*, a middle and late Miocene genus, the latter is generally considered to be the first grazing horse. All of the molariform cheek teeth

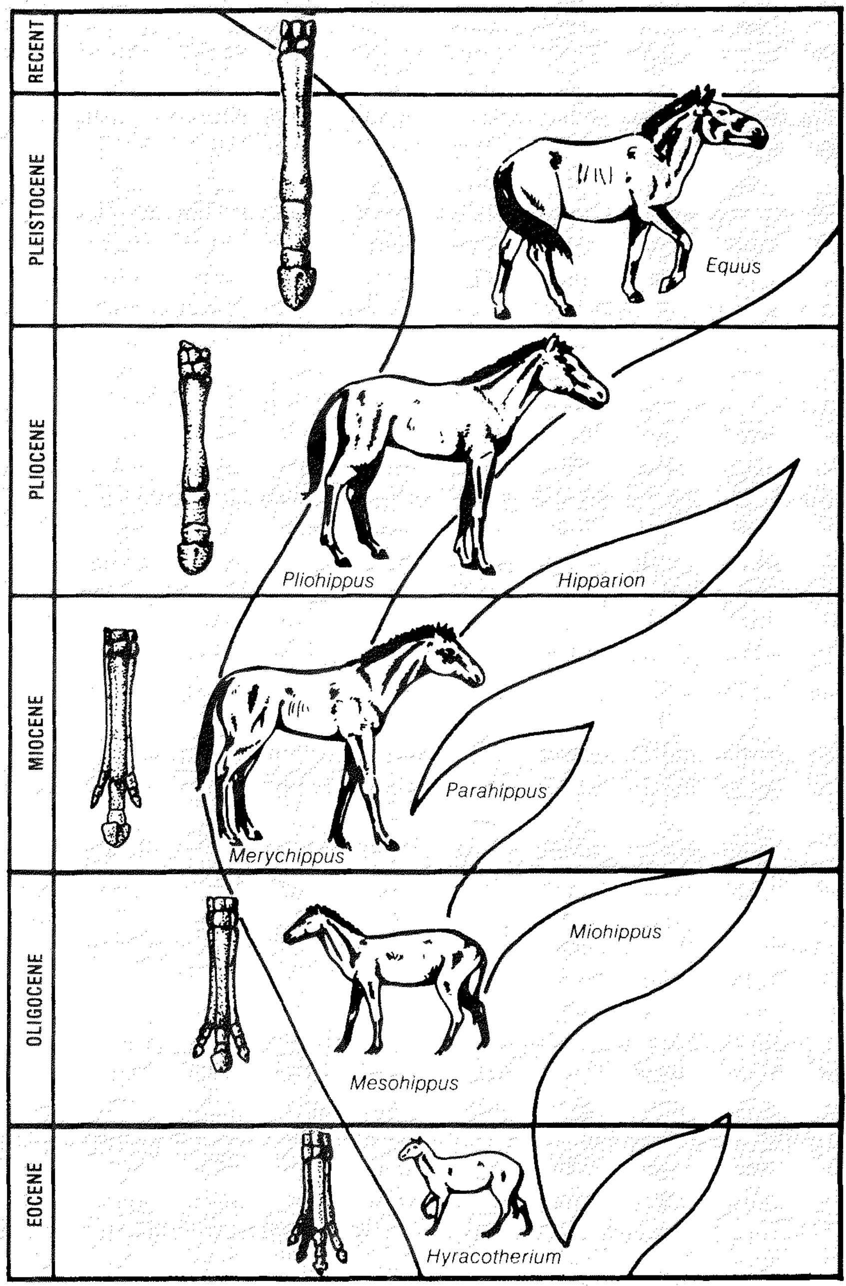

FIGURE 1: Evolution of the horse family (greatly simplified), showing the transition from *Hyracotherium* to the modern horse, *Equus*, and the evolution of the forelimb.

were high-crowned (hypsodont), richly covered with cement, and the enamel pattern on the chewing surfaces was more complex. *Merychippus* stood about 40 inches at the shoulder, the size of some modern ponies. The feet were still functionally three-toed, but the side toes were further reduced compared with earlier genera.

Pliohippus-Dinohippus-Equus: The modern stage of evolution is closely approached with the appearance of *Pliohippus* in the Miocene. *Pliohippus* shows further progression in those trends established much earlier. For example, *Pliohippus* was functionally one-toed, although some early species still possessed minute side toes not seen in later species. The molariform cheek teeth were much like those of *Merychippus* except they were higher-crowned, had more cement, and a more complex enamel pattern. The cheek teeth were, however, markedly curved unlike those of *Equus*.

Dinohippus was the later Miocene descendant of *Pliohippus*, and in the Pliocene gave rise to *Equus*. Both genera are very similar to one another. *Dinohippus* was restricted to North America, but *Equus* migrated to the Old World where it survives, although in considerably reduced numbers.

To summarize, size increase was rather constant in the "main line" genera from *Mesohippus* to *Equus*. Molarization of the premolars was completed when *Mesohippus* appeared, but hypsodonty and cement are first seen in their incipient stages in *Parahippus*. Changes in skull proportions occurred more-or-less with the continued development of increasingly high-crowned cheek teeth. Reduction of toes from four to three in the forefoot probably occurred within *Mesohippus*, and further reduction of toes to one, in both forefeet and hind feet, occurred in *Pliohippus*. Limb elongation is first seen in *Mesohippus* with later genera showing a continuation of this trend.

Surprisingly, creationists have written very little on horse evolution. Wysong (1976), Gish (1978), and Hiebert (1979) each devote little more than a page to the topic. Cousins (1971) presents the most complete coverage, but his paper is mostly a report on the work of Nilsson in 1954 who derived some of his data from Abel, a 1929 source; the latter work claimed by Cousins/ Nilsson (?) ". . . to be representative of the present position of relevant research." This is quite a remarkable statement in view of the hundreds of papers on horse evolution which have appeared since 1929. Nonetheless, it is true that only one general summary work has appeared in recent decades (*Horses* by G. G. Simpson, 1951), and, as Woodburne and MacFadden (1982) point out, the early workers had the overall story essentially correct.

Cousins (1971) concentrates on two transitions in the horse lineage, *Epihippus* to *Mesohippus* and *Parahippus* to *Merychippus*. According to Cousins (p. 106):

> *Epihippus* is the last of the old horses, while *Mesohippus* is the first of the new horses. Between these we have a very considerable jump. For the first

> were small animals, only as big as foxes, with four-toed forefeet; only with the latter did the large, three-toed type first occur.

It seems that size and the number of toes in the forefront is the evidence for this "considerable jump." Kofahl (1977, p. 66) has almost certainly paraphrased and elaborated a bit on Cousins' work in his discussion of *Hyracotherium*, *Orohippus*, and *Epihippus*:

> . . . the average size of these creatures, sometimes called 'old horses', decreases along the series, which is contradictory to the normal evolutionary rule, and they were all no larger than a fox.
>
> Between *Epihippus* and *Mesohippus*, the next genus in the horse series, there is a considerable gap.

In addition to these statements simply being wrong, Kofahl has cited none other than Simpson (1951) as his source. Simpson said no such thing, and in fact on p. 117 stated:

> The larger species of eohippus were not particularly tiny animals: they were about half the size of a Shetland pony.

It is true that later Eocene horses, *Orohippus* and *Epihippus*, were somewhat smaller than *Hyracotherium*, but not by much. Species of *Hyracotherium* varied from 10 to 20 inches at the shoulder, and the mounted skeleton of *Orohippus* in the Peabody Museum of Natural History measures 13 or 14 inches at the shoulder. "The typical height [of *Mesohippus*] was probably about 6 hands (24 inches) although species considerably smaller and larger are known" (Simpson, 1951, p. 124). Lull (1931, p. 18) described *Mesohippus bairdi* as about 18 inches in height, but noted that *Mesohippus intermedius* was much larger. Scott and Jepsen (1941, p. 911) described *Mesohippus* as about the size of a greyhound.

Cousins' "very considerable jump" in size is a creationist myth. But can the three-toed forefoot of *Mesohippus* substantiate Cousins' claim? Paleontologists have for a long time maintained that *Mesohippus* was the first three-toed horse. For example, Scott (1891, p. 324-325) states:

> The *metacarpus* . . . consists of three functional members, the second, third, and fourth, and one rudimentary, the fifth.
>
> The fifth metacarpal is represented by a rudiment which carries no phalanges. The head is as large as in No. IV, but the shaft is very slender and tapers rapidly to a point.

Taken with the other similarities between *Mesohippus* and *Epihippus*, it would seem the rudimentary fifth metacarpal would be compelling evidence for a close relationship. Creationists of course demand more.

It is not widely known, except among those who study mammalian evolution, but *Mesohippus* with four metacarpals and only three toes has been known at least since 1975. According to MacFadden (1976, p. 12) who cites a personal communication from Emry (1975):

> Recently . . . *Mesohippus* has been found with a fourth metacarpal (V) that is nearly as long as metacarpal IV, which articulates with three phalanges.

In his response to my inquiry for additional data on four-toed *Mesohippus*, Dr. Emry of the National Museum of Natural History kindly gave permission to use his data. He pointed out that forefeet of middle Oligocene *Mesohippus* are well known, and as far as he is aware all are three-toed. But there are specimens representing at least two individuals from the early Oligocene of Wyoming which have four metacarpals as noted by MacFadden above. Dr. Emry further noted that the Wyoming specimens have dentition much like that of *Mesohippus hypostylus*, which means that the second premolars are molariform.

It seems that the main difference between *Epihippus* and *Mesohippus* is the molarization of the second premolars. The number of toes will no longer help creationists since: "The present specimens suggest that the reduction of the most lateral digit took place within *Mesohippus* rather than between *Epihippus* and *Mesohippus*" (Emry, 1984, personal communication). Some specimens of *Mesohippus* have forefeet not quite like those of *Epihippus*, three toes but four metacarpals, which is not characteristic of typical *Mesohippus*. These same specimens do have typical *Mesohippus* dentition, however. In addition, some *Mesohippus* species were not particularly larger than their ancestors. Even before Emry's data were available, a compelling case for an *Epihippus-Mesohippus* relationship could be made. In view of the data now available, continued use of Cousins' argument would be meaningless.

Cousins (1971) apparently thinks that *Mesohippus* and *Parahippus* are of the same kind, but draws a clear distinction between *Parahippus* and *Merychippus*. On p. 107 he says:

> With *Merychippus* and *Hipparion* there is a rich group of Equus-like forms which are all separated from the former 'brachydontal' groups by a gaping evolutionary gap.

Cousins tries to make a case for this "gaping evolutionary gap" by concentrating on toes and teeth. As for toes he claims: "One-toedness dominated, although quite clear rudiments of two side-toes may occur." He claims that *Merychippus* had hypsodont, cement covered teeth, which is correct, but that horses of this type appeared suddenly with no indication of ancestors. Cousins' choice of toes and teeth was a poor one, at least in support of the creationist cause, since these two evolutionary trends did not proceed at the same rate. Cousins is simply wrong with respect to toes; *Merychippus* was three-toed as was *Parahippus*, but *Pliohippus* was one-toed. Typical *Merychippus* had teeth more similar to *Pliohippus* than *Parahippus*, however. Cousins' "gaping evolutionary gap" may exist in his mind, but the fossils tell a completely different story.

What do authorities on horse evolution have to say about *Parahippus-Merychippus* relationships? Stirton (1940, p. 178) says:

> Differences between the most primitive species of *Merychippus* and the most advanced species of *Parahippus* are hardly distinguishable.

Forsten (1975, p. 395) in referring to fossils from the Burkeville fauna of the Texas Gulf Coastal Plain noted that: "*Merychippus gunteri* . . . resembles *Parahippus leonesis* in many characteristics." Woodburne and Robinson (1977) point out that one author (White, 1942) identified *Merychippus gunteri* in the Thomas Farm fauna of Florida, but a second author (Bader, 1956) regarded these same specimens as *Parahippus leonesis*. Simpson (1953, p. 104) has made one of the strongest statements in defense of this transition:

> . . . he [Dietrich, 1949] says of *Parahippus* and *Merychippus* that no intermediate form bridges the gap between the two, 'no gradual transition can be established.' The statement is . . . false. There are unified samples, surely representing local populations, perfectly intermediate between *Parahippus* and *Merychippus* and so varying in the 'diagnostic' characters that assignment of individuals in a single population could be made to both genera and assignment of the population to one or the other is completely arbitrary.

The most significant evolutionary event seen in *Merychippus* was the development of hypsodont (high-crowned) cheek teeth which were covered by cement. Most paleontologists interpret this change in dentition as an adaptation for grazing, but it was in *Parahippus* ". . . that the inception of hypsodonty took place" (Stirton, 1940, p. 177).

From *Merychippus* to *Equus* not much need be said. Creationists no doubt realize the futility of trying to draw distinctions between these genera and the intermediates *Pliohippus* and *Dinohippus*. *Merychippus* was functionally three-toed while the others were one-toed, and the latter genera had higher-crowned cheek teeth, but all are recognizably horses.

Cousins (1971, p. 108) in his conclusion seems unable to clearly state what his argument for creation is. For example, he criticizes a study done by Stecher (1968) in which that author drew evolutionary conclusions based on variability in the chromosome count of modern equids and the variability in their spinal columns. Cousins disagrees with Stecher's evolutionary conclusions:

> It suggests, to my mind, nothing of the kind; it shows conclusively that the spines and chromosome counts are different in different animals and absolutely no evolutionary argument can legitimately be imported into his researches.

The key phrase here is "different in different animals." Yet Cousins' final sentence reads:

> **The horse family is unique and separate and the evidence can, without any weighting, be fitted to the case for special creation.**

Cousins has argued that Eocene horses are different from *Mesohippus*, and that *Mesohippus-Parahippus* are different from later horses. If they are really as different as he claims, they cannot all represent variation within a single "kind," so there must be three "kinds," a point with which Kofahl (1977, p. 66) seems to agree. Cousins then argues that different chromosomes and vertebral spines occur in different animals. Is each then a different "kind"? This isn't clear. But, if Kofahl's view is accepted, some horses must have evolved, even if we consider it to be only microevolution. In this case, however, Stecher was correct in the beginning. So why does Cousins argue against him? And, worse yet, why does Cousins finally argue that the whole horse family was specially created—as though we were back to thinking of it as a single kind? Consistency such as this is the hallmark of pseudoscience.

Hiebert (1979, p. 60-61) concentrates on problems of size and ribs, and makes no mention of other features showing the relationships among fossil and living horses. He notes that *Eohippus* (*Hyracotherium*) has 18 pairs of ribs, *Orohippus* has 15 pairs, *Pliohippus* has up to 19 pairs, and *Equus scotti* has 18 pairs, and concludes (p. 61): "The rib count denies any continuous evolution here." Perhaps Hiebert is unaware, but in mammals, ribs are found on the thoracic vertebrae, and the number of thoracic vertebrae and hence the number of ribs varies (Romer, 1962). The rib count is usually consistent in a species, but even here there is some variation, for example, in some individual humans (Crouch, 1965). And among the equids, Epstein (1971, p. 422) reports that modern horses may have 17, 18 or 19 pairs of ribs.

Creationists are particularly fond of small modern horses, dwarfed Argentine horses for example, and try to make a case for their similarity to some of the smaller fossil horses (Wysong, 1976, p. 304; Hiebert, 1979, p. 61). The dwarfed Argentine horse is similar only in size to Eocene and perhaps early Oligocene horses, genera which Cousins (1971) has claimed are quite different from later equids both in size and morphology. Moore and Slusher (1974, p. 420) think that "poor feed" may account for some small fossil horses, and give an example of small modern horses discovered in 1942 which reportedly were small for this reason. It seems, however, that *all* known specimens of Eocene and early Oligocene horses were small. Surely if "poor feed" were the cause, there must have been some that enjoyed an adequate diet and "normal size." And claiming that these small horses were simply size variants of other larger genera will not work. "Poor feed" may account for smaller size, but it will not change molars into premolars, nor will it add toes to the feet.

Paleontologists have long been aware that there was size variation in fossil equids. *Archaeohippus* (Miocene) and *Calippus* (Miocene-Pliocene) do in fact show a decrease in size compared to their contemporaries. In the "main line" leading from *Hyracotherium* to *Equus*, however, there was a general increase in size, a point exploited by Hiebert (1979, p. 61):

> Once horse fossils were found in a variety of sizes, it took little ingenuity to line them up from smallest to largest and to insist that the evolution of the horse has been proven.

Obviously Hiebert is charging paleontologists with outright deception. But it has never been claimed that size increase through time was uniform and continuous in all genera, nor is size increase the only evidence for horse evolution.

Moore and Slusher (1974) and Kofahl (1977) claim that horse fossils have a scattered distribution making them useless for evolutionary studies.

> . . . the fossils of these horses are found widely scattered in Europe and North America. There is no place where they occur in rock layers, one above another (Moore and Slusher, 1974, p. 420).

This quote contains two statements, both of which are only partly correct. As for the scattered distribution, only two of the "main line" genera, *Hyrocotherium* and *Equus*, are known from both Europe and North America. All others on the "main line" are uniquely North American, and *all* of the relevant genera have been recovered from sediments in the western United States. In fact, the relevant genera are known from Utah, Wyoming, Nebraska, and South Dakota, although the geographic distribution of some was much greater than this. While it is true that equids lived in Europe and Asia, it seems that the scattered distribution is true only in the broad sense; the "main line" genera occur in a considerably more restricted area. However, this is still a rather large area, and that brings us to the second part of the above quote: "There is no place where they occur in rock layers, one above the other."

A full response to this claim would be rather lengthy, because what is really being questioned here is mammalian biostratigraphy. This is an area in which "stage of evolution" actually has been the basis for relative age determinations and correlations. Fortunately this issue has been dealt with in some detail (see Schafersman, 1983, p. 238-241), so it will not be repeated here. Suffice it to say that the relative sequence of continental mammal-fossil-bearing strata has been independently verified by radiometric dating. And, while it is true that the entire horse lineage is not represented by fossils in a single area of superposed beds, there are many places where at least parts of the sequence have been found. The fact is that in those superposed strata containing a part of the horse lineage the sequence is consistent.

Cousins (1971) and Wysong (1976) compare *Hyrocotherium* with the modern hyrax:

> *Hyrax*, like *Hyracotherium*, is a small animal, about the size of a rabbit or fox. Like these, *Hyrax* has four toes on the fore-limbs and three on the hind limbs, a quite striking similarity. The back teeth of the two genera

> exhibit many similarities and resemble those of the rhinoceri more than those of horses (Cousins, 1971, p. 106).

Cousins notes that *Hyracotherium* is not much like the modern horse, which is true, but then *Archaeopteryx* does not resemble *any* modern bird, except for having feathers, yet creationists consistently claim it was a bird. Cousins also tries to capitalize on the fact that Owen (1841) derived the name *Hyracotherium* to suggest the similarity to hyrax. There are some problems with Cousins' arguments. For one thing, Owen did not have other fossil equids with which to compare. Also, Owen compared *Hyracotherium* with pigs and rodents. Apparently, he felt the similarities with hyrax were greater, hence the name he chose. Superficial similarities can, however, be misleading and Owen was not the only one to make such a mistake. For example, Colbert (1980, p. 423) notes that: "Among ancient peoples, and even among the earlier modern naturalists, these animals [hyraxes] were thought to be rabbits of some sort . . ." In addition, hyrax is also called a coney as are some lagomorphs.

In view of these facts, and the fact that hyrax incisors are rodent-like, are we to assume that the hyrax, rabbits and rodents are "amazingly similar"? One could certainly make as good a case for this as Cousins has for the *Hyracotherium-hyrax* similarities. Perhaps all Eocene horses, modern rabbits, hyraxes and rodents (and maybe pigs too) were all derived from a single "basic kind." All of these resemblances are, however, rather superficial. In fact, the differences among these animals are much greater than the differences between *Epihippus* and *Mesohippus* or between *Parahippus* and *Merychippus*.

As evidence that the fossil record is supposedly more in accord with creationism, Gish (1978, p. 157) quotes Goldschmidt (1952, p. 97): "Moreover, within the slowly evolving series, like the famous horse series, the decisive steps are abrupt without transition." Wysong (1976, p. 301) makes a similar statement: "There are no gradations from one link to another. All suggested links appear suddenly in the fossil record."

However, these same fossils, at least some of them, are sometimes cited by other creationists as evidence for variation within a "basic created kind" (Moore and Slusher, 1974, p. 420). To sum up creationist opinion on this, then, it seems that all the following things must be true: (1) horses show variation within a "basic created kind," (2) all of the thousands of fossil horses were alive at the same time, (3) all were buried in deposits of a single flood, (4) but only distinctive types without intermediate variants were preserved. "Gaps" between these distinctive types are used as evidence against evolution, yet the same distinctive types show variation with a "basic created kind." Clearly, the creationist position on horse evolution is self contradictory.

Furthermore, contrary to creationist critiques, the evolutionary relationships among horses are *not* based upon conjecture, supposition, or a fragmentary or incomplete fossil record. Thousands of fossils, some of which are exactly what creationists have demanded (intermediates between intermediates), have provided the evidence for these relationships. So why don't creationists simply accept this evidence? They could still claim that *Hyracotherium* to *Equus* only shows variation within a "basic created kind." They will not likely do this, however, since *Hyracotherium* is just too different from *Equus*. In fact, Cousins particularly has argued that *Hyracotherium* is very unhorselike, and more similar to the modern hyrax. No doubt creationists will simply continue to rely on Cousins' work, continue to selectively quote evolutionary biologists, and/or largely ignore horses and concentrate on bats and rats.

Tapirs

Living tapirs are represented by a single genus and four species. Like other perissodactyls, they were formerly more varied and abundant, but are now geographically restricted occurring only in the New World tropics and the Malayan area. Tapirs are large animals measuring up to eight feet long and weighing as much as 700 pounds.

Since tapirs appear to have always been forest dwellers, their fossil record is not as good as that of most other perissodactyls. Nevertheless, fossils are abundant enough to document their ancestry with a fair degree of accuracy. See Figure 2.

Tapirs are closest to the ancestral perissodactyl condition since they have changed far less than members of the other groups. Indeed, some authors (Scott and Jepsen, 1941) consider them living fossils because so little change has occurred, especially since the Oligocene. All tapirs, living or fossil, have four-toed forefeet and three-toed hind feet, and have low-crowned teeth. However, modern forms have only two premolars in each jaw. The most notable evolutionary trends were the development of a short proboscis and an increase in size with the skeleton becoming stouter.

The earliest tapiroids, *Homogalax* (Family Isectolophidae) and *Heptodon* (Family Helaletidae), are found in strata of early Eocene age. Neither is particularly different from the earliest of the horse series, *Hyracotherium*, but *Homogalax* shows a greater similarity than does *Heptodon*. Both genera were small, a little larger than *Hyracotherium*, and both were also similar to a third middle Eocene tapiroid genus, *Hyrachyus* (Family Helaletidae).

Hyrachyus differs from *Heptodon* only in being slightly larger and in having

> **slightly higher crested teeth and no third molar hypoconulid . . . (Radinsky, 1968, p. 317).**

This is an important point since most authorities think *Hyrachyus* was ancestral to "one group of primitive rhinocerotoids" (Radinsky, 1968, p. 317). In fact, *Hyrachyus* has been classified as a rhinoceros by some, but the consensus now seems to be that it is a tapiroid.

True tapirs (Family Tapiridae) are found in the early Oligocene, being derived from ancestors like *Heptodon*. *Protapirus* has a skull length of about one foot, not quite one-half as large as the skull of the largest modern tapirs, but the "proportions of the limb bones are decidedly more slender" (Scott and Jepsen, 1941, p. 749). Scott and Jepsen also noted that while the dentition is tapir-like, it is not as specialized as in modern tapirs. *Protapirus* may have been developing an incipient proboscis as evidenced by some retraction of the nasal bones.

Miotapirus of the Miocene is the direct descendant of *Protapirus*, and is ancestral to *Tapirus*, the modern tapir. It was somewhat smaller than *Tapirus*, but had strongly retracted nasals indicating the presence of a proboscis.

Rhinoceroses

The Family Rhinocerotidae contains four living genera and five species, all being confined to Africa or southeast Asia. These are large animals weighing up to 3600 kg (7937 lbs.) (Kingdon, 1979). Among the fossil rhinoceroses is found the largest known land mammal: *Baluchitherium* (or *Indricotherium*), an Oligocene-Miocene rhinoceros of Asia, probably stood 16 to 18 feet at the shoulder. Like all perissodactyls, rhinoceroses were formerly more varied, abundant, and more widespread geographically, especially in the Oligocene and Miocene, but now seem to be headed for extinction (see Martin, 1984).

Modern rhinoceroses are all recognizably rhinoceroses, but they do show a great amount of variability. For example, three genera, *Diceros*, *Ceratotherium*, and *Dicerorhinus*, have no upper or lower tusks, but do have nasal and frontal horns. In contrast, *Rhinoceros* has both upper and lower tusks, but has only a nasal horn (Matthew, 1931). In addition, the Asian forms have folds in the skin giving them an armor-plated appearance not seen in African forms. Rhinoceroses also vary considerably in size from the relatively small Sumatran rhino (*Dicerorhinus sumatrensis*) to the large white rhino (*Ceratotherium simum*). There is also variation in the crown height of the cheek teeth.

Fossil rhinoceroses are placed in three families. One, the Amynodontidae, was restricted to the Eocene and Oligocene and became extinct. Amynodonts were probably derived from a tapiroid stock (Figure 2), but their ancestry is

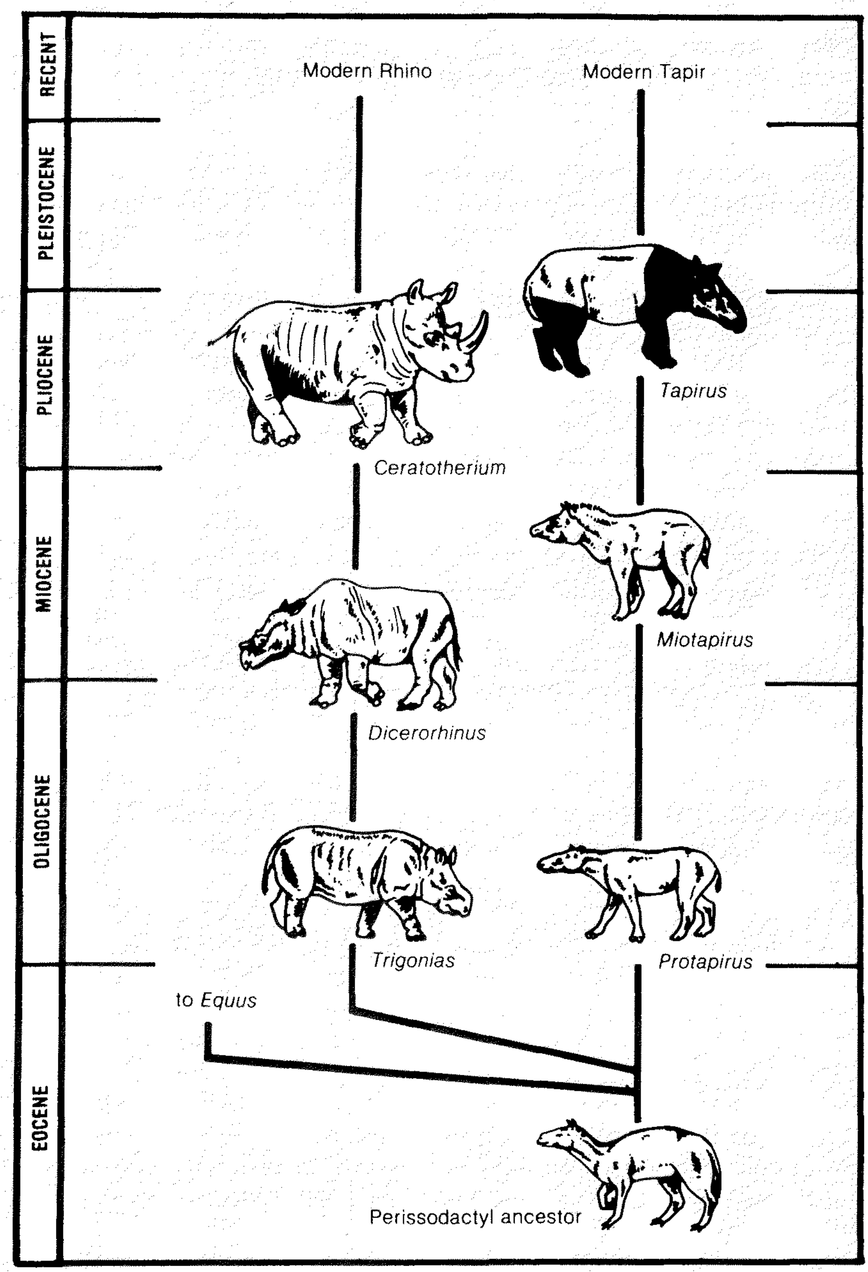

FIGURE 2: Evolution of the rhinoceros and tapir families (greatly simplified), showing the early Perissodactyl common ancestor.

not so well documented as compared to the other two families. The other families are the Hyracodontidae, or running rhinoceroses, and the Rhinocerotidae, or true rhinos. The former appeared first and was ancestral to the latter.

Rhinoceros evolution is more complex than that of other perissodactyls. Rhinoceroses were numerous and varied earlier in the Cenozoic, and several lineages show evidence of parallel evolution. In any case, the details would require considerable space, so I have chosen instead to concentrate on the earliest rhinoceroses and those descendants that led to animals that are undeniably rhinoceroses. Accordingly, the discussion will be restricted mostly to Eocene and Oligocene forms.

As noted earlier, the Eocene genus *Hyrachyus* has in the past been classified as a rhinoceros, but most experts now agree that it belongs in the extinct tapiroid family Helaletidae. *Hyrachyus* was quite similar to other early tapiroids, especially *Homogalax* and *Heptodon*, which were in turn quite similar to *Hyracotherium*. There seems to be little doubt that the earliest rhinocerotoids, *Triplopus* (Family Hyracodontidae), were derived from *Hyrachyus* or a *Hyrachyus*-like tapiroid ancestor:

> Characteristic rhinocerotoid dental features are approached in some variants of a late middle Eocene species of *Hyrachyus*, which is overlapped in dental morphology by primitive variants of an early late Eocene species of *Triplopus*, a hyracodontid rhinocerotoid: thus it appears that at least one line of hyracodontid rhinocerotoids evolved from *Hyrachyus* (Radinsky, 1967, p. 12).

Hyrachyus had four toes in the front foot and three in the hind foot, while *Triplopus* had three toes in all feet. Some hyracodontids were fairly large animals measuring up to five feet in length and two and one-half feet at the shoulder. *Forstercooperia*, for example, had a skull about seventeen inches long (Lucas *et al.*, 1981, p. 834), but *Triplopus* was considerably smaller.

Triplopus was ancestral to other hyracodontids in North America, but more importantly, in Asia it gave rise to the earliest member of the Rhinocerotidae, *Prohyracodon*, from which it differed very little. *Prohyracodon*, from the late Eocene, and the related Oligocene genera *Caenopus*, *Trigonias* and *Subhyracodon* represent the central stock of true rhinoceroses. These were large animals, *Caenopus* was up to eight feet long, and all were rhinoceroses in every sense of the word except for being hornless.

Horned rhinoceroses appeared in the latest Oligocene and Miocene. One of the earliest was *Dicerorhinus*, the genus to which the modern Sumatran rhino belongs. *Rhinoceros*, which includes the living Javan and Indian rhinos, is known as far back as the middle Miocene. Kingdon (1979) reports that *Paradiceros mukiri* from the Miocene of Africa may be ancestral to the modern African species. He further notes that both modern African genera,

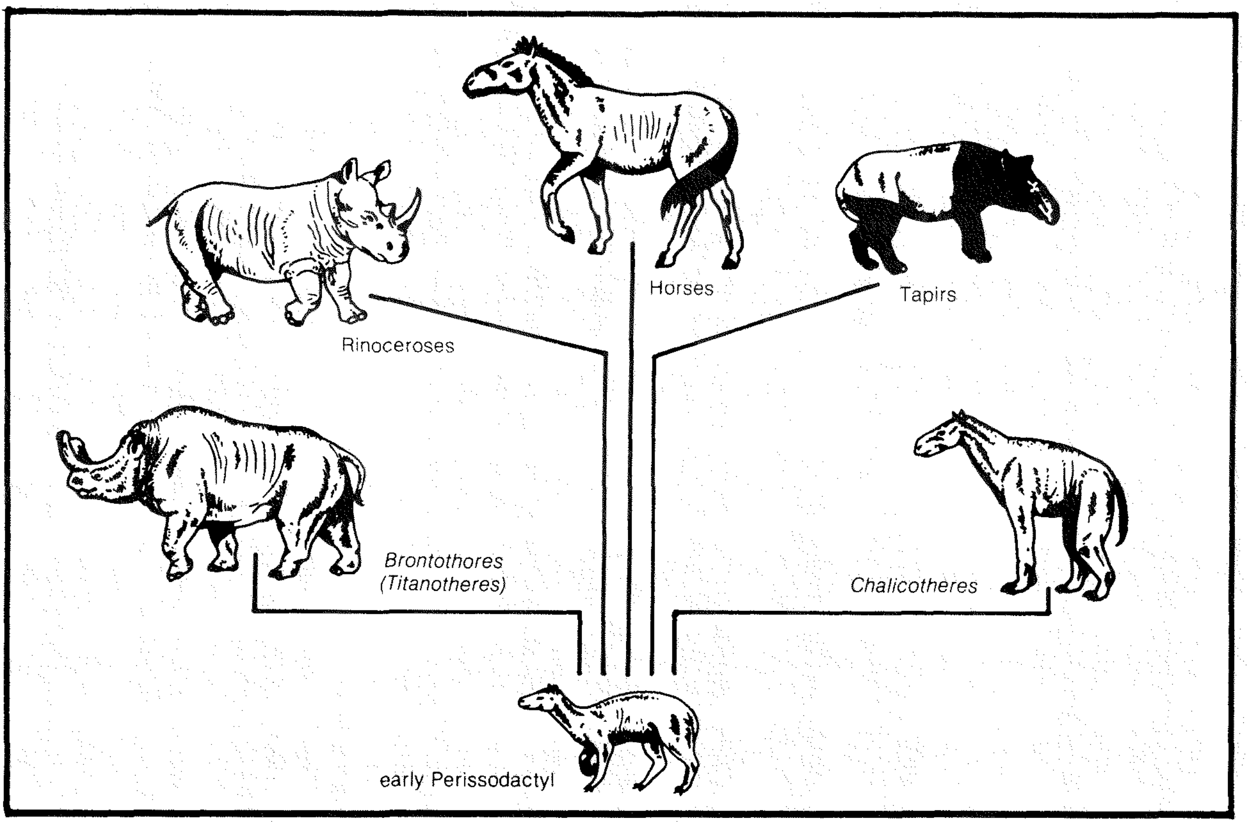

FIGURE 3: Simplified chart showing Perissodactyl "kind" evolving from early common ancestor.

Ceratotherium and *Diceros*, were present in the Pleistocene, the latter in its present form, but *Ceratotherium praecox* of the late Pliocene still shows resemblances to *Diceros*, but is probably directly ancestral to *Ceratotherium simum*, the modern white rhino.

The preceding discussion has been intended only to demonstrate the continuity in rhinoceros evolution. There were certainly many other Cenozoic rhinoceroses, such as the common North American forms *Hyracodon*, *Aphelops* and *Teleoceras*, but these were not ancestral to modern forms and therefore have not been considered. In addition, there were rather bizarre Asian forms, *Sinotherium* and *Elasmotherium*, that, unlike other horned rhinoceroses, had a single rather large horn located on the frontal bones of the skull.

Brontotheres (Titanotheres)

Compared with other major perissodactyl groups, the titanotheres were short lived, first appearing in the early Eocene and disappearing at the end of the early Oligocene. Nevertheless, they persisted for about 21 million years, during which time they evolved from small *Hyracotherium*-sized animals to giants measuring up to eight feet at the shoulder. Numerous genera of titanotheres have been described, and while their interrelationships are complicated, the overall trends in titanothere evolution are quite clear. The dominant trends were the attainment of large size, and the development of large horns on the skull. In contrast to the equids, the cheek teeth remained unprogressive and simple; the molars were low-crowned, and the premolars remained small and became only partly molariform. All titanotheres had four toes in the forefoot and three in the hind foot. There were, however, skeletal modifications related to the large size of the later members of the family, and skull modifications related to the development of horns.

The first titanotheres, *Lambdotherium* and *Eotitanops*, appeared in the early Eocene. The former measured about fourteen inches at the shoulder (Osborn, 1929), and had a skull about seven inches long (Gazin, 1952, Pl. 10). Except for details of the dentition, *Lambdotherium* differed little from the earliest horse, *Hyracotherium*. *Eotitanops* was about 50% larger than *Lambdotherium*. In this genus there was established "the basic molar pattern that remained essentially unchanged throughout titanothere evolutionary history" (Radinsky, 1968, p. 314).

Palaeosyops and *Manteoceras* are typical middle Eocene genera. The former gave rise to a branch of titanotheres which was hornless but had enlarged canines. The latter measured a bit over four feet at the shoulder, and can be considered on the "main line" to the giant early Oligocene forms. Incipient horns first appeared in *Manteoceras* being represented by "the paired roughening of the nasal bones, to which horns must have been attached" (Scott, 1945, p. 239).

The late Eocene is characterized by genera like *Dolichorhinus* and *Protitanotherium* which had rudimentary horns on elongate nasal bones, and which were larger than modern tapirs. With the development of horns came a change in the configuration of the skull: it became saddle shaped. This trend is first seen in these later Eocene genera, but is more pronounced in early Oligocene forms.

Titanotheres of the early Oligocene such as *Brontops* and *Brontotherium*, were very large animals. The nasal bones had large rugose horn-like structures which Stanley (1973, p. 456) thinks served "to protect the head and neck region against injury during butting, which was probably chiefly intraspecific in nature." *Brontops*, *Brontotherium*, and other large contemporary genera are the last titanotheres known. Their extinction may be accounted for by their unprogressive dentition not being suitable for the harsher vegetation that characterized the early Oligocene and later parts of the Tertiary.

Chalicotheres

Chalicotheres are the most peculiar perissodactyls. Later types were large animals, about the size of modern horses, and they had a rather horse-like appearance. However, their similarity to horses is rather superficial. The dentition was more like that of the titanotheres, the front limbs were longer than the hind limbs, and there were large claws on the toes. In fact, the feet are so peculiar that in the early fossil finds of these animals the teeth were classified as perissodactyl and the feet as edentate. The use of these clawed feet by a somewhat horse-like animal has been the subject of debate. Some authors (Romer, 1966; Colbert, 1980) suggest that they were used to dig up roots and tubers. Whatever their use, they represent a specialization not seen in any other perissodactyl group. Other than these peculiar feet, however, the Chalicothere skeleton is typically perissodactyl (Peterson, 1907; Romer, 1966).

Chalicotheres are divided into two families, the Eomoropidae and the Chalicotheriidae, the former being ancestral to the latter. Eomoropids were confined mostly to the Eocene, although one genus, *Eomoropus*, persisted into the early Oligocene. Chalicotherids range from the late Eocene to the early Pleistocene, but were most varied in the middle Miocene when six genera were present. Chalicotheres are much more common in Old World, especially Asian, deposits and it appears that most of their evolution took place there. In fact, only four of the fifteen known genera are found in North America, the last being *Moropus* and *Tylocephalonyx* of the middle Miocene.

The earliest eomoropid, *Paleomoropus* of the early Eocene, is quite similar to *Hyracotherium* and equid as well as *Homogalax* (a tapiroid). In fact, Radinsky (1968, p. 308) notes that these three genera "are distinguished from each other by slight differences in molar cusp pattern and in size." *Paleomoropus* was about the size of a sheep, had four toes in the forefoot and three in the hind foot, but apparently lacked the clawed feet of Chalicotherids.

Eomoropus appeared in the middle Eocene and gave rise to all later chalicotheres. This genus differed from its ancestor, *Paleomoropus*, in details of the dentition, and from its descendants in being "smaller and more lightly built, with feet unspecialized (digits not sharply flexed)" (Radinsky, 1964, p. 9), and in dental details. The biggest difference between *Eomoropus* and its descendants is stated by Radinsky (1964, p. 13):

> In short, I can find no features in the manus or pes of *Eomoropus* which suggest in any way the extraordinary modifications which appear in the feet of later chalicotheres.

The earliest and most primitive genus of the Chalicotheriidae, *Schizotherium*, appeared in the late Eocene. It is the only chalicothere known from the middle and late Oligocene, but was only one of several Miocene genera. Chalicotheres were probably never particularly abundant, but the six middle Miocene genera no doubt represent their greatest diversity. With the appearance of Miocene chalicotheres, such as the North American genus *Moropus*, not much more occurred. These animals were large, with claws on all the functional toes (three in each foot, although the forefoot retained a large vestige of the fifth metacarpal). The limbs were elongated, and the skull had a long deep face similar to the horses. To be sure, there was some variation in Miocene and later genera, doming of the skull in some, and variations in the anterior dentition (incisors and canines), but for the most part later chalicotheres differed little from typical Miocene forms. Only two genera, *Ancylotherium* and *Nestrotherium*, both Old World forms, are known from the Pliocene, and the latter did not become extinct until the Pleistocene.

Summary

Many of the earliest perissodactyls can be differentiated only with great difficulty. For any one lineage there is a sequence of fossils more-or-less continuously linking the earliest forms with their descendants. It may be argued that any one lineage simply shows variation within a "basic created kind." But the earliest members of each lineage are similar enough that, if morphology is the criterion for inclusion in a "kind," they also represent a "basic created kind." Therefore, *all* perissodactyls must have been derived from a single "basic created kind." See Figure 3.

The *Chalicotheres* developed a uniquely different kind of foot from the other Perissodactyls. The illustration above shows the front foot of *Moropus*. Note that the inner toe, rather than the middle toe, was the largest.

In view of the perissodactyl fossil record, it seems that creationists have several options. First, they could simply ignore the evidence, which is not scientific, and continue to concentrate on bats and rats. Second, they could acknowledge that perissodactyls have evolved, but no other group has (which seems unlikely). Third, they could argue that perhaps *all* perissodactyls were derived from the same "basic created kind," their fossil record thus showing evidence only of microevolution. (This too seems unlikely since "recognizably different" animals, zebras and rhinoceroses, would be of the same "kind.") And fourth, they could arbitrarily divide perissodactyls into several "kinds," as Cousins seemed to do with horses.

Creationists will almost certainly take the last option since they have done so in the past, the mammal-like reptile-mammal transition being a case in point. However, it is quite incredible that anyone could seriously argue that *Epihippus* and *Mesohippus* or *Parahippus* and *Merychippus* are really that different, especially when one considers the variability allowed in modern "kinds." Likewise, the earliest known equid, tapir, titanothere, and chalicothere are certainly similar enough to be considered members of the same "kind," if the morphological criterion is applied objectively and consistently. The earliest rhinoceroses can also be included in this "kind" since they differ so little from the ancestral tapirs. But since objectivity and consistency would yield negative evidence for creation "science," such a course will not likely be followed. After all, creation "is the basis of all true science" (Morris, 1983), and any evidence to the contrary is irrelevant.

The more that creationists demand of the fossil record, the weaker their case will become. Of course we will never be able to document the pedigree of all organisms, but many can be documented. For example, among the mammals, many artiodactyls, some carnivores, and others can be traced back in the fossil record, demonstrating the interrelationships among many life forms. As these data become more widely known, there will be fewer and fewer "basic created kinds" until it is apparent that all life forms are interrelated. Of course creationists could simply fall back on their Scopes era tactics by claiming that all species, living or fossil, are "basic created kinds." But then Noah's Ark would have had millions of passengers.

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The Role of "Nebraska Man" in the Creation-Evolution Debate

John Wolf and James S. Mellett

In 1922, solely on the basis of a worn fossil tooth from Nebraska, paleontologist Henry Fairfield Osborn described *Hesperopithecus haroldcookii* as the first anthropoid ape from North America. Five years later, Osborn's colleague William King Gregory concluded that the tooth most likely came from an extinct peccary, a pig-like animal. During its brief life, *Hesperopithecus* provoked intemperate speculations about its relation to humans, including a "reconstruction" of "Nebraska Man" by an artist in a popular British tabloid news magazine. The Nebraska tooth also sparked some memorable exchanges between Osborn and William Jennings Bryan, from whose home state the tooth had come. Osborn apparently began to have doubts about his identification of the tooth shortly before the Scopes "monkey trial" in July 1925, and he stopped mentioning it in his publications.

Although Nebraska Man did not survive long enough to become widely accepted by the scientific community and was quickly forgotten when its true identity was recognized, *Hesperopithecus* is again being trotted out in the current recrudescence of creationist attacks on evolution. The creationists who belittle mistakes by scientists cannot admit that science advances, in part, by correcting error.

Discovery, Debate, Doubt, and Downfall

In 1917, rancher and geologist Harold Cook found a human-looking tooth in Pliocene (recently redesignated Miocene) sediments in northwestern Nebraska. In March 1922, Cook submitted the specimen to Henry Fairfield Osborn, President of the American Museum of Natural History and an eminent vertebrate paleontologist, to determine the tooth's affinities.

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Osborn received the tooth on March 14, 1922. He wrote to Cook: "I sat down with the tooth and I said to myself: 'It looks one hundred per cent anthropoid'." (Osborn, 1922b, p. 2.) One month later, Osborn announced *Hesperopithecus haroldcookii* as the first anthropoid ape from America.

The tooth that became the "Ape of the Western World" has a virtually featureless crown surface, and the comparison with anthropoid teeth depended heavily on size and general shape. Osborn, however, did not attempt to bury the meager evidence of *H. haroldcookii* in a drawer at the American Museum. He had casts made of the tooth and sent them to 26 institutions in Europe and the United States (Anon., 1924a).

After seeing one of the casts, British paleontologist Arthur Smith Woodward, who had given the world Piltdown Man, was highly skeptical, feeling that "The occurrence of a man-like ape among fossils in North America seems so unlikely that good evidence is needed to make it credible." (Woodward, 1922.)

Despite Woodward's doubts, British anatomist Grafton Elliot Smith acknowledged *Hesperopithecus* as the third known genus of extinct hominids, along with *Eoanthropus* and *Pithecanthropus* (Smith, 1922), and also became an accomplice to an imaginative artistic reconstruction of *Hesperopithecus* that appeared in the *Illustrated London News* (Forestier, 1922). Given a large spread on the two pages preceding an article by Smith, the drawing shows a pair of very human-looking "*Hesperopithecus*" individuals hunting for their next meal. In the background, as Smith described, are various Pliocene mammals whose remains had been recovered from the same strata that yielded the *Hesperopithecus* tooth. The artist, Amèdée Forestier, explained that he modeled *Hesperopithecus* after "*Pithecanthropus*, the Java ape-man, whose proportions and attitude were those of the average Englishman." (Forestier, 1922, p. 943.) Osborn and his colleagues at the American Museum were not impressed with Forestier's handiwork and felt that "such a drawing or 'reconstruction' would doubtless be only a figment of the imagination of no scientific value, and undoubtedly inaccurate." (Anon. 1922.)

Forestier's black-and-white drawings, especially those dealing with archeological and anthropological discoveries, were featured in the *Illustrated London News* in the first three decades of the century. One of his earlier reconstructions had been of Piltdown Man. When the artist died in 1930, a friend paid too-generous tribute when asserting that "Forestier was especially interested in prehistoric man and loved to bring him to life, not by fictitious imaginings but by the most careful reconstructions based on scientific research." (Q., 1930.)

Forestier's reconstruction of Nebraska Man was not reproduced in any other contemporary publication and has only recently been "rediscovered" and reprinted by critics of evolution (e.g., Hitching, 1982; Bowden, 1981; see also Fix, 1984).

The argument over *Hesperopithecus*, especially in England, left Osborn scrambling for the middle ground. "Every discovery directly or indirectly relating to the pre-history of man attracts world-wide attention and is apt to be received either with too great optimism or too great incredulity," Osborn observed. "One of my friends, Prof. G. Elliot Smith, has perhaps shown too great optimism in his most interesting newspaper and magazine articles on Hesperopithecus, while another of my friends, Dr. A. Smith Woodward, has shown too great incredulity . . ." (Osborn, 1922d, p. 281.)

Osborn was willing to settle for an anthropoid ape, even if it was not a direct human ancestor. He put a respected colleague, William King Gregory, in charge of defending *Hesperopithecus*. Gregory, an unquestioned authority on fossil primates, compared the type tooth with Old World monkeys and apes and concluded that the Nebraska tooth "combines characters seen in the molars of the chimpanzee, of *Pithecanthropus*, and of man, but . . . it is hardly safe to affirm more than that *Hesperopithecus* was structurally related to all three." (Gregory and Hellman, 1923a, p. 14.) Later in 1923, Gregory backed off his assertion that *Hesperopithecus* showed human affinities and suggested that "the prevailing resemblances of the *Hesperopithecus* type are with the gorilla-chimpanzee group." (Gregory and Hellman, 1923b, p. 518.)

Thus, even during the "reign" of *Hesperopithecus* as a putative human ancestor, many scientists, including its discoverer (Osborn) and its chief defender (Gregory), did not go as far as Elliot Smith in making overzealous extrapolations based on the Nebraska tooth.

Field work resumed in the spring of 1925 at the site where Cook had found the original *Hesperopithecus* tooth in 1917. It was material uncovered at the site during 1925 that assuredly sowed the seeds of doubt about the true possessor of the Nebraska tooth. As evidence accumulated in subsequent field seasons, Gregory became aware that, despite the tooth's uncanny superficial resemblance to an anthropoid molar, *Hesperopithecus* was probably an extinct peccary. Gregory announced his retraction in *Science* at the end of 1927 (Gregory, 1927). The self-correcting feature of science thereby aborted America's only entry in humankind's prehistoric lineage *before* Nebraska Man significantly affected the opinions of most scientists regarding human evolution.

Gergory's change of heart on *Hesperopithecus* made front-page news in *The New York Times* (Anon. 1928a) and was picked up by *The Times* of London (Anon., 1928c). Editorial writers for both papers jumped at the chance to extract a lesson from the affair. *The New York Times* opined that

> Professor Henry Fairfield Osborn and his colleagues can snatch consolation from the extinct jaws of the toothsome wild peccary. For science, as this

> incident shows, demands proof from even its most exalted. Nothing ever went through so many tests as this peccary molar from Nebraska. It survived them all, but then science went digging in the ancient river-bed again. . . . After which the whole business was "on the hog." (Anon. 1928b.)

The Times of London also had some words to say about the "zeal for the discovery of ancestors, which is so often observed in the newly ennobled." (Anon., 1928d.)

Despite the editorials, the scientific impact of Gregory's retraction of *Hesperopithecus* was remarkably light, especially in America. The scientist who seems to have been most offended was Grafton Elliot Smith, the English anatomist who had seized upon Osborn's announcement in 1922 and shamelessly promoted *Hesperopithecus* as a full-fledged human ancestor. Four years after the retraction, Smith, neglecting his own role in the affair, thought that "It would be interesting and entertaining to discuss some of the false claims by over-enthusiastic searchers [for remains of fossil hominids . . . such as] the assumption that the tooth of a Pliocene peccary from Nebraska gave America the right to claim this 'Playboy of the Western World' (Hesperopithecus) as the earliest member of the Human Family." (Smith, 1931, p. 20.)

French paleoanthropologist Marcellin Boule, who had expressed doubts about *Hesperopithecus* since the original announcement, seemed only too delighted to sympathize, "What bad luck for a fossil called on to play a major role in the history of prehumanity, but also what a lesson for paleontologists with too vivid an imagination." (Boule, 1928, p. 209.) Long after other paleontologists had relegated *Hesperopithecus* to oblivion, Boule continued to remind the world, in a posthumous edition of his widely used textbook on human paleontology, that "The Nebraska Ape-Man became a 'Pig-Man'." (Boule and Valois, 1957, p. 86.)

Osborn, Hominids, and Peccaries

How could a worker as careful and methodical as Osborn have made such an egregious error?

Misidentifications and misallocations of fossil specimens are quite common in the paleontological literature. After publication, these errors are subject to examination by others in the field and corrections are made in print, usually without fanfare. Some of the misidentifications are extreme: a fossil whale first identified as a giant reptile, rodents misidentified as primates, carnivores as ungulates, ungulates as anteaters. The list is endless, but the public nature of science leads to quick corrections, particularly when the biological group in question is under intense study by a number of competing workers.

To prevent embarrassing errors when a new but very incomplete fossil is found, most paleontologists and anthropologists will make a tentative identification of a specimen and await further discoveries for confirmation of their find. Overly cautious individuals await complete skeletons and may never publish their finds, whereas more reckless ones will establish new species, genera, and families on sometimes inadequate evidence.

But was Osborn reckless? Why did he not make a more tentative identification of the ". . . single, small water-worn tooth . . ." (Osborn, 1922b, p. 1) that later became a *cause célèbre*?

Three factors contributed to the mistaken identification of *Hesperopithecus* as a primate.

First, the circumstantial evidence of some of the other fossil specimens associated with *Hesperopithecus* made the existence of a North American Pliocene anthropoid a distinct possibility. A fossil antelope, an animal otherwise native to Africa and Asia, was discovered in the same strata that produced *Hesperopithecus*. If an antelope could migrate from the Old World to North America in the Pliocene, why not an anthropoid?

Secondly, the sediments that yielded the tooth also contained abundant bone fragments and splinters that looked extraordinarily similar to bones that had been worked and shaped by unquestioned humans in the later Pleistocene (or Ice Age) of Europe. As it turned out, the "worked" fragments from Nebraska were produced when hyaena-like dogs crushed and split bones to obtain marrow, in the same way that African hyaenas feed today. To Osborn and his field workers, however, it looked as if a human culture existed and was preserved in these sediments.

Thirdly, the morphology of the fossil tooth itself was extremely deceptive. Even if one examines the tooth after reading all the literature about it, the tooth bears a compelling resemblance to human or hominid molar teeth, both in overall size and shape, and in the mode of wear on the tooth (the latter being the result of an abrasive diet and tooth-on-tooth contact). After comparing the Nebraska tooth with teeth of contemporaneous peccaries belonging to the species *Prosthennops crassigenus*, it is clear that the *Hesperopithecus* tooth is not an upper molar, as Osborn had thought, but a fourth upper premolar (a bicuspid in human dental terms). Keep in mind that all surface features, those essential to correct identification, had been virtually obliterated by heavy tooth wear during life and later by postmortem abrasion in the streams that deposited the sediments containing the *Hesperopithecus* tooth. The overall morphology of the *Hesperopithecus* tooth matches that of a *P. crassigenus* fourth premolar, but there is no similarity in the wear patterns of the two teeth. This is an important point, because the jaw motions of mammals are quite stable, and an animal that chews in a certain way would be very unlikely to change that mode of chewing and produce a novel wear pattern in its teeth. The only reasonable explanation is that the tooth of *Hesperopithecus* was rotated in the jaw in life, and that its odd position produced the primate-like wear pattern. This is not a totally *ad hoc* idea, because a 90 degree rotation about the long axis of a fourth premolar has been described and illustrated for the fossil peccary *Dyseohyus* sp. by Woodburne (1969, plate 51, fig. 1). Tooth rotation along all three axes has been described for a fossil carnivore (Mellett, 1977), so it is not an unexpected phenomenon in mammals, although it occurs only rarely.

Ironically, the similarity between peccary teeth and those of hominids had been noted 13 years before Osborn published his description of *Hesperopithecus*. In 1909, W. D. Matthew and Harold Cook had the following to say in describing *Prosthennops*: "The anterior molars and premolars of this genus of peccaries show a startling resemblance to the teeth of Anthropoidea, and might well be mistaken for them by anyone not familiar with the dentition of Miocene peccaries." (P. 390.) Matthew was Osborn's younger colleague at the American Museum of Natural History, but he said very little about the identification (rather, misidentification) of *Hesperopithecus* as a primate; his published comments on the tooth stressed its stratigraphic position rather than its affinities.

Nebraska Man, Bryan, the Scopes Trial, and Creationism

The consequences for science of the downfall of *Hesperopithecus* might have been more serious were it not for other substantial discoveries in the 1920's, especially *Australopithecus* and "*Sinanthropus*" (Peking Man), that helped shore up the argument for the evolution of humans from ape-like ancestors at a time when the concept of human evolution was being attacked by the likes of William Jennings Bryan.

In fact, Bryan played a pivotal role in the *Hesperopithecus* episode. At the end of a colorful political career, Bryan became an instant leader in the so-called fundamentalist crusade against evolution in the early 1920's. In 1921, trying out arguments that would receive wider attention during the Scopes "monkey trial" in 1925, Bryan preached that "The greatest enemy of the Bible is the *numerous* enemy, and the numerous enemy today is the believer in the Darwinian hypothesis that man is a lineal descendant of the lower animals." (Bryan, 1921, p. 19.) "Darwin," Bryan continued, "gives us a family tree which begins in the water . . . and then traces the line of descent to European apes—he does not even allow us the patriotic pleasure of descending from *American* apes." (1921, p. 39.)

Osborn, in his role as an established American defender of evolution, went after Bryan in a March 5, 1922 article in *The New York Times* (Osborn, 1922a). Osborn optimistically believed that "If Mr. Bryan, with open heart and mind, would drop all his books and all the disputations among the doctors and study first-hand the simple archives of Nature, all his doubts would disappear; he would not lose his religion; *he would become an evolutionist.*"

Osborn's answer to Bryan was published just nine days before the *Hesperopithecus* tooth arrived at the American Museum from Nebraska. The tooth seemed to be the very evidence he needed—and from Bryan's home state! Here, perhaps, was the *American* ape that Bryan had chauvinistically and sarcastically wished for. Osborn's glee must not have been entirely scientific as he studied the tooth from Cook. Perhaps the opportunity to undercut Bryan colored Osborn's analysis of the tooth and perhaps induced him to rush into print prematurely.

We do know that Osborn gloated over this small, worn tooth. In his 1922 announcement before the National Academy of Science, Osborn remarked on the fact that the discovery had come so soon after he had "advised William Jennings Bryan to consult a certain passage in the book of Job, 'Speak to the earth and it shall teach thee,' and it is a remarkable coincidence that the first earth to speak on this subject is the sandy earth of the Middle Pliocene Snake Creek deposits of western Nebraska." (Osborn, 1922c, p. 246.) Perhaps, he suggested mockingly, the animal should have been named *Bryopithecus* "after the most distinguished Primate which the State of Nebraska has thus far produced." (1922c, p. 246.)

In May 1925 Osborn again picked up the theme of the earth speaking to Bryan. He then called on Bryan to honor his own dictum that *Truth is Truth and must prevail.* An element of Truth, Osborn argued, appeared as a diminutive tooth from Nebraska.

> What shall we do with the Nebraska tooth? Shall we destroy it because it jars our long preconceived notion that the family of manlike apes never reached the western world . . . ? Or shall we continue our excavations, difficult and baffling as they are, in the confident hope, inspired by the admonition of Job, that if we keep speaking to the earth we shall in time hear a more audible and distinct reply? Certainly we shall not banish this bit of Truth because it does not fit in with our preconceived notions and because at present it constitutes infinitesimal but irrefutable evidence that the man-apes wandered over from Asia into North America. (Osborn, 1925a, pp. 800-801.)

Almost on the eve of the Scopes trial, Bryan finally answered Osborn on the subject of the Nebraska tooth:

> Professor Osborn is so biased in favor of a brute ancestry . . . that he exultantly accepts as proof the most absurd stories. . . . Each new exhibit, – no matter how largely the product of an inflamed imagination, – lifts him to a new altitude of exultation, and each one in itself furnishes him sufficient foundation for unchangeable convictions. . . . His latest "newly discovered evidence" is a long lost witness captured in Nebraska. He would probably

> have declared it "irrefutable" even if it had been found in some other state, – all the evidence on his side seems "irrefutable" to him, – but the fact that it was found in Nebraska, my home state for a third of a century, greatly multiplied its value. Some one searching for fossils in a sand hill came upon a lonely tooth. . . . The body of the animal had disappeared, and all the other pieces of "imperishable ivory" had perished; not even a jaw bone survived to supply this Sampson of the scientific world with a weapon to use against the Philistines of to-day. But a tooth in his hand is, in his opinion, an irresistible weapon. The finder of this priceless tooth, conscious that it could impose upon but a few, even among those who prefer speculation to reason, wisely chose Professor Osborn. He hastily summoned a few congenial spirits, nearly as credulous as himself, and they held a postmortem examination on the extinct animal, which had at one time been the proud possessor of this "infinitesimal" and "insignificant" tooth. After due deliberation, they solemnly concluded and announced that the tooth was the long looked-for and eagerly longed-for missing link which the world awaited. The Professor's logic leaks at every link, but it is no worse that that of his boon companions who, having rejected the authority of the word of God, are like frightened men in the dark, feeling around for something they can lean upon. (Bryan, 1925, pp. 104-105.)

This spirited exchange sounded like a prelude to a spectacular confrontation between Osborn and Bryan at the Scopes trial. Osborn appeared to be gearing up for a clash with Bryan when, in a series of essays published in May 1925, he singled out the Great Commoner as the man who would be on trial in Tennessee (Osborn, 1925b). Late in June he was listed as one of eleven "scientists who will be called to testify in the defense of John T. Scopes." (Anon., 1925a.)

Then a very odd thing happened, at least as far as the published record goes. As Boule (1928, p. 208) characterized it, "the silence descended" on *Hesperopithecus* at the end of June 1925. The Scopes trial was about to start, and a genuine American fossil hominoid from his home state could have, at the least, put Bryan and his colleagues of the prosecution on the defensive. Bryan, in fact, was prepared to take on Nebraska Man—upon his arrival in Dayton on July 7, he repeated his comments belittling the "missing link" founded on a single tooth from Nebraska and, dredging up one of his favorite lines, told reporters that "these men would destroy the Bible on evidence that would not convict a habitual criminal of a misdemeanor." (Anon., 1925b, p. 6.)

Five days later, just as the trial was beginning, Osborn produced another full-page defense of evolution in *The New York Times* (Osborn, 1925c). With Bryan's July 7 quote about the Nebraska tooth standing as a goad at the top of the article, Osborn nonetheless went through his entire argument without even a passing reference to *Hesperopithecus*.

What had happened? Quite simply, *Hesperopithecus* had come to the end of its short life, although most of the world would not learn of the demise for another two-and-one-half years. By mid-July, Osborn had undoubtedly received the first specimens from the renewed collecting at the *Hesperopithecus* discovery site. This material, as we have noted, probably caused doubts in the minds of Osborn and Gregory over the reality of *Hesperopithecus*. And what if Bryan had found out about the uncertain status of *Hesperopithecus*? If such doubts had been raised at the Scopes trial, it could have led to disastrous consequences for Scopes's defense and even for the public image of evolution. Clearly, it would have been best for Osborn to back off and stay out of reach in New York. So, having fulfilled his obligation to Scopes's defense with the July 12 piece in *The New York Times*, Osborn sat out the Scopes trial, not even submitting written testimony.

A review of the court record indicates that *Hesperopithecus* was not mentioned by anyone during the course of the Scopes trial, although other major discoveries of fossil hominids were discussed from the stand and in written testimony. Recent claims by Hitching that "the *Hesperopithecus* tooth was proudly displayed [at the trial] as evidence that man had a long evolutionary past" (1982, p. 211) are simply untrue; it is equally false that "the trial that became a significant turning point in U.S. educational history . . . was steered towards its verdict by a pig's tooth." (Hitching, 1982, p. 212.)

With one minor exception, Osborn dropped all mention of *Hesperopithecus* in works published after July 1925, and Nebraska Man sank into oblivion without a great outcry. Bryan died on July 26, just five days after the end of the Scopes trial, leaving no one of his stature to assume the leadership role of the fundamentalist crusade against evolution.

One who would have liked to be the leader of the opposition to evolution was John Roach Straton, pastor of Calvary Baptist Church in New York and a foe of Osborn's museum. In a letter to Osborn in 1924, Straton professed that he was "entirely friendly in my feeling toward the museum. The sole exception to this attitude in my mind is your so-called 'Hall of the Age of Man.' Frankly, I, for one, think that you ought to label that 'Our Humorous Department'." (Anon., 1924b.)

Straton was no mere crank. Even into the early years of his ministry, he was a believer in evolution, but by 1924 he had become a strong and articulate opponent of evolution. In a famous debate with Charles Francis Potter in January 1924, Straton, deftly countering the pro-evolution arguments of his Unitarian foe, invoked his own strong resemblance to Woodrow Wilson to argue that similarity of appearance need not imply relation (Straton and Potter, 1924, p. 58).

Straton's 1924 battle with the museum subsided, only to be rekindled shortly after the Scopes trial. But the fundamentalists had failed to discredit evolution in Tennessee and Bryan was dead, so the attack on the museum became bogged down.

Before his death in 1929, however, Straton had one final opportunity to chide Osborn. Shortly after Gregory's retraction, the minister suggested that the Nebraska tooth could be called "Hesperopigdonefoolem osbornicuckoo in honor of Mr. Osborn himself, who defended the tooth heatedly and, cuckoo-like said 'Me too' after gleeful dogmatic assertions of Cook, Gregory and others." Straton, of course, thought that the exposé of *Hesperopithecus* "justifies my assertion of some time ago that evolution is the most gigantic bluff in the history of the human mind." (Straton, 1928.)

The fundamentalists should have gotten some good ammunition from the *Hesperopithecus* episode. Even the editor of *Scientific American* had to admit that "It looks as if Straton had morally won this round and it might possibly work out a lot nicer if we of the scientific camp were to concede it gracefully and get ready for the next one." (Anon., 1928e.) In the same note, Gregory was praised for the retraction, "knowing as he must have known, when he did it, that the story of the ape's tooth that was reduced in station to that of a Pliocene pig, would surely be triumphantly intoned in the songs of hate of every anti-evolution gathering for a century to come."

Certainly not *every* anti-evolution gathering, and maybe not a full century, but the story of Nebraska Man has continued to show up occasionally in anti-evolution literature to this day (e.g., Dewar and Shelton, 1947) and has more recently become a stock item in creationist debates. More than half a century after Forestier's ill-fated attempt at a reconstruction of *Hesperopithecus*, one of the creationist's chief point-men—Duane Gish of the Institute for Creation Research—is still unable to resist making fun of the drawing and repeating the obvious humor in Osborn's misidentification—"I believe this is a case in which a scientist made a man out of a pig and the pig made a monkey out of the scientist." (Gish, 1979, p. 130.)

Ancestors, Error, and the Stuff of Science

Today, with the evolutionary prehistory of humans firmly documented by African fossil discoveries beginning with *Australopithecus* in 1924, *Hesperopithecus* is little more than a peashooter in the creationists' arsenal. George Gaylord Simpson even wondered whether the whole matter needs re-airing—"So even famous scientists make mistakes, as all humans do. Jove does nod. No one was hurt. No one was even misled for long. So what of it?" (Personal communication, 1983.)

But this mistake involved humankind's origins, a topic that is inherently provocative, especially in the context of a creation-evolution conflict. Even after being corrected by scientists themselves, mistakes in descriptions of human ancestors are likely to be immortalized in the diatribes of creationists. Whereas a few of the creationists' criticisms of the fossil evidence for human evolution are technically correct—as in the case of *Hesperopithecus*—they are often trivial. The reality of human evolution cannot be challenged by reference to one misidentified peccary tooth!

Good science can be practiced only when inappropriate external influences, such as politics, are left out. It is clear now that Osborn's wish to embarrass Bryan may have clouded his scientific judgment and led him to misidentify a specimen whose affinities required a more restrained assessment.

Finally, the issue relates to the fundamentally different values that creationism and science place on error. Creationists are quick to point out error by scientists, and ridicule it. They go on to argue that error and disagreement among specialists are indications that the fabric of science is coming apart, and that it will eventually collapse, with creationism reigning trimphant after Armageddon.

But what creationists ridicule as guesswork, and trial and error, and flip-flopping from theory to theory, are the very essence of science, the stuff of science. Error correction is part of the creative element in the advance of science, and when disagreement occurs, it means not that science is in trouble but that errors are being corrected and scientific advances are being made. Creationism comes on the scene arguing that the Bible is inerrant as a source of scientific truth and that "creation science" cannot admit of error because it simply does not exist.

We cannot conceive of two more diametrically opposed methods of explaining the world around us. One uses the correction of error as an inherent part of the process of searching for the truth, or ultimate reality in nature; the other rejects error or cannot admit its existence. Although it may be human to make mistakes, it is scientific to correct them. That is the nub of the issue between creationism and science.

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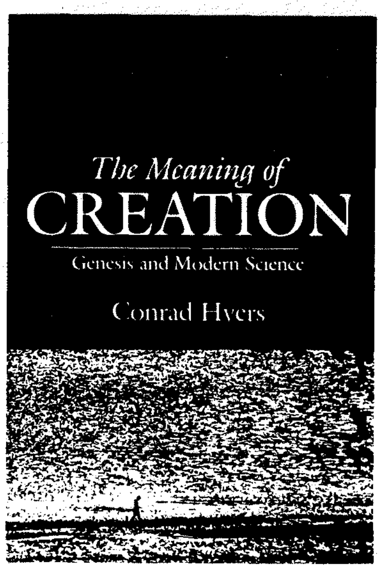
The Meaning of
CREATION
Genesis and Modern Science
Conrad Hyers

Letters to the Editor

Editor's note: Creation/Evolution *has been featuring an ongoing debate, initiated by Dr. Norman Geisler, on the question of design in nature. During the course of this debate, we have received many letters, a selection of which appear here. Because we wish to give Dr. Geisler the opportunity to respond to the arguments in these letters, if he so chooses, we are holding off resumption of the formal debate until the next issue.*

I can't wait to have my students in my freshman class in the processes of science analyze the Geisler articles. Even without instruction in logic and probability they'll enjoy critiquing the following inferences, reasonably deduced from a reading of Geisler's thesis.

1. Intelligence and its application is not natural; it's either unnatural or supernatural.
2. Anomalous objects and events are to be assumed a priori to be the result of intelligence and therefore unnatural or supernatural.
3. The use of intelligence to produce a given effect (object or event) is not natural.
4. The results of the application of intelligence do not result in pattern redundancy and therefore cannot be explained naturalistically.
5. A rounded, banded stone and an exquisitely formed crystal are due to natural causes and thus not the product of creative forces (those controlled or set in motion by a creator).

They know, perhaps intuitively, that assertions submitted for verification by logico-scientific means must have their basic terms defined operationally. They will ask for Geisler's definitions of *natural* and *intelligence.*

They will also conclude that it is no great intellectual feat to conclude that the discretionary information content of most humans probably exceeds that of other organisms. A discrepant theologian may need to ascribe this to other than natural causes. The uniform experience and logico-deductive thought processes of scientists and others make this effort unnecessary.

Paul Joslin

There are a number of confusions and assumptions made in the fascinating dialogue between Norman Geisler and his antagonists in the summer and fall 1984 issues of *Creation/Evolution*. A brief explanation and clarification of a few of these issues might shed some light on Geisler's modern rendition of the age-old argument from design. My efforts will concentrate on those issues not mentioned or briefly alluded to in the various articles.

The terms *order, purpose,* and *design* and especially the phrase *marks of contrivance* have been a dominant feature of the writers in the various articles, but their use has often been confused. Clearly a design implies a designer, just as a sculpture implies a sculptor or an effect a cause. These are usually termed co-relatives, since one implies the other. Whether purpose requires one who gave the purpose is less clear than the *design-designer* pair, for common English usage seems less clear in this case. The word *order*, on the other hand, does not necessarily imply an *orderer* (notice the term is not even a word in English, and rightfully so). The phrase *marks of contrivance* just as obviously implies a contriver, one who made the contrivance.

Order (as a pattern or constantly repeated motion) is a commonly observed feature of the natural world. Some of this order—as artifacts—comes about by human or animal intent and is then called design or *marks of contrivance* (Paley's term). But *order* is a neutral term, and, to know whether or not a natural feature has design and not just order, some observation is required. That Mt. Rushmore was designed is clear from our past experience with sculptured materials. Even had the Mt. Rushmore Memorial existed some three centuries earlier in its present location, the native Indians would have judged it the product of some intelligent being rather than the product of purely natural forces. But that is *only* because four clearly defined human heads together are never seen naturally. However, given a more sharply defined human head (or less sharply defined Mt. Rushmore), it would not be at all clear whether the cause was due to natural forces or some intelligent being. Take, for example, the Punch and Judy figures in the Chiricahua Mountains in southeastern Arizona. The latter might well have been taken as intelligent design. And such is the mistake made by Geisler. He assumes that the transfer of information can only be done by intelligent beings since he knows of no transfer systems that are nonintelligent (despite the efforts of Fred Edwords and William Thwaites to show nonintelligent information transfer systems). Geisler remains unimpressed, however. He assumes that, like human knowledge, intelligence is the best explanation for complex information systems. This is, of course, just anthropocentricism at its worst. So, Geisler is right in thinking that marks of contrivance require a designer but wrong in thinking that information storage and transfer requires intelligence just because it does for humans and human contrivances. What Geisler needs to do first is to show that *all* information systems require an intelligence, purpose, and design. But this he cannot do without begging the question. Random change plus a theory of evolution seem quite sufficient to explain the complex information content of the DNA helix that produces life forms. At best, such anthropocentric talk of purpose and design when speaking about complex organisms may be a linguistic necessity—as some have suggested—but these ways of speaking do not necessarily reflect the real world any more than "it" does in the expression, "It is raining outside."

Allow me one last observation that may well be the basis for the belief in the viability of the design argument so often used by fundamentalist thinkers, especially creationists. These thinkers strongly believe that organic life could not have derived from inorganic matter, since life can only derive from life (the principle of biogenesis). Since inorganic matter is not living, it is argued, it cannot give rise to living organisms—only a living supernatural being can be the cause of life in this world. They argue that organic matter is *more* like God than it is like inorganic matter. But there are at least two flaws with this basic assumption of fundamentalists.

First, organic matter really has more in common with inorganic matter with which it shares common elements, obeys the same laws of nature, and exists in space and time; God shares none of these. Organic matter can be looked at as just inert matter in a more complicated state. Clearly, for most life forms here on Earth, matter is more like these life forms than is God who shares only the vague characteristic "life" which is not at all like the life forms found here on Earth.

Second, by analogy—and as Jerry Borchardt has correctly pointed out in the fall 1984 issue of *Creation/Evolution*—the creator must be an organism in order to have created life and this would require a material body of some sort. So, if this argument from biogenesis proves anything, it proves that the creator is a material being and this would make such a hypothesis scientifically verifiable. . . . The kind of nonmaterial being believed by most theists, however, can neither be confirmed nor disconfirmed scientifically. Creationists seem to want their cake and eat it, too. They want a being that can serve as a scientific explanation of natural causes and objects but want this being to be nonmaterial as well, above and beyond our world of space, time, and matter. But they can't have it both ways. Either this being is physical and a source of energy—hence subject to the principles and laws of physics—or it is nonmaterial and above and beyond this world (and hence it could not be a scientific explanation for the world). Either way, creationists lose.

To put the argument in another way, if there is an intelligent cause of life, then it must be material, for no known information systems (human or otherwise) have derived from nonphysical causes. Importantly, the conclusion of an analogy can have no characteristic *not* found in the premises. The characteristic of nonmateriality is not found in any organic beings. Therefore, the cause of organic beings cannot have been nonmaterial. Logic is not magic. The nonmateriality of a creator of life cannot be pulled out of a materialistic hat. The rabbit must be material or forget the logic! This, Professor Geisler, is why evolutionists insist upon leaving out the intelligent-designer hypothesis; it is simply not scientific as long as the designer is nonmaterial.

Professor Geisler would have us teach creationism on the same footing as evolution. Consider the following class scenario, however. The creationist teacher would criticize evolutionists for allowing an apparent violation of entropy. Principles in science cannot be violated and there still be science, they would argue. Therefore, evolution is not science. At the end of the period, no doubt, the creationist teacher criticizing evolution would end by pointing out the magnificence of the creation by God, all from nothing! That this act of creation violates both the conservation of mass-energy and, perhaps, entropy as well does not seem to bother creationists. How are creationists going to explain to little Johnny why evolution cannot violate basic scientific principles but scientific creationism can do this with impunity! They never seem to realize the fundamental inconsistency in all this. They usually counter by claiming that since God made the principles of nature he can violate them at will. Although this makes little sense, let's grant God this possibility. Once granted, though, the explanation is no longer scientific. Again, Professor Geisler, this is why scientific creationism is a self-contradictory notion and why the modern form of the argument from design must ultimately fail.

Paul Ricci

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