

ANNOTATIONS FROM THE LITERATURE

ARCHAEOLOGY: SHIP-BUILDING ERECTINES

Morwood MJ, O'Sullivan PB, Aziz F, Raza A. 1998. Fission-track ages of stone tools and fossils on the east Indonesian island of Flores. *Nature* 392:173-176.

Summary. Many southeastern Asian islands, such as Java, Sumatra and Borneo, lie in shallow waters, and were once connected to the Asian mainland during low sea level. Other islands, including Flores, lie in deeper water, and are believed to have been always isolated. Stone tools have been found associated with fossils of *Stegodon* pygmy elephants and *Geochelone* tortoises, indicating the activities of humans in the area. Fission track dating of volcanic tuffs adjacent to the fossils produced ages of about 800,000 to 880,000 years. *Homo erectus* was the only known hominid in the area at the time. This indicates that *Homo erectus* must have had the ability to build boats and cross short stretches of ocean, an ability not generally attributed to the erectines.

Comment. If erectines could build boats and use them to migrate to new regions, it seems likely they must have had language. They may well have been intellectually much more similar to modern humans than previously thought. Arguments that *Homo erectus* should be interpreted as within the normal range of humans have been offered by Lubenow (1992, *Bones of Contention*, Grand Rapids, MI: Baker) and Morton (1997, *Adam, Apes and Anthropology*, Dallas: DMD Publishing).

BIOGEOGRAPHY: DISPERSAL OR VICARIANCE?

Baum DA, Small RL, Wendel JF. 1998. Biogeography and floral evolution of baobabs (*Adansonia*, Bombaceae) as inferred from multiple data sets. *Systematic Biology* 47:181-207.

Summary. Baobabs are often-photographed trees with distinctive shapes. One species is found in Africa, six in Madagascar and one in northwestern Australia. At least three explanations might be offered for this unusual distribution. It might be produced by fragmentation of

a continuous distribution as a consequence of the breakup of Pangaea, or it might be the result of overwater dispersal. A third possibility, that the trees are not truly related, seems unlikely. Relationships among the eight baobab species were estimated from morphology and from three different molecular sequences. Morphologically, four of the Madagascan species are more similar to the Australian species than to the African species. Internal transcribed sequences from nuclear ribosomal DNA showed the Madagascan species to be more similar to the African species. Comparisons of a chloroplast intron showed two of the Madagascan species to be most similar to the African species, but the other four Madagascan species equally similar to the African and Australian species. Restriction site analysis showed the Australian species to be most similar to the African species. All the molecular differences among the species were small in magnitude. This fact, coupled with the discordance among the gene phylogenies and the lack of *Adansonia* pollen in Mesozoic rocks, led the investigators to conclude that the present distribution of baobabs is the result of overwater dispersal. This is made more plausible by the tough water-resistant seeds.

Comment. Vicariance biogeographers have sometimes been quick to assume that distributions restricted to southern continents must be the result of fragmentation of Pangaea. This example shows that there may be other interpretations of the data. Dispersal should not be ruled out *a priori*, even when vicariance appears probable.

BIOGEOGRAPHY: HURRICANES AS DISPERSAL AGENTS

Censky EJ, Hodge K, Dudley J. 1998. Over-water dispersal of lizards due to hurricanes. *Nature* 395:556.

Summary. The Caribbean island of Anguilla lacked green iguanas until 4 October 1995, when at least 15 of the lizards washed up on the shore on a floating mat of logs and trees. This event was preceded by two large hurricanes in the month of September, and it is postulated that the lizards were washed away from their original home by the winds and rain of one or both of these hurricanes. The most likely source of the iguanas is thought to be the island of Guadeloupe, at a distance greater than 250 km. The group of lizards included both males and females, and this observation confirms that overwater dispersal and successful colonization can occur.

Comment. Dispersal has fallen out of favor among some biogeographers who prefer more testable hypotheses, comparing distribution patterns with movements of tectonic plates. Examples such as this show that overwater dispersal due to catastrophic conditions such as hurricanes may be an important factor in the distributions of species.

DESIGN: THE GENETIC CODE

Freeland SJ, Hurst LD. 1998. The genetic code is one in a million. *Journal of Molecular Evolution* 47:218-248.

Summary. The genetic code consists of 64 codons (groups of 3 bases), each of which codes for a specific amino acid or a reading signal. Similar codons generally code for the same or similar amino acids, which means that a point mutation (change of a single nucleotide) is likely to result in replacement of an amino acid by the same or a similar amino acid. Considering that transition mutations (purine to purine, or pyrimidine to pyrimidine) are more frequent than transversion mutations (purine to pyrimidine, or pyrimidine to purine), what is the probability that a code assembled at random would be as efficient as the existing code? Calculations indicate that the probability is only one in a million, indicating that the genetic code is non-random in arrangement, as expected if it were produced by selection.

Comment. The efficiency of the genetic code is best explained as a striking example of design. It seems implausible to propose that a randomly generated genetic code could be so significantly improved through natural selection, since changing the meanings of the codons would disrupt the process of natural selection of the protein products.

DESIGN: MOLECULAR MACHINES

Alberts B. 1998. The cell as a collection of protein machines: preparing the next generation of molecular biologists. *Cell* 92:291-294.

Summary. This is the introductory article to a collection of articles describing molecular machines in cells. The author no longer views cellular processes as driven by random collisions of proteins, colliding two at a time in an undirected sequence. He now believes that virtually every major cellular process involves assemblies of 10 or more protein molecules, each of which is interacting with other molecular assemblies. Each of these assemblies function as machines, with highly coordinated

moving parts. The author then discusses whether one should have expected such well-engineered protein machines as are found, and to appeal to university science departments to consider how better to prepare the next generation of molecular biologists. They will need to have a good knowledge of mathematics and the physical sciences in order to unravel the mysteries of how these machines operate.

Baker TA, Bell SP. 1998. Polymerases and the replisome: machines within machines. *Cell* 92:295-305.

Summary. Replication of DNA involves an interacting complex of several molecular machines. These include the primases and polymerases that copy the DNA, the exonucleases that correct copying mistakes, the clamping proteins that attach the polymerases to the DNA, and the helicases that separate the DNA strands so they can be copied. The clamping proteins provide an example of mechanical action. A sliding clamp protein forms a ring around the DNA strand at the appropriate location, and attaches the polymerase unit. A clamp loader protein opens the ring-shaped sliding clamp protein, moves it to the correct location, and closes it around the DNA strand. This requires specific recognition sites for DNA initiation sites, the sliding clamp protein, and ATP, along with specific structural features that facilitate appropriate configurational changes to open and close the sliding clamp protein at the proper times.

Bukau B, Horwich AL. 1998. The Hsp70 and Hsp60 chaperone machines. *Cell* 92:351-366.

Summary. Molecular chaperones are molecules that cause conformational changes in other molecules, converting them into active forms. For example, an inactive protein may be converted into an active enzyme by a molecular chaperone that causes an appropriate change in the folding of the protein. In some cases, proper folding may be achieved by a series of molecular chaperones. Chaparonins consist of double-ring assemblies with a central cavity that can attach to proteins that are not properly folded. Attachment of the protein molecule triggers conformational changes in the chaparonin that result in proper folding of the protein. The chaparonin's function is made possible by its three-part, hinged structure, its inner hydrophobic recognition site, an ATP recognition site, and by its specific shape that facilitates appropriate conformational changes.

DeRosier DJ. 1998. The turn of the screw: the bacterial flagellar motor. *Cell* 93:17-20.

Summary. The mechanism for movement of the bacterial flagellar motor is unknown, but much has been learned of the structure. The flagellum “resembles a machine designed by a human...” It consists of a rigid filament connected to a curved piece by two junction proteins. The flagellum is set into a socket in the inner cell membrane, and rotates within two bushing-like rings embedded in the outer cell membrane. Three other rings are also present. About 50 genes are involved in flagellar structure and sensitivity to chemicals.

Kinosita K, Yasuda R, Noji H, Ishiwata S, Yoshida M. 1998. F_1 -ATPase: a rotary motor made of a single molecule. *Cell* 93:21-24.

Summary. ATP, the major energy carrier molecule for living cells, is constructed with the aid of an enzyme, ATP synthase. The ATP synthase molecule includes a rotary motor only 10 nm in size. The motor has a central shaft that rotates inside a hexagonal structure of six subunits. Rotation of the central shaft has been confirmed by observing movement of a larger molecule attached to the shaft. When ATP is added to the medium, the central shaft rotates counterclockwise, hydrolyzing the ATP, probably with an efficiency near 100%. If the shaft is turned clockwise, as by passage of a proton, ATP is produced.

Comment. The articles in these issues of *Cell* provide an impressive reminder of the complexity of cellular processes, and the extraordinary amount of information in their sequences. If, as seems probable, each molecular machine is irreducibly complex, creation by direct agency seems the best explanation for the origins of these molecular machines.

EVOLUTION: THE HOMOLGY PROBLEM

Tautz D. 1998. Debatable homologies. *Nature* 395:17-18.

Summary. The concept of homology is foundational for evolutionary theory, but extremely difficult to define. Further, “homology concepts tend to fail when it comes to tracing evolutionary novelties.” Studies of developmental genes have complicated the issue by showing that genes with similar sequences may produce similar structures, such as eyes or legs, in different phyla, when such structures are believed absent from their common ancestors. The potential for gene

duplications, losses and re-duplications means that sequence similarities are not, of themselves, sufficient to establish homology. Studies of sea urchin hybrids may provide increased understanding of development, but it appears that their regulatory modules may be composed of subunits that can be combined in different ways. If homology must be identified through similarities in complex regulatory modules, the term “homology” would indeed be “ripe for burning,” as suggested by evolutionist J. Maynard Smith.

Comment. Morphological evolution can be divided into two aspects: variation/modification, and addition/subtraction. Homology is certainly a useful concept in the studies of variation/modification that can be observed experimentally, which all creationists accept. Homology’s most difficult problems occur when attempting to explain differences in species with different body plans. At the same point, problems occur in explaining the origin of the genetic information responsible for the differences in body plans. Rather than trying to force a concept on a situation where it doesn’t work, it would seem better to use differences in body plans as a useful starting point for proposing independent ancestries.

EVOLUTION: IS THE PRESENT THE KEY TO THE PAST?

Thompson JN. 1998. Rapid evolution as an ecological process. *Trends in Ecology and Evolution* 13:329-332.

Summary. The importance of rapid changes in species has been overlooked, but greater recognition of such change rates would increase the importance of the field of evolutionary ecology. Introduced species provide many examples of rapid changes, perhaps because they are more likely to undergo directional selection rather than fluctuating selection. Rates of proportional change over time are measured in units known as “darwins.” Calculated rates of change are inversely proportional to the estimated time. Rates over short time scales, as measured in real time, tend to be relatively very high. Rates of change over long time scales, as calibrated against the geological time scale, tend to be relatively very low.

Comment. The inverse relationship between rates of change and time is exactly what would be predicted by creationists. Relatively high rates of change observed over short periods of time are real.

Relatively low rates of change extrapolated from the geological time scale may be an artifact of the inflated time scale.

EVOLUTION: NATURAL SELECTION AND LIZARDS

Losos JB, Jackman TR, Larson A, de Queiroz K, Rodriguez-Schettino L. 1998. Contingency and determinism in replicated adaptive radiations of island lizards. *Science* 279:2115-2118.

Summary. Lizards of the genus *Anolis* are abundant on Caribbean islands. Especially on the larger islands, these lizards have diversified into different “ecomorphs” — differing in size and habitat preference. The question is whether similar ecomorphs on different islands are most closely related to each other or if the different ecomorphs of an island are most closely related to each other. Phylogenetic relationships among *Anolis* lizards of the four Greater Antilles (Cuba, Hispaniola, Jamaica and Puerto Rico) were determined using mitochondrial DNA sequences. Results indicate that the different ecomorphs of an island are closely related to each other, and that similar ecomorphs from different islands have independent origins. This example shows that natural selection is more important than chance in modifying body form in these lizards.

Comment. This is a nice illustration of the power of natural selection to modify morphological characters such as body shape and limb proportions. Creationist theory postulates extremely large changes in environmental conditions since the creation, making significant variation, often accompanied by speciation, necessary for survival.

EVOLUTION: A NATURAL SELECTION AND PEPPERED MOTHS

Coyne JA. 1998. Not black and white. (Review of) *Melanism: evolution in action*, by M.E.N. Majerus, Oxford University Press. *Nature* 396:35-36.

Summary. The peppered moth has been the centerpiece in the story of the power of natural selection. Moths resting on lichen-colored tree trunks were camouflaged if white but conspicuous to predators if black. Accordingly, most moths in pre-industrial England were white. As soot darkened the tree trunks, black moths were better camouflaged, and the white forms were selectively removed. As pollution came under better control after 1950, the white forms again became common.

The story has lost much of its punch by the realization that the moths do not normally rest on tree trunks during the day, do not choose matching backgrounds in controlled studies, and the white form increased in areas where there was no change in the abundance of lichens on the tree trunks. According to Coyne, we must now abandon the claim that we understand how natural selection has caused shifts in the proportions of white and black peppered moths. Especially notable is his comment:

It is also worth pondering why there has been general and unquestioned acceptance of Kettlewell's work. Perhaps such powerful stories discourage close scrutiny. Moreover, in evolutionary biology there is little payoff in repeating other people's experiments, and unlike molecular biology, our field is not self-correcting because few studies depend on the accuracy of earlier ones.

Comment. The above quote should provide a sobering reminder to all involved in discussions of creation and evolution that the nature of historical science simply does not justify the degree of confidence seen in more experimental science, despite the reassurances of some of the discussants.

GENETICS: MOBILE GENES IN VERTEBRATES

Kordis D, Gubensek F. 1998. Unusual horizontal transfer of a long interspersed nuclear element between distant vertebrate classes. *Proceedings of the National Academy of Sciences (USA)* 95:10704-10709.

Summary. LINEs, or long interspersed nuclear elements, are segments of DNA found repeated in many copies in a genome. One particular LINE, called ART-2 retroposon, was previously found first in cattle, then throughout the ruminants. It was thought to be specific to the ruminants until it was discovered also in vipers. This appeared to be a case of horizontal genetic transfer, perhaps by a common parasite. This possibility was tested by surveying 22 species of snakes, 17 species of lizards, 2 crocodilians, and 2 turtles. ART-2 retroposons were discovered in all the snake species and a majority of the lizard species, but not in the crocodilians or turtles. Horizontal transfer appears to be the best explanation for this pattern.

Comment. Horizontal transfer is common among bacteria, but it is thought to be rare among multicellular organisms. If horizontal transfer is much more common among multicellular organisms than currently believed, inferences from similarities in molecular sequences might be greatly weakened.

MOLECULAR EVOLUTION: STRONG OR RELAXED SELECTION?

Bargelloni L, Marcato S, Patarnello T. 1998. Antarctic fish hemoglobins: Evidence for adaptive evolution at subzero temperature. *Proceedings of the National Academy of Sciences (USA)* 95:8670-8675.

Summary. The Antarctic fish fauna is dominated by a group known as notothenioids, which have some exceptional physiological features. Notothenioids include the icefish, famous as the only vertebrate lacking hemoglobin. Icefish are believed able to survive without hemoglobin because of the high oxygen content and reduced metabolic needs in the cold Antarctic waters.

Fish in most environments have multiple forms of hemoglobin, thought to be useful in dealing with changing environments. In contrast, several notothenioid species have reduced levels of hemoglobin, dominated by a single form. In the fish *Gymnodraco acuticeps*, only one form of hemoglobin is present. It has been proposed that there is a simple trend from multiple hemoglobins to a single form of hemoglobin, to loss of hemoglobin as in the icefishes. This hypothesis was tested by comparing hemoglobin DNA sequences in several notothenioid species, including *G. acuticeps*. Results showed that *G. acuticeps* hemoglobin has an unusually large number of amino acid differences, which appear to be the result of strong directional selection, rather than relaxed or weak selection. This is interpreted as not supporting the hypothesis of a simple trend toward loss of hemoglobin in these fishes.

Comment. This conclusion would be strengthened if an improvement in function can be discovered for the *G. acuticeps* hemoglobin. If not, the high number of amino acid differences in *G. acuticeps* may be just as easily explained as due to relaxed selection, potentially leading to loss of hemoglobin function.

MOLECULAR PHYLOGENY: WOOLY MAMMOTH DNA

Noro M, Masuda R, Dubrovo IA, Yoshida MC, Kato M. 1998. Molecular phylogenetic inference of the woolly mammoth *Mammuthus primigenius*, based on complete sequences of mitochondrial cytochrome *b* and 12S ribosomal RNA genes. *Journal of Molecular Evolution* 46:314-326.

Summary. The elephant family, Elephantidae, includes both types of living elephants and the extinct mammoths. Controversy has surrounded the question as to which two types are the more closely related. Immunological and hair comparisons showed the three genera to be equally distant from each other. Dental studies suggested mammoths and Asian elephants to be more closely related. Previous molecular studies suggested mammoths and African elephants to be more closely related. This study is the first to use the complete sequences of two mitochondrial genes. This study agrees with previous molecular studies that the mammoth is slightly more closely related to African elephants than to Asian elephants.

Osawa T, Hayashi S, Mikhelson VM. 1998. Phylogenetic position of mammoth and Steller's sea cow within Tethytheria demonstrated by mitochondrial DNA sequences. *Journal of Molecular Evolution* 44:406-413.

Summary. Mitochondrial DNA sequences were compared for African elephants, Asian elephants, extinct woolly mammoths, and several other species. Results show that the woolly mammoth was more closely related to the Asian elephant than to the African elephant. This is consistent with the fossil record, where the African elephant appears before the Asian elephant.

Comment. The relationships of the three genera of elephants remain ambiguous, despite a good fossil record, availability of molecular sequences, and accessibility of specimens for morphological comparison. In this example, it is doubtful that one can infer phylogenetic branching sequences based on sequences of first appearances of the species, as attempted by Osawa et al. The Asian elephant, African elephant, and woolly mammoth are each in a separate genus, and all three genera have first appearances close together in the fossil record. A common ancestry of the three genera of elephants seems plausible to many creationists, and the lack of resolution may be due to a recent, near-simultaneous geographic isolation and genetic divergence.

ORIGIN OF LIFE: CHIRALITY

Clery D, Bradley D. 1994. Underhanded “breakthrough” revealed. *Science* 265:21.

Comment. A previous report of separation of chiral molecules in a strong magnetic field has been retracted. The report was discussed in *Origins* 24:94 without knowledge of the problem. It turns out that the experiment had been manipulated by one member of the investigating team. Regrettably, fraud occasionally shows up in science, and we apologize for not correcting our report sooner. We thank the *Origins* reader who informed us of the error.

ORIGIN OF LIFE: LIFE ON MARS PUT TO REST

Bada JL, Glavin DP, McDonald GD, Becker L. 1998. A search for endogenous amino acids in Martian meteorite ALH84001. *Science* 279:362-365.

Summary. Meteorite ALH84001 was discovered in Antarctica, and identified as having come from Mars, presumably as the result of an asteroidal impact on that planet. Certain features of the meteorite were interpreted as probable evidence of life on Mars, a claim that was eventually abandoned. This paper reports that amino acids extracted from the meteorite had an excess of L-enantiomers, indicating contamination by terrestrial sources, rather than being carried from an extraterrestrial source.

Jull AJT, Courtney C, Jeffrey DA, Beck JW. 1998. Isotopic evidence for a terrestrial source of organic compounds found in Martian meteorites Alan Hills 84001 and Elephant Moraine 79001. *Science* 279:366-370.

Summary. Possible traces of life were previously reported from meteorites believed to have been ejected from Mars. This possibility was tested by analyzing both the carbon-14 and carbon-13 contents of the meteorites. Carbon-14 is produced by interaction of nitrogen and cosmic rays, and is not expected to be present in significant quantities in the Martian meteorites, since nitrogen is much less abundant on Mars than on Earth. The level of carbon-14 in the meteorites was determined to be about half that of modern terrestrial carbon. This is much greater than expected if the meteorites were from Mars, and strongly indicates that the meteorites have been

contaminated by terrestrial carbon. Carbon from living organisms tends to be low in carbon-13 as compared to carbon from inorganic sources. The proportion of carbon-13 in the Martian meteorites was reduced, indicating that the meteorites have been contaminated by organic carbon from terrestrial organisms. It seems that the organic compounds found in the Martian meteorites did not originate on Mars, but were added to the meteorite after it fell to the Earth.

Comment. These results confirm that the Martian meteorites do not provide evidence for life on Mars.

ORIGIN OF LIFE: PROTEINS PRODUCED IN WATER?

Huber C, Wachtershauser G. 1998. Peptides by activation of amino acids with CO on (Ni,Fe)S surfaces: implications for the origin of life. *Science* 281:670-672.

Summary. Origin of life experiments have shown that amino acids can be produced abiotically, but no way is known for combining the amino acids into proteins. Water tends to hydrolyze the peptide bonds of proteins rather than facilitating their bonding. In this experiment, peptide bonds were formed in hot aqueous solution. Peptide bonding required the presence of carbon monoxide, nickel and/or iron sulfide, hydrogen sulfide, methanethiol, and a pH of 7-10. Amino acids tested include L-phenylalanine, L-tyrosine, and L-glycine. Products were racemic dipeptides. Dipeptides hydrolyzed rapidly in separate experiments using the same conditions. The authors claim these results support the hypothesis of a thermophilic origin of life.

Comment. Major problems in the production of proteins from amino acids include at least: sources of a variety of amino acids; protection from interference by chemical contaminants; formation of peptide bonds; preservation of peptide bonds as the protein is being produced; appropriate sequence of amino acids for biological function. This experiment shows that peptide bonds can be formed in hot aqueous solutions, but that they break down rapidly. The claim that this experiment supports the origin of life in hydrothermal vent environments seems greatly exaggerated.

PALEONTOLOGICAL PATTERNS: DIVERSITY

Adrain JM, Fortey RA, Westrop SR. 1998. Post-Cambrian trilobite diversity and evolutionary faunas. *Science* 280:1922-1925.

Summary. Ordovician rocks are noted for two notable diversity trends: 1) a rapid increase in diversity as compared to Cambrian rocks; and 2) an abrupt turnover in the types of fossils at the top of the Ordovician. This paper is an attempt to better understand the details of the patterns as they apply to trilobites, which are one of the major components of Ordovician fossils. The authors were able to identify two faunal components among Ordovician trilobites. (One family did not fit in either component.) One group, called the IbeX Fauna, dominates the lowest Ordovician layers, but declines through the Ordovician, disappearing from the record at the top of the Ordovician. The other group, called the Whiterock Fauna, increases through the Ordovician and on into the Silurian rocks. The two groups differ in geographic range and in depositional environment. The declining group is found mainly in Gondwana and Baltica, and in a variety of depositional environments, while the expanding group is found mainly in Laurentian regions, and in depositional environments interpreted as platform-margins. Many of the Whiterock families first appear without obvious relationships, while many IbeX families are known also from Cambrian rocks.

Thus, one group of trilobites participated in the “End-Ordovician mass extinction” while the other group did not. The families that did not disappear at the top of the Ordovician had more genera per family, and were more likely to have first appearances in tropical Laurentian platform-margin depositional environments.

Comment. Many creationists have predicted that the fossil sequence should be strongly influenced by geographical and ecological factors. It is interesting to note that these factors have been proposed as important in producing Ordovician diversity patterns among trilobites.

Jablonski D. 1998. Geographic variation in the molluscan recovery from the end-Cretaceous extinction. *Science* 279:1327-1330.

Summary. The Cretaceous-Tertiary boundary is characterized by a major change in fossil types, commonly called a “mass extinction.” A previous study of North American Gulf Coast fossil faunas showed

that certain molluscan families abruptly become abundant above the boundary. This has been interpreted as a population explosion among groups who took advantage of new ecological opportunities following the “mass extinction” (so-called “bloom taxa”). The pattern of sudden expansion of ecological opportunists after a “mass extinction” has been accepted as the normal pattern of recovery after a geological catastrophe. However, the pattern is different in northern Europe, northern Africa and Pakistan-northern India, where the abundance of so-called “bloom taxa” remains relatively steady through Paleocene sediments, or even increases at the top of the Paleocene. These observations are problematic in view of the similar extent of end-Cretaceous taxonomic turnover in all four regions.

Comment. Fossil trends are an important aid in interpreting earth history, but they may be misleading. Global summaries hide regional differences and give equal weight to rare taxa and abundant taxa. Regional studies such as this one may provide the best picture of earth history, including the effects of global catastrophe.

DeHaan RF. 1998. Do phyletic lineages evolve from the bottom up or develop from the top down? *Perspectives on Science and Christian Faith* 50:260-271.

Summary. The received view of evolution is that it branches from the bottom up, so that new higher taxa originate through accumulation of small changes over long ages. But this view is refuted by two observations. First, living species change at rates much greater than those inferred from the fossil record. Furthermore, the changes are minor, and variable rather than cumulative. Second, the pattern of diversity in the fossil record is inconsistent with the bottom-up hypothesis. The major taxa appear first, followed by diversity at lower taxonomic levels. This second fact, especially, points toward a top-down development of diversity. The Cambrian Explosion involved numerous distinct phyla, the highest taxonomic category. The eleven phyla of fossil marine invertebrates can be divided into 62 classes, the next-lower category. The stratigraphic midpoint of first appearances for Classes occurs in the Ordovician, above the Cambrian. (Half of all classes appear before the midpoint, and half after the midpoint.) The midpoint of the 307 orders occurs in the Devonian, well above the Ordovician. The greatest number of fossil species is in the upper layers,

deposited after virtually all the higher taxa. The view of top-down evolution is reinforced by the stability of body plans, and the top-down direction of development.

Comment. The implication of this paper is that biodiversity is polyphyletic rather than monophyletic. This conclusion is supported by the actual arrangement of fossils, even when the geologic record is viewed as a record of history rather than a record of catastrophe. This is opposite to the conventional view of evolution as monophyletic.

Miller AI. 1998. Biotic transition in global marine diversity. *Science* 281:1157-1169.

Summary. Three types of global diversity patterns are easily observable in the fossil record: expansion (e.g., Cambrian, post-Paleozoic); abrupt turnover (e.g., end-Permian, end-Cretaceous), and gradual transitions in dominance among higher taxa. "Mass extinctions" seem to occur abruptly, while expansions are more gradual. However, combining all data into a single global pattern may mask smaller-scale patterns. Ordovician sediments display a major expansion (Ordovician radiation), followed by a major turnover (end-Ordovician extinction). Major faunal transitions generally appear abrupt locally or regionally, but differences in stratigraphic position cause global patterns to appear more gradual. The fossil record is determined by local and regional processes, so that mass extinction events are not fundamentally different from those operating during background times.

Comment. It is interesting to note that mass extinctions appear more abrupt locally and regionally than globally. This suggests that regional catastrophic activity in the history of the geologic column may be more informative than that which is deduced strictly from global patterns. This should stimulate creationists to search for regional patterns of depositional conditions and fossil trends.

Rampino MR, Adler AC. 1998. Evidence for abrupt latest Permian mass extinction of foraminifera: Results of tests for the Signor-Lipps effect. *Geology* 26:415-418.

Summary. The end-Permian mass extinction was the largest in the fossil record, but controversy continues over whether it was abrupt or gradual. One difficulty is that extinctions are difficult to estimate for species with an incomplete fossil record. This results in a "smearing"

of apparent extinctions (last appearances) when real extinctions are simultaneous. This is known as the Signor-Lipps effect. Stratigraphic analysis of forams in an end-Permian section in Italy are consistent with an abrupt mass extinction rather than a gradual, stepped extinction. The mass extinction appears to coincide with a negative carbon-13 anomaly probably caused by a global ecological stress event.

Comment. Many workers regard the end-Permian “mass extinction” as a gradual process. This paper suggests a more catastrophic process. If an extraterrestrial impact crater is found (a South African impact site has been suggested), the catastrophic view would be more persuasive. In the meantime, the cause of the end-Permian “mass extinction” remains unresolved.

PALEONTOLOGICAL PATTERNS: DEPOSITIONAL

Taylor PD, Allison PA. 1998. Bryozoan carbonates through time and space. *Geology* 26:459-462.

Summary. Bryozoans are invertebrate animals, usually with a calcareous skeleton, found commonly as fossils from the Ordovician onward. Paleozoic and post-Paleozoic bryozoans are mostly classified in different taxonomic orders. Living bryozoans leave significant sedimentary remains in temperate zones, but not in the tropics. This paper reports a test of whether bryozoan-rich limestones have a similar distribution pattern in the fossil record. The study included 176 bryozoan-rich Paleozoic and Jurassic to Pleistocene stratigraphical units. (No bryozoan limestones have yet been found in Triassic or Lower Jurassic rocks.) Results show that the present extra-tropical distribution pattern goes back only to the Jurassic. Paleozoic bryozoan-rich deposits are mostly from regions thought to have been tropical, based on plate reconstructions. One explanation for the difference in patterns is that predators were less common in Paleozoic tropical habitats, permitting greater bryozoan growth than in Mesozoic tropical habitats.

Comment. This study provides information on bryozoan fossil distributions that might be useful in modeling global processes in earth history. The contrast between Paleozoic and post-Paleozoic taxonomic and distributional patterns is particularly enigmatic.

PALEONTOLOGICAL PATTERNS: ECOLOGY AND BEHAVIOR

Labandeira CC. 1998. Plant-insect associations from the fossil record. *Geotimes* 43(9):18-24.

Summary. Herbivorous insects produce tell-tale effects of their mode of feeding. These effects may be preserved in the fossil record, and provide evidence concerning the diversity of feeding strategies in the fossil groups being studied. Evidence of Paleozoic insect diversity is seen in the diversity of insect damage seen in fossil plants from the upper Pennsylvanian of Illinois and the lower Permian of Texas. Most groups of Paleozoic insects are not found in Mesozoic sediments, but are replaced by insects more similar to those living today. A large majority of modern insect families with a fossil record are found in sediments below the mid-Cretaceous, which is the point at which angiosperm diversity begins to expand. Lower and middle Mesozoic plant fossils show evidence of feeding strategies matching virtually any seen at present. Insect diversity does not appear to be dependent on angiosperm diversity.

Comment. Diversification of angiosperms and insects are often linked. However, the patterns of insect and angiosperm fossil diversities suggest neither is dependent on the other.

Lockley MG. 1998. The vertebrate track record. *Nature* 396:429-432.

Summary. Vertebrate trackways are much more common than thought only a few decades ago. To illustrate, the number of Jurassic dinosaur trackways in the western United States is estimated to be equal to the total number of identifiable dinosaur skeletal remains for the entire world (about 2000). Fossil footprints are abundant in terrestrial sediments from the Carboniferous to Holocene. Fossil tracks have also been used to infer gait and posture, social behavior, to establish stratigraphic correlations, and to fill in gaps in distributions of taxa. Tracks may appear lower in the fossil record than any evidence from body fossils, as is the case for shorebirds, and perhaps for tetrapods. The study of fossil trackways has the potential to greatly enhance our understanding of the fossil record.

Comment. Lockley's systematic studies of fossil footprints are highly informative. Such data may be useful in estimating minimum depositional time, since formation of identifiable footprints probably requires damp surfaces and their preservation requires rapid but limited-

energy sedimentation. The abundance of vertebrate trackways from the Carboniferous onward suggests that some vertebrates were alive and moving about throughout the period of deposition. Studies of regional and stratigraphic distributions of identified trackways could contribute significantly toward improving our understanding of Earth history.

PALEONTOLOGICAL PATTERNS: MORPHOLOGY

Alroy J. 1998. Cope's Rule and the dynamics of body mass evolution in North American fossil mammals. *Science* 280:731-734.

Summary. The author reports the results of comparing body sizes of fossil mammal species from the same genus but from different stratigraphic levels. His study covers essentially the entire North American mammal fossil record, from the Upper Cretaceous (Campanian) to the Upper Pleistocene. His results show that species found higher in the stratigraphic record are larger than those from the same genus found lower in the stratigraphic record. The difference averages 9.1%, and is greater for large than for small species. A stratigraphic trend toward increasing body size has been called "Cope's Rule" in honor of the paleontologist who first proposed the trend. Although Cope's Rule has sometimes been found not to apply, this study shows that it does generally apply to species within the same genus of mammals.

Comment. Creationists have wondered whether Cope's Rule might be an effect of differential survival, with the largest and strongest individuals surviving longer and being buried higher in the geologic column. Such a possibility would be negated if Cope's Rule is invalid. This study helps affirm that the Rule is valid within limits. One important limit is that this trend is seen within single groups, such as genera. Any single stratigraphic unit may contain individuals of different sizes.

PALEONTOLOGY: FOSSIL INVERTEBRATES

Li C-W, Chen J-Y, Hua T-E. 1998. Precambrian sponges with cellular structures. *Science* 279:879-882.

Summary. Fossil sponge spicules have been identified in Precambrian phosphatic sediments significantly lower than any previously known sponges. The spicules are derived from the Class Demospongiae, which is the most abundant group of living sponges.

A fossil embryo appears to be from a different Class, the calcareous sponges. The sponges are thought to have been buried catastrophically. The Demospongiae have been thought to have evolved from the glass sponges, Class Hexactinellida, but these fossils appear lower than any glass sponges. This may indicate a need for revising sponge phylogeny.

Comment. If this report stands, sponges must be removed from the list of groups first appearing in the “Cambrian Explosion.” However, the new discovery raises additional questions. Can the absence of connecting links in the Precambrian be plausibly attributed to the poor quality of the fossil record when microscopic fossil embryos have been found? Perhaps further discoveries in the phosphate deposits will reveal fossils from other groups. If the calcareous sponge embryo is correctly identified, we have two Classes of sponges appearing together, and in lower strata than their putative ancestors. Surely the fossil record has a lot of reinterpretation ahead of it.

Moldowan JM, Talyzina NM. 1998. Biogeochemical evidence for dinoflagellate ancestors in the Early Cambrian. *Science* 281:1168-1170.

Summary. Dinoflagellates are abundant single-celled organisms in aquatic environments. Their known fossil record extends only down to the Middle Triassic, and their apparent absence from Paleozoic strata is puzzling. Dinoflagellates produce certain chemicals not found in other taxa. The presence of dinosterane and 4-alpha-methyl-24-ethyl-cholestane is considered to be indicative of dinoflagellates. Examination of Cambrian sediments in Estonia revealed the presence of these dinoflagellate-specific compounds. This indicates that dinoflagellates or their ancestors were incorporated in Cambrian sediments, despite the difficulties in identifying their cysts. It appears that many acritarchs (fossil cysts of uncertain affinity) may actually be fossil dinoflagellates or their ancestors.

Comment. Dinoflagellate systematics are not well understood, but this report suggests that the dinoflagellate fossil record might be much more extensive than believed. Perhaps dinoflagellates were actually present during Paleozoic sedimentation, but were not preserved.

PALEONTOLOGY: FOSSIL PLANTS

Gandolfo MA, Nixon KC, Crepet WL, Stevenson DW, Friis EM. 1998. Oldest known fossils of monocotyledons. *Nature* 394:532-533.

Summary. Monocot fossils have a meager fossil record, and fossil flowers are especially rare. Tiny fossil flowers representing at least 100 species have recently been identified from Turonian sediments (lower Cretaceous) in New Jersey. Among them are the geologically oldest known monocot flowers. The fossil flowers have features that indicate a close relationship to the family Triuridaceae, a group of tropical saprophytic plants lacking chlorophyll. This discovery suggests the need for new hypotheses of monocot origins and diversification.

Comment. The discovery of these fossil flowers significantly expands the Mesozoic fossil record for flowering plants. The new data appear to be consistent with creationist expectations that monocots have separate origins from dicots; but the fossil record of angiosperms in general poses significant challenges regardless of one's frame of interpretation.

Sun G, Dilcher DD, Zheng S, Zhou Z. 1998. In search of the first flower: a Jurassic angiosperm, *Archaeofructus*, from Northeast China. *Science* 282:1692-1695.

Summary. The Yixian Formation of China has yielded many well-preserved fossils, representing both freshwater and terrestrial habitats. Among these is a plant fossil with a fruit containing seeds, a defining characteristic of angiosperms. The surrounding sediments are classified as Upper Jurassic. This is the most plausible claim for a fossil angiosperm in sediments below the Cretaceous. The fossil has a unique combination of characters, leading the discoverers to propose a new subclass to contain it. Currently dominant hypotheses of angiosperm origins are inconsistent with the newly discovered fossil.

Comment. The origin of angiosperms has puzzled evolutionary biologists since Darwin, and the angiosperm fossil record has puzzled creationists as well. The new fossil does not solve the problems of either group, but does remind us of the challenges contained in the fossil record.

PALEONTOLOGY: TAPHONOMY

Davis PG, Briggs DEG. 1998. The impact of decay and disarticulation on the preservation of fossil birds. *Palaios* 13:3-13.

Summary. The condition of a fossil can provide important clues to the circumstances under which it was fossilized. This study identified five stages in the decomposition of bird carcasses, one of which was disarticulation of the skeleton in seven steps. Disarticulation typically began after about 4 days, and was complete by about 52 days in protected specimens. Scavengers greatly hastened the process of disarticulation of unprotected specimens. It was noted that decomposition occurs much more rapidly in the subtropical waters of Florida than in previous experiments performed in cooler latitudes. The results were compared to the preservational condition of fossil birds from some famous fossil localities. These include the Jurassic Solnhofen Limestone in Germany (the source of *Archaeopteryx*), the Eocene Messel shale from Germany (124 specimens from 18 families of birds), the Eocene Green River Formation of Wyoming (42 specimens from 5 families), and the Eocene La Meseta shoreline deposit of Antarctica (1243 specimens, mostly penguins). The Solnhofen specimens show the least decomposition. The Messel and Green River specimens show a moderate amount of disarticulation, while the La Meseta specimens are preserved as isolated bones, many of them broken. The authors conclude that experiments such as this can aid in interpreting fossil deposits.

Hof CHJ, Briggs DEG. 1997. Decay and mineralization of mantis shrimps (Stomatopoda: Crustacea) — a key to their fossil record. *Palaios* 12:420-438.

Summary. Mantis shrimps are active predators common on tropical and subtropical seafloors. Their fossils first appear in the upper Jurassic Solnhofen limestone, and are also known from several widely scattered localities throughout the world. However, their relatively scanty fossil record contrasts with their present abundance. Experiments were conducted to study the processes of decomposition of stomatopod bodies as a means of interpreting the conditions under which fossil stomatopods were preserved. Three stages of decomposition were identified: swollen but complete; ruptured (by 1 week); and partially decomposed to fragmentary (by 4 weeks). Mineralization occurred

through precipitation of calcium carbonate and replacement of soft tissue by calcium phosphate. All known Mesozoic and Tertiary fossil stomatopods were assigned to one of the three preservation states. About 40% are complete (probably buried alive), 40% ruptured, and 20% fragmentary. Stomatopods exhibit a high potential for fossilization, and their poor record must be due to causes other than decay.

Comment. The presence of fossils is often an indicator of catastrophic conditions, but more quantitative data are often needed. The quantitative studies reported in these papers might provide a way to test the hypothesis that catastrophic depositional conditions dominate the fossil record.

PALEONTOLOGY: VERTEBRATE FOSSIL DISCOVERIES

Loope DB, Dingus L, Swisher CC, Minjin C. 1998. Life and death in a Cretaceous dune field, Nemegt basin, Mongolia. *Geology* 26:27-30.

Summary. The Gobi Desert of Mongolia continues to be an important source of dinosaur fossils. The Upper Cretaceous Ukhaa Tolgod fossil locality is especially rich, with more than 100 dinosaur skeletons and more than 500 mammalian and reptilian skulls recovered. The sediments are largely sandstone, with some siltstones and conglomerates. They have been interpreted as wind-blown, with animals overcome and buried by sand storms, but this hypothesis has problems. Present-day windstorms are not known to be able to overcome and bury live animals, and it seems highly unlikely that live dinosaurs would permit themselves to be buried by blowing sand. Closer analysis shows three different sandstone facies, two of which are eolian (wind-blown) and lack fossils. If sandstorms were responsible, more fossils should be found in the eolian sands. The fossiliferous layer lacks sedimentary structure, and might be interpreted as a gradual accumulation of wind-blown sand, except for the presence of articulated skeletons. The articulated skeletons indicate rapid deposition, probably by landslides from surrounding hills.

Comment. The new interpretation of catastrophic burial by wet sediments seems more reasonable than the previous interpretation of burial of living animals by wind-blown sand. Articulated skeletons might be used as indicators of rapid deposition in other deposits.

Thewissen JGM, Madar SI, Hussain ST. 1998. Whale ankles and evolutionary relationships. *Nature* 395:452.

Summary. Whales are an order of mammals with obvious similarities to each other, but with major differences from any other mammals. Their relationships to other mammals are controversial. Molecular sequences have been used to argue that the hippopotamus is the closest living relative of the whales. Hippos are artiodactyls, which are distinguished by a particular morphology of their ankle bones. Fossil evidence has been used to argue that whales are most closely related to a group of extinct terrestrial mammals known as mesonychians. A fossil ankle bone from a “walking whale” found in Pakistan was compared with ankle bones from artiodactyls and mesonychians. The “whale” ankle bone has features that seem to exclude it from the artiodactyls, and also argue against a close relationship between whales and mesonychians. Extensive convergence or reversals must have occurred in these groups.

Comment. This report suggests that whales, mesonychians and artiodactyls are not directly related, based on their ankle bones. Whales and hippos do share some distinct molecular sequence similarities, but this might be due to convergence (designed similarities), or to horizontal transfer. Fossils with whale-like traits and short limbs might be extinct types of animals rather than evolutionary intermediates. Whale-hippo relationships are enthusiastically defended by some evolutionists, but results such as this remind us that such enthusiasm is sometimes not strictly a matter of data.

SCIENCE AND RELIGION: IMPLICATIONS OF SCIENTIFIC THEORIES

Lubenow ML. 1998. Pre-Adamites, sin, death and the human fossils. *Creation Ex Nihilo Technical Journal* 12:222-232.

Summary. The idea that some humans may have existed before Adam is advocated by some Christians today. The concept of pre-Adamites is used to explain the existence of fossil humans with dates much older than 10,000 years. Almost all who hold a pre-Adamite view maintain that Adam was a Neolithic human who lived about 10,000 years ago. This raises a major theological question — how can death be the result of Adam’s sin, if pre-Adamites were dying before Adam

existed? This proposal removes the basis for Christ's physical death in our place, thus endangering the doctrine of salvation which is the heart of Christianity. The human fossil record shows evidence of premature death, periodic starvation, cannibalism, violence, and disease in fossils dated at over 10,000 years. This is inconsistent with the biblical description of a creation that was "very good," and with Romans 5:12-21, which states that death came to all because of Adam's sin. The solution to these theological problems is to interpret all human fossils as having lived after the fall of Adam.

Comment. The issues raised by Lubenow are critical for Christians, but seems to be avoided by many who advocate acceptance of long ages in the fossil record. At the present time, there is no theory that does a better job of explaining the totality of human experience, including God's continuing providence in human lives, His direct revelation in Scripture, and His indirect revelation in nature, than the straightforward reading of a six-day creation and global catastrophe as described in Genesis.

SCIENCE AND RELIGION: WHICH IS THE ULTIMATE AUTHORITY?

Day AJ. 1998. Adam, anthropology and the Genesis record. *Science and Christian Belief* 10:115-143.

Summary. According to this article, the perceived conflict between science and Scripture is not intrinsic to the two disciplines, but is due principally to emerging scientific theories conflicting with static interpretations of Scripture. We need to be open to reinterpret Scripture if that seems necessary. "Taking the Bible seriously" seems to mean that Scripture teaches some truths, but not necessarily about the material world. "Taking science seriously" seems to mean that Scriptural interpretation should be determined by science. Two key issues for Christians are the method by which the "image of God" was installed into humans, and how the Fall occurred. The text permits the interpretation that both processes could have occurred gradually, and science confirms the need for this interpretation. Adam need not have been an individual, but a term to symbolize humanity. The Fall need not have been an individual act, but a developing separation from God. The "soul" need not be a separate entity, but a reference to the whole person. Insistence on God's intervention in the special creation of humans requires a series of miracles, making science irrelevant.

Comment. This approach as presented in the article purports to take Scripture seriously, but actually seems limited to seeking some spiritual truth, reducing the claims of Scripture to only those that cannot be empirically tested. Day is probably right in identifying the “soul” as the whole person rather than a separate entity, but a gradual appearance of humans, and a gradual Fall do not fit with the basic motif of Scripture — salvation history.

Day seems to claim that interpretations of the acts of God must be subjected to science, and appears to reject the possibility of miracles. This seems to limit God to activity that is scientifically accessible, rendering Scripture superfluous. If science is to have the final word, who needs Scripture? Why postulate the existence of a God whose activities are restricted to “natural” processes? The view presented here seems very much like a god-of-the-gaps approach — invoking God’s activity only until some more natural explanation can be developed.