

ANNOTATIONS FROM THE LITERATURE

BIODIVERSITY: CONSERVING TROPICAL FOREST BIRDS REQUIRES LARGE REFUGES

Ferraz G, Russell GJ, Stouffer PC, Bierregaard RO, Pimm SL, Lovejoy TE. 2003. Rates of species loss from Amazonian forest fragments. *Proceedings of the National Academy of Sciences (USA)* 100:14069-14073.

Summary. Species of birds vary in the size of habitat necessary to sustain a viable population. One of the major questions in conservation is the size of refuge required to protect the biodiversity of a region. The effects of habitat fragmentation were studied in the central Amazon region of Brazil. Diversity of understory birds was surveyed over a period of 13 years in forest fragments of about 1, 10, and 100 hectares (1 hectare is approximately 2.5 acres). Results showed that about half the species disappeared from the 10-hectare fragments in less than 15 years. This is not enough time to put conservation measures into place to preserve diversity. Comparison with experience in the Kakamega Forest of Africa suggests that even 10,000-hectare reserves may lose half their understory species in about 100 years.

Comment. Habitat fragmentation is probably the most serious threat to biodiversity. Refuges must be large enough to preserve a viable, self-sustaining population. Creationists should support responsible efforts to be good stewards of the biodiversity God has created.

BIODIVERSITY: CORAL CONVERGENCE CONFOUNDS TAXONOMY

Fukami H, Budd AF, Paulay G, Solé-Cava A, Chen CA, Iwao K, Knowlton N. 2004. Conventional taxonomy obscures deep divergence between Pacific and Atlantic corals. *Nature* 427:832-835.

Summary. Reef-building corals are found in both the Pacific and Atlantic Oceans, with the Atlantic corals generally considered to belong to lineages from the Pacific. Two families, “Faviidae” and “Mussidae” are prominent in both regions. DNA sequences show that some

of the Atlantic “Faviidae” are more closely related to the Atlantic “Mussidae” than to the Pacific “Faviidae.” Of the 27 genera of Atlantic reef-building corals, nine genera belong to a previously undetected lineage endemic to the Atlantic. These results indicate a previously unrecognized high degree of endemism in the Atlantic corals, a high degree of morphological convergence among these corals, and a need to re-evaluate the systematics of corals using molecular methods.

Comment. These results show the need for caution in drawing conclusions from phylogenies constructed solely on morphological data. This has important implications in conservation and biodiversity studies, in that similar groups from different regions may actually represent different clades. The implications for paleontological studies are even more serious, since relationships of fossils are generally based on morphological data that are incomplete at best.

BIOGEOGRAPHY: DISPERSAL DOMINANT IN THE SOUTHERN HEMISPHERE

Sanmartin I, Ronquist F. 2004. Southern Hemisphere biogeography inferred by event-based models: plant versus animal patterns. *Systematic Biology* 53:216-243.

Summary. Vicariance is the splitting of a population by development of a barrier within its range. Vicariance has been the dominant explanation for biotic distributions in the southern hemisphere. In this study, 54 animal phylogenies and 19 plant phylogenies were compared with the sequence of continental separation, to see if the two patterns coincide. Results showed that plant phylogenies did not correlate well with the sequence of continental separation, while animal phylogenies did. This indicates that long-distance dispersal has been more important for plants than for animals. Only two of the plant groups do not seem to require long-distance dispersal. Ten insect groups, two other invertebrate groups, and three groups of fish do not require dispersal. Dispersal seems important for the ratite birds, but not for the marsupials. Several groups show closest relationships between Australia and South America, which can be explained by Antarctica forming a bridge between the two continents.

Comment. These results indicate the importance of long-distance dispersal in explaining distributions in the southern continents, even

for groups restricted to the southern hemisphere. Most of the data are consistent with predictions of creation biogeographic theory, since plants, fish and invertebrates are not mentioned as taken into the ark, but the marsupials present an interesting opportunity for further investigation.

BIOGEOGRAPHY: DISPERSAL MORE IMPORTANT THAN CONTINENTAL VICARIANCE AMONG PLANTS

Munoz J, Felicisimo AM, Cabezas F, Burgaz AR, Martinez I. 2004. Wind as a long-distance dispersal vehicle in the Southern Hemisphere. *Science* 304:1144-1147.

Summary. The southern continents are separated by oceans, yet frequently have similar plants. This could be due to vicariance — separation of a once-connected population when the continents broke away from each other. An alternate explanation is dispersal — immigration from one continent to the other across the ocean. Long-distance dispersal is a difficult hypothesis to test, so biogeographers have tended to focus their attention on vicariance explanations. This paper reports the results of a study of floristic similarities among 27 southern land masses, including several subantarctic islands. Four taxonomic groups were studied: mosses, liverworts, lichens, and pteridophytes (ferns and their allies). Floristic similarities among land masses were tested for correlation against distance to the nearest land mass, versus “wind connectivity.” “Wind connectivity” incorporates both wind speed and direction. Results showed that “wind connectivity” is more important than geographic proximity in explaining floristic similarity. This suggests that long-distance dispersal by wind is an important factor in explaining the distribution of these groups of plants.

Comment. Although vicariance explanations may be easier to test, the desire to provide “scientific” explanations has led many biogeographers to neglect explanations including dispersal. Yet this and other studies have shown that dispersal is often much more important than vicariance in explaining present distributions. Just because a method is thought to be “scientific” does not insure that it will be more accurate.

GEOLOGY: BIFS, A CONFUSING STATE OF AFFAIRS

Dauphas N, van Zuilen M, Wadhwa M, Davis AM, Marty B, Janney P. 2004. Clues from Fe isotope variations on the origin of Early Archean BIFs from Greenland. *Science* 306:2077-2080.

Summary. Precambrian banded iron formations (BIFs) are enigmatic structures of uncertain origin. Current theories propose 1) abiotic photo-oxidation of ferrous Fe to ferric Fe, 2) direct oxidation by anaerobic bacteria or 3) mediated oxidation by aerobic bacteria. The identification of bio-signatures has been difficult due to the overprinting of the original characteristics of the Archean rocks by high grade metamorphism. This paper correlates the Fe enrichment of the BIFs in SW Greenland with the titanium content of the deposits to ascertain the source of the Fe as either igneous or sedimentary. The alteration of basalt (the probable igneous source) results in a loss of Fe relative to Ti; whereas, precipitation and sedimentation associated with hydrothermal vents results in enriched Fe relative to Ti. Support for the latter model is presented by this paper.

Comment. The formation of the BIFs is currently debated and the theory for biotic oxidation of ferrous to ferric Fe is based largely on the proposed age of the deposits and the theoretical concept of an anoxic environment for the origin of the amino acid building blocks necessary for the origin of life. The authors of this paper recognize that the fractionation of the Fe isotopes cannot be used to unequivocally identify biotic activity. More research is needed to determine the essential characteristics that might identify fractionation by abiotic photo-oxidation. (EK)

GEOLOGY: END-CRETACEOUS MASS EXTINCTION DOWNSIZED?

Belcher CM, Collinson ME, Sweet AR, Hildebrand AR, Scott AC. 2004. New constraints on the thermal energy released from the K-T impactor: evidence from multi-method charcoal analysis. Abstract 81-9. Geological Society of America Program with Abstracts 36(5):204.

Summary. The K-T impactor has been postulated to have delivered sufficient energy to the biosphere to cause spontaneous, near-global wild fires. This would produce large quantities of charcoal in K-T boundary sediments. A study of K-T boundary sediments from Saskat-

chewan to Colorado revealed abundant non-charred plant remains, and an amount of charcoal only one-ninth the amount found in Cretaceous sediments. This indicates the impact did not deliver as much energy to North America as has been proposed.

Comment. Some calculations have suggested a global inferno at the K/T boundary, making it difficult to understand how any terrestrial life could have survived. The evidence reported here suggests a much smaller energy release by the impact. This may explain the inferred survival of some terrestrial organisms across the boundary, but it still leaves unexplained why certain groups disappear from the fossil record at that point, while other groups continue. It also points out a gap in our understanding of the energetics of such impacts.

GEOLOGY: END-CRETACEOUS IMPACT PRECEDED THE END OF THE CRETACEOUS

Keller G, Adatte T, Stinnesbeck W, Rebolledo-Vieyra M, Fucugauchi JU, Kramar U, Stüben D. 2004. Chicxulub impact predates the K-T boundary mass extinction. *Proceedings of the National Academy of Sciences (USA)* 101:3753-3758.

Summary. A core taken from the Chicxulub impact structure shows a 50-cm layer of finely laminated sediments containing latest Cretaceous microfossils, is capped by a clay that represents the Cretaceous-Tertiary boundary. The 50-cm layer shows several intervals of bioturbation, indicating *in situ* deposition over a period of time. The microfossils (forams) are indicative of zone CF1, which spans the last 300,000 years of the Cretaceous. This shows that the impact site accumulated 50 cm of bioturbated sediments after the impact and before the Cretaceous-Tertiary boundary, and suggests that the mass extinction may have occurred in stages rather than triggered by a single event.

Comment. The relationship of mass extinctions to extraterrestrial impacts has always had some puzzling aspects. Why are the last dinosaurs found below, rather than in the impact horizon. Why did some groups disappear while others did not? This report makes matters more complicated: what is the actual causal relationship between a mass extinction and an impact that preceded it?

GEOLOGY: END-PERMIAN MASS EXTINCTION AND ITS CAUSES

Becker L, Poreta RJ, Basu AR, Pope KO, Harrison TM, Nicholson C, Iasky R. 2004. Bedout: a possible end-Permian impact crater offshore of northwestern Australia. *Science* 304:1469-1476. *Reactions: Science* 306:609-612.

Summary. An uplifted area near the northwestern coast of Australia has been proposed as the site of a giant end-Permian extraterrestrial impact. The Bedout High is about 40-60 km in diameter and 3-4 km high. It is located along a passive continental margin, which indicates a cause other than tectonic activity. The authors propose that the uplifted area represents the central uplift of a large impact crater. They report a negative gravity anomaly, suggestive of an impact, but admit it is somewhat obscured by subsequent geologic activity. Minerals found at the site include maskelynite, silica glass and shocked plagioclase. Minerals with unique chemical compositions were also found. Each of these features is consistent with an impact. Argon/argon dating indicates an age equivalent to the Permian/Triassic boundary. The proposed impact might explain the presence of P/T boundary meteorites in Antarctica, shocked quartz in Australia and Antarctica, and extraterrestrial fullerenes in Asia. It might also be related to the Siberian flood basalts, and perhaps the end-Permian mass extinction.

This proposal has been severely criticized by other scientists. There seems to be fewer shocked minerals than expected from such a large impact. Surrounding regions lack evidence of impact ejecta or turbidites. The gravity anomaly is very weak, the altered rocks resemble volcanic breccias, the evidence of shocked minerals is weak, and the radioisotope age was not properly measured.

Comment. This is probably the most dramatic claim to date relating extraterrestrial impacts to the end-Permian fossil turnover (mass extinction). There is variation in the kinds of evidence seen at impact sites; one important variable is whether the impactor was an asteroid or a comet. The cause(s) of the end-Permian mass extinction are currently being debated. The major contenders include large-scale volcanism, release of methane hydrates from the ocean floor, and changes in sea level. New developments are to be expected.

Erwin DH, Bowring SA, Jin Y. 2002. End-Permian mass extinctions: a review. In: Koeberl C, MacLeod KG, editors. Catastrophic Events and Mass Extinctions: Impacts and Beyond. Geological Society of America Special Paper 356:363-383.

Summary. The cause of the P/T mass extinction remains unclear. Putative causes need to include explanations for anoxia in ocean sediments, reduced concentrations of carbon-13, occurrence during a sea-level transgression, increase of fungal spores, and relationship to the Siberian flood basalts. The available data are largely consistent with an extraterrestrial impact, climatic effects of the Siberian flood basalts, and perhaps a release of marine hydrates. A combination of these and other factors may have been the cause of the extinction.

Comment. The end-Permian fossil turnover (“mass extinction”) is one of the most prominent features of the fossil record. It occurs globally and involves both marine and terrestrial organisms. About two-thirds of the genera fossilized in the upper Permian are absent from the overlying sediments. This dramatic feature of the fossil record begs for an explanation. Mass extinctions in general have not been explained satisfactorily, and remain a fertile topic for exploration.

Koeberl C, Farley KA, Peucker-Ehrenbrink B, Sephton MA. 2005. Geochemistry of the end-Permian extinction event in Austria and Italy: No evidence for an extraterrestrial component. *Geology* 32:1053-1056.

Summary. Extraterrestrial impacts are expected to leave a geochemical signature that includes enriched concentrations of iridium, helium-3, and osmium-188. Examination of sediments spanning the P/T boundary sections in Austria and Italy showed only a relatively small increase in iridium and osmium-188 concentrations, but no increase in helium-3. These results are not typical of sediments associated with extraterrestrial impacts, but are compatible with terrestrial anoxic sedimentation regimes. This suggests the end-Permian mass extinction was not the result of a giant extraterrestrial impact.

Racki G. 2003. End-Permian mass extinction: oceanographic consequences of double catastrophic volcanism. *Lethaia* 36:171-173.

Summary. This review favors the flood basalt hypothesis for the end-Permian mass extinctions. The Siberian flood basalts erupted at the end of the Permian, coincident with the end-Permian mass extinction. The massive basalt outpouring could have completely melted

the northern glaciers and the permafrost. This would disrupt ocean circulation by reducing the latitudinal temperature gradient. Normally, deep water originates in the north and flows southward at depth, promoting mixing of waters. Cessation of this system would produce anoxia in deep water. Marine anoxia might explain the end-Permian collapse of chert production and the marine mass extinction. Runaway greenhouse effects due to gases released by the flood basalts could explain the terrestrial phase of the mass extinction event. A smaller mass extinction at the end of the Permian Guadalupian stage seems to be correlated with a smaller basalt outpouring in China, the Emeishan Traps. This two-staged flood basalt pattern is unique to the upper Permian, and appears to be a good candidate to explain the two mass extinctions.

Ryskin G. 2003. Methane-driven oceanic eruptions and mass extinctions. *Geology* 31:741-744.

Summary. The P/T boundary is marked by a large decrease in the C-13/C-12 ratio. This might have resulted from release of massive amounts of methane hydrates from the floor of the ocean. Methane can potentially dissolve in ocean water and accumulate to high concentrations in stagnant basins, where it may form a metastable complex with seawater. If such a system were disturbed, such as by an earthquake, methane bubbles could be shaken loose and rise to the surface, expanding quickly as they rise. This movement would further disturb the water column, reinforcing the release of methane. The result could be a violent eruption of methane, similar to the eruption of carbon dioxide in Lake Nyos in 1986. Methane is typically depleted in C-13, so the release of large volumes of methane could explain the reduction in the C-13/C-12 ratio at the P/T boundary. An area of ocean floor the size of the Black Sea could hold, at saturation, 10^{18} g of carbon, which is about half the total content of the terrestrial biomass. Oxidation of the methane could severely reduce the atmospheric oxygen level, killing much of the world's biota and producing a major mass extinction.

Comment. The release of large amounts of methane into the water column would be a catastrophic event that, although perhaps capable of causing a mass destruction of marine life, should produce a kill horizon of rather limited thickness. This does not appear to be a satisfactory explanation for the extinction pattern in Upper Permian sediments.

Ward PD, Botha J, Buick R, De Kock MO, Erwin DH, Garrison GH, Kirschvink JL, Smith R. 2005. Abrupt and gradual extinction among Late Permian land vertebrates in the Karoo Basin, South Africa. *Science* 207:709-714.

Summary. A total of 126 vertebrate skulls were collected from Permo-Triassic boundary sediments in the Karoo Basin of South Africa. Twenty-one taxa of reptiles and amphibians were identified. Four of thirteen Permian taxa have ranges extending into the Triassic. Three taxa disappear between 50 to 20 meters below the boundary, and six of the remaining ten taxa disappear within ten meters of the boundary. This shows a gradual extinction punctuated by a larger, abrupt extinction at the boundary. The extinction pattern differs from that at the K/T boundary, and is not what is expected from an extraterrestrial impact.

GEOLOGY: MAYBE THE MEDITERRANEAN WAS NOT A DESERT?

Hardie LA, Lowenstein TK. 2004. Did the Mediterranean Sea dry out during the Miocene? A reassessment of the evaporite evidence from DSDP Legs 14 and 42 A cores. *Journal of Sedimentary Research* 74:453-461.

Summary. Hardie and Lowenstein maintain that the evidence that had been used to support the shallow water deposition of evaporites during repeated dessication of the Mediterranean Sea had been misinterpreted for more than 30 years by a number of researchers. In this paper, the authors systematically review the data used in the arguments for dessication and submit evidence for the deep water deposition of these same data, in particular, the “chicken-wire” anhydrite (anhydrite crystals forming a mosaic pattern in the sediments) and algal stromatolites.

Comment. The finer points regarding the repeated dessication of the Mediterranean Sea have been discussed through the past three decades with the majority of the scientists favoring the shallow water, dessication model. Recently scientists with expertise to address this issue garnered their evidence and arguments to review the data first-hand and present their case for an alternative view. Following the example of these authors, Christian researchers do not necessarily need to change their views though the opposing majority opinion may hold sway for decades; but rather we need to study the literature and data seeking insight into the issues. (EK)

HUMAN PALEONTOLOGY

Brown P, Sutikna T, Morwood MJ, Soejono RP, Jatmiko, Saptomo EW, Due RA. 2004. A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia. *Nature* 431:1055-1061.

Morwood MM, Soejono RP, Roberts RG, Sutikna T, Turney CSM, Westaway KE, Rink WJ, Zhao J-x, van den Bergh GD, Due RA, Hobbs DR, Moore MW, Bird MI, Fifield LK. Archaeology and age of a new hominin from Flores in eastern Indonesia. *Nature* 431:1087-1091.

Summary. A skeleton of a very small fossil human has been found in a limestone cave on the Indonesian island of Flores, associated with bones of extinct pygmy elephants and large Komodo dragons. The human skeleton is of an adult female about 1 meter in height, with an estimated weight of around 20-25 kg, and a cranial capacity of about 380 cm³. The brain size is smaller than a chimp, and as small as any known australopithecine. The skull has several features that link it to *Homo erectus* skulls. The new find has been given the name *Homo floresiensis*.

Comment. Populations isolated on islands often change in size. For example, fossil pygmy elephants are known from several islands, including Sicily and Malta, where they shrank from 4 meters to 1 meter in height in less than five thousand years. Flores is quite isolated, and is separated from both Asia and Australia by deep water. This individual may have belonged to a population of small humans that were isolated on Flores, showing that humans, as do other species, possess the capacity for rapid changes in morphology. The fossils apparently had human mental abilities in a brain as small as an australopithecine, reminding us that brain structure is more important than brain size in determining intelligence.

PALEONTOLOGY: ARCHAEOPTERYX HAD A BIRD-BRAIN

Dominguez Alonso PA, Milner C, Katcham RA, Cookson MJ, Rowe TB. 2004. The avian nature of the brain and inner ear of *Archaeopteryx*. *Nature* 430:666-669.

Summary. The London specimen of *Archaeopteryx* was subjected to a computed tomography scan (CAT-scan). Three-dimensional re-

construction of the braincase indicates that *Archaeopteryx* had enlarged regions for seeing, hearing, and spatial perception. These features indicate that *Archaeopteryx* had a brain much more like modern birds than like reptiles.

Comment. These findings are consistent with expectations based on the presence of well-developed flight feathers and other bird-like features. Application of computer tomography scan is a welcome advance in understanding this enigmatic fossil.

PALEONTOLOGY: SHELL MINERALOGY AND FOSSIL TRENDS

Kidwell SM. 2005. Shell composition has no net impact on large-scale evolutionary patterns in mollusks. *Science* 307:914-917.

Summary. Patterns and trends in the fossil record are based on preservation of fossils, generally of hard parts such as shells. But shells are made of different materials, and a bias favoring preservation of one material over another could distort the observed patterns. Shells made of calcite are generally better preserved than those made of aragonite. This study of shells of marine bivalve genera through the Phanerozoic compared stratigraphic ranges with shell composition. Results show no bias toward preferential preservation of calcitic shells over aragonitic. This implies that patterns observed in the fossil record are reliable, and not due to preservational bias.

Comment. These results strongly suggest that shell preservation is not unduly dependent on differences in shell composition. Thus, fossil patterns in bivalves may carry an important signal that could help us in understanding the processes leading to their preservation.

PALEONTOLOGY: FIRST FOSSIL INSECT SHOWS ADVANCED FEATURES

Engel MS, Grimaldi DA. 2004. New light shed on the oldest insect. *Nature* 427:627-630.

Summary. Fossil insects first appear in Devonian sediments, in such places as the Rhynie Chert of Scotland. This is the report of a fragmentary insect fossil, *Rhyniognatha hirsti*, found in the Rhynie

Chert. The specimen is the oldest known fossil insect, but it is not the most primitive. *Rhyniognatha* has a mandibular structure found only in true insects, with details that resemble flying insects. This discovery implies that insects were present in the Silurian.

Comment. Creation theory predicts that insects were present throughout the time when Phanerozoic sediments were deposited. The discovery that the first fossil record of an insect is that of a relatively “advanced” insect is not surprising. It is, perhaps, more surprising that fossil insects seem to be missing from Upper Devonian and Lower Carboniferous sediments.

PALEONTOLOGY: HUMMINGBIRDS IN EUROPE?

Mayr G. 2004. Old World fossil record of modern-type hummingbirds. *Science* 304:861-864.

Summary. Hummingbirds are a specialized group of birds presently restricted to the New World, and most speciose in the Neotropical region. The fossil record of hummingbirds is poor. A few fossils from Europe and Asia are thought to represent extinct types of hummingbirds or their close relatives, but none of them appears to be closely related to living hummingbirds. Two fossil hummingbirds have been found in Oligocene deposits in Germany. These fossils have the elongated beak and other features of modern hummingbirds, although they are not believed to belong to any living group of hummingbirds.

Comment. This discovery raises some interesting biogeographic questions. How could hummingbirds travel between Europe and the New World? In which area did they start? If a group is presently restricted to a geographic region, does this mean they probably originated in that region? If a group is restricted to two separate geographic regions, does this mean the two regions were once connected and later became separated? Examples such as this fossil hummingbird remind us of how precarious are our speculations regarding the history of life.

PALEONTOLOGY: WHAT CAUSES CHANGES IN MAMMAL PALEOFAUNAS?

Prothero DR. 2004. Did impacts, volcanic eruptions, or climate change affect mammalian evolution? *Palaeogeography, Palaeoclimatology, Palaeoecology* 214:283-294.

Summary. A careful analysis of Cenozoic mammal diversity curves failed to show a strong correlation between high rates of mammal turnover and environmental events such as climate change, volcanic eruptions, or extraterrestrial impacts. Episodes of high faunal turnover were not correlated with any extrinsic cause. Factors causing high mammal turnover are still unknown.

Comment. The observed disconnect between large-magnitude environmental events and faunal changes in Cenozoic mammals is unexpected. The cause of the disconnect is not clear, but it would seem worthwhile to explore the effects of compressing the time scale over which the events are deemed to have occurred.

PALEONTOLOGY: DINOSAUR-EATING MAMMALS

Hu Y, Jin M, Yuanqing W, Chuankui L. 2005. Large Mesozoic mammals fed on young dinosaurs. *Nature* 433:149-152.

Summary. A medium-sized triconodont mammal with dinosaur remains in its stomach area has been found in the Lower Cretaceous Yixian Formation of China. The mammal is the size of an opossum, while the baby *Psittacosaurus* dinosaur was five to six inches in length. (Adult *Psittacosaurus* reached the size of a sheep, and are common in the area.) An even larger fossil mammal, about the size of a badger, was also found in the Yixian Formation. These fossil mammals challenge conventional thinking that Mesozoic mammals were small because they could not compete with dinosaurs.

Comment. Fossils from the Yixian Formation have spectacularly expanded our knowledge of the fossil record, and remind us of how much remains to be discovered.

SPECIATION: ARE MINOR MORPHOLOGICAL DIFFERENCES DUE TO MOLECULAR REPEATS?

Fondon (III) JW, Garner HR. 2004. Molecular origins of rapid and continuous morphological evolution. *Proceedings of the National Academy of Sciences (USA)* 101:18058-18063.

Summary. Repeated DNA sequences associated with seventeen genes known to be active in development were analyzed in 92 breeds of dogs, and quantitatively compared with differences in skull and limb morphology. Results showed a close correlation between the number and purity of DNA repeats and morphological differences. The authors conclude that differences in the number and length of repeat sequences can explain rapid, but topologically conservative, morphological changes seen in species.

Comment. This discovery may hold the key to understanding how species can change rapidly, producing morphological variations equivalent to those seen among members of a taxonomic family. A possibility worth exploring is whether repeat sequences cause differences in rates of division among cell lineages during development. This mechanism might explain post-flood diversification of lineages at a rate much faster than evolutionists have predicted.