

ANNOTATIONS FROM THE LITERATURE

BIOGEOGRAPHY

Read J, Francis J. 1992. Responses of some Southern Hemisphere tree species to a prolonged dark period and their implications for high-latitude Cretaceous and Tertiary floras. *Paleogeography, Paleoclimatology, Paleocology* 99:271-290.

Summary. Fossils of trees are found in Antarctica, Australia and South America in Cretaceous and lower Tertiary sediments believed deposited when those areas were within the Antarctic Circle. This raises the question as to how trees could survive in a region that is too cold at present for tree growth. Two to three-year old seedlings of several Southern Hemisphere tree species were grown under controlled conditions of temperature and exposed to ten weeks of continuous darkness. Trees were examined for tissue damage at the end of the dark period. Most trees survived quite well, with little tissue damage. Those that suffered the most were *Banksia grandis* (family Proteaceae) and *Nothofagus betuloides* (Southern beech). Some species of *Nothofagus* suffered no notable damage. Trees generally did better at 4°C than at 15°C, probably because of reduced loss of carbon due to respiration. Ten weeks probably do not give enough time to draw conclusions, but the main problem in explaining the apparent growth of Cretaceous and Tertiary Antarctic trees might be that the temperatures appear to have been high enough to maintain respiratory rates that could have led to tree starvation during the prolonged periods of darkness.

BIOSTRATIGRAPHY

Sweet WC, Yang Z, Dickins JM, Yin H (editors). 1992. Permo-Triassic events in the eastern Tethys. Cambridge and NY: Cambridge University Press.

Summary. This book discusses the biostratigraphy and geology of the Permo-Triassic boundary in the Old World, with emphasis on Asia. One or more chapters are devoted to biostratigraphy of the

boundary in India, China, Russia, Europe and Australasia. Conodont stratigraphy is discussed in two chapters, and the pollen and spores of Israel are discussed in one chapter. The geology, geochemistry and tectonism of the boundary are discussed in three respective chapters. The authors document dramatic faunal and floral changes across the Permo-Triassic border, but do not agree on the causes. Yin Hongfu et al. (Ch 13) favor volcanism over extraterrestrial impact, but Chai Chifang et al. (Ch 14) advocate the involvement of both volcanism and impact. The widespread evidence of Permo-Triassic volcanism was mentioned by several authors. The most impressive example of this is the Siberian Traps, a lava outflow covering 1.5 million km². The Emeishan Basalt in China is estimated to cover an additional 0.3 million km², and other lava outflows are known in Permian or Triassic strata (Ch 13). Both the Upper Permian and the Lower Triassic began with marine transgressions and ended with regressions (Ch 15), which may have been worldwide.

DENDROCHRONOLOGY

Lara A, Villalba R. 1993. A 3620-year temperature record from *Fitzroya cupressoides* tree rings in southern South America. *Science* 260:1104-1106.

Summary. The alerce tree, *Fitzroya cupressoides*, is a member of the cypress family (Cupressaceae). It is the second-longest growing tree species known. Tree-ring samples were taken from alerce trees in southern Chile. Forty-three of 96 samples were successfully cross-dated. The oldest tree was estimated to be 3613 years old when cut down in 1975, as determined by cross-dating. Only four cross-dated samples were found for the period before 875 B.C., but the remainder of the tree-ring chronology is sufficiently supported to justify inferences about the climate where the tree was growing. Climatic inferences based on the tree-ring widths do not correlate well with historical records maintained since 1910. This disagreement may be partly due to local differences between the area where the trees grew and the areas where climate records were collected. Matching is better for warm summers than for cold summers.

Comment. Such events as the Little Ice Age are not reflected in these tree rings. There is no indication of a recent continuous warming trend.

EVOLUTION

Block BA, Finnerty JR, Stewart AFR, Kidd J. 1993. Evolution of endothermy in fish: mapping physiological traits on a molecular phylogeny. *Science* 260:210-214.

Summary. Endothermy, the ability to warm the body through metabolic activity, is absent in most fish, but is present in two families of sharks and three families of bony fish. The bony fish with endothermy are all members of the suborder Scombroidei, and include tunas and two families of billfishes, but not bonitos. The question addressed here is whether endothermy is convergent in these three families, or whether it was inherited from a common ancestor. Tunas achieve endothermy through high metabolic rates and low rates of body heat loss. Billfishes possess a heat-producing organ that warms only the brain and retina. The butterfly mackerel also warms only the brain and retina, but the anatomical details differ from the billfishes. The authors compare the distribution of endothermy with a molecular phylogeny based on the DNA sequence of the mitochondrial gene for cytochrome b. Their comparison indicates that endothermy occurs independently in each of the three groups of fish, and is not inherited from a common ancestor.

GENETICS

Dessauer HC, Gee GF, Rogers JS. 1992. Allozyme evidence for crane systematics and polymorphisms within populations of sandhill, sarus, Siberian and whooping cranes. *Molecular Phylogenetics and Evolution* 1:279-288.

Summary. There are 15 living species of cranes, all of which were sampled for this study. Based on protein electrophoresis, the two species of African crowned cranes are distinct from the remaining species, which are themselves divided into two groups. The "sandhill group" consists of seven species, and is distributed across the Old World, with the sandhill crane reaching North America. The "whooper group" consists of six species which are all restricted to the northern continents.

Single species diversity was also analyzed. A significant result was the discovery that genetic diversity among whooping cranes was surprisingly high, similar to that for the six other species with which it

was compared. This is contrary to expectations of genetic loss due to a population bottleneck of some 15 individuals in the 1940s.

Comment. The possibility should be explored that some mechanism exists for rapidly restoring genetic variability after population bottlenecks.

Hatfield D, Diamond A. 1993. UGA: a split personality in the universal genetic code. *Trends in Genetics* 9:69-70.

Summary. UGA, a three-base unit for the genetic code system, has the largest variation of uses in the genetic code. It most often is a stop codon, but it codes for the amino-acid tryptophan in mitochondria and *Mycoplasma* (a small bacterial type of organism), inefficiently so in *B. subtilis* (a bacterium), and codes for cysteine in a species of *Euplotes* (a protozoan). It can also function as a selenocysteine codon in species from the following groups: bacteria, fungi, protists, higher plants, and mammals. Thus UGA should be considered to function both as a stop signal and as a part of the universal genetic code for a 21st amino acid, selenocysteine.

Ohta T, Basten CJ. 1992. Gene conversion generates hypervariability at the variable regions of kallikreins and their inhibitors. *Molecular Phylogenetics and Evolution* 1:87-90.

Summary. Kallikreins are a group of serine proteases found in mammals. A family of genes codes for these enzymes. DNA sequences in the active region of the proteins' sites are more variable than in neutral sites between genes, suggesting that some mechanism is causing a higher rate of mutation in the region coding for the active site. Kallikrein genes are believed to engage in frequent exon shuffling, but gene conversion seems to be the mechanism involved here. Gene conversion occurs when one sequence is copied to match a second, usually similar, sequence. Some gene copies may act as reservoirs of genetic variability by retaining alternative sequences which may be substituted into a transcribed gene. Thus, gene conversion may be an important source of genetic variability.

Thompson CB. 1992. Creation of immunoglobulin diversity by intrachromosomal gene conversion. *Trends in Genetics* 8:416-422.

Summary. Antibody molecules are an important part of body defenses against disease. Each antibody molecule is made of various "chains" that include three parts: a variable region (V), a constant region (C) and a joining region (J). These three parts are coded for by

different DNA sequences, which are spliced together. In humans, immunoglobulin (Ig) genes undergo somatic recombination during B cell development, in which different combinations of V, J and C regions are produced, each forming a distinct antibody molecule. Up to 10^{11} different combinations may be produced. However, a different process occurs in rabbits and many birds, in which pseudogenes play a key role in creating antibody diversity in B cells by gene conversion (copying of the DNA sequence from one gene into another). In the chicken, the 5' to 3' gene sequence is: about 25 psi-V pseudogenes, followed by single V, J and C regions. The single V and J regions are spliced together, followed by gene conversion of the V region from one of the upstream psi-V pseudogenes.

Comment. Pseudogenes are commonly thought to be non-functional, but this may simply indicate our lack of understanding of their function.

GEOLOGY

Raup DM, Jablonski D. 1993. Geography of end-Cretaceous marine bivalve extinctions. *Science* 260:971-973.

Summary. Many Cretaceous fossils do not have corresponding fossils in Tertiary sediments. This disappearance is generally attributed to an extraterrestrial impact that wiped out much of Earth's biota, including dinosaurs. For bivalve mollusks, 63% of Cretaceous genera are not found in Tertiary sediments. Previous studies have suggested that the degree of extinction was greatest in tropical latitudes west of 30° W paleolongitude, which includes the area of the Chicxulub Crater on the Yucatan Peninsula of Mexico. Raup and Jablonski report that this geographical trend is due to the rudists, an extinct group of bivalve mollusks.

Comment. When the rudists are removed from the analysis, the extinction rate appears to be rather uniform worldwide. Accordingly there seems to be no evidence for a local cause of the end-Cretaceous extinction.

Seaman SJ, Ramsey PC. 1992. Effects of magma mingling in the granites of Mount Desert Island, Maine. *Journal of Geology* 100:395-409.

Summary. Fine-grained inclusions (enclaves) in felsic plutons (major granitic masses) and volcanic rocks are usually interpreted as magmas that cooled and crystallized when they came into contact

with more siliceous host magmas. The minerals that crystallize from the enclave liquids and disaggregate into the host granite contaminate the granite with exotic components. Three mechanisms affecting composition and texture of the granite are described: 1) disaggregation and dispersion of crystals from pegmatite pods formed during the cooling of the enclave liquids; 2) ionic exchange between the enclave and granitic magmas; and 3) alkalic feldspar and hornblende rinds surrounding the enclaves. While the third process of rind development simplifies the process of identifying the extent of contamination granites, the authors state: "... textural and compositional data presented in this study suggest that the effects of ionic and mineralogic contamination by enclave liquids may be strong and pervasive, regardless of the appearance of a granite."

Comment. This contamination has important implications for the interpretation of radiometric dates with respect to magma crystallization.

IMPACT CATASTROPHES

Gratz AJ, Nellis WJ, Hinsey NA. 1992. Laboratory simulation of explosive volcanic loading and implications for the cause of the K/T boundary. *Geophysical Research Letters* 19:1391-1394.

Summary. Planar deformation features found in particles associated with craters are interpreted as evidence of extraterrestrial impact. Explosive volcanism appears to be incapable of producing these features. The largest historical volcanic event was Tambora, which released about 10^{20} joules of energy and created pressures of about 1.5 GPa. Impact of an asteroid greater than 10 km diameter would release at least 10^{25} joules and generate peak shock stresses in excess of 100 GPa. Laboratory simulations subjecting granite samples at 600°C to 0.9 and 1.3 GPa did not produce any planar deformation features. The only available explanation for these features is a large extraterrestrial impact.

Gudlaugsson ST. 1993. Large impact crater in the Barents Sea. *Geology* 21:291-294.

Summary. A crater discovered on the sea floor north of Scandinavia is thought to be an impact crater. Known as the Mjølnir structure, the crater is 39 km in diameter, probably produced by an impactor from 0.7 to 2.5 km in diameter. The stratigraphic position of the crater is Upper

Jurassic to Lower Cretaceous. Only 18 craters larger than 30 km in diameter are known. This crater is one of the best preserved large impact craters, and is situated in a relatively complete epicontinental seaway sedimentary series extending from Carboniferous to Cretaceous.

Oberbeck VR, Marshall JR, Aggarwal H. 1993. Impacts, tillites, and the breakup of Gondwanaland. *Journal of Geology* 101:1-19.

Summary. Many extraterrestrial impact craters have been identified on the earth's surface, and more such identifications are expected. A study of the 26-km Ries Crater in Germany revealed that the impact stripped the local ground surface, producing striations and polished surfaces, with dislodged blocks as large as 200 m in diameter. Accumulated deposits increase with distance from the crater rim, reaching a maximum thickness of 200 m. Impact deposits formed in water may produce dropstones and multiple turbidite layers. Tillites and diamictites, classically interpreted as produced by glaciers, may also be produced by impacts.

Some features of tillites are problematic for a glacial origin. Known glacial deposits do not exceed about 300 m in depth, whereas some tillite deposits may reach 3000 m in depth. Tillites often are found among deposits that appear to be from warm environments. Since impacts can produce similar features, many tillites should be reinterpreted.

The effects of impacts on continental targets are also considered by Oberbeck et al. Extensive tillite deposits are found stratigraphically lower than some of the largest flood basalts, and geographically associated with them. These flood basalts (Parana, Karoo and Siberian) were followed by continental breakup. Flood basalts seem to appear abruptly within plates, without known cause. A mechanism is needed to explain continental breakup.

Comment. The current model of mantle flow has some serious shortcomings. Extraterrestrial impacts may be the cause of the fragmentation of Gondwana.

Robin E, Froget L, Jehanno C, Rocchia R. 1993. Evidence for a K/T impact event in the Pacific Ocean. *Nature* 363:615-617.

Summary. Spinel-containing spherules, believed caused by extraterrestrial impact, have been recovered from Cretaceous/Tertiary boundary sediments at several sites on the sea floor of the Pacific Ocean. Chemical analysis suggests the spherules are composed of

almost pure meteoritic material. This evidence and their location suggests a source other than the Yucatan peninsula, which is thought to be the site of a major end-Cretaceous extraterrestrial impact. The authors postulate a Pacific Ocean impact of an asteroid 2 km in diameter to explain the presence of the ocean floor spherules. The worldwide evidence for extraterrestrial impact may have been the result of many smaller impacts rather than one or two large ones.

MAMMALOGY

Dung VV, Giao PM, Chinh NN, Tuoc D, Arctander P, MacKinnon J. 1993. A new species of living bovid from Vietnam. *Nature* 363:443-445.

Summary. A new species of living antelope has been discovered in forests of Vietnam. This is the first new species of large mammal to be discovered since the Chaco peccary was found in the 1970s. A new genus, *Pseudoryx*, has been erected to classify the species. Mitochondrial DNA sequences indicate the new species may not be closely related to any known bovid. Unfortunately, its distribution lies in an area raged by war, and its survival is precarious.

MOLECULAR EVOLUTION

Bradley D, Carpenter R, Sommer H, Hartley N, Coen E. 1993. Complementary floral homeotic phenotypes result from opposite orientations of a transposon at the plena locus of *Antirrhinum*. *Cell* 72:85-95.

Summary. Snapdragons may undergo a mutation (plena) in which carpels develop in place of the petals and sepals. Another mutation (ovulata) is known in which sepals and petals develop in place of the pistils and stamens. Study of these two mutations reveal that both mutations are caused by insertion of a transposon, called Tam3. Without Tam3, the flower develops normally. The normal gene appears to be made of nine exons, each separated by an intron. The Tam3 transposon inserts in the second intron, between exons 2 and 3. When Tam3 inserts in the same orientation as the normal gene, the result is the plena mutation. When Tam3 inserts in the reverse orientation, the ovulata mutation results.

Comment. While neither of these mutations is likely to endure in a population, they do illustrate the sensitivity of normal development to the effects of transposable elements.

Hagemann AT, Craig NL. 1993. Tn7 transposition creates a hotspot for homologous recombination at the transposon donor site. *Genetics* 133:9-16.

Summary. The *lacZ* gene in the common bacterium, *E. coli*, may have a transposable element (Tn7) inserted, resulting in loss of lactase production. When Tn7 is stimulated to transpose (move to a new location), the donor sequence is left with a gap, and the host sequence receives a Tn7 transposon. Repair of the broken donor chromosome is accompanied by restoration of the Tn7 transposon sequence. This is accomplished by homologous recombination and gene conversion, in which the Tn7 sequence is restored by homologous recombination with a sister chromosome. (Rapidly growing cells of *E. coli* contain more than 1 copy of the chromosome.) Thus Tn7 transposition, normally non-replicative, may be effectively replicative. If an ectopic chromosome lacking Tn7 is available, it may be used as a template for gene conversion. If this occurs, lactase activity is restored. The frequency of homologous recombination of the transposon may be increased 10-fold when the rate of transposition of Tn7 is stimulated.

MOLECULAR SYSTEMATICS

Chevret P, Denys C, Jaeger J-J, Michaux J, Catzeflis FM. 1993. Molecular evidence that the spiny mouse (*Acomys*) is more closely related to gerbils (Gerbillinae) than to true mice (Murinae). *Proceedings of the National Academy of Sciences (USA)* 90:3433-3436.

Summary. Dental morphology has played a central role in many hypotheses of mammalian evolution. A particular molar pattern has been used to support the monophyly of mice of the subfamily Murinae. This molar pattern is present in mice of the genus *Acomys*, and they have accordingly been classified in Murinae. However, immunological data previously reported, and DNA-DNA hybridization data reported here, indicate that *Acomys* and two African genera form a monophyletic group which is actually more similar to the subfamily Gerbillinae than to Murinae. Thus the unique dental pattern thought to unite the subfamily Murinae is interpreted as convergent in these three genera.

Comment. Such findings illustrate the frequent disagreement of molecular and morphological data in phylogenetic hypotheses, and do not bode well for phylogenetic hypotheses of mammalian relationships based almost entirely on dentition.

Dowling TE, DeMarias BD. 1993. Evolutionary significance of introgressive hybridization in cyprinid fishes. *Nature* 362:444-446.

Summary. The fish family Cyprinidae contains several species in the genus *Gila*, often known as chubs. Two different clustering methods gave similar phylogenies for several *Gila* species using genetic distances derived from protein electrophoresis. Likewise, two clustering methods gave similar phylogenies using mitochondrial DNA restriction sites. However, phylogenies based on the two data are in poor agreement. The pattern of discordance suggests that hybridization among different species has occurred in the past. This hybridization has produced discordance in phylogenies, and has contributed to the production of new varieties. Hybridization seems to be an important mechanism increasing the number of species within some groups.

Graur D. 1993. Molecular phylogeny and the higher classification of eutherian mammals. *Trends in Ecology and Evolution* 8:141-147.

Summary. A primary goal of phylogenetic systematics is to produce a classification that is based totally on monophyletic groups. (A monophyletic group consists of an ancestor and all its descendants.) Various groupings of mammal orders have been proposed, such as “Glires” (Rodentia + Lagomorpha) and “Archonta” (typically Primates + Dermoptera + Scandentia). However, these groupings have received limited support, and various contradictory alternatives have been proposed.

Molecular data is now having a significant impact on classification, resulting in some new ideas and new problems. Molecular phylogenies sometimes share few similarities with morphological phylogenies. For example, perissodactyls (horses and allies) and artiodactyls (cattle and allies) have traditionally been grouped together on morphological grounds. Molecular comparisons group artiodactyls with whales, while perissodactyls are grouped with hyraxes and elephants. Furthermore, whales do not show up as a sister group to artiodactyls, but nest within artiodactyls as a sister group to ruminants. In other words, whales appear more closely related to cattle than pigs or camels do. If so, then either Artiodactyla must be redefined to include whales, or Cetacea must be retained as an order, and the artiodactyls separated into probably three orders: Ruminantia, Tylopoda, and Suiformes. Another problem arises with Rodentia, which appears to be paraphyletic (does not include all the descendants of an ancestor) with respect to other groups in some molecular phylogenies. One solution to this is to

dismember Rodentia. into several orders, such as Myomorpha, Hystricomorpha and Ctenodactyla.

Comment. Although molecular phylogenies tend to contain many inconsistencies and contradictions, they have had the beneficial effect of forcing a reappraisal of mammalian relationships. It remains to be seen what the result will be.

Martin W, Lydiate D, Brinkmann H, Forkmann G, Saedler H, Cerff R. 1993. Molecular phylogenies in angiosperm evolution. *Molecular Biology and Evolution* 10:140-162.

Summary. DNA sequences for glyceraldehyde-3-phosphate dehydrogenase were compared from a bryophyte, a gymnosperm and three angiosperms, along with other published species, totaling 19 species. Results indicate the deepest angiosperm dichotomy is between monocots and dicots, not one between magnoliads or other dicot groups and the others. On fossil evidence, the bryophyte spermatophyte dichotomy is dated at about 450 Ma. Application of the molecular-clock hypothesis yields dates of about 330 Ma for the conifer-angiosperm dichotomy, and about 300 Ma for the monocot-dicot divergence.

Comment. Both dates are far older than the conventional date of about 130 Ma for the earliest unequivocal angiosperm. The origin of angiosperms, Darwin's "abominable mystery," is still unsolved.

Melnick DJ, Hoelzer GA, Absher R, Ashley MV. 1993. mtDNA diversity in rhesus monkeys reveals overestimates of divergence time and paraphyly with neighboring species. *Molecular Biology and Evolution* 10:282-295.

Summary. Rhesus monkeys have a wide geographic distribution, ranging from Pakistan to the Pacific coast of China, and occupying a variety of habitats. Despite the ecological heterogeneity, the degree of morphological diversity among rhesus monkeys is no greater than normal for a single species. Nuclear DNA sequences link eastern and western rhesus monkeys, while mitochondrial DNA sequences link eastern continental rhesus monkeys with island species on Japan and Taiwan. This is explained as follows: glaciation in the center of the habitat range separated eastern and western populations of rhesus monkeys. During this time, lowered sea levels permitted eastern rhesus monkeys to reach Japan and Taiwan. Thus eastern rhesus monkeys and insular species share a more recent ancestry than eastern and western rhesus populations, as indicated by mitochondrial DNA similarities. Later, the insular populations became isolated as the glaciers

melted. Contact was re-established between eastern and western rhesus populations. Since dispersal is usually accomplished by males, nuclear DNA was exchanged but mitochondrial DNA was not exchanged between the eastern and western rhesus populations, as reflected in nuclear DNA similarities.

Comment. Mitochondrial DNA diversity is high in rhesus monkeys. If only a single individual had been studied, the putative history described above could not have been discerned.

Milinkovitch MC, Orti G, Meyer A. 1993. Revised phylogeny of whales suggested by mitochondrial ribosomal DNA sequences. *Nature* 361:346-348.

Summary. Modern whales are classified into two suborders, toothed whales (Odontoceti) and baleen whales (Mysticeti). Toothed whales have a fossil record from Eocene to Recent, while mysticete whales are found from Oligocene to Recent. Comparison of mitochondrial DNA sequences for 12S and 16S RNA was done for 16 cetacean species. Most of these species were toothed, but one family of baleen whales was included.

Comment. According to the results, sperm whales are more similar to baleen whales than to other toothed whales. This result is in conflict with classification based on morphological grounds, and does not seem to correlate well with the fossil record.

Sherman DR, Kloek AP, Krishnan BR, Guinn B, Goldberg DE. 1992. *Ascaris* hemoglobin gene: plant-like structure reflects the ancestral globin gene. *Proceedings of the National Academy of Sciences (USA)* 89:11696-11700.

Summary. Animal globin genes have three exons and two introns, while plant globin genes have a third intron, dividing one of the exons in two. The ancestral globin gene has been predicted to have had three introns. The parasitic roundworm *Ascaris* globin gene has three introns. *Ascaris* and plants also share two other features not found in other multicellular animals: the glyoxylate cycle and de novo synthesis of polyunsaturated fatty acids. One explanation for this anomalous pattern is that *Ascaris* retains the primitive traits. An alternative explanation is that *Ascaris* and other multicellular groups are unrelated.

ORIGIN OF LIFE

Kasting JF, Egglar DH, Raeburn SP. 1993. Mantle redox evolution and the oxidation state of the Archean atmosphere. *Journal of Geology* 101:245-257.

Summary. The composition of the primordial atmosphere is an important concern for development of a naturalistic explanation for the origin of life. An oxidizing atmosphere would favor chemical destruction of biomolecules. Current models postulate a primordial atmosphere rich in carbon dioxide, but such an atmosphere would be too oxidizing for efficient production of amino acids and other molecules needed for life. The authors propose a model in which the oxidation state of the mantle has changed over time. According to their model, the mantle was originally more reduced than at present. The loss from the mantle of reduced volcanic gases, combined with the gain by subduction of oxidized sea floor sediments, would result in a steadily increasing oxidation state for the mantle. Once the atmosphere became oxidized, the oxidation state would remain about the same, because atmospheric hydrogen would be oxidized to water rather than lost to space. Oxidation of the sources of volcanic gases would chemically balance the gain of oxidized sediments. This model is proposed to explain why Archean (lower Precambrian) photosynthetic activity was not associated with an oxidizing atmosphere. The authors admit that the evidence is mixed for the oxidation state of the Archean mantle.

Comment. Although the knowledge gained from study of the mantle may be useful, naturalistic attempts to explain the origin of life continue to be unsuccessful.

Schwartz AW, de Graaf RM. 1993. The prebiotic synthesis of carbohydrates: a reassessment. *Journal of Molecular Evolution* 36:101-106.

Summary. One of the major difficulties with origin of life scenarios is a plausible source of sugar, particularly the ribose needed for nucleic acid synthesis. The formose reaction involves the polymerization of formaldehyde to form sugars in the presence of a base catalyst. This reaction was studied to see whether it was a plausible prebiotic source of sugar. The formose reaction does occur in abiotic conditions, with certain minerals acting as catalysts in near-neutral pH solutions. However, the reaction specifically produces the sugar pentaerythritol, which has no known biological significance. The formose reaction is

not a plausible prebiotic source of ribose, nor is any other plausible prebiotic source known.

Widdel F, Schnell S, Heising S, Ehrenreich A, Assmus B, Schink B. 1993. Ferrous iron oxidation by anoxygenic phototrophic bacteria. *Nature* 362:834-836.

Summary. Precambrian (Archean and lower Proterozoic) banded iron formations (BIFs) are alternating layers of iron-rich and silica rich sediments that may cover large areas. Their origin is something of an enigma. It was thought that oxygen was required to oxidize ferrous iron (iron 2) to ferric iron (iron 3). This presented a problem for the standard model of earth history, because it is thought that oxygen was not present in the atmosphere in significant quantities during the period of Archean deposition. Newly discovered bacteria are now known to be able to oxidize ferrous iron to ferric iron, and reduce carbon dioxide for biological use, without the presence of oxygen.

Comment. Although the new discovery does not demonstrate the origin of banded iron formations, it does open up a new area for discussion.

PALEONTOLOGY

Brigg DEG, Kear AJ. 1993. Fossilization of soft tissue in the laboratory. *Science* 259:1439-1442.

Summary. Most fossils occur as bones, shells, or plant debris. However, fossils are sometimes found with muscles and other soft tissues preserved. Preservation of muscle tissue usually involves calcium phosphate. Experiments with two species of crustaceans showed that mineralization of soft tissue is inhibited by the presence of oxygen. Normal decay processes rapidly reduce the oxygen concentration in the fluid surrounding the crustaceans, permitting tissue mineralization unless reoxygenation is permitted. At least partial mineralization of muscle tissue occurred in 4-8 weeks in the majority of those specimens in which oxygen remained depleted. The source of the calcium phosphate can be the specimen itself, but microbial action is involved in its deposition within the muscle tissue. Mineralization was initiated within 2 weeks. Results indicate that specific conditions are required in order for soft tissue to become mineralized.

Budd AF. 1993. Faunal turnover in Neogene to Recent Caribbean reef coral and regional environmental change. GSA Abstracts with Program (North-Central Section) 25(3):9.

Summary. More than 75% of all species found in uppermost Miocene or lower Pliocene Caribbean reef deposits became extinct by the beginning of the Pleistocene. After the drastic faunal change at the Pliocene-Pleistocene transition, the total number of species was about the same as before.

Comment. The coral reef fauna has been stable throughout the Pleistocene. This seems difficult to explain with the standard model of Earth history in which dramatic climatic changes occurred throughout the Pleistocene. One would expect considerable faunal changes in response to Pleistocene climatic changes.

Dilly PN. 1993. *Cephalodiscus graptolitoides* sp. nov. a probable extant graptolite. Journal of Zoology, London 229:69-78.

Summary. Graptolites are somewhat enigmatic fossils, at various times considered to be plants or animals of uncertain affinities. A close affinity with pterobranchs in the phylum Hemichordata was suggested in 1948. This interpretation is greatly strengthened by the recent discovery of a living graptolite-like organism.

The new species was discovered near the island of New Caledonia in water 253 m deep. It has been assigned to the genus *Cephalodiscus*, a pterobranch genus of 16 described species. The new species is a sessile encrusting form, with separate sacs each containing a single adult zooid. The critical feature of the new species that indicates its relationship with graptolites is the presence of long slender spines on the surface of the colony. Each spine appears to be a feeding station alternately shared by several zooids. The spine is interpreted as being homologous to the nema of graptolites.

Comment. If this interpretation is correct, this species can truly be considered a living fossil, because graptolites were thought to have been extinct since the Carboniferous.

Martin RD. 1993. Primate origins: plugging the gaps. Nature 363:223-233.

Summary. Modern primates are generally classified into two major groups. Lemurs, galagos and their allies form one group, while monkeys, apes and humans form the other. Tarsiers are usually placed

closer to monkeys than to lemurs, with some uncertainty. These two major living groups have been associated with different putative ancestors in the fossil record. Lemurs and their allies have been considered to be derived from the extinct Adapidae, with the tarsiers and probably monkeys derived from extinct Omomyidae. The extinct Plesiadapiformes were thought to be the most primitive of all primates. This picture was based largely on interpretations of the evolution of mammal teeth. New fossil discoveries have added other skeletal parts, greatly revising the interpretation of relationships.

Plesiadapiformes are now thought not to be primates at all, and their affinities are obscure. The extinct Adapidae and Omomyidae are now seen as evolutionary dead-ends. Diverse monkey-like fossils have been discovered in Eocene deposits, the stratigraphic level in which the Adapidae and Omomyidae fossils are found.

Comment. There are no fossils available as plausible ancestors of the primates, leaving the primate tree without a trunk.

Thewissen JGM, Hassain ST. 1993. Origin of underwater hearing in whales. *Nature* 361:444-445.

Summary. Fossil incus bones of the inner ear of the archeocete *Pakicetus* have been recovered and are described here. Whales have ear bones that differ from those of other mammals. Sound is transmitted through the jaw in modern whales, whereas in terrestrial mammals sound is transmitted through the external auditory meatus. *Pakicetus* appears to have lacked the jaw structure for sound transmission, and thus must have used a system similar to that of land mammals.

The whale incus has a greatly inflated body and crus longum, and the joint between the malleus and incus faces rostrally. In terrestrial mammals, the incus is more slender, the crus longum is longer, and the joint between the malleus and incus faces rostromedially. *Pakicetus* is the only whale known with the intermediate condition of an inflated incus with elongated crus longum (found also in some pinnipeds), and the joint between the malleus and incus partially rotated. The morphology of the ear of *Pakicetus* and the shallowness of the “river” in which the fossil was found is said to suggest that it might not have been fully aquatic.

Vartanyan SL, Garutt VE, Sher AV. 1993. Holocene dwarf mammoths from Wrangel Island in the Siberian Arctic. *Nature* 362:337-340.

Fossil tusks of woolly mammoths have been found that give radiocarbon ages of less than 4,000 years. This is less than half the radiocarbon age of the youngest previously known woolly mammoths. The fossils were found on Wrangel Island, which lies to the north of eastern Siberia, at 180 degrees longitude. The youngest fossil teeth are smaller than average for the species, which is explained as a case of dwarfing on islands. Survival of this population long after the rest of the species became extinct seems to favor the human overkill hypothesis over the climate-change hypothesis of Pleistocene megafaunal extinction.

PALEONTOLOGY: FOSSIL BIRDS

Altangerel P, Norell MA, Chiappe LM, Clark JM. 1993. Flightless bird from the Cretaceous of Mongolia. *Nature* 362:623-627.

Summary. A bird-like fossil has been recovered from the Upper Cretaceous Nemegt Formation in Mongolia. Nearly all parts of the skeleton were present. The fossil appears to be intermediate between *Archaeopteryx* and living birds. This conclusion is supported by five characters, and contradicted by two characters. Six characters of birds are lacking. The fossil has a long reptilian tail, and the forelimb is strongly built, with a single stout claw. The organism was clearly unable to fly, although the sternum is keeled. The claw appears to be potentially useful for digging, but the hindlimbs do not appear to fit with a burrowing lifestyle.

Comment. The fossil is in the wrong stratigraphic position to be interpreted as ancestral to modern birds, but illustrates the previous existence of combinations of characters that are no longer found together.

Feduccia A. 1993. Evidence from claw geometry indicating arboreal habits of *Archaeopteryx*. *Science* 259:790-793.

Summary. The arc of curvature of a bird's claw varies according to whether it lives on the ground, perches in trees, or climbs trees. *Archaeopteryx* has claws on both the feet and wings. The claws on the feet have the curvature typical of perching birds, while the wing claws have curvature typical of trunk-climbing birds. Based on this and other evidence, the conclusion presented is that *Archaeopteryx* lived in trees, and probably could fly.

Speakman JR. 1993. Flight capabilities in *Archaeopteryx*. *Evolution* 47:336-340.

Summary. Living birds that can take off from the ground have at least 16% of their body mass as deltoid and pectoral muscles. It appears that birds with less than this proportion of flight muscle are unable to spring directly into flight from the ground. *Archaeopteryx* is estimated to have had only 9% of its body mass as flight muscle. However, it has been suggested that *Archaeopteryx* might have been able to fly anyway, because it may have had reptilian tissue, which produces power with greater efficiency. Speakman challenges this suggestion by pointing out that reptilian tissue is not really more efficient, it merely can briefly produce more power by using anaerobic metabolism. Previous estimates of power production by reptiles and birds used different methods, which are not equivalent. Applying the same method to both birds and reptiles shows that power production of reptiles is not as much greater than birds as had been previously calculated. The conclusion is that *Archaeopteryx* could not take flight directly from the ground.

PALEONTOLOGY: DINOSAURS

Carpenter K. 1992. Behavior of hadrosaurs as interpreted from footprints in the “Mesaverde” Group (Campanian) of Colorado, Utah, and Wyoming. *Contributions to Geology, University of Wyoming* 29:81-96.

Summary. Dinosaur footprints in coal mines near Price, Utah correlate with the lower Two Medicine Formation of Montana. Grand Mesa (Colorado) footprints correlate with the upper Two Medicine and Judith Formations. Dinosaur tracks from Rock Springs, Wyoming, correlate with the Horseshoe Canyon Formation of Alberta. In both Price and Grand Mesa, the majority of the footprints were headed south. Trackways are uncommon. The explanation given for the footprints is that the hadrosaurs migrated seasonally, occupying the swamps during the dry season in order to find food and water. Hatching is inferred to have occurred at the beginning of the rainy season. Hadrosaurs are inferred to have been terrestrial most of the year.

Comment. Inferences of dinosaur behavior from footprints depend on whether one assumes the behavior was normal or whether the animals were under stress at the time. In a catastrophic model, one cannot assume the footprints or nest relationships represent the normal behavior of the species.

Nadon GC. 1993. The association of anastomosed fluvial deposits and dinosaur tracks, eggs and nests: implications for the interpretation of floodplain environments and a possible survival strategy for ornithopods. *Palaios* 8:31-44.

Summary. The St. Mary River Formation is a nonmarine unit, 200-300 m in thickness, in southeastern Alberta and northwestern Montana. It contains numerous dinosaur tracks and eggshell fragments, amphibians, fish scales, freshwater mollusks and plant fossils. Only one articulated skeleton has been found, a small *Champsosaurus*. The depositional environment is interpreted as a floodplain with anastomosing streams and shallow, probably short-lived, lakes. Most of the tracks are of herbivores, but some tracks of carnivorous theropods have also been found. Similar depositional environments are inferred for dinosaur trackways in the Gething Formation in northeastern British Columbia, the Two Medicine Formation in western Montana, and several other sites in North America, one in South Africa and two in France.

Various interpretations of hadrosaur habitat have been proposed, ranging from aquatic to fully terrestrial. Nadon infers a marshy habitat. The possibility that the inferred depositional environment might not represent the normal habitat for these dinosaurs should be considered.

Rogers RR, Swisher (III) CC, Sereno PC, Monetta AM, Forster CA, Martinez RN. 1993. The Ischigualasto tetrapod assemblage (Late Triassic, Argentina) and $^{40}\text{Ar}/^{39}\text{Ar}$ dating of dinosaur origins. *Science* 260:794-797.

Summary. The stratigraphically lowest dinosaur fossils are found in the part of the Triassic known as the Carnian. They appear at this same point in North America, South America, India and Africa. The Ischigualasto Formation of Argentina is one of the areas from which Carnian dinosaur fossils are known. Three genera of dinosaurs are found here; two genera are saurischians and one is ornithischian, indicating a diversity at first appearance of the dinosaurs.