

ANNOTATIONS FROM THE LITERATURE

DESIGN: TRILOBITE COMPLEXITY

Chadwick, AV, DeHaan RF. 2000. The trilobite: enigma of complexity. A case for intelligent design. Perspectives on Science and Christian Faith 52:233-241.

Summary: Trilobites are extinct arthropods, with a level of complexity similar to that of living arthropods. It seems reasonable to infer that they shared biological processes seen in arthropods today. This means that trilobites had a complex genetic system, cell division, a nervous system, a developmental system, sense organs including eyes, etc. These systems imply the existence of the same biomolecules seen in living arthropods, including DNA, histones, and other associated proteins, microtubules, neurotransmitters, regulatory proteins, and many others. But there is no evidence in the fossil record of the source of this complexity. Trilobites are found in Cambrian sediments, without a trace of ancestry in the underlying sediments. Intelligent design theory provides an explanation for the source of this complexity, while ordinary evolutionary theory does not. Speculation on the identity of the designer goes beyond the boundaries of science.

Comment: It seems apparent that design can be seen throughout the history of life on this planet. Trilobites, as well as living organisms, illustrate this design as well.

GEOLOGY: CHANGES IN EARTH'S AXIS

Prevot M, Mattern E, Camps P, Daignieres M. 2000. Evidence for a 20° tilting of the Earth's rotation axis 110 million years ago. Earth and Planetary Science Letters 179:517-528.

Summary: The author used paleomagnetic measurements from continental rocks to infer that Earth's axis shifted through the Cretaceous, with an abrupt shift of about 20° during the mid-Cretaceous. This may have reflected a major shift in distribution of Earth's mass during the Lower Cretaceous. Effects of the axial shift on distribution of mantle material might be linked to high plume activity and low frequency of geomagnetic reversals during this time.

Comment: The breakup of Pangaea is thought to have occurred largely in the Cretaceous. An abrupt change in the angle of Earth's axis could produce sufficient force to move the continents. How these processes are linked remains an important research question.

MOLECULAR EVOLUTION: DEGENERATION OF DUPLICATED GENES

Lynch M, Conery JS. 2000. The evolutionary fate and consequences of duplicate genes. *Science* 290:1151-1155.

Summary: Gene duplication and divergence is widely regarded as the source of new genetic information. The theory is that a duplicated gene might evolve to a new function. Alternatively, duplicated genes might experience crippling mutations and degenerate into useless DNA sequences. By prospecting for duplicate genes in genomic sequences from several eukaryotic species, Lynch and Conery concluded that gene duplications occur much more frequently than expected, with rates similar to those of point mutations. The vast majority of duplicated genes become nonfunctional. Very few duplicated genes retain any function, and those that survive experience strong selective pressures. Different fates of duplicated genes in different populations could contribute to the process of speciation.

Comment: An interesting implication of this study is that it indicates duplicated genes are highly unlikely to produce new functions. It is much more likely that duplicated genes will degenerate and contribute nothing to evolution. The high rate of duplication inferred in this study is based on the supposition that only a single gene copy existed at the origin of the species. This supposition might be testable by comparing genomic sequences among closely related species to see whether they vary in the number of gene copies. If some genes were created in duplicate, the actual rate of gene duplication might be overestimated.

ORIGIN OF LIFE: RNA CAN'T TAKE THE HEAT

Moulton V, Gardner PP, Pointon RF, Creamer LK, Jameson GB, Penny D. 2000. RNA folding argues against a hot-start origin of life. *Journal of Molecular Evolution* 51:416-421.

Summary: Deep-sea hydrothermal vents have been proposed as a likely location for the origin of life. The presence of charged metallic surfaces, particularly iron pyrite, might facilitate chemical reactions

leading to the production of RNA and other biologically important macromolecules. Both theoretical and experimental results show that high temperatures such as exist around hydrothermal vents strongly reduce RNA folding. RNA molecules showed no secondary structure at temperatures above about 70^o C. Furthermore, high temperatures are destructive to RNA molecules. At 100^o C, an RNA molecule of 2000 nucleotides is expected to experience one break every 26 seconds. Cytosine is especially unstable at high temperatures. These features make it highly unlikely that life originated in a high-temperature environment, such as around hydrothermal vents.

Comment: These results reinforce previous reports that macromolecules are destroyed rather than created in hot aqueous environments. The presence of archaea in extreme environments is not a reflection of the origin of life, but of its diversity.

PALEONTOLOGY: DINOSAURS ON THE BEACH?

Lopez-Martinea N, Moratalla JJ, Sanz JL. 2000. Dinosaurs nesting on tidal flats. *Palaeogeography, Palaeoclimatology, Palaeoecology* 160:153-163.

Summary: Sauropod and hadrosaur dinosaurs have been variously interpreted as aquatic or terrestrial reptiles, with most paleontologists now favoring the terrestrial interpretation. However, dinosaur fossils are often found in sediments interpreted as marine, sometimes scavenged by sharks, or even encrusted with oysters. Dinosaur tracks are often located in sediments interpreted as margins of aquatic environments.

Now a group of dinosaur eggs has been found in an Upper Cretaceous tidal flat environment in Spain. The eggshell fossils have a high porosity. If the original eggshells were this porous, they would become dehydrated if left in a dry environment. This points to a periaquatic habitat for these dinosaurs. Modern crocodiles lay their eggs near water, and cover them with vegetation and mud. It is not known whether these dinosaurs followed a similar behavioral pattern. The identity of the dinosaurs is not known. Sauropod bones have been found in a nearby mine, and many eggshell fragments are found in the general area, along with fossils of mostly marine species.

Comment: It seems likely that some types of dinosaurs lived in or near aquatic habitats, while others did not. The preservation of such a

large number of eggshells and other fossil material must have required special circumstances. Examples such as this provide interesting problems regarding the conditions under which the fossils were assembled and preserved.

PALEONTOLOGY: PERMIAN BACTERIA BROUGHT TO LIFE

Graur D, Pupko T. 2001. The Permian bacterium that isn't. *Molecular Biology and Evolution* 18(6):1143-1146.

Summary: The small differences in DNA sequence between the "Permian" bacteria and contemporary bacteria indicate a short history of divergence and point to a more recent contamination of the salt deposits.

Comment: Contamination is a potential problem, but the investigators took great pains to carefully select salt crystals that appeared uncontaminated. A criticism based on expectation of great divergence in DNA sequence seems less than compelling in the absence of any empirical basis for suspecting contamination.

Vreeland RH, Rosenzweig WD, Powers DW. 2000. Isolation of a 250 million-year-old halotolerant bacterium from a primary salt crystal. *Nature* 407:844-845. For reactions, see *Nature* 411:155 (2001).

Summary: Bacteria were cultured from a salt crystal recovered from the Permian Salado Formation near Carlsbad, New Mexico. Care was taken to avoid contamination with modern bacteria at every step of the process. The salt crystal did not show signs of recrystallization or other alteration. The bacteria were identified as a *Bacillus* species. Sequence comparisons of 16s ribosomal DNA showed close similarity to *B. marismortui* (99% identity), and *Virgibacillus panthotheticus* (97.5% identity). The previous accepted record for oldest viable bacterial spores was based on bacteria cultured from 25-30 million-year-old amber.

Comment: This is a remarkable claim. If the bacteria were truly deposited with the salt, the spores have been quiescent since the time of deposition of the salt. According to the molecular clock hypothesis, one would expect a sequence divergence far greater than 1% over a period of 250 million years. For example, a recent experiment on *E. coli* over 10,000 generations showed an average detected rate of genetic

divergence of approximately 10^{-3} per generation. At this rate, an average divergence of 1% would be reached in 1,000 generations, about 150 days. The number of generations in 250 million years should be on the order of 10^{11} . Clearly interesting research questions are raised by the report of viable Permian bacteria.