ANNOTATIONS FROM THE LITERATURE

MOLECULAR PHYLOGENY

Kemmerer EC, Lei M, Wu R. 1991. Structure and molecular evolutionary analysis of a plant cytochrome c gene: surprising implications for *Arabidopsis thaliana*. Journal of Molecular Evolution 32:227-237.

> ***Summary.*** *Arabidopsis* is a plant belonging to the mustard family. The *Arabidopsis* cytochrome c gene is a single-copy gene, consisting of three exons and two introns. Cladograms for cytochrome c amino-acid sequences, and DNA sequences for histone H3, alcohol dehydrogenase, and actin genes place *Arabidopsis* with yeasts or *Neurospora* rather than with other higher plants.
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> ***Comment.*** This result contrasts with the classic picture of cytochrome c as an excellent "molecular clock." It seems that increasing the number of species being compared results in increasing problems for the molecular-clock concept.

Shapiro SG. 1991. Uniformity in the nonsynonymous substitution rates of embryonic beta-globin genes of several vertebrate species. Journal of Molecular Evolution 32:122-127.

> ***Summary.*** Placental embryonic beta-globin gene sequences are more similar than adult beta-globin gene sequences. The greater similarity is due to the nonsynonymous coding sites in the DNA. This is interpreted as suggesting greater functional constraints on the structure of the embryonic beta-globin genes than on the adult genes.
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> ***Comment.*** The theoretical basis for the molecular clock includes the necessity that most mutations be neutral and not subject to natural selection. This necessity appears to be violated in the case of embryonic beta-globin.

Westerman M, Edwards D. 1991. The relationship of *Dromiciops australis* to other marsupials: data from DNA-DNA hybridisation studies. Australian Journal of Zoology 39:123-130.

> ***Summary.*** The possible relationships of Australian marsupials to South American marsupials is of considerable interest to biogeographers and evolutionists. South American marsupials mostly belong to two

groups: the opossums and the shrew-like caenolestids. *Dromiciops*, a South American marsupial, was first assumed to be an opossum, but some studies have suggested it might be more closely related to the Australian marsupials than to the other South American marsupials. This paper reports on DNA-DNA hybridization of *Dromiciops* and several other marsupials, representing both Australian and South American groups. The results are interpreted as indicating that *Dromiciops* is distinct from both groups of marsupials, and should be classified in a group by itself.

ORIGIN OF LIFE

Avetisov VA, Goldanskii VI, Kuz'min VV. 1991. Handedness, origin of life and evolution. Physics Today 44:33-41.

Summary. This paper discusses some of the theoretical requirements for the origin of life. Two parts of the problem are studied in detail: the problem of "handedness," and the problem of self-replication. Many organic molecules occur in two alternate forms, which can be called left-handed (L form) or right-handed (D form). Only D forms of sugars are used, and only L forms of amino acids. This feature is called homochirality. Homochiral molecules are required for life. This means that self-replication must be stereospecific, preserving the homochirality of the molecules. How such a system could have arisen is the subject of this paper.

Life requires both homochirality of polymers and very high stereospecificity in self-replication. The question is, Which came first, the high stereospecificity or the homochirality? Calculations show that the formation of homochiral polymers requires one of two types of conditions. If the stereospecificity is not very high, then the medium must be essentially chirally pure. If the medium is not essentially chirally pure, then the stereospecificity must be extremely high. The authors conclude that homochirality is necessary for extremely high stereospecificity, so stereospecificity could not have arisen first. This means that a chirally pure medium must have been present in order for life to originate.

The production of a homochiral medium presents difficult problems. Some mechanism can be postulated which will increase the rate of the D form of a molecule relative to the rate of formation of the L form. The concentration of D form in the medium would increase through this hypothetical process. At the same time, however, the concentration

of D form would decrease as it was used in constructing polymers. This means that L and D forms would be in equilibrium, and the probability of avoiding addition of an L form would approach zero as the length of the polymer increased. Addition of an L form would disrupt the secondary structure of the molecule, preventing life from arising. The authors propose a different mechanism to achieve homochirality of the medium. They propose a "bifurcation" type process, and suggest that such a system is capable of producing a chirally pure medium just long enough for stereospecificity to arise.

Comment. A scientific explanation for the origin of life involves many apparently insoluble problems. This paper illustrates the seriousness of just one of these problems, the origin of homochiral replication.

PALEONTOLOGY

Benton MJ. 1991. Polar dinosaurs and ancient climates. Trends in Ecology and Evolution 6(1):28-30.

Summary. Scientists have generally considered dinosaurs to have lived in warm, tropical, usually humid environments. However, dinosaur fossils have been found at several locations within the arctic or antarctic. Locations include Spitsbergen, the North Slope of Alaska, Northwest Territory, Yukon Territory, southern Australia, New Zealand and Antarctica. How could such large animals live in an area with the long periods of darkness typical of polar regions? One suggestion is that the dinosaurs were "warm-blooded." No one really knows whether they were or not, but their reptilian structure is usually associated with being "cold- blooded." Another suggestion is that the dinosaurs migrated long distances to avoid the winter cold. Required distances for migration may have been 2000-4000 km each way. Another suggestion is that polar regions were warmer at the time the dinosaurs lived.

Comment. Whatever the answer, it appears that conditions were once greatly different from what they are today.

Buick R. 1991. Microfossil recognition in Archean rocks: an appraisal of spheroids and filaments from a 3500 m.y. old chert-barite unit at North Pole, Western Australia. Palaios 5:441-459.

Summary. Various claims of Archean (lower Precambrian) fossils have been made, but controversy has surrounded the claims. The author summarizes some criteria that should be applied to claims of fossils in

Archean rocks. Several examples of supposed Archean microfossils from Western Australia are described. None of these claimed microfossils is convincingly supported. The author suggests that claims of Archean microfossils be examined closely, applying the list of criteria he has prepared.

Coates MI, Clack JA. 1991. Fish-like gills and breathing in the earliest known tetrapod. Nature 352:234-236.

Summary. The amphibian-like *Acanthostega* is one of the earliest known tetrapods. This paper reports the discovery of a gill-support structure on a specimen of *Acanthostega* that was collected from the Upper Devonian of Greenland. The specimen also has front feet with 8 digits, a stapes, and fish-like bones in the skull. *Ichthyostega* is generally considered a link between fishes and tetrapods. Some of the characteristics of *Ichthyostega* resemble the tadpole stage of an amphibian, but interpretation is complicated by the lack of any modern representatives of the group to which it belongs.

Reisz RR, Laurin M. 1991. *Owenetta* and the origin of turtles. Nature 349:324-326.

Summary. *Owenetta* is a procolophonid reptile (Order Cotylosauria, Suborder Procolophonia, Family Nyctiphruretidae) from the Upper Permian and Lower Triassic of South Africa. *Owenetta* shares several derived features with turtles, and the authors suggest that the procolophonids are the sister group to turtles, and that turtles may have arisen in the Late Permian. The alternative sister group for turtles is the Captorhinidae (Order Cotylosauria, Suborder Captorhinomropha), which first appear in the Lower Permian of North America. Turtles first appear in the Middle or Upper Triassic, with no obvious links to any other group. This paper represents an attempt to resolve the puzzle of the origin of turtles.

Shubin NH, Crompton AW, Sues HD, Olsen PE. 1991. New fossil evidence on the sister-group of mammals and Early Mesozoic faunal distributions. Science 251:1063-1065.

Summary. Newly discovered fossil material from the Lower Jurassic of Nova Scotia, Canada reveals the presence of a fossil mammal-like reptile from the family Tritheledontidae. This is the first definite record of this family in North America. The material appears to be from the same genus and species (*Pachygenelus monus*) as

previously found in South Africa. Other material from the same formation in Nova Scotia is similar or indistinguishable from material from other Lower Jurassic formations in Africa, Europe or Asia. Several synapomorphies form the basis for considering the tritheledontids to be the sister group of mammals. One of these is a jaw joint between the dentary and squamosal.

The nearly worldwide distribution of Lower Jurassic species, after the initiation of Pangean fragmentation, is of interest biogeographically. The first fossil mammals are found in the Upper Triassic, stratigraphically lower than the Nova Scotial reptiles.

POPULATION GENETICS

Fleischer RC, Conant S, Morin MP. 1991. Genetic variation in native and translocated populations of the Laysan finch (*Telespiza cantans*). Heredity 66:125-130.

Summary. Much theoretical work has been done on the concept of genetic bottlenecks and founder effects, but little actual field evidence is available. This paper reports genetic differences among populations of Laysan finches on four islands. Contrary to expectations, population bottlenecks did not result in reduced levels of genetic variation. In fact, genetic variation appears possibly to have increased after the bottleneck. The differences are relatively minor, but occurred in less than twenty years.

Comment. This result is contrary to the conventional wisdom, and may have important implications for models of speciation.

PUNCTUATED EQUILIBRIA OR INCOMPLETE SAMPLING?

Cuffey RJ, Pachut JF. 1991. Clinal morphological variation along a depth gradient in the living scleractinian reef coral *Favia pallida*: effects on perceived evolutionary tempos in the fossil record. Palaios 5:580-589.

Summary. Coral from the Pacific island of Enewetak was used in this study. Samples were taken of a reef coral at depth intervals of about 4.5 m, and measured for corallite diameter and growth rate. Coral samples showed a clinal gradation from shallow to deep water. Samples from different depths were statistically different. If sampling were incomplete, they would form a stepwise "punctuated" pattern, while more complete sampling would reveal a clinal "graduated" pattern.

The possible existence of environmental gradients should be considered in efforts to understand trends in the fossil record.