ANNOTATIONS FROM THE LITERATURE*

BIOGEOGRAPHY: AN AFRICAN FISH IN CHIAPAS?

Lundberg JG, Sullivan JP, Rodiles-Hernandez R, Hendrickson DA. 2007. Discovery of African roots for the Mesoamerican Chiapas catfish, *Lacantunia enigmatica*, requires an ancient intercontinental passage. *Proceedings of the Academy of Natural Sciences of Philadelphia* 156:39-53.

Summary. A fresh-water catfish in Chiapas, Mexico has been found to be more closely related to African catfish than to other species of Mexican catfish, based on sequence comparisons of two genes. The fish is so distinctive in its morphology it has been classified in a family of its own. Its closest relatives seem to be a group of seven families of African catfish. Molecular clock estimates of divergence time are around 85 Ma, long after the separation of Africa from the Old World. It is unlikely that this freshwater fish traversed across the ocean, so the most likely explanation is that it dispersed across either the Beringian land bridge or a land bridge formerly connecting North America and northern Europe. A mid-Eocene freshening of Arctic surface waters might have facilitated the intercontinental dispersal via partly fresh water.

Comment. This is another example of a transoceanic disjunct distribution that has traditionally been explained by Gondwanan vicariance — the theory that some species living today descended from a common ancestor whose range was divided when Gondwanaland split into several continents. The idea proposed in the paper, that at least some parts of the ocean might have had fresh or partially fresh surface waters, is an intriguing idea that might be worth exploring further to determine any potential relationship to catastrophic global flooding.

BIOGEOGRAPHY: RATITE PARALLELISM

Harshman J, Braun EL, Braun MJ, Huddleston CJ, Bowie RCK, Chojnowski JL, Hackett SJ, Han K-L, Kimball RT, Marks BD, Miglia KJ, Moore WS, Reddy S, Sheldon FH, Steadman DW, Steppan SJ, Witt CC, Yuri T. 2008. Phylogenomic evidence for multiple losses of flight in ratite birds. *Proceedings of the National Academy of Sciences (USA)* 105:13462-13467.

*Other annotations are available on our website: www.grisda.org

Summary. Ostriches, rheas, emus and other large flightless birds make up a group known as ratites. All ratites have a palatal structure known as paleognath and lack a keel on the sternum. The tinamous are a group of South American birds resembling grouse or quails, but having a paleognathic palate. They have a keeled sternum for attachment of flight muscles, and they can fly. Relationships among the paleognath birds have been controversial, but the majority opinion is that tinamous are the sister group to the ratites. This implies that the ratites are all a single lineage, and that the ability to fly was lost only once, in the ancestor of the ratites. Since the ratites are restricted to the southern continents, their distribution has been explained as the result of vicariance, meaning that the ratite ancestor lived on Gondwana, and the different ratites evolved sequentially on different continents as the supercontinent Gondwana broke apart. This scenario, although it has several problems, has been used as a classic example of evolution by vicariance (splitting of an ancestral range). The present article reports results of DNA sequence comparison of 20 unlinked nuclear genes for all the ratite genera, four genera of tinamous, and several other birds as well as crocodiles. The results strongly indicate that ostriches are the outgroup to the other paleognaths, including tinamous. The tinamous are the most derived group, about equidistant from the rheas and the emu-cassowary-kiwi group. Two scenarios can explain this pattern. Either the ancestral ratite was flightless and the tinamous regained the ability to fly, or the ancestor of the group could fly, and flight has been lost three different times. No examples are known of regain of flight, but dozens of examples are known of loss of flight, so the latter explanation is far more likely. This suggests dispersal by a flighted ancestor, followed by loss of flight in the entire group except the tinamous, and removes the need for the vicariance hypothesis of ratite origins.

Comment. Vicariance biogeography states that new species arise when the range of a single ancestor species is split. This theory received a strong impetus from development of plate tectonics and stimulated a large body of research. Numerous taxa were studied in a search for examples of evolutionary lineages with relationships that corresponded to the sequence of fragmentation of Gondwana. The ratites have been a prime example, despite the fact that their oldest fossils are of flighted birds from Europe, with a fragmentary possible ratite from South America of about the same geological age. These fossils are interpreted as preserved long after the breakup of Gondwana. A further problem is evidence that the moas and kiwis dispersed to New Zealand independently and too recently for Gondwanan vicariance.[1] Conflict with geochronology is also seen in other groups thought to have originated by Gondwanan vicariance; in most cases the

continents are thought to have separated long before the groups diversified, implying transoceanic dispersal rather than vicariance.[2] (TGS)

ENDNOTES

1. Cooper AC, et al. 2001. Complete mitochondrial genome sequences of two extinct moas clarify ratite evolution. *Nature* 409:704-707.
2. De Quiroz A. 2004. The resurrection of oceanic dispersal in historical biogeography. *Trends in Ecology and Evolution* 20:68-73.

BIOLOGY: GLASS SPONGE REEFS FOUND ALIVE

Dybas CL. 2008. Deep sea lost and found. *BioScience* 58:288-294.

Summary. Reefs formed by glass sponges are most common in Jurassic sediments, but were thought to be extinct for 100 million years until discovered in the 1980s off the coast of British Columbia in southwestern Canada. Living glass sponges, of the Class Hexactinellida, are known from the deep sea, but these forms do not produce reefs. Recent exploration of the sea floor with acoustic sonar and underwater photography revealed the existence of several glass-sponge reefs in water 150-250 meters deep in Hecate Strait, British Columbia. In 2007 scientists discovered more reefs on the seafloor some 30 miles west of Grays Harbor, Washington, the first such reefs found on the open seafloor.

Comment. The term "living fossil" is often given to organisms that seemingly went extinct in the fossil record, but are found living today. The coelacanth is another famous example of a "living fossil." Such examples, although relatively uncommon, show that there is much more to be learned about the geologic column, and we may be mistaken in thinking that we understand such phenomena as extinctions. They also raise questions about gradual evolution if they are millions of years old and have not changed significantly.

CHEMICAL EVOLUTION: MORE PRIMORDIAL SOUP

Johnson AP, Cleaves HJ, Dworkin JP, Glavin DP, Lazcano A, Bada JL. 2008. The Miller volcanic spark discharge apparatus. *Science* 322:404.

Summary: Stanley Miller conducted research purporting to show that the building blocks of life could be produced under prebiotic conditions at Earth's surface. This research was reported in a seminal 1953 paper[1] that is routinely referenced in biology textbooks. Variations of the device Miller constructed for amino acid production and reported in the 1953 paper were constructed by Miller and described in his 1954 doctoral dissertation.[2]

However, these variations appeared to be less successful at producing amino acids than the one reported in 1953. Samples from three apparatuses constructed by Miller were found among his belongings after his death. These samples were analyzed using Liquid Chromatography with UV Fluorescence Detection and Time of Flight-Mass Spectrometry (LC-FD/ToF-MS), revealing that a greater variety of amino acids, 22, than those detected by Miller were present in samples produced in one of the devices modified slightly from the original. However, these additional amino acids were present at far lower concentrations than those reported in the 1953 paper using the "classic" apparatus. The authors suggest that conditions in the early earth may have more closely resembled the modified apparatus with steam from volcanoes, a reducing atmosphere and lightning producing amino acids that were then polymerized by carbonyl sulfide.

Comment: Inorganic production of amino acids is uncontroversial, but real questions revolve around the conditions necessary, yields achieved and what happens afterwards. The same unrealistic conditions used in the device first reported in Miller's 1953 paper were used in the modified apparatus. No compelling evidence of a strongly reducing atmosphere before life evolved has been found. The original amino acid products of Miller's devices were very dilute; the most abundant, glycine, was produced on the order of 0.63 mM. Of the 20 amino acids commonly used in proteins, Miller only reported glycine, alanine and possibly aspartic acid.[3] The newly reported amino acids were so dilute they required the extreme sensitivity of modern equipment to detect them. In extremely dilute aqueous solutions, amino acids do not polymerize significantly because production of peptide bonds involves a condensation reaction. In samples from Miller's "classic" apparatus, serine, aspartic acid, valine, glutamic acid were detected, the only additional amino acid found in proteins produced by one of the modified devices was phenylalanine at about 5×10^{-5} the yield of glycine. Across samples from all three of Miller's devices, 15 amino acids not used in proteins were identified along with some other molecules. Both Miller's original report and this recent re-analysis of his samples give little encouragement to theories of chemical evolution. (TGS)

ENDNOTES

1. Miller SL. 1953. A production of amino acids under possible primitive earth conditions. *Science* 117:528,529.
2. Miller SL. 1954. A production of organic compounds under possible primitive earth condition. PhD Thesis, University of Chicago.
3. Miller SL. 1955. Production of some organic compounds under possible primitive earth conditions. *Journal of the American Chemical Society* 77:2351-2361.

GENETICS: GENETIC BASIS OF VARIATION

Stranger BE, Forrest MS, Dunning M, Ingle CE, Beazley C, Thorne N, Redon R, Bird CP, de Grassi A, Lee C, Tyler-Smith C, Carter N, Scherer SW, Tavaré S, Deloukas P, Hurles ME, Dermitzakis ET. 2007. Relative impact of nucleotide and copy number variation on gene expression phenotypes. *Science* 315:848-853.

Summary. This report seeks to explain the genetic basis for phenotypic variation, particularly in humans. This information could be useful in understanding the causes and suggesting potential cures of human genetic diseases. Two types of genetic variation were studied: single-nucleotide polymorphisms (SNP), and copy number variants (CNV). Single-nucleotide polymorphisms are differences in single nucleotides in different individuals, and are known to affect phenotypic variation, including susceptibility to disease. Less is known about copy number variants, in which individuals differ in the number of copies of a gene or a portion of a gene. This study focused on CNVs involving sequences at least 100 kilobases in length. SNPs were associated with 83.6% of the detected genetic variation and CNPs with 17.7% of the variation. Both factors were associated with the variation in 1.3% of the cases. Further studies are needed to explore the associations of phenotypic variation with differences in nucleotide sequence less than 100 kilobases in length. This suggests that both SNPs and CNVs contribute significantly to human phenotypic variation, which provides the material on which natural selection acts.

Comment. Identification of specific genetic differences with known phenotypic variants may provide opportunity for medical intervention through genetic engineering. It may also contribute to our understanding of the limits of variation and biological change. It remains to be seen whether we have the ethical fortitude to use this information in morally appropriate ways.

PALEOECOLOGY: ARCTIC TREE RINGS

Jahren AH, Sternberg LSL. 2008. Annual patterns within tree rings of the Arctic middle Eocene (ca. 45 Ma): Isotopic signatures of precipitation, relative humidity, and deciduousness. *Geology* 36:99-102.

Summary. Axel Heiberg Island is located in the far north of Canada, above the Arctic Circle. A "fossil forest" of well-preserved wood is known from Eocene sediments of Axel Heiberg Island.[1] The wood is not petrified, but retains essentially its original composition. The "forest" is dominated by *Metasequoia*, a genus of deciduous coniferous trees now native only

to China. This paper reports the results of analyzing changes in isotopic composition of carbon, oxygen and hydrogen within individual tree rings. The analysis indicates progressively increasing temperatures during the growing season, and shows similar patterns to those seen in modern high-latitude deciduous trees.

Comment. Some features of this fossil site are of interest. First, the exquisite preservation of the wood in near-pristine condition is remarkable. The standard explanation is that the trees grew in warm temperatures and were buried before they had time to decompose. The climate is thought to have been frost-free, and has been compared with the modern climate of the Pacific Northwest of the United States.[2] This might imply a fairly rapid temperature decline, since fungi and other wood-destroying organisms are generally abundant in warm climates, and would eventually decompose the wood. Second, the presence of rings in the fossil trees indicates seasonal growth, as would be expected in a region that had alternating periods of continuous daylight and continuous darkness. In plate tectonic theory, Axel Heiberg Island was about 79 degrees north latitude when the fossil trees were buried. At this latitude, continuous daylight would last for about 130 days and continuous night for about 110 days. Third, the forest is dominated by a tree that was not known to be living today until it was discovered by Tsang Wang and Wan-Chun Cheng in central China in 1944.[3] A tree that is now rare and highly restricted in its native distribution was once widespread and dominant in an environment probably different from anything known today. These features remind us that the world has not always been as it is now. (TGS)

ENDNOTES

1. Jahren AH. 2007. The Arctic Forest of the Middle Eocene. *Annual Review of Earth and Planetary Science* 35:509-540.
2. Ibid.
3. Chaney RW. 1950. A revision of fossil Sequoia and Taxodium in western north America based on the recent discovery of Metasequoia. *Transactions of the American Philosophical Society* 40(3):171-263.

PALEONTOLOGY: GECKO TOES

Arnold EN, Poinar G. 2008. A 100 million year old gecko with sophisticated adhesive toe pads, preserved in amber from Myanmar. *Zootaxa* 1847:62-68.

Summary. A tiny fossil gecko with modern-looking toe pads has been discovered in Lower Cretaceous amber. The fossil was found in 2001 in an amber mine in Myanmar, and includes a foot and toes, along with part of the tail. The specimen is thought to be a juvenile of a species

that may have grown to 30 cm (12 in) in length. This is the geologically oldest fossil gecko known; the oldest previous reports were based on fragmentary material from the Upper Cretaceous, and a well-preserved Eocene gecko found in Baltic amber from northwestern Russia. The toe pads on this fossil have hair-like structures similar to those of many modern gecko species. These structures enable the lizards to climb vertical surfaces such as walls and even glass.

Comment. Geckos are commonly found roaming freely across walls, windows and ceilings in pursuit of insects. Their ability to crawl on virtually any surface is due in part to a precisely structured set of hair-like setae on the pads of the toes that have the property of sticking even to smooth surfaces.[1] The setae and toe action are arranged so that attachment and detachment of the foot is accomplished in a fraction of a second, permitting the gecko to run surprisingly quickly across a wall or ceiling.[2] The narrow specification of the setae and their arrangement on gecko's bodies makes evolutionary explanations of their origin problematic and is suggestive of design. This is the oldest known gecko fossil, suggesting that the very first geckos had the ability to perform the remarkable climbing feats we admire today. (TGS)

ENDNOTES

1. Autumn K, et al. 2000. Adhesive force of a single gecko foot-hair. Nature 204:681-685; Autumn K, et al. 2002. Evidence for van der Waals adhesion in gecko setae. *Proceedings of the National Academy of Sciences (USA)* 99:12252-12256.
2. See Y Tian et al. 2006. Adhesion and friction in gecko toe attachment and detachment. *Proceedings of the National Academy of Sciences (USA)* 103(51):19320-19325.