13

SORDES PILOSUS AND THE FUNCTION OF THE FIFTH TOE IN PTEROSAURS

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Early pterosaurs ('rhamphorhynchoids') have a clawless fifth toe composed of two elongate phalanges. In early pterodactyloids this toe is reduced to a single phalange, and lost in later forms. Explanations for this intriguing structure include tensioning of the cheiropatagium or uropatagium, manipulation of a foot web, or a gripping function.

Exceptionally well preserved remains of *Sordes pilosus* (Rhamphorhynchoidea: Scaphognathinae) from the Upper Jurassic of Kazakhstan provide clear evidence of the function of the fifth toe. The foot was twisted backward and the fifth toe lay medially with its distal phalange inserted into the rear edge of an extensive uropatagium stretched between the hind limbs, but free of the tail. In flight, the fifth toe supported, tensioned and manipulated the uropatagium; it was thus positionally, but not functionally, analogous with the calcar of bats.

The uropatagium is not clearly preserved in other pterosaurs, but in many 'rhamphorhynchoids' (*Peteinosaurus, Dimorphodon, ?Eudimorphodon, Campylognathoides, Dorygnathus* and *Rhamphorhynchus*) and some early pterodactyloids (*Pterodactylus* and *?Ctenochasma*), the foot and fifth toe of articulated specimens exhibit a very similar position to that in *Sordes*. A uropatagium was almost certainly present in all these cases and is probably plesiomorphic for pterosaurs.

The presence of a uropatagium and attachment of the cheiropatagium to the leg (clearly evident in *Sordes* and *Pterodactylus*) point to an intimate association between the hind limb and flight apparatus. This arrangement must have severely restricted the terrestrial ability of early pterosaurs and is totally inconsistent with a fully-erect, bipedal stance and gait.

14

LATEST MIOCENE MARINE VERTEBRATES FROM THE ALMEJAS FORMATION, ISLA DE CEDROS, BAJA CALIFORNIA, MEXICO

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A joint Mexican and US team, after a hiatus of 27 years, renewed collecting this year in the marine Almejas Formation on Isla de Cedros, off the coast of Baja California. The formation ranges in age from latest Miocene to Pliocene (*circa* 9 to 3 Ma), and the latest Miocene age (*circa* 9 to 6 Ma) lower member of the formation has now yielded over 30 species of sharks, bony fishes, birds, and marine mammals, a mixture of nearshore and offshore animals, and one of the most diverse fossil marine vertebrate assemblages of its age known from the North Pacific realm. Extant relatives of some of the species still live in the same area. The closest living relatives of others, such as a gannet, walrus-like pinniped (*Aivukus*), pontoporiid dolphin (*Parapontoporia*), and beluga-like monodontid (*Denebola*) now live in different ocean basins and/or different latitudes. A third component of the assemblage includes animals with no living relatives; for example, the giant sharks (*Carcharocles*), flightless auks (*Mancalla*), dusignathine pinnipeds, and an albireonid dolphin (*Albireo*). The Almejas Formation and correlative parts of the Pisco Formation in Peru contain apparently antitropical (= bitemperate) taxon pairs of marine vertebrates, analogous to some living northern and southern hemisphere species.

15

OXYGEN ISOTOPE ANALYSIS OF TURTLE SHELLS: POTENTIAL USE AS CONTINENTAL PALEOCLIMATE INDICATORS

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North American freshwater turtles occur in waters ranging in $\delta^{18}O$ from -2‰ (Florida) to -15‰ (Montana) SMOW. Emydid and kinosternid turtles show an essentially constant positive effect of $\delta^{18}O$ in body fluids from freshwater due to retention of metabolic water. A further positive offset in shell phosphate (+7‰ to +20‰) results from the temperature of shell growth. This indicates an optimal growth temperature of about 30°C. Growth experiments indicate that basking turtles did not grow at temperatures below 25°C. They did grow at variable but increasing rates as temperature was raised from 26-32°C, close to their mean preferred temperatures.

Analyses of fossil turtles may make it possible to map the isotopic composition of ancient drainage systems with implications for climate and for mountain elevations. Ambient water $\delta^{18}O$ roughly correlates with mean annual air temperature. $\delta^{18}O$ of associated fish and invertebrates can be used to correct for water $\delta^{18}O$ to yield accurate paleotemperatures. The advantage of turtle bones over mammals is that fractionation of $\delta^{18}O$ between ambient and body water does not appear to be taxon-specific. This promises to provide new insights into paleogeography and paleoclimatology of ancient drainage systems.

16

COMPARATIVE TAPHONOMIC ANALYSIS OF FOSSIL VERTEBRATE ASSEMBLAGES USING MULTIVARIATE DATA ARRAYS

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A new method of taphonomic analysis is proposed to facilitate comparisons among fossil assemblages and between fossil assemblages and modern analogues. This method specifies three categories of variables: 1) *assemblage* (sample size, number of individuals and species, relative abundance, body size, age spectra, articulation, and skeletal parts); 2) *quarry* (size of bone accumulation, spatial density and arrangement); and 3) *bone modification* (breakage, weathering, abrasion, surface marks), which are used together or independently depending on the type of assemblage (surface or quarry sample). Each variable is presented as a value on a univariate axis, and resulting multivariate arrays provide the basis for inter-assemblage