PERIMIAN DICYNODONTs IN THE TWENTY-FIRST CENTURY

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Dicynodonts were the most abundant and diverse group of Late Permian terrestrial vertebrate herbivores. Although the study of dicynodonts dates to the time of Owen, new research is currently providing a fresh view of dicynodonts and their place in the Permian world. The phylogeny of dicynodonts is now better known than at any previous time, thanks to recent cladistic studies. This increasing phylogenetic knowledge provides a framework for testing evolutionary, biogeographic, and biostratigraphic hypotheses. The discovery of several new, basal dicynodonts from the Tapinocephalidae Assemblage Zone of South Africa suggests a Gondwanan origin for the group, which fits well with recent challenges to the traditional hypothesis of a Laurasian origin of most major therapsid clades. Six new dicynodont genera also have been described recently from Russia. Among the new Russian taxa may be the Permian sister taxon of the Kannemeyeriiforms, suggesting that this important Triassic clade may have originated in Laurasia. The success of dicynodonts in the Permian has been attributed largely to their complex, masticatory system, based on a propalinal jaw movement. However, new studies have shown that at least one dicynodont (Lystrosaurus) was able to overcompensate for the propalinal jaw movement and, therefore, that this feature may have evolved twice within Anomodontia. Dicynodonts continue to be used extensively in Permian biostratigraphy. As our understanding of dicynodont phylogeny and stratigraphy improves, we may need to reassess some previously recognized, biogeographic correlations and divisions. For example, the well known genus Deinosuchus may be paraphyletic, and careful biogeographic, stratigraphic, and phylogenetic research will be necessary to determine the nature of these correlations across widely separated basins. Much of the new research on dicynodonts challenges traditional ideas, and demonstrates the importance of new methods and new discoveries to our understanding of extinct synapsids. Only through similarly detailed consideration of other terrestrial organisms will we have an accurate picture of the Permian world and the extinction that ended it.

FRESHWATER FISHES OF THE LOS RASTROS FORMATION (MIDDLE TRIASSIC)

ICHIGUALASTO-VILLA UNION BASIN, ARGENTINA

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The continental Triassic deposits of the Ichigualasto-Villa Uni n Basin in northwestern Argentina yield pivotal tetrapod faunas, but fish remains are rarely described, and are only known from lacustrine facies of the Los Rastos Formation (Ladinian?). The fishes described here are preserved in a mass kill layer in the fifth lacustrine hemicycle of Los Rastos Formation near Ca n del Gualo (La Rioja Province). Prior to our work, only one fish taxon had been described from the Los Rastos Formation. This fish was referred to the Australian genus Myriolepis, and biogeographic relationships were proposed on the basis of this assignment. However, the material is poorly preserved, and the assignment to the Australian genus is questionable. Based on five new specimens, we have identified three additional basal actinopterygian fishes in the Los Rastos Formation. Unfortunately, because of the preservation of the material only one of the new taxa can be diagnosed. This specimen represents the first record of the Redfieldiformes in South America, and it is characterized by its strikingly large body size. Interestingly, the other two new taxa from the same bed are also represented by large specimens (400-600 mm estimated total length). The close association of these relatively large specimens in a single bed is suggestive of some type of event mortality. Selective preservation in this case may not have biased the preservation of smaller forms. A preservation bias might also explain the absence of ceratodont dipnoans, which tend to occur with redfieldiforms in other Triassic sediments of Gondwana.

CHEIROLEPIFORM FISH FROM THE DEVONIAN OF RED HILL, NEVADA

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Middle-Late Devonian actinopterygians were poorly diversified and represented by only seven genera (Cheirolepis, Howquaapelys, Mimia, Myophyllosia, Osiroichthys, Petrolisthes, and Tepippus). Although complete specimens are rare, scales are found world-wide. The Cheirolepididae, representing one of the oldest actinopterygian groups, is a monographic family known from Cheirolepis canadensis (Frasnian; Miguasha, Canada), C. tualii (Givetian; Scotand), and questionably by C. gaptured (Givetian; Germany), and C. gracilis (Givetian; Germany). A few years ago, additional cheirolepid remains (lower jaw, scales) from the Middle-Upper Devonian boundary of Red Hill, Nevada, were identified as Cheirolepis sp. cf. C. canadensis. Currently, Cheirolepis is interpreted as basal actinoptery-

PHYLLOGENETICS OF LIVING AND EXTINCT INSECTIVORAN MAMMALS: APPLY-

ING TOTAL EVIDENCE AND SUPERCOMPUTING

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The more intriguing proposals in higher mammalian phylogenetics during the last decade have involved suggestions that in many cases the modern subfamilies within the Chiropteridae, Chrysochloridae, and Tadaridae may be monophyletic groups. For most of the 20th century, tenrecs and golden moles were considered to be a part of the Lipotyphla, along with shrews, hedgehogs, moles, and solenodons. More recently, a large amount of sequence data has been interpreted to support a close relationship among tenrecs, golden moles, elephants, sea cows, hyraxes, elephant shrews, and aardvarks, collectively known as the Afrotetra. Here, we test the support for Afrotetra from approximately 2000 of sequence data using several distinct analyses that vary statements of sequence homology and character transformation weights (including gaps). We combine the molecular data with a new morphological matrix that samples extinct insectivores, condylarths, anagalids, embirichodonts, desmostylians, proboscideans, and Cretaceous eutherians, all of which have been hypothesized either to nest within Afrotetra or influence the position of placental root. Our data indicate that Afrotetra is not a well-supported node, and there is evidence that this may have evolved twice within Anomodontia. Dicynodonts continue to be used extensively in Permian biostratigraphy. As our understanding of dicynodont phylogeny and stratigraphy improves, we may need to reassess some previously recognized, biogeographic correlations and divisions. For example, the well known genus Deinosuchus may be paraphyletic, and careful biogeographic, stratigraphic, and phylogenetic research will be necessary to determine the nature of these correlations across widely separated basins. Much of the new research on dicynodonts challenges traditional ideas, and demonstrates the importance of new methods and new discoveries to our understanding of extinct synapsids. Only through similarly detailed consideration of other terrestrial organisms will we have an accurate picture of the Permian world and the extinction that ended it.

HUMAN EVIDENCE AND SUPERCOMPUTING

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Body mass is an important aspect of the biology of an organism. Many methods have been proposed to estimate body mass from skeletal measurements. Most have been based on univariate regression of the mass of specimens against single measurements, usually of limb bones, and subsequent use of the regression relationship to predict specimens of unknown mass. Although these methods are frequently used (e.g., diameter measurements of the phalanges and weight-bearing bones), typically no attempt is made to compare the degrees of correlation of these measures with body mass against other possible skeletal measures. Another class of body-size estimates has been based on volumetric models of reconstructed body forms. These models are advantageous for fossil organisms with no modern analog, but require complete skeletal elements to allow for reconstruction and involve various conjectures about the anatomy of soft tissues.

We describe the use of a simple multivariate method (principal component analysis) to predict body mass from sets of log-transformed skeletal measurements, and compare the results of these predictions with mass estimates based on univariate regression of a variety of elements. The multivariate method has the advantages of using measurements that provide information on both body size and shape, of averaging the predictive values of all individual measures and their prediction errors, and of not requiring complete skeletons.

We used both ontogenetic and interspecific data on modern birds, bats, and crocodilians to test the predictive abilities of univariate versus multivariate estimates of body mass and to compare the predictive values of individual measurements. Different bone measurements varied widely in their contribution to the variance in body mass, and it was a much better estimate than any univariate method. We then applied the multivariate and volumetric methods to estimate body sizes of three species of pterosaurs, including the giant Quetzalcoatlus, and of Archaeopteryx. Depending on the body density used to scale volume to mass, we estimate the body mass of Quetzalcoatlus to be 90-120 kg.

A PHYLOGENETIC APPROACH TO GONDWANA BIOGEOGRAPHY

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Widespread use of cladistic methodology during the last decades has made it possible to compile enough phylogenetic data to test biogeographic hypotheses using parsimony methods. Here we attempt a cladistic reconstruction of the Gondwanan breakup. We analyze eleven vertebrate phylogenetic data sets using Brooks Parsimony Analysis in order to produce a comprehensive hypothesis of the historic relationships. Our data include phylogeny of Cichildae (freshwater fishes), Dipnoi (lungfishes), peirosaurids and Araripesuchidae (extinct Crocodylomorpha), Neoceratosauroidea and Spinosauridae (theropod dinosaurs), Titanosauria and Dilophosauridae (sauropus dinosaurs), Raites (ostreiches and relatives), Natalidae (bats), and Gondwanatheria (extinct mammals) obtained from the literature. To produce a matrix of areas versus taxa, ancestral and terminal taxa specified by the phylogenies were coded according to the presence of their descendants in each presumptive area of endemism. A single most parsimonious area cladogram was selected using global parsimony analysis (127 steps; consistency index = 0.74; retention index = 0.61). The following set of area relationships was specified: (Mongolia [(New Zealand, Australia), (Africa (Inda-Madagascar (Argentina, Brazil))].) According to this hypothesis, the first vicariant event associated with the break up of the Gondwanan supercontinent was the separation of Australia and New Zealand from the remaining landmasses (Upper Jurassic-Early Cretaceous). The formation of the South Atlantic Ocean and the Strait of Mozambique subsequently lead to isolation of Africa from surrounding continental plates (African-Antarctic). According to our data set, India, Madagascar, and South America share a common history subsequent to the isolation of Africa. Such relationship may be explained by a lasting connection of the southern tip of South America to Antarctica, Madagascar, and the Indian subcontinent. We predict that further fossil discover-

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