MORPHOLOGICAL, PHYLOGENETIC AND ECOLOGICAL ASSESSMENT OF A NEW SPECIES OF GEOMORPHA FROM THE PAWNEE CREEK FORMATION, COLORADO

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The Geomyoidea are a group of rodents endemic to North America that exhibit great ecological diversity today as well as throughout their fossil record. However, less is known about the diversifications and ecologies of early geomyoids and stem taxa (together part of Geomorpha). Here, we present a new genus and species of Geomorpha from Hemingfordian-aged deposits of the Pawnee Creek Formation in Colorado. The specimen includes a partial skull, complete upper and lower dentitions, as well as several fragments of limbs and vertebrae, notably a complete right astragalus. Distinguishing features of the new fossil include its large size in comparison to many other stem geomyoids, the presence of frontal foramina and a supraorbital bony flange, the inflation of both the mastoid and auditory bulla, and the coronoid process of the dentary ascending at the middle of the m2. The upper premolars are larger than the molars and have a paracone and elongated protocone. On the lower premolars, the metaconid is connected

CRANIAL ONTOGENY IN THE EARLY CRETACEOUS CERATOPSIAN DINOSAUR *PSITTACOSAURUS LUJIATUNENSIS*: INTRASPECIFIC VARIATION BY AGE AND TAXONOMIC IMPLICATIONS

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Before using ontogenetically variable character data and character scorings from immature individuals in maturity assessment and taxonomy of fossils, character state changes across ontogeny should first be evaluated at the species level. *Psittacosaurus* is one of the best-sampled dinosaur genera in the fossil record and the most speciose genus of dinosaur, with ten species currently accepted as valid. Histological data for *Psittacosaurus* specimens from China, Mongolia, and Russia have been reported, showing different life history strategies for each analyzed species. However, no study has yet comprehensively examined changes in character states

or evaluated characters specific to an ontogenetic stage. Here we examined the post-hatchling variation of *Psittacosaurus lujiatunensis* based on 30 three-dimensionally preserved complete skulls, of which 16 have associated long bone histology data. The specimens are all from the Lujiatun Unit (Barremian, Early Cretaceous) of the lowermost Yixian Formation in Liaoning Province, northeast China. Taphonomic effects were accounted for when identifying and scoring variation. Taphonomic processes inferred from articulated skeletons support the presence of only a single species of *Psittacosaurus* in the Lujiatun bed, with other proposed Lujiatun species exhibiting different skull morphology due to diagenetic deformation. Based on histological ages, specimens range from less than a year old to fully mature individuals more than ten years old. As previously reported, commonly used body measurements are strongly correlated with age. The efficacy of size-independent character changes for assessing maturity and assigning a specimen to an ontogenetic stage was tested by treating the ontogenetic hierarchy as a form of phylogenetic hierarchy (cladistic ontogeny). We built a character matrix of ontogenetically variable characters of the skull defined as binary or multistate transformation series. The matrix was analyzed with TNT, recovering a strict consensus tree (i.e., ontogram). The consensus ontogram is poorly resolved indicating prevalent intraspecific variation, and is incongruent with the ontogenetic sequence of specimens based on age and size rankings. Although some histologically supported age groups cluster in the ontogram, others are separated by varying patristic distances. Some trait combinations proposed as diagnostic of different *Psittacosaurus* species are in fact observed across the growth series of *P. lujiatunensis*, meriting a revision of *Psittacosaurus* diversity and evolutionary patterns.

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measurements and text-based descriptions. Logically, representations derived from these sources should be roughly equivalent since they are merely different ways of describing the same characteristics. However, few empirical tests of this assumption have been made. To explore whether disparity ordinations derived from text-based descriptions are consistent with those derived from morphometric measurements and/or from a quantitative comparison of the images themselves, data were collected for three fossil groups: microfossils (planktonic foraminifera), invertebrate macrofossils (gastropods and trilobites) and fossil vertebrates (amphibians). Text-based data were coded numerically and all three datasets used to construct linear multivariate ordination spaces for comparison. Multidimensional analyses and statistical tests were then preformed to determine whether the resulting ordinations exhibit comparable patterns of similarity and/or distinction. In an associated study we also investigated the degree to which expert-assessed text-based character-state assignments were consistent with morphometric and image-based assessments of the same morphological characteristics. Our results demonstrate that linear ordinations of different representations of the same specimen sets are inconsistent with one another for all fossil-group datasets examined. Disparity results of important cranidium characters of Tremadocian trilobites exhibited particularly different disparity patterns. Our results suggest that text-based descriptions have inherent limitations in terms of accurately and consistently characterizing complex fossil forms. Results from morphometric measurements and direct image-based assessments were much closer to one another than either was to text-based character ordinations. These results have important implications for future disparity studies. Geometric morphometric data represent forms more accurately and consistently than text-based character-state descriptions. However, direct analysis of images may be an acceptable alternative for geometries that are difficult to characterize morphometrically. Regardless, disparity results