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SHORT COMMUNICATION

REASSESSMENT OF *UTAHDACTYLUS* FROM THE JURASSIC MORRISON FORMATION OF UTAH

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The Jurassic Morrison Formation of western North America is justifiably famous for the abundant remains of dinosaurs and other vertebrates; however, its pterosaur record is poor. Named pterosaur taxa include: the diminutive pterodactyloid *Dermodactylus montanus* (Marsh, 1878) based on an incomplete elongate wing metacarpal, the rhamphorhynchoid (i.e., non-pterodactyloid) *Comodactylus ostromi* (Galton, 1981) based on a complete wing metacarpal, and the indeterminate *Laopteryx priscus* (Marsh, 1881) based on a fragmentary braincase originally interpreted as avian but reinterpreted as pterosaurian by Ostrom (1986), all from Como Bluff, Wyoming; *Mesadactylus ornithosphyos* (Jensen and Padian, 1989; Smith et al., 2004) based on a small synsacrum and many unassociated referred fragments from the Brushy Basin Member of Colorado; the pterodactyloid *Kepodactylus* (Harris and Carpenter, 1996) based on a cervical vertebra, humerus, metatarsal and various wing phalanx fragments from Garden Park, Colorado, and the scaphognathine *Harpactognathus gentryii* (Carpenter et al., 2003) based on an incomplete rostrum from Bone Cabin Quarry, Wyoming. Furthermore, *Mesadactylus* may include multiple taxa (*contra* Smith et al., 2004) because referred materials include elongate wing metacarpals characteristic of pterodactyloids, whereas the synsacrum, although originally interpreted as pterodactyloid by Jensen and Padian (1989), differs markedly from pterodactyloid synsacra and may be an anurognathid (Bennett, pers. obs.).

With that poor record, the recent description by Czerkas and Mickelson (2002) of a fragmentary disarticulated skeleton from the Tidwell Member of the Morrison Formation of Utah as a new rhamphorhynchoid, *Utahdactylus kateae*, was potentially significant. The specimen was described as consisting of a small posterior skull fragment, one procoelous cervical vertebra, three procoelous dorsal vertebrae, an incomplete centrum of an elongate caudal vertebra preserved in association with long rod-like bones interpreted as hyperelongate zygapophyses, some ribs, the right scapulocoracoid and fragments of the left, the right humerus, and sections of radii, ulnae, and wing phalanges (Fig. 1). The scapulocoracoid was noted as indicating that the specimen was a pterosaur, and the lack of elongation of the cervical vertebra plus the elongate caudal vertebra with associated elongate zygapophyses were noted as indicating that the specimen was a rhamphorhynchoid. However, examination of the specimen by the author suggested that some of the elements were misidentified and failed to produce any evidence to support the interpretation as pterosaurian.

The fragment identified as a skull fragment (Fig. 1:a) is simply a small indeterminate bone fragment. There is no evidence to suggest it pertains to the skull.

The element identified as a cervical vertebra (Fig. 1:b; Czerkas and Mickelson, 2002, fig. 3) is visible in longitudinal section. Its preserved length is 17.2 mm but one end is broken so it may have been longer, and its maximum height or width is 8.7 mm. It is filled by coarse cancellous bone, and the preserved end has a rounded articular surface that Czerkas and Mickelson presumably interpreted as the posterior condyle. The element may be a vertebra, but there is no trace of zygapophyses, neural spine, or cotyle and thus no direct evidence that it is a vertebra, and no evidence that it is procoelous.

Three elements identified as dorsal vertebrae (Fig. 1:dv; Czerkas and Mickelson, 2002, figs. 4, 5, 10, 11) are visible only in longitudinal, and not necessarily sagittal, sections. The centra are 10 mm long and 4.5 mm high with strongly convex condyles and concave cotyles. Two vertebrae are preserved in loose articulation and exhibit neural arches separated from the centra by a vertebral canal that appears as tall as 3 mm in places. The neural arch of a fourth vertebra of similar size is preserved on a small isolated block and appears to be in anterior or posterior view. The neural spine is broad and the transverse processes are short with notched ends that are consistent with involvement in costotransverse articulations although no articular surfaces are visible. No zygapophyses are visible on any of the vertebrae, so although they are clearly vertebrae and seem to be dorsal vertebrae based on the shape of the transverse process of the fourth vertebra, there is no evidence that they are procoelous.

The element identified as an elongate caudal vertebra with associated elongate zygapophyses (Czerkas and Mickelson, 2002, figs. 6, 7) consists only of an impression 21 mm long and 4.0 mm wide on a second small isolated block. The impression is of a cylindrical bone, not spool-shaped with a narrower waist in the middle, and as neither end is preserved the bone must have been at least 25 mm long. The cross-section of the impression is less than a semicircle, so if the bone was circular in cross-section it would have been somewhat more than 4 mm in diameter. There is no evidence that the impression is of a vertebra of any sort, and it is more likely that it is an impression of a propodial or epipodial. The elements identified as elongate zygapophyses lie 4 mm away from the cylindrical impression and consist of gently curving sections of bone ranging from 7 to 12 mm long with a maximum diameter of 1.5 mm at the end where they are broken and tapering to a blunted tip at the other end. There is no evidence that the elements identified as zygapophyses are zygapophyses or that they are associated with the cylindrical impression. They closely resemble the elements identified elsewhere on the specimen as ribs, and they are interpreted as such here.

The element identified as a right scapulocoracoid (Fig. 1:sc; Czerkas and Mickelson, 2002, figs. 10,11) is a scapulocoracoid, but it does not resemble pterosaur scapulocoracoids. Czerkas and Mickelson interpreted it as having a long coracoid with an expanded end, and a short scapula. Pterosaurs (with the exception of the Triassic *Eudimorphodon* cf. *ranzii*, Wellnhofer, 2003)

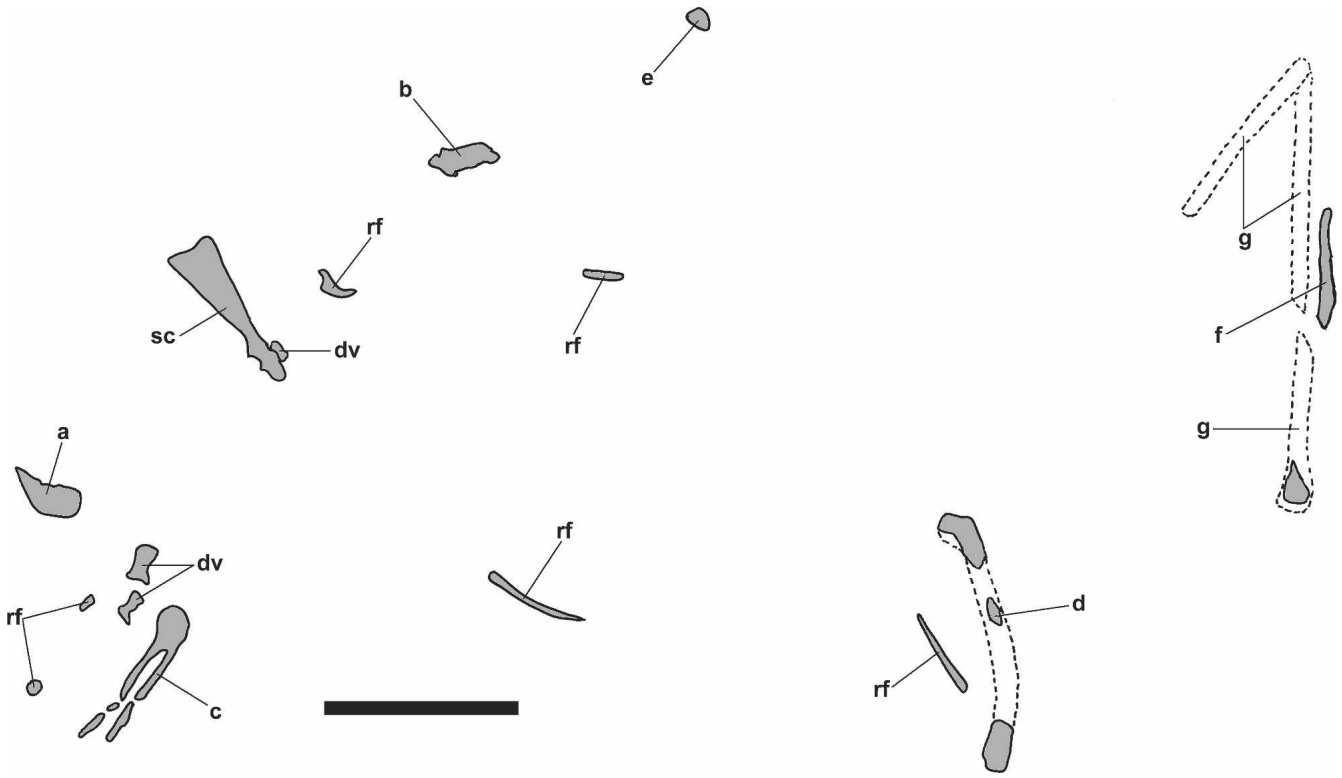

FIGURE 1. Diagram of *Utahdactylus katae*, DM 002, showing the main blocks, modified from Czerkas and Mickelson (2002). Isolated blocks containing other fragments are not shown. **Abbreviations** (if identification by Czerkas and Mickelson differs it is indicated in parentheses): **a**, indeterminate fragment ("skull fragment"); **b**, indeterminate fragment ("cervical vertebra"); **c**, indeterminate propodial or epipodial ("wing phalanx"); **d**, indeterminate propodial or epipodial ("wing phalanx"); **dv**, dorsal vertebra; **e**, indeterminate propodial or epipodial ("limb bone cross-section"); **f**, impression with weathered bone fragment, not seen ("tibia"); **g**, impressions, not seen ("wing phalanges"); **rf**, rib fragment; and **sc**, scapulocoracoid. Scale bar equals 5 cm.

do not have the ventral end of the coracoid broadly expanded, and none have a short scapular blade. The broadly expanded end of the longer part of the scapulocoracoid does not bear an articular surface, and the morphology of the glenoid does not resemble that of pterosaurs in that it is not complementary to the saddle-shaped head typical of pterosaur humeri. It seems more likely that the longer part of the scapulocoracoid is the scapula and the shorter part the coracoid, in which case it is a left scapulocoracoid.

The element identified as the right humerus (Czerkas and Mickelson, 2002, figs. 8, 9) is preserved on an isolated block as a impression 61 mm long with a least width of 7.1 mm and lacking both ends. Czerkas and Mickelson stated that portions of the deltopectoral crest and posterior tuberosity were present, but there is no trace of either. There is a small fragment of bone adhering to the impression in a position corresponding to the base of the deltopectoral crest in Czerkas and Mickelson's reconstruction of the element as a humerus, but there is no evidence that the fragment pertains to a deltopectoral crest. The impression is that of a bone somewhat larger than the scapula. On the one hand it may be of a humerus, on the other hand it bears some resemblance to a crocodilian tibia; however, there is no direct evidence that it is either bone and it is considered an indeterminate propodial or epipodial.

Czerkas and Mickelson (2002) stated that there were cross-sections and portions of limb bones that might represent radii, ulnae, and wing phalanges, but their diagram of the specimen identified only one limb bone shaft cross-section, a tibia, and five pieces of wing phalanges, some of which were preserved only as impressions. One element identified as a wing phalanx (Fig. 1:c) is a 41-mm-long longitudinal section of a bone with a slightly displaced fragment that brings its overall length to 50 mm. The shaft is straight, 5.0 mm in diameter, and there is a rounded articulation at one end. Another element identified as a wing phalanx (Fig. 1:d) is a 68 mm long impression with some bone preserved at either end. The shaft is gently curving, 5.6 mm in diameter, and is expanded at one end for articulation. The articular ends of the two bones do not closely resemble either end of a pterosaur wing phalanx. It is possible that they are propodials or epipodials, but there is not enough information to identify either with certainty.

I was unable to locate the elements identified as a tibia (Fig. 1:f) and three pieces of wing phalanges (Fig. 1:g) preserved largely as impressions. In addition, two bones on a isolated block approximating a 15 cm cube could not be matched to Czerkas and Mickelson's diagram of the specimen. One of the bones consists of a 37 mm long section of the shaft of a gently curving bone 4.3 mm in diameter with a circular cross-section. The second bone seem to be the most identifiable limb element preserved in the specimen and consists of an articular end 16 mm wide and 7 mm deep and a short section of shaft that tapers away from the articular end (Fig. 2). Its overall length is 21 mm. The articular end supports two concave articular surfaces facing about 45º from the long axis of the bone. Given that it includes an epiphysis with articular surfaces, it is the one long bone most likely to be identifiable. It may be a distal humerus, proximal ulna, or proximal tibia, but I cannot identify it with certainty. None of the elements identified as limb bones are particularly elongate, and none provide any evidence to suggest that they pertain to a pterosaur.

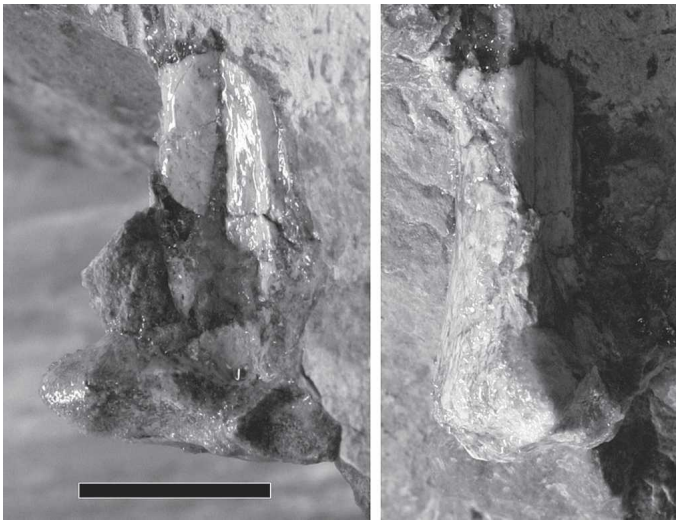

FIGURE 2. Articular end of indeterminate propodial or epipodial of *Utahdactylus katae*, DM 002, in two views. Scale bar equals 1 cm.

Based on the above examination and reinterpretation, the specimen consists of four dorsal vertebrae, several ribs, the left scapulocoracoid, several incomplete propodials and/or epipodials, and other unidentifiable fragments. The specimen does not provide any evidence to suggest that it is a pterosaur, and provides evidence in the form of the scapulocoracoid and the broad neural spine of the dorsal vertebra to suggest that it is not a pterosaur. Lastly, although it cannot be quantified, the quality of the bone of the specimen is not consistent with a pterosaurian interpretation. Pterosaurs have distinctive dense and highly mineralized bone tissue with a very linear grain pattern that differs in appearance from that found in other diapsids (Bennett, 1993; de Ricqlés, et al., 2000).

The pterosaur skeleton has been highly modified to adapt it to flight, and as a consequence contains many uniquely characteristic elements: broad sternum with cristospine; scapulocoracoid with distinctive glenoid morphology and long strut-like coracoid that articulates with the cristospine; pelvis with broad puboischiadic plate; prepubis; humerus with saddle-shaped head and large deltopectoral crest; syncarpals; preaxial carpal; pteroid bone; robust metacarpal IV; elongate wing phalanges with distinctive proximal and distal articular surfaces and often distinctive cross-sections; and in many rhamphorhynchoids caudals with hyperelongate pre- and post-zygapophyses that stiffened the tail. Anyone entertaining a pterosaurian interpretation of a specimen who cannot identify at least several diagnostic features with certainty should seriously reconsider the interpretation.

SYSTEMATIC PALEONTOLOGY

Subclass DIAPSIDA Osborn, 1903
Order undetermined
Family undetermined

UTAHDACTYLUS KATEAE Czerkas and Mickelson, 2002, nomen dubium

Holotype—DM 002/CEUM 32588. The specimen is apparently catalogued into the collections of The Dinosaur Museum, Blanding, Utah (DM) and the Prehistoric Museum, College of Eastern Utah, Price, Utah (CEUM), but is housed in The Dinosaur Museum.

Horizon and Locality—Tidwell Member of the Morrison Formation. The locality was identified only as "Locality 42Gr191V" in Utah despite the fact that the type specimen was virtually the only fossil material found in the area (S. A. Czerkas, pers. comm. 2005), so that there should be no reason not to identify the locality.

Paratypes—None.

Referred Materials—None.

Remarks—In describing the species, Czerkas and Mickelson (2002:6) mentioned only three characters in their diagnosis: 1) "elongate caudal vertebra associated with long ossified rods that represent the hypertrophied extensions of the zygapophyses"; 2) "comparatively large cervical vertebra is not elongate as in pterodactyls"; and 3) "no indications of the inset groove which is typical in the phalanges of digit IV." Based on the above reinterpretation, the specimen does not exhibit any of those characters. The element identified as an elongate caudal vertebra is probably a propodial or epipodial, and the elements identified as zygapophyses are ribs. The element identified as a cervical vertebra may not be a vertebra, but even if it is, it is missing one end so its length cannot be determined. The elements identified as wing phalanges are probably propodials and/or epipodials and provide no information as to the cross-section of manual phalanges.

Based on the reinterpretation of the specimen, it does not exhibit the proposed diagnostic characters, but even if it did, they are not sufficient to diagnose a species. Moreover, the specimen does not exhibit any other characters that might be used to diagnose a species. The morphology of the scapulocoracoid, the absence of evidence of a carapace or plastron, the size of the specimen, and the stratigraphic position suggest that it is a diapsid, but I cannot narrow down its affinities further. Consequently, *Utahdactylus kateae* must be considered a *nomen dubium*.

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