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Troodontidae (Dinosauria: Theropoda) from the Upper Cretaceous of Uzbekistan

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ABSTRACT

To date three taxa of troodontid theropod dinosaurs have been recognized from Upper Cretaceous strata in two regions of the Kyzylkum Desert in Uzbekistan. The Cenomanian Khodzhakul Formation in the southwestern Kyzylkum Desert has yielded isolated serrated teeth and some postcranial bones of an indeterminate troodontid. In the central Kyzylkum Desert troodontids are known from the Cenomanian Dzharakuduk Formation (*Urbacodon itemirensis*) and the Turonian Bissekty Formation (*Urbacodon* sp.). *Urbacodon itemirensis* is known from a single dentary whereas *Urbacodon* sp. is represented by isolated teeth, maxilla and dentary fragments, a partial braincase, and some postcranial bones. The troodontid affinities of *Urbacodon* are supported by several synapomorphies: presence of a subotic recess; reduced basal tubera placed directly under the occipital condyle; maxilla participating in the margin of the external naris; nutrient foramina on dentary situated within a deep lateral groove; dentary without distinct interdental plates; large number of small dentary and maxillary teeth; teeth constricted between root and crown; anterior dentary teeth smaller, more numerous, more closely spaced than those in the middle of the tooth row, and implanted in a groove; posterior dorsal vertebrae with tall and posterodorsally tapering neural spines; and presence of a midline sulcus on the neural arches of distal caudals. Among Troodontidae, *Urbacodon* resembles *Byronosaurus*, *Gobivenator*, and *Xixiasaurus* in the absence of serrations on the tooth crowns and having premaxillary teeth that are D-shaped in cross-section. However, phylogenetic analysis did not recover a clade of Asiatic troodontids with unserrated teeth.

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1. Introduction

Troodontidae is a clade of small to medium-sized Cretaceous theropod dinosaurs definitely known only from North America and Asia. Troodontids are rare in all vertebrate assemblages and were most diverse in Asia. They were agile predators, with well-developed vision and hearing and a relatively large brain. This is evident from the large orbit with its raised dorsal rim, vaulted frontals and parietals, a lateral depression on the braincase for the middle ear cavity, and a periotic sinus system (Currie, 1985; Varricchio et al., 1997; Makovicky and Norell, 2004). Furthermore, the pneumatic basisphenoid bulla may have aided in detection of low-frequency sounds (Currie, 1985; Makovicky and Norell, 2004). The long hind limbs of troodontids, with a slender and elongated crus and metatarsus, and a functionally didactyl pes with a specialized second digit, appear suitable for fast running (Makovicky and Norell, 2004). The narial passage and oral cavity were separated by a secondary bony palate formed by the palatal shelves of the maxillae. In the largest known species, *Troodon formosus* from the Campanian–Maastrichtian of western North America and eastern Russia, the orbits face anterolaterally, which may indicate binocular vision (Makovicky and Norell, 2004). The occurrence of this species at high paleolatitudes in present-day Alaska and Chukotka (Clemens and Nelms, 1993; Fiorillo and Gangloff, 2000; Averianov and Sues, 2007; Fiorillo, 2008; Fiorillo et al., 2009; Godefroit et al., 2009) suggests that it could survive the polar winter and darkness. In Alaska, *Troodon* was the most common theropod (Fiorillo and Gangloff, 2000). It constructed nests for egg incubation and had a bird-like mode of egg-laying, but retained two functional ovaries and oviducts (Varricchio et al., 1997; Varricchio et al., 1999).

In Uzbekistan two regions have yielded skeletal remains of troodontid dinosaurs. Isolated serrated teeth of Troodontidae indet. have been found in the lower Cenomanian Khodzhakul Formation

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of the Khodzhakul and Sheikhdzheili localities in the southwestern Kyzylkum Desert (Nesov, 1995; Averianov and Sues, 2007). In the Itemir-Dzharakuduk depression of the central Kyzylkum Desert a thick sequence of Upper Cretaceous deposits is exposed along escarpments bordering the depression to the north (Fig. 1). Averianov and Sues (2007) described a dentary of the troodontid *Urbacodon itemirensis* with unserrated teeth from the lower part of the Cenomanian Dzharakuduk Formation of Itemir. Similar unserrated isolated teeth as well as troodontid bones are known also from the upper Turonian Bissekty Formation of Dzharakuduk. Averianov and Sues (2007) briefly discussed these specimens and referred them to *Urbacodon* sp. Here we provide a detailed description of the troodontid specimens from the Bissekty Formation. The sole exception is a well-preserved partial troodontid braincase CCMGE 466/12457, which was recently CT-scanned and will be included in a separate study on the endocranial structure of Troodontidae. Some troodontid features of this specimen were previously noted by Averianov and Sues (2007: p. 92). In addition to these characters, CCMGE 466/12457 has a well-developed subotic recess, which Makovicky et al. (2003) considered a troodontid synapomorphy.

Strata of the Bissekty Formation are exposed along an approximately 8 km long escarpment near the small settlement of Dzharakuduk (variously given in the literature as Dzhara-Kuduk, Dzhirakuduk, Dzhyrakuduk, Bissekty, and Kul'beke) in the central Kyzylkum Desert, 32 km SW of Mynbulak in the Navoi district, Uzbekistan (Nesov, 1995, 1997). The escarpment extends from about 42°06′22.60″ N and 62°37′09.00″ E to 42°05′44.22″ N and 62°41′06.49″ E (Fig. 1). The Bissekty Formation comprises medium-grained, poorly lithified, cross-bedded fluvial sandstones and clast-supported, well-cemented infraformational conglomerates. It reaches a thickness of up to 80 m.

1.1. Institutional abbreviations

CCMGE – Chernyshev's Central Museum of Geological Exploration, Saint Petersburg, Russia; SPbGU VZ Din – Department of Vertebrate Zoology, Saint Petersburg State University, Saint Petersburg, Russia; USNM – Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.; ZIN PH – Paleoherpetological Collection, Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia; ZIN PO – Paleornithological Collection, Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia.

1.2. Locality abbreviations

The locality information following catalog numbers uses Nesov's prefixes CBI – Central (Kyzylkum) Bissekty and CDZH – Central (Kyzylkum) Dzharakuduk for localities within the middle-upper and lower parts of the Bissekty Formation, respectively.

1.3. Measurements

Vertebrae: ACH, anterior height of centrum (without hypapophysis); ACW, anterior width of centrum; CL, centrum length (ventral); NAL, neural arch length (measured between anterior and posterior margins of dorsal roof of neural canal); NSL, neural spine length (maximum); PCH, posterior height of centrum; PCW, posterior centrum width.

Metapodials and phalanges: L, length; PW, maximum width of proximal end; DW, maximum width of distal end.

All measurements are in millimeters.

2. Systematic paleontology

Dinosauria Owen, 1842
Saurischia Seeley, 1887
Theropoda Marsh, 1881
Maniraptora Gauthier, 1986
Paraves Sereno, 1997
Deinonychosauria Colbert and Russell, 1969 sensu Turner et al., 2012
Troodontidae Gilmore, 1924 sensu Turner et al., 2012

Troodontidae indet.

1981a *Saurornithoides* [sp.]: Nesov, p. 91
1985a *Pectinodon* [sp.]: Nesov, p. 148

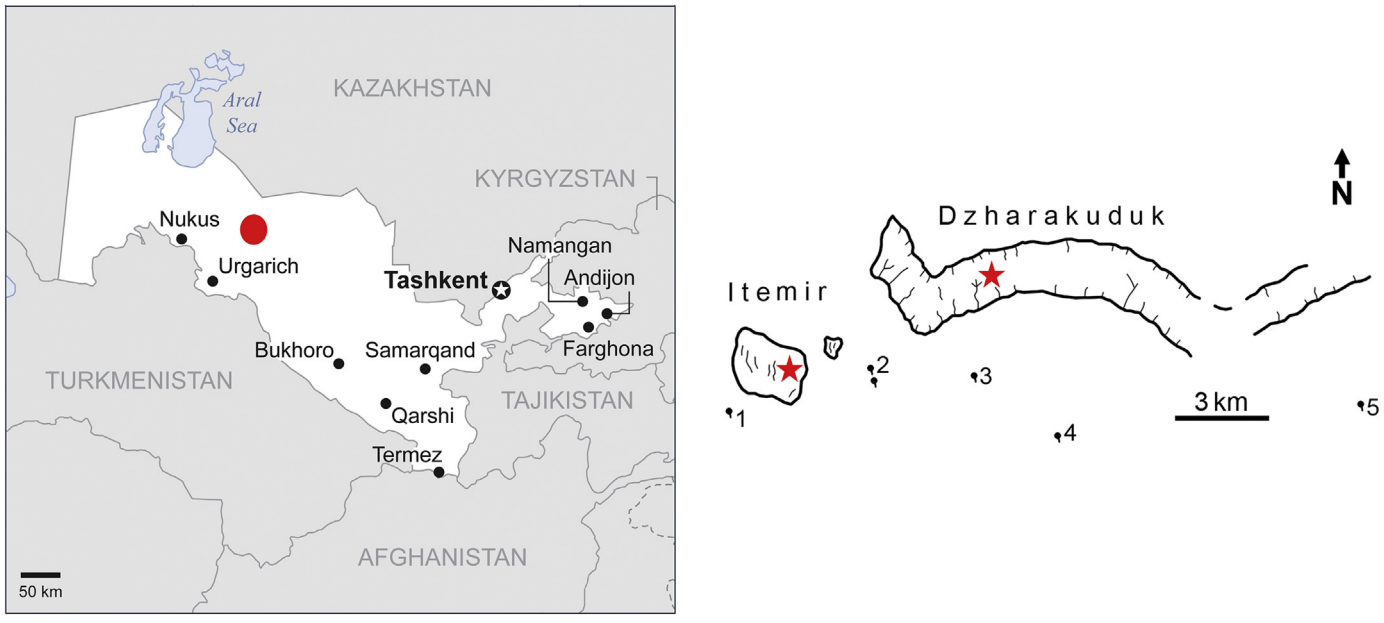

Fig. 1. Geographic position of (left) and sketch map of the Itemir-Dzharakuduk depression (right). The geographic positions of the two occurrences of specimens of *Urbacodon* (Dzharakuduk Formation at Itemir and Bissekty Formation at Dzharakuduk) are marked by asterisks. 1, Itemir well; 2, Dzharakuduk wells; 3, Kul'beke well; 4, Bissekty well; 5, Khodzhakhmet well. The left illustration is adapted and modified from a United Nations map and the right one is modified from Averianov and Sues (2007).