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TOCHISAURUS NEMEGTENSIS GEN. ET SP. N., A NEW TROODONTID (DINOSAURIA, THEROPODA) FROM MONGOLIA

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A troodontid dinosaur, *Tochisaurus nemegtensis* gen. et sp. n., is described. Material consists of a solitary metatarsus from the upper Campanian or lower Maastrichtian Nemegt Formation, southern Gobi, Mongolia. The metatarsus is very slender and has strongly reduced second metatarsal, which implies that the second pedal digit was also reduced.

Key words: Dinosauria, Theropoda, Troodontidae, Late Cretaceous, Mongolia.

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INTRODUCTION

The specimen described in the present paper as *Tochisaurus nemegtensis* gen. et sp. n. was found by the Mongolian Paleontological Expeditions of the USSR Academy of Sciences in 1948 in the deposits of the Nemegt Formation (upper Campanian or lower Maastrichtian) at Nemegt, Nemegt Basin, the southern Gobi, Mongolia.

In Asia, the troodontids are known from the Gobi Desert in Mongolia and China (Currie and Peng, in press). They were reported from the upper Cretaceous deposits of the Djadokhta Formation at Bayn Dzak and Bayan Manduhu (*Saurornithoides mongoliensis* Osborn, 1924), the Bugeen Tsav beds at Bugeen Tsav (*S. junior* Barsbold, 1974) and the Nemegt Formation at Altan Ula (*Borogovia gracilicrus* Osmólska, 1987), all located in the southern Gobi. An Early Cretaceous troodontid, described as troodontid indet. by Barsbold *et al.* (1987), was reported from the Barunbayanskaya Svita at Khamrin Us in the eastern Gobi. Except for *S. mongoliensis*, each of these species is represented by a single specimen only. Isolated troo-

dontid teeth are rarely found in Asia. It seems that troodontids were scarce on this continent, although relatively well differentiated. The troodontids were more common in North America, where more than 10 incomplete specimens and numerous teeth were found, although all these remains are considered as representing a single species, *Troodon formosus* Leidy, 1856 (Currie 1987).

The specimen here described represents a metatarsus, and is the only complete troodontid metatarsus described from Asia. Thus, we consider that it worthy of description, in spite of the fact that no other skeletal remains were found associated with it. The almost perfect state of preservation of this metatarsus allows observation of its structure, which is distinct from that of the North American *Troodon formosus*, the only other troodontid species in which the complete metatarsus is known. The metatarsus of *Tochisaurus nemegtensis* is also distinct from known Mongolian species.

The specimen is stored at the Paleontological Institute and Museum of the USSR Academy of Sciences (abbreviated as PIN), in Moscow.

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SYSTEMATICS

Family **Troodontidae** Gilmore, 1924
Genus *Tochisaurus* gen. n.

Derivation of the name: *toch'* (Mongolian) — ostrich, because of the functionally didactylous foot.

Genus monotypic: Diagnosis and distribution as for the type species, *Tochisaurus nemegtensis* sp. n.

Tochisaurus nemegtensis
(pl. 11, 12; fig. 1)

1987. unknown theropod, Kurzanov, 67.
1987. unidentified troodontid, Osmólska, 137.
1990. indeterminate troodontid. Osmólska and Barsbold, 263, 265.

Holotype: almost complete metatarsus PIN 551—224.

Type locality: Nemegt, Nemegt Basin, S. Gobi Desert, Mongolia.

Type horizon: Nemegt Formation, zone of Tarbosaurus bataar and Saurolophus angustirostris, late Campanian or early Maastrichtian, Late Cretaceous.

Derivation of the name: found at the Nemegt locality.

Diagnosis. — Troodontid with long, slender metatarsus and strongly reduced metatarsal II.

Material. — Only holotype specimen known, PIN 551—244.

Dimensions see table 1.

Table 1

Measurements (in mm) of metatarsus of *Tochisaurus nemegtensis* gen. et sp. n.

Metatarsal II:		Metatarsal III:	
Length (dors.)	222	Length (dors.)	232
Length (ventr.)	233 *e.*	Length (ventr.)	?
Width (prox., tr.)	20	Width (tr., below dorsal contact between Mtt II & IV)	5
Width (prox., sag.)	27 *e*		
Width (med., tr.)	6	Width (dors., med., tr.)	2.5
Width (med., sag.)	13	Width (dist., tr.)	20
Width (dist., tr.)	15	Width (dist., sag.)	22
Width (dist., sag.)	14 *e.*		
Metatarsal IV		Articulated metatarsus:	
Length (dors.)	242		
Length (ventr.)	252	Width (prox., tr.)	50 *e.*
Width (tr., below proximal end)	19	Width (prox., sag., across Mtt IV)	30
Width (sag., below proximal end)	20	Width (med., tr.)	32
Width (med., sag.)	27	Circumference (med.)	86
Width (dist., tr.)	18		
Width (dist., sag.)	19		

e. estimated; measured: *dist.* distally, *dors.* dorsally, *med.* medially, *prox.* proximally, *sag.* sagittaly, *tr.* transversely, *ventr.* ventrally.

Description. — Extensor surface of metatarsus has a trough along the proximal half of its length which shallows more distally. The trough lies between the strong sagittal expansion of the shaft of metatarsal IV and that of metatarsal II. In contrast, the flexor surface of the metatarsus is almost flat and only metatarsal III, in places where it is not obscured by the adjoining metatarsals, is placed slightly deeper. The proximal articular, surface of the metatarsus is inclined relatively strongly anterodistally. It may indicate that the distal tarsals, which were not found with the specimen, were placed close to the extensor margin of the proximal articular surface.

Due to a damage, exact relations between proximal ends of metatarsals are not known. The specimen has been here reconstructed with plaster (comp. pls. 11, 12) and contacts of metatarsal III with adjoining bones were marked with ink on the flexor surface of the metatarsus as it may be seen on the photograph (comp. pl. 11: 2). However, it is most probable that the reconstruction is erroneous and true metatarsal contacts were the same as in other troodontids, i.e. the greatly expanded metatarsal IV adhered posteroproximally to metatarsal II.

Metatarsal II is distinctly shorter than the other two. It is thin transversely and larger in the fore-aft direction. Its distal head is much smaller than those of

metatarsals III and IV. The distal end is separated from metatarsal III by a narrow space. The proximal part of metatarsal II is damaged and filled with plaster, but it may have formed as much as a third of the width of the proximal articular end of the metatarsus. The medial surface of the shaft does not preserve any evidence of metatarsal I, but on the medial side of the shaft one third the length from the distal end, there is a striated surface that may represent the attachment site for the first metatarsal.

Metatarsal III is the longest unit in the metatarsus. For most of its length, it is wedged between the adjoining metatarsals. In the distal half, its shaft is prismatic in cross-section.

The extensor surface of the shaft is narrow in the proximal half and broadens distally. The proximal half forms the narrow bottom of the longitudinal trough above mentioned. Distally, the flattened portion of the shaft slopes towards the contact with metatarsal IV, forming the medial wall of the trough, which is rather shallow here. The proximal end of metatarsal III is hidden by metatarsals II and IV which contact each other.

On the flexor side, metatarsal III is almost entirely hidden by metatarsals II and IV, except for its distal end which is well exposed. The width of metatarsal III at its very proximal end cannot be determined because of damage, but, judging from the extreme thinning of the proximal end of metatarsal III, its share in the formation of the proximal articular surface of the metatarsus was very small, or more probably, none, as is the case in *Saurornithoides* (Barsbold 1974).

The distal head of metatarsal III bears a shallowly grooved articular surface that extends on the flexor surface as a broad and relatively short tongue of bone. The lateral surface of the distal head is concave and bears centrally the ill-defined fossa for the collateral ligament. Medially, the concavity is less pronounced and the fossa is not discernible due to the worn surface of the bone.

Metatarsal IV is almost as long as metatarsal III and it forms a half, or slightly more in places, of the entire width of the metatarsus. It is the most robust bone in the metatarsus. In cross-section, its shaft is anteroventrally flattened close to the proximal end, mediolaterally flattened somewhat below, and subquadrate close to the distal end.

On the etxensor surface, the shaft of metatarsal IV is relatively narrow and ridge-like along the proximal half of its length, due to its fore-aft expansion. Below mid-length, the steep medial side of the shaft becomes gradually less pronounced.

On the flexor surface, metatarsal IV occupies two-thirds of the entire width of the metatarsus. Along most of its distal half, it contacts metatarsal II to completely hide the shaft of metatarsal III. The posterior and medial regions of the proximal end of metatarsal IV and the relationship to metatarsal III are unknown.

The distal end of metatarsal IV curves away from metatarsal III. The distal articular head is equal in size to the head of metatarsal III but it is not grooved distally. There is a relatively small subtriangular articular surface extending onto the extensor surface. On flexor surface, there were two well pronounced condyles, the lateral of which is damaged in this specimen. The medial condyle extends relatively far proximally. On the medial side of the distal articular head, an extensive collateral ligament fossa is present, which is somewhat closer to the extensor face of the metatarsal. The collateral ligament fossa on the lateral side is small and relatively deep.

Comparisons. — PIN 551—224 is the second almost complete troodontid metatarsus known. The other is the metatarsus of NMC 8539, formerly known as the type specimen of "*Stenonychosaurus inequalis*" Sternberg, 1932, but which is now considered as a junior synonym of *Troodon formosus* Leidy, 1856 (Currie 1987). Other described metatarsi of troodontids (Russell 1969, Barsbold 1974, Wilson and Currie

1985, Barsbold *et al.* 1987, Osmólska 1987) are represented either by distal or proximal portions.

As compared with the metatarsi of other troodontid species, the one here described is similar to the metatarsus in *T. formosus* in that the distal articular head of metatarsal II is distinctly smaller than the heads of remaining metatarsals. However, the proportions of the metatarsi are quite different. The metatarsus in *T. formosus* (comp.: Sternberg 1932, Russell 1969, Wilson and Currie 1985) is relatively stout while that in our form is very slender. The sizes of the distal articular ends of the metatarsals in *Tochisaurus nemegtensis* sp. n., suggest that our specimen was from a smaller animal than specimens NMC 8539, 12340 (Russell 1969) and TMP 84.65.1 of *T. formosus*. In the Canadian species, the distal head of metatarsal II is relatively more robust than that in our species; metatarsal III narrows less uniformly proximally; the distal end of metatarsal IV is narrower than that of metatarsal III, while both are about equal in thickness in the Mongolian species.

Although the digits are unknown in *Tochisaurus nemegtensis*, a general similarity of the second metatarsal to that in *T. formosus* indicates that the second digit did not generally contact the ground in our species. Judging by the small articular head of this metatarsal in *Tochisaurus nemegtensis*, the second digit was most probably reduced in relation to this digit in other troodontids.

Wilson and Currie (1985) have drawn attention to the peculiar structure of the metatarsus in *T. formosus* in which metatarsal III is excluded from the dorsal surface of the metatarsus along its proximal half. The same structure, resulting in the deep dorsoproximal trough, is also characteristic of the *Tochisaurus nemegtensis* metatarsus, thus confirming their statement that this is a distinctive character of the Troodontidae (fig. 1).

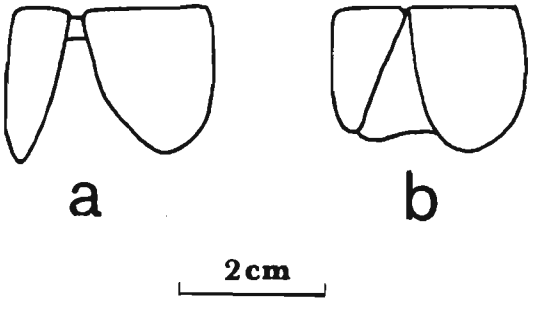

Fig. 1. *Tochisaurus nemegtensis* gen. et sp. n. PIN 551—224. Cross section of the left matetarsus: *a* 65 mm, *b* 175 mm, from the proximal end. Flexor surface is up in both drawings.

Comparison between *T. nemegtensis* and the contemporaneous Mongolian *Saurornithoides junior* Barsbold, 1974 is difficult, because only the proximal end of the metatarsus is preserved in the latter species. There are, however, two differences observable that may be important for distinguishing these two species. One of them is the distinct inclination of the proximal articular surface of the metatarsus in *T. nemegtensis* which is not present in *S. junior*. The other is the width of metatarsal II, which is proximally about half of the width of metatarsal IV in *T. nemegtensis*, but is relatively larger in *S. junior*.

The metatarsus is incomplete and strongly damaged in the type (and the only known specimen; AMNH 6516) of *Saurornithoides mongoliensis* Osborn, 1924 thus its

proportions are virtually unknown. The distal articular head of metatarsal II is damaged in this specimen and it cannot be stated whether it was as reduced as it is in *Tochisaurus nemegtensis*, or whether it was more comparable to that of *T. formosus* in which the distal head of the second metatarsal is only slightly smaller than those of metatarsals III and IV. However, taking into account that there is a significant time span separating *S. mongoliensis* and *T. nemegtensis*, it is probable that they are not conspecific.

Osmólska (1987) has speculated on the possibility that PIN 551—224 may represent *Borogovia gracilicrus* Osmólska, 1987, which comes from the same formation (locality Altan Ula IV). However, a closer examination reveals that this is not possible, because the distal articular head of metatarsal II in *B. gracilicrus* is of about the same size as the heads of other metatarsals while it is much smaller in *T. nemegtensis*.

Similarly, in the stratigraphically oldest troodontid known, the Early Cretaceous form described as a troodontid indet. by Barsbold *et al.* (1987), the head of metatarsal II is about the same size as those of metatarsals III and IV.

The metatarsus of *T. nemegtensis* described in the present paper was previously illustrated and commented by the senior author (Kurzanov 1987: fig. 35) who noticed its general similarity to the metatarsus of the ostrich. This similarity is expressed in the tendency to a reduction of the second pedal digit. In this respect, *T. nemegtensis* is the most progressive troodontid so far known.

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TOCHISAURUS NEMEGTENSIS GEN. ET SP. N., NOWY TROODONTID (DINOSAURIA, THEROPODA) Z MONGOLII

Streszczenie

Z osadów późnokredowych (formacja Nemegt) Nemegtu, w południowej Gobi (Mongolia), opisano nowego dinozaura z rodziny Troodontidae, *Tochisaurus nemegtensis* gen. et sp. n. Okazem typowym jest śródstopie i jest to jedyny dotychczas znany szczątek tego dinozaura. Kości długie przedstawicieli tej rodziny mają bardzo cienkie ściany i bardzo rzadko zachowują się w całości. Jedyne dotychczas znane kompletne śródstopie troodontida, opisane z późnej kredy Kanady, znacznie różni się od śródstopia *T. nemegtensis*, którego budowa wskazuje na silną redukcję drugiego palca stopy. *T. nemegtensis* opierał się więc na dwupalcowej stopie, podobnie jak struś.

EXPLANATIONS OF PLATES 11 AND 12

Plate 11

Tochisaurus nemegtensis gen. et sp. n.
Nemegt, Nemegt Basin, S. Gobi, Mongolia; Nemegt Formation, Zone of Tarbosaurus bataar and Saurolophus angustirostris, Late Cretaceous

1. Left metatarsus, anterior view; stereophotograph. PIN 551—224.
2. Drawing of the same metatarsus in anterior view; parts filled with plaster are marked.

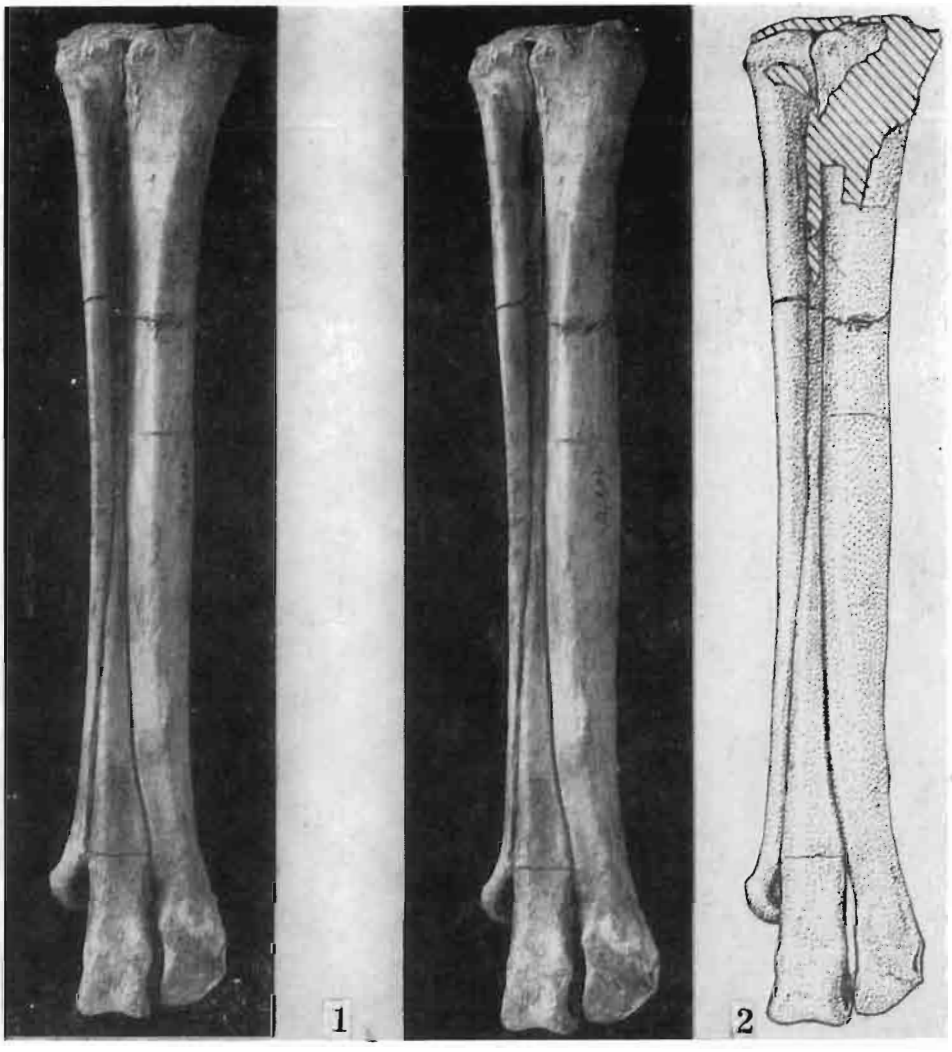
×0.55

Plate 12

Tochisaurus nemegtensis gen. et sp. n.
Nemegt, Nemegt Basin, S. Gobi, Mongolia; Nemegt Formation, Zone of Tarbosaurus bataar and Saurolophus angustirostris, Late Cretaceous

1. Left metatarsus, posterior view; note that contacts between proximal ends of metatarsals are here incorrectly reconstructed; stereophotograph. PIN 551—224.
2. Drawing of the same metatarsus in posterior view; parts filled with plaster are marked.

×0.55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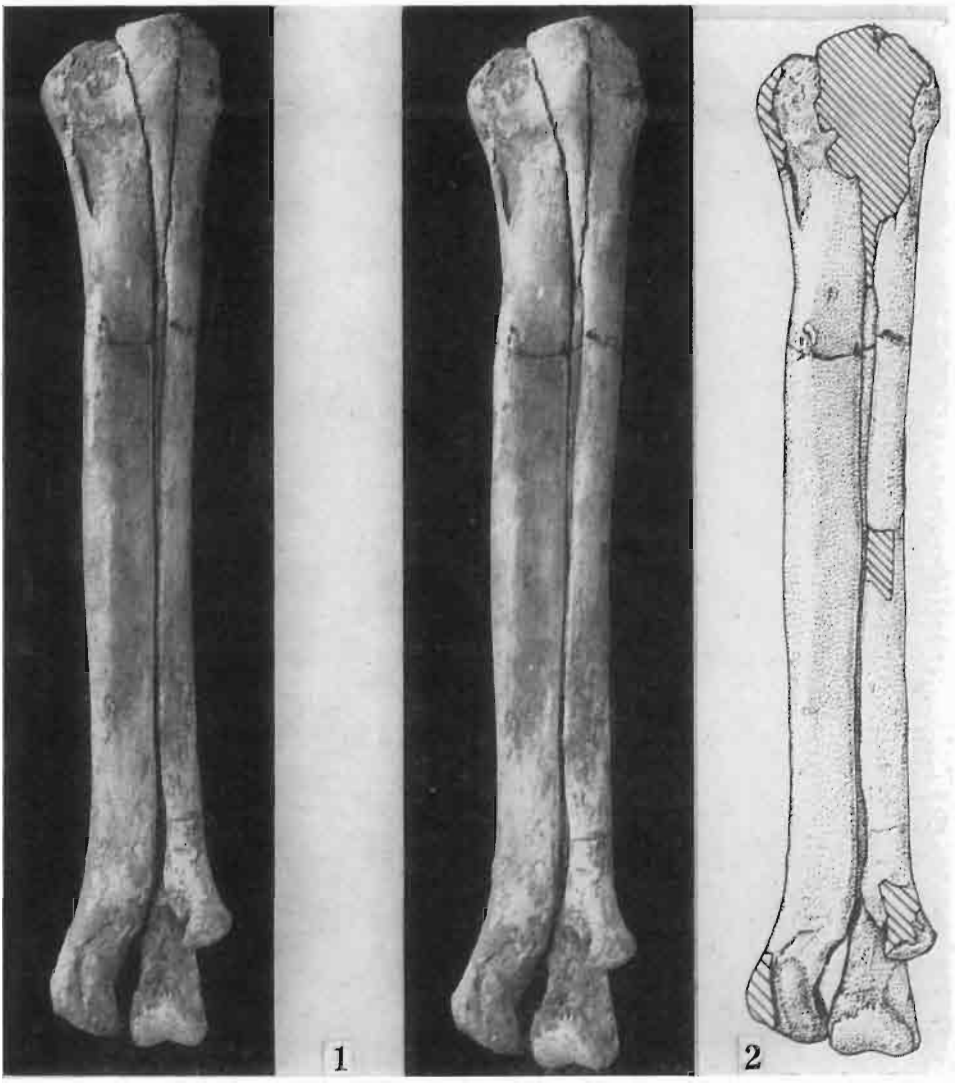
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