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ADDITIONS TO THE EARLY CRETACEOUS DINOSAUR FAUNA OF TRANSBAIKALIA, EASTERN RUSSIA

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ABSTRACT

Eight dinosaur taxa are currently known from the Early Cretaceous (Barremian-Aptian) Murtoi Formation in the Lake Gusinoe Depression of western Transbaikalia: the theropod *Richardoestesia* sp.* and indeterminate therizinosauroid, ornithomimosaur and dromaeosaurid material; a titanosauriforme sauropod (cf. *Euhelopus*), and cf. *Mongolosaurus* sp.; and an indeterminate ornithopod* and the ceratopsian *Psittacosaurus* sp. (taxa marked with an asterisk were not reported previously). In the more easterly Chikoi-Khilok Depression the Early Cretaceous (Aptian) Khilok Formation has produced fragmentary remains of four dinosaur taxa: the theropod '*Prodeinodon*' sp. and an indeterminate dromaeosaurid, an indeterminate titanosauriform (cf. *Nemegtosaurus*) and an indeterminate ornithopod. The most notable differences between the two faunas are the absence of large carnivorous theropods in the Murtoi Formation and the different composition of the sauropod and, perhaps, the ornithopod faunas in each basin.

Key words: Dinosauria, Early Cretaceous, Transbaikalia, Russia

ДОПОЛНЕНИЯ К РАННЕМЕЛОВОЙ ДИНОЗАВРОВОЙ ФАУНЕ ЗАБАЙКАЛЬЯ, ВОСТОЧНАЯ РОССИЯ

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РЕЗЮМЕ

Восемь таксонов динозавров определено из раннемеловой (баррем-апт) муртойской свиты в гусиноозерской впадине Западного Забайкалья: тероподы *Richardoestesia* sp.*, Therizinosauroidea indet., Ornithomimosauria indet., Dromaeosauridae indet., завропод Titanosauriformes indet. (cf. *Euhelopus*), завропод(?) cf. *Mongolosaurus* sp., орнитопод*, и цератопсий *Psittacosaurus* sp. (звездочками отмечены таксоны, не отмечавшиеся ранее). В более восточной чикой-хилокской впадине в раннемеловой (апт) хилокской свите обнаружены фрагментарные остатки четырех таксонов динозаров: теропод '*Prodeinodon*' sp. и Dromaeosauridae indet., завропода Titanosauriformes indet. (cf. *Nemegtosaurus*) и орнитопода. Наиболее существенные различия между двумя фаунами заключаются в отсутствии крупных плотоядных теропод в муртойской свите и различном составе завропод и, возможно, гипсилофодонтид.

Ключевые слова: динозавры, ранний мел, Забайкалье, Россия

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INTRODUCTION

The first unquestionable dinosaur in Russia was found in Transbaikalia almost one hundred years ago (Riabinin 1915). In spite of this, the dinosaur fauna of Transbaikalia is poorly known. In 1998–2002 the authors undertook several paleontological expeditions to Buryatia and later published a preliminary study of the Early Cretaceous dinosaurs from this region (Averianov et al. 2003b; see that paper for a summary of previous work on Transbaikalian dinosaurs). Here we report on additionally collected specimens and correct some previous misidentifications. The material described herein comes from the two richest localities of the Early Cretaceous tetrapods in Transbaikalia (Fig. 1):

1) Mogoito (GPS coordinates N 51° 12' 03", E 106° 17' 06" for MRT-102), a series of vertebrate sites in shallow ravines on the western bank of Lake Gusinoe between the villages of Gusinoe Ozero and Baraty in Selenga District of the Republic Buryatia. Specimens were recovered from the gray and yellow sands of the Mogoito Member of the Murtoi Formation. The Murtoi Formation is dated Berriasian–Hauterivian on the basis of its invertebrate fauna (Skoblo et al. 2001) or late Barremian–middle Aptian based on its vertebrates and climatostratigraphy (Nessov and Starkov 1992; Nessov 1997). The first vertebrate fossil was found here by P.M. Klivenskii in 1931 (Riabinin 1937). Vertebrates have been collected from Mogoito by G.A. Dmitriev, V.M. Skoblo, A.K. Rozhdestvensky, L.A. Nessov, and A.I. Starkov, including low-scale excavations in 1959 and 1963. In 1998–1999 and 2001–2002 approximately four tons of matrix were screen-washed by the authors and colleagues at the microvertebrate site MRT-102. This site and adjacent localities in the Mogoito tract produced a rich assemblage of vertebrates (Table 1), even though the majority of the specimens are isolated teeth and bones (Riabinin 1937; Dmitriev 1960; Dmitriev and Skoblo 1966; Dmitriev and Rozhdestvensky 1968; Rozhdestvensky 1970, 1976; Nessov and Khozatskyi 1981; Nessov 1992; Nessov and Starkov 1992; Nessov 1995, 1997; Efimov 1996; Averianov and Skutschas 1999a, b, 2000a–c, 2001; Efimov and Storrs 2000; Skutschas 2001, 2008; Averianov et al. 2003a, b; Danilov et al. 2003, 2006; Averianov 2007, 2008).

2) Krasnyi Yar (GPS coordinates N 50° 40' 33", E 107° 54' 55"), a high precipice along the right bank of the Khilok River approximately 1–2 km downstream from the confluence with the Shibertui River, near Ust'-Zagan village in Bichura District of the Republic Buryatia. Specimens were collected from the yellow and gray sands of the Khilok Formation. L.A. Nessov (1995, 1997) erroneously assigned this locality to the Murtoi Formation: however, the latter is confined to the Lake Gusinoe depression. The Khilok Formation was dated Berriasian–Hauterivian based on its invertebrate fauna (Skoblo et al. 2001), but the absolute ages of basalts within the Khilok Formation in the neighboring section on the Chikoi River is 113.2–122.0 Ma (Gordienko et al. 1999), giving an Aptian age. The vertebrate locality was discovered by G.A. Dmitriev in the late 1950s or early 1960s (Dmitriev and Rozhdestvensky 1968; Nessov and Khosatzky 1981). Vertebrates were also collected from this site by L.A. Nessov and A.I. Starkov in 1990 (Nessov and Starkov 1992; Nessov 1995, 1997). In 2002 P.P. Skutschas and students of the Saint Petersburg State University screen-washed approximately 2 tons of matrix at the KYAR-1 fossil site and recovered fragmentary remains of fishes, frogs, turtles, choristoderes, lizards, pterosaurs, and dinosaurs (Skutschas 2003a–c, 2004, 2006; Averianov 2007, 2008; see Table 2 for the list of vertebrates).

Table 1. List of vertebrates from the Early Cretaceous Mogoito locality (Murtoi Formation, Transbaikalia).

Pisces	
	Stichopterus sp.
	Paleonisciformes indet.
	cf. *Irenichthys* sp.
Testudines	
	Kirgizemys dmitrievi
Choristodera	
	Khurendukhosaurus sp.
Squamata	
	Paramacellodidae indet.
Pterosauria	
	Ornithocheiridae indet.
Theropoda	
	Richardoestesia sp.
	Therizinosauroidea indet.
	Ornithomimosauria indet.
	Dromaeosauridae indet.
Sauropoda	
	Titanosauriformes indet.
?Sauropoda	
	cf. *Mongolosaurus* sp.
Ornithopoda	
	Ornithopoda indet.
Ceratopsia	
	Psittacosaurus sp.
Aves	
	Aves indet.
Mammalia	
	Murtoilestes abramovi

Fig. 1. Map of Buryatia (top) showing positions of Mogoito (1) and Krasnyi Yar (2) localities and more detailed maps of vicinities of the Mogoito (bottom left) and Krasnyi Yar (bottom right) localities with positions of MRT-102 and KYAR-1 fossil sites. Maps are modified from http://maps.google.ru/maps.

Table 2. List of vertebrates from the Early Cretaceous Krasnyi Yar locality (Khilok Formation, Transbaikalia).

Pisces
- *Hybodus* sp.
- Paleonisciformes indet.
- Amiiformes indet.
- Teleostei indet. (2 species)

Amphibia
- cf. Discoglossidae indet.

Testudines
- *Kirgizemys* sp.
- Chelonioidea? indet.

Choristodera
- Choristodera indet.

Squamata
- Scincomorpha indet.

Pterosauria
- Ornithocheiridae indet.

Theropoda
- ‘*Prodeinodon*’ sp.
- Dromaeosauridae indet.

Sauropoda
- Titanosauriformes indet.

Ornithopoda
- Ornithopoda indet.

Tooth measurements. ADC, anterior carina denticle count per 1 mm unit length; BCW, basal crown width; DSDI, denticle size difference index (Rauhut and Werner 1995); FABL, fore-aft-basal length; PDC, posterior carina denticle count per 1 mm unit length; TCH, tooth crown height. All linear measurements are in mm.

Institutional abbreviation. ZIN PH, Paleoherpetological collection, Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

SYSTEMATIC PALEONTOLOGY

Dinosauria Owen, 1842

Saurischia Seeley, 1887

Theropoda Marsh, 1881

Tetanurae Gauthier, 1986

Tetanurae incertae sedis

‘*Prodeinodon*’ Osborn, 1924

‘*Prodeinodon*’ sp.
(Fig. 2A–G)

Material. ZIN PH 3/112, tooth (KYAR-1, 2002). ZIN PH 4/112, posterior tooth (KYAR-1, 2002).

Description. The tooth ZIN PH 3/112 (Fig. 2A D) is almost identical in size and morphology to the paratype of ‘*Prodeinodon mongoliensis*’ from the Early Cretaceous of Mongolia (Osborn 1924: fig. 6). The crown is posteriorly recurved, with the crown apex placed somewhat distal to the tooth base. The tooth is laterally compressed (BCW/FABL=0.52), with shallow lateral grooves on the root. The mesial carina is short, 22.9 mm in length. The crown and root below the mesial carina is rounded. The distal carina bears denticles along the whole length. The distal denticles are closely packed rectangles with rounded cutting edge. The mesial denticles are smaller (dorsoventrally) and shorter (mesiodistally), but otherwise similar in morphology. There is a small wear facet at the apex of the crown.

A smaller posterior tooth ZIN PH 4/112 (Fig. 2E–G) is very similar to ZIN PH 3/112: it is compressed laterally (BCW/FABL=0.42), has a short mesial carina with smaller denticles and shallow lateral grooves. It likely belongs to the same taxon.

Measurements. See Table 3.

Remarks. ‘*Prodeinodon mongoliensis*’ Osborn, 1924 was based on one tooth and a tooth fragment from the Aptian-Albian Oshish [=Ashile] Formation at Oshi Nuru in the Gobi Desert, Mongolia (Osborn 1924). Bohlin (1953) described a similar tooth as ‘*Prodeinodon*’ sp. from the Barremian-Aptian deposits at Tebch [=Haratologay, =Haratologai] in Inner Mongolia, China. ‘*Prodeinodon kwangshiensis*’ Hou et al., 1975 is based on isolated teeth from the Early Cretaceous Napai Formation in Guangxi Zhuang Autonomous Region of southern China (Hou et al. 1975). Both named species of ‘*Prodeinodon*’ are currently considered nomina dubia (Molnar 1990; Holtz et al. 2004). Here we use the name ‘*Prodeinodon*’ for designation of a distinctive dental morphotype of relatively slender and compressed (BCW/FABL about 0.5) large theropod teeth with short mesial carina, rounded mesial crown side below the carina, and with mesial denticles distinctly smaller than the distal denticles (DSDI about 1.2). Such teeth are common in Shestakovo and Bolshoi Kemchug 3 localities of the Early Cretaceous Ilek Formation of West Siberia (Leshchinskiy et al. 2003; Averianov et al. 2004), in the Valanginian-Hauterivian Kuwajima Formation of Japan (Manabe and Barrett 2000), and in the uncertain dated Early Cretaceous Sangar Series of Yakutia (Kurzanov et al. 2003). This dental morphotype was also reported from the Hauterivian-Barremian deposits of Spain (Ruiz-Omeńaca and Canudo 2003). Referral of ‘*Prodeinodon*’ to the Megalosauridae (Lim et al. 2002; Buffetaut et al. 2008) is not convincing.

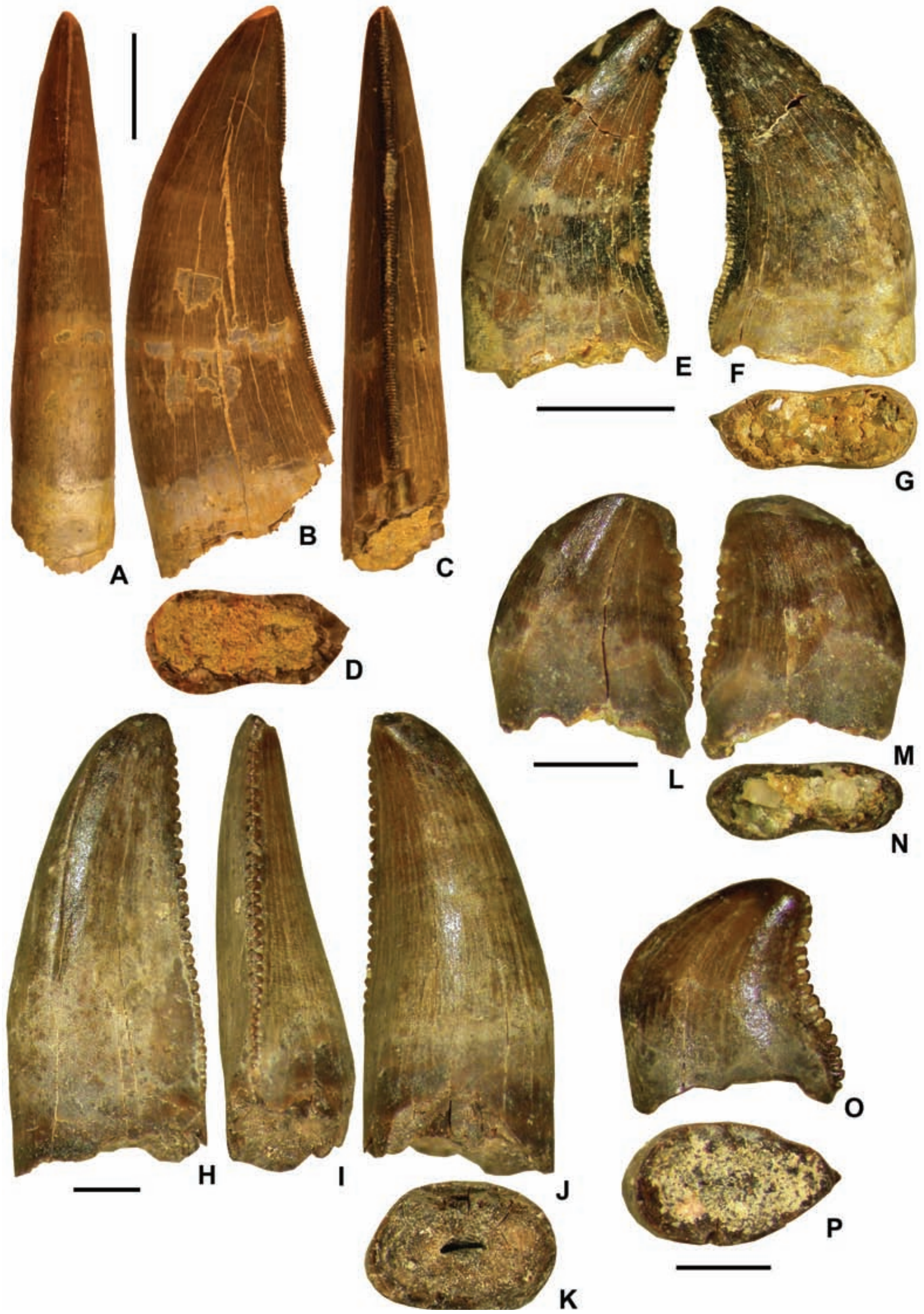

Fig. 2. Theropod teeth from Krasnyi Yar (A–G) and Mogoito (H–P) Early Cretaceous localities in Transbaikalia. A–D – ZIN PH 3/112, '*Prodeinodon*' sp., tooth, in mesial (A), lateral or mesial (B), distal (C), and basal (D) views. E–G – ZIN PH 4/112, '*Prodeinodon*' sp., posterior tooth, in lateral/medial (E and F) and basal (G) views. H–K – ZIN PH 6/112, Dromaeosauridae indet., premaxillary tooth, in lingual (H), distal (I), labial (J), and basal (K) views. L–N – ZIN PH 8/112, Theropoda indet., tooth, in lateral/medial (L and M) and basal (N) views. O, P – ZIN PH 7/112, Theropoda indet., tooth, in lateral or medial (O) and basal (P) views. Scale bar = 10 mm (A–D); and 1 mm (E–P).

Table 3. Measurements of theropod teeth from the Early Cretaceous Khilok and Murtoi formations in Transbaikalia.

Specimen ZIN PH	FABL	TCH	BCW	ADC	PDC	DSDI
			'*Prodeinodon*' sp.			
3/112	18.8	41.3	9.7	4.5	3.5	1.29
4/112	7.6	~13.0*	3.2	6.0	4.0	1.50
			Richardoestesia sp.			
10/13	2.8	7.5	1.3	11.0	11.0	1.00
			Dromaeosauridae indet.			
3/13	4.5	7.9	2.3	9.0	6.0	1.50
11/13	4.0	7.1	2.1	8.0	6.5	1.23
5/112	3.5	8.7	2.3	13.0	9.0	1.44
6/112	3.0	7.1	2.2	0	5.5	—
			Theropoda indet.			
7/112	2.5	2.7	1.4	— **	7.0	—
8/112	1.9	2.1	0.7	0	8.0	—

* The crown is not complete. ** The denticles are worn down.

Averianov et al. (2004) proposed that these teeth may belong to a dromaeosaurid theropod. They are similar to the teeth of *Nuthetes destructor* Owen, 1854 from the Berriasian Purbeck Limestone of England, usually considered a nomen dubium (e.g., Holtz et al. 2004), but recently redescribed as a valid dromaeosaurid (Milner 2002). The theropod teeth with the '*Prodeinodon*' morphotype are widely distributed in the Early Cretaceous strata of Asia. More material is needed to clarify the systematic status of this theropod, which was probably one of the dominant species and top predators in those ecosystems.

***Richardoestesia* Currie, Rigby et Sloan, 1990**

***Richardoestesia* sp.**

Dromaeosauridae indet. [partim]: Averianov et al. 2003b: 589, fig. 4A, B.

Material. ZIN PH 10/13, tooth (MRT-102, 1999).

Description. The crown is angled to the root (145°) and laterally compressed (BW/FABL=0.46). The mesial carina is slightly convex while the distal carina is almost straight, suggesting that it is a posterior tooth in the dental series. The crown is faceted from each side by two poorly pronounced longitudinal ridges. The crown surface between these ridges is flat or slightly concave. The denticles are small closely packed rectangles with rounded cutting edge. They are longer (mesiodistally) on the distal carina, but have approximately the same height, producing the same denticle count per one mm. The denticles extend along the whole length of distal carina, but do not reach the crown base on the mesial carina.

Measurements. See Table 3.

Remarks. ZIN PH 10/13, was considered as an anterior dentary or maxillary tooth of an indeterminate dromaeosaurid (Averianov et al. 2003b), but is referred here to *Richardoestesia* because it has a relatively straight crown and denticles of similar size on the mesial and distal carinae. It is otherwise similar to the teeth of *R. gilmorei* Currie et al., 1990 from the Late Cretaceous of North America (Currie et al. 1990). Teeth referable to the *Richardoestesia* dental morphotype are widely distributed in Jurassic and Cretaceous strata from Europe, Asia and North America (e.g., Estes 1964; Currie et al. 1990; Fiorillo and Currie 1994; Rauhut and Zinke 1995; Baszio 1997; Zinke 1998; Alifanov 2000; Sankey 2001, 2008; Rauhut 2002; Sankey et al. 2002; Longrich 2008). In the IUCZN there is no basis for the changing the generic name spelling to *Ricardoestesia* as used by some authors (e.g., Holtz et al. 2004).

Maniraptora Gauthier, 1986

Dromaeosauridae Matthew et Brown, 1922

Dromaeosauridae indet.

(Fig. 2H–K)

Dromaeosauridae indet. [part.]: Averianov and Skutschas 2000c: 357; Averianov et al. 2003b: 589, figs. 2I, 4C, D.

Material. ZIN PH 6/112, premaxillary (?) tooth (MRT-102). ZIN PH 5/112, tooth (KYAR-1, 2002). ZIN PH 3/13, tooth (MRT-102, 1998). ZIN PH 11/13, tooth (MRT-102).

Description. ZIN PH 6/112 with the whole mesial carina displaced lingually is possibly a premaxillary tooth (Fig. 2H–K). The mesial carina is not worn but it is devoid of denticles; it is accentuated by a longitudinal groove immediately distal to it. The lingual crown surface is flattened; the opposite surface is more convex. The distal carina is slightly concave, with coarse denticles.

In three other teeth there are small denticles on the mesial carina. In ZIN PH 3/13 and 11/13 the mesial carina is displaced lingually only at the level of the crown base. This inverted part of the carina has denticles in ZIN PH 3/13 but not in ZIN PH 11/13. The lingual crown surface is more convex in these specimens than the labial surface. In ZIN PH 5/112 the mesial carina is not displaced, but is followed distally by a longitudinal groove. The distal denticles are coarse as in ZIN PH 6/112.

Measurements. See Table 3.

Remarks. These teeth are referable to Dromaeosauridae because they possess asymmetrical, but not D-shaped, premaxillary teeth and the characteristic twist of the mesial carina on the lingual surface of the other teeth (e.g., Currie et al. 1990; Baszio 1997). The average DSDI from the three specimens (1.39) is closer to that of velociraptorines than dromaeosaurines (Rauhut and Werner 1995), but the lingually displaced mesial carina precludes referral of these teeth to Velociraptorinae.

Theropoda indet.

(Fig. 2L–P)

Material. ZIN PH 7/112, tooth (MRT-102). ZIN PH 8/112, tooth (MRT-102).

Description. These small and apparently juvenile teeth may belong to any of the taxa described above. The crown is more strongly recurved, with a markedly convex mesial surface in ZIN PH 7/112, but which is straighter in the smaller ZIN PH 8/112. In ZIN PH 7/112 the mesial denticles are worn down; in ZIN PH 8/112 the mesial carina apparently lacked denticles. The distal denticles are disproportionately large, which is typical for juvenile teeth (Farlow et al. 1991). ZIN PH 8/112 is more laterally compressed, compared with ZIN PH 7/112, and has a considerably worn crown apex.

Measurements. See Table 3.

Sauropoda Marsh, 1878

Titanosauriformes Salgado, Coria et Calvo, 1997

Titanosauriformes indet.

(Fig. 3)

Material. ZIN PH 2/112, tooth (KYAR-1, 2002).

Description. ZIN PH 2/112 (Fig. 3A–C) is slightly curved and oval in cross-section, with the mesiodistal axis longest. The crown is more convex mesially than distally and is flattened along its margins. A prominent elliptical wear facet has a concave surface and is inclined at ~33° to the mesial crown surface. A small pulp cavity is exposed in the centre of this facet. There is a remnant of a lateral carina preserved on one side. The enamel is wrinkled, except at

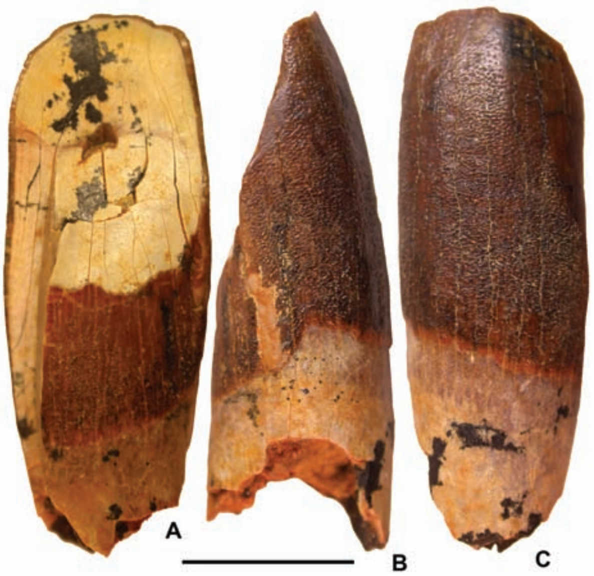

Fig. 3. ZIN PH 2/112, tooth of Titanosauriformes indet. from the Early Cretaceous Krasnyi Yar locality, Khilok Formation, Transbaikalia, in lingual (A), mesial or distal (B), and labial (D) views. Scale bar = 10 mm.

one spot along the lateral edge of wear facet. The root is thin-walled, with a large pulp cavity.

Measurements. ZIN PH 2/112: FABL=10.5; BCW=~11.5.

Remarks. The comparison of ZIN PH 2/112 with ZIN PH 4/13 from Mogoito (Averianov et al. 2003b: fig. 5A–C) is difficult because both specimens come from animals of different sizes. However, the elliptical wear facet in the Krasnyi Yar specimen compared with the V-shaped wear facet of the Mogoito specimen might suggest a taxonomic difference between the two sauropods. The ZIN PH 9/13 from Mogoito, interpreted previously as a juvenile sauropod tooth (Averianov et al. 2003b: fig. 5D–F), is referred here to Ornithopoda indet. (see below).

The Mogoito tooth ZIN PH 4/13 with V-shaped wear facet and broad crown is similar to the teeth of brachiosaurids, some titanosaurs and *Euhelopus* from the Early Cretaceous of China (Wiman 1929: pl. 2; Bohlin 1953; Barrett et al. 2002). Reference of an analogous tooth from the Early Cretaceous of South Korea to Brachiosauridae (Lim et al. 2001) is incorrect (Barrett et al. 2002). Similar teeth can be found in other sauropods, like the Late Jurassic *Camarasaurus* (Wilson and Sereno 1998: fig. 10). The phylogenetic position of *Euhelopus* is controversial; it varies from a sister taxon to Titanosauria (Wilson and Sereno 1998) to a eusauropod outside Neosauropoda (Upchurch et al. 2004). *Euhelopus*-like teeth are common in the Early Cretaceous deposits of Asia and Europe (e.g., Barrett et al. 2002; Canudo et al. 2002; Kurzanov et al. 2003; Barrett and Wang 2007) and currently attributed to Titanosauriformes indet.

The tooth ZIN PH 2/112 from Krasnyi Yar is more slender and pencil-like and has a single elliptical wear facet. In these respects it is more reminiscent of the teeth of *Nemegtosaurus* (Nowiński 1971: pl. 13, fig. 3) or *Alamosaurus* (Kues et al. 1980: fig. 2). This specimen could belong to a more derived titanosauriform sauropod with a precise crown-to-crown occlusion pattern (Calvo 1994; Upchurch and Barrett 2000).

Ornithopoda Marsh, 1881

Ornithopoda indet.

(Figs. 4–5)

Titanosauridae indet. [part.]: Averianov et al. 2003b: 590, fig. 5D–F.

Psittacosaurus sp. [part.]: Averianov et al. 2003b: 592, fig. 7C, D.

Material. Premaxillary teeth: ZIN PH 9/13 (MRT-102, 1999); ZIN PH 16/112 (MRT-102); ZIN PH 17/112 (MRT-102); ZIN PH 18/112, broken (MRT-102). Maxillary or dentary teeth: ZIN PH 13/13 (MRT-102, 1999); ZIN PH 15/112 (MRT-102); ZIN PH 12/112 (KYAR-1, 2002); ZIN PH 13/112 (KYAR-1, 2002); ZIN PH 14/112, worn (KYAR-1, 2002). ZIN PH 1/112, left pubis (MRT-102).

Description. The premaxillary teeth (Averianov et al. 2003b: figs. 5G–F, 4A–F) have a conical crown with a bulbous base. The crowns are wider mesiodistally than labiolingually. The crown apex is slightly bent posteriorly in ZIN PH 9/13 and 17/112, but straight in ZIN PH 16/112. The enamel is sculptured by a groove on labial side close to mesial margin and small pits in ZIN PH 17/112 and smooth in other specimens. In ZIN PH 17/117 there is a small apical wear facet; a facet along the distal margin; and isolated possibly wear facet on the lingual side. In ZIN PH 9/13 there are prominent wear facets on lingual side and on the mesial and distal edges. The ZIN PH 16/112 is more heavily worn, with large lingual and distal facets, and shorter mesial facet. The root is narrower than the crown and elliptical in cross-section.

The maxillary or dentary teeth (Averianov et al. 2003b: figs. 7C, D, 4G–L) have a leaf-like denticulate crown. One crown side (labial for dentary teeth and lingual for maxillary teeth) is convex or flattened, the opposite side is slightly concave. The median denticles are larger than marginal denticles. There 10–14 denticles which are separated on the convex side by deep grooves, which do not reach the base of the crown. In the teeth from Krasnyi Yar (ZIN PH 12 and 13/112) there is a heel-like protuberance of the crown on the convex side, and the root is narrower mesiodistally than the crown. In the teeth from Mogoito (ZIN PH 13/13 and 15/112) there is no such a heel and the root is wider labiolingually than the crown. The enamel is retracted apically along the mesial and distal edges of the root, where sometimes a distinct sulcus for the replacement tooth is formed (usually more pronounced from one side). The enamel is wrinkled, mostly on the convex side. On the opposite side the enamel sometimes does not reach the crown-root junction.

The pubis (Fig. 5) lacks a small part of the anterior margin of the prepubic process and most of the postpubic rod. The prepubic process is long, rod-like, and dorsoventrally flattened, so its mediolateral width is larger than the dorsoventral height. The prepubic

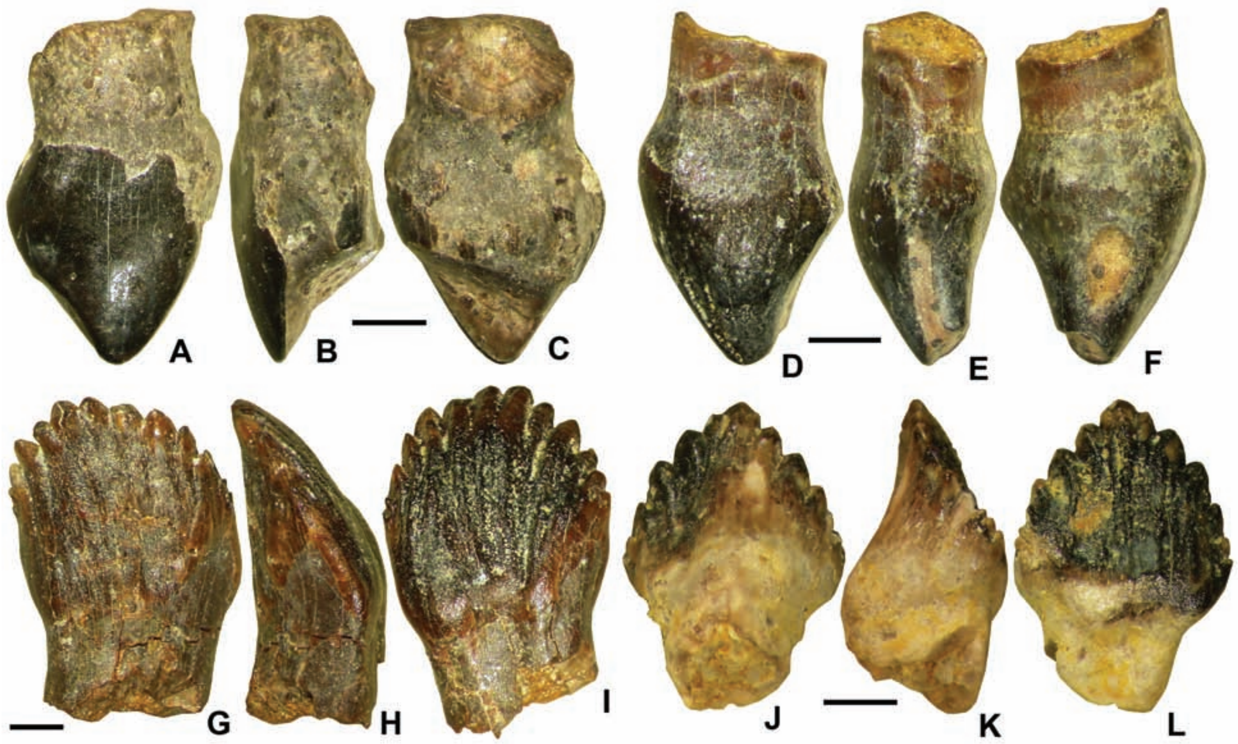

Fig. 4. Premaxillary (A–F) and maxillary or dentary (G–L) teeth of Ornithopoda indet. from Mogoito (A–J) and Krasnyi Yar (J–L) Early Cretaceous localities in Transbaikalia. A–C – ZIN PH 16/112, in labial (A), distal? (B), and lingual (C) views. D–F – ZIN PH 17/112, in labial (D), distal? (E), and lingual (F) views. G–I, ZIN PH 15/112, in lingual (G), mesial or distal (H), and labial (I) views. J–L, ZIN PH 13/112, in lingual (J), mesial or distal (K), and labial (L) views. Scale bar = 1 mm.

process is directing anterolaterally and meets the postpubic rod at an angle ~175°. The acetabular region is mediolaterally expanded in dorsal portion, but the acetabular surface is eroded, and possibly was not fully ossified. The obturator foramen is large and elliptical. It is bordered posteriorly by a dorsal outgrowth of the postpubic rod. The obturator foramen is open posteriorly for a small distance, but possibly this is a postmortem damage, or artifact caused by not fully ossified and not fossilized bone. The ventral floor of the obturator foramen is concave, with sharp lateral and medial edges, and small foramina for blood vessels. Posterior to the outgrowth closing the obturator foramen, the dorsolateral surface of the postpubic rod is concave, apparently for the reception of the ventral edge of ischium pubic peduncle, and has a sharp medial margin. The opposite ventromedial surface of the postpubic rod is rounded.

Measurements. For teeth measurements see Table 4.

Remarks. The teeth from Mogoito and Krasnyi Yar may represent two different taxa of ornithopods, because they differ in the presence/absence of a heel-like protuberance of the crown. Leaf-like denticulate

Fig. 5. ZIN PH 1/112, left pubis of Ornithopoda indet., in dorsal (A) and lateral (B) views. Mogoito locality, Murtoi Formation, Transbaikalia. Scale bar = 30 mm.

Table 4. Measurements of ornithopod teeth from the Early Cretaceous Khilok and Murtoi formations in Transbaikalia.

Specimen ZIN PH	FABL	TCH	BCW
Premaxillary teeth			
16/112	3.0	3.8	2.3
9/13	3.0	2.3	2.3
17/112	2.9	3.1	2.1
Maxillary or dentary teeth			
15/112	4.4	5.3	2.5
13/13	3.9	5.6	2.0
12/112	3.2	– *	2.3
13/112	3.0	3.3	2.4

teeth without a defined medial ridge are common in Jurassic and Cretaceous deposits of Eurasia and North America and are traditionally attributed to the Hypsilophodontidae (e.g., Sternberg, 1940; Thulborn 1973; Galton 1980, 1983, 1997, 1999; Manabe and Barrett 2000; Rauhut 2001). However, recent cladistic analyses do not recognize a monophyletic Hypsilophodontidae (e.g., Norman et al. 2004; Butler et al. 2008). Thus the materials described herein identified as Ornithopoda indet.

The premaxillary teeth from Mogoito (unknown from Krasnyi Yar) differ from those of the basal euornithopods from the Late Jurassic of Portugal (Thulborn 1973; Rauhut 2001) as they possess less pronounced sculpturing and lack serrations.

The pubis ZIN PH 1/112 is referable to 'Hypsilophodontidae' because of its rod-shaped prepubic process which is wider transversely than tall dorsoventrally (Sereno 1986; Weishampel and Heinrich 1992; Sues 1997). In contrast with *Hypsilophodon* (Galton 1974), the prepubic process of ZIN PH 1/112 is smooth and bears neither striations, nor a distinct groove on the ventral side. These features, as well as the incomplete ossification of the acetabular margin, may indicate immaturity. In *Hypsilophodon* the obturator foramen is variably enclosed within the pubis (Galton 1974). In *Psittacosaurus* the prepubic process is also dorsoventrally flattened, but distinctly more expanded mediolaterally and not rod-like, and there is no outgrowth of the pubic rod which closes the obturator notch posteriorly (Young 1958; Sereno and Chao 1988; Sereno 1990).

G.A. Dmitriev (1960) mentioned an ornithopod distal tibia fragment from Mogoito.

Ceratopsia Marsh, 1890

Psittacosauridae Osborn, 1923

***Psittacosaurus* Osborn, 1923**

***Psittacosaurus* sp.**

(Fig. 6)

Psittacosaurus sp. [part.]: Averianov and Skutschas 2000c: 358; Averianov et al. 2003b: 592, fig. 7A, B.

Material. ZIN PH 12/13, maxillary tooth (MRT-102, 1999). ZIN PH 6/13, dentary tooth (MRT-102, 1998).

Description. The isolated teeth referable to *Psittacosaurus* differ from those of ornithopods described herein in that the root more is compressed labiolingually and the crown which is not so wide at the base, with the labial and lingual surfaces meeting at the apex at a more acute angle. In psittacosaurid teeth usually there is a depression or flattened area at the base of the crown and adjacent root surface on the side opposite to the working side (lingual on lowers and labial on uppers). In ornithopods there is a heel-like protuberance of the crown at this place. Additionally, in the psittacosaurid teeth usually there are no such prominent "resorption" side facets for the replacing teeth, as present in the ornithopod teeth described above.

The ZIN PH 12/13 is an unworn maxillary tooth because of lack of a bulbous median ridge (Fig. 6A–C). The crown is relatively long and low; it is 1.5 times longer than the longest (mesiodistally) part of the root, which is at the crown-root junction. There are ten denticles, with the smallest first mesial (?) and two last distal (?) denticles. The four median denticles are of similar size; two distal (?) ones are somewhat higher. The base of the crown is inflated on the lingual side and concave on the labial side.

The ZIN PH 6/13 is a dentary tooth with an incompletely preserved median ridge on the lingual side (Fig. 6D–F). In contrast to the maxillary tooth described above, the root is maximally long (mesiodistally) some distance distal to the crown and constricted at the crown-root junction. The crown is only 1.3 times longer than the longest (mesiodistally) part of the root. There are possible eight denticles on the crown. The smaller side denticles are not present on one crown side (mesial?) which is almost straight. There are three smaller denticles on the opposite (distal?) side which are separated by a groove from more lingual ridge, extending from the previous large denticle towards the end of the crown. The root is

Fig. 6. Maxillary (A–C) and dentary (D–F) teeth of *Psittacosaurus* sp. from Mogoito locality, Murtoi Formation, Transbaikalia. A–C – ZIN PH 12/13, in labial (A), mesial or distal (C), and lingual (D) views. D–F – ZIN PH 6/13, in labial (D), mesial and distal (E), and lingual (F) views. Scale bar = 1 mm.

convex labially but almost flat on the lingual side. Similarly, the base of the crown is inflated labially and depressed lingually.

In both specimens the enamel is sculptured by small pits.

Measurements. ZIN PH 12/13: FABL = 2.1; BCW = 1.1; TCH = 1.6. ZIN PH 6/13: FABL = 2.7; BCW = 1.6.

Remarks. The tooth with the leaf-like crown from Mogoito (ZIN PH 13/13), identified previously as *Psittacosaurus* sp. (Averianov et al. 2003b: fig. 7C, D) is attributed here to Ornithopoda indet. (see above). An earlier report on *Psittacosaurus* from Krasnyi Yar (Skutschas 2004) was based on ZIN PH 12/112, which is referred here to the Hyspsilophodontidae. Currently there are no specimens from Krasnyi Yar attributable to *Psittacosaurus*. Although some dental characters were proposed for distinguishing the *Psittacosaurus* species (e.g., Sereno and Chao 1988), the high individual, ontogenetic, and positional variation in the dentition (see Brinkman et al. 2001) makes impossible attribution of the isolated *Psittacosaurus* teeth to a particular species.

The attribution of ZIN PH 12/13 to *Psittacosaurus* is not certain. Alternatively, it may belong to an ankylosaur (P. Barrett, pers. com.). However, there are no other evidences for presence of Ankylosauria in the Murtoi Formation.

GENERAL DISCUSSION

Comparisons between the dinosaur assemblages of the Murtoi and Khilok formations (Tables 1 and 2) are hampered by the limited nature of the available material, and absence of a particular taxon from either sample could be caused by sampling bias rather than reflecting its genuine absence. Nevertheless, some differences should be pointed out. In the Murtoi Formation there are no large carnivorous theropods, which are represented by a '*Prodeinodon*'-like animal in the Khilok Formation. A tooth fragment ZIN PH 4/13 from Mogoito identified previously as cf. *Mongolosaurus* sp. (Averianov et al. 2003b: fig. 2J) is almost symmetrical, with mesial and distal denticles of similar size which are meeting at the apex (an unusual feature for a theropod), and has wrinkled enamel. It is similar to the denticulated tooth of the sauropod *Mongolosaurus* from the Early Cretaceous of Mongolia (Gilmore 1933; fig. 4). The presence of a *Euhelopus*-like sauropod in Mogoito and a *Nemegtosaurus*-like sauropod in Krasnyi Yar may reflect temporal and/or ecological differences between the two localities. Another faunistic difference could be in the presence of different ornithopod taxa in the two units, with a heel on the teeth in the Krasnyi Yar animal and without in Mogoito. Absence of unquestionable *Psittacosaurus* teeth in Krasnyi Yar is most likely because of sampling bias.

In the Early Cretaceous Sangar Series of Yakutia, East Siberia (Kurzanov et al. 2003) there are theropods cf. '*Prodeinodon*' (similarity with Krasnyi Yar), sauropods cf. *Euhelopus* (similarity with Mogoito) and stegosaurs (absent from both Transbaikalian assemblages). All these three dinosaurian taxa are also present in the Barremian(?)–Aptian–Albian(?) Ilek Formation of West Siberia (Averianov et al. 2004). In the Ilek Formation there are also dromaeosaurid teeth similar to those from the Transbaikalian localities. The lack or rarity of stegosaurs in Transbaikalia may reflect some environmental peculiarities of this region. Stegosaurs were quite rare in the Early Cretaceous of West Siberia and Mongolia (Alifanov et al. 2005) but seem to be more common in East Siberia (Yakutia). The most notable peculiarity of the Siberian Early Cretaceous dinosaur faunas, including that of Transbaikalia, is the complete absence of iguanodontians, which were present in the Early Cretaceous of Europe, Mongolia, China, and Japan, the territories around the Siberia (Rozhdestvensky 1952; Norman 1986, 1996, 1998, 2002; Wang and Xu 2001; Kobayashi and Azuma 2003; You et al. 2003). Many more new localities and fossils are needed for a better understanding of the stratigraphic and geographic distribution of dinosaurs in Siberia.

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