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Original article

# A new sauropod dinosaur from the Lower Cretaceous Ilek Formation, Western Siberia, Russia☆

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ABSTRACT

*Sibirotitan astrosacralis* nov. gen., nov. sp., is described based on isolated but possibly associated cervical and dorsal vertebrae, sacrum, and previously published pedal elements from the Lower Cretaceous (Barremian?) Ilek Formation at Shestakovo 1 locality (Kemerovo Province, Western Siberia, Russia). Some isolated sauropod teeth from the Shestakovo 1 locality are referred to the same taxon. The phylogenetic parsimony analyses place *Sibirotitan astrosacralis* nov. gen., nov. sp., as a non-titanosaurian somphospondyl titanosauriform. The new taxon exhibits four titanosauriform and one somphospondylan synapomorphies, and one autapomorphy – a hyposphene ridge that extends between the neural canal and the postzygapophyses. It differs from all other Somphospondyli by having only five sacral vertebrae. The new taxon shares with *Euhelopus* and *Epachtosaurus* sacral ribs that converge towards the middle of the sacrum in dorsal view. *Sibirotitan astrosacralis* nov. gen., nov. sp., is only the second sauropod taxon from Russia and one of the oldest titanosauriform described so far in Asia.


## 1. Introduction

The outcrop of the Lower Cretaceous Ilek Fm. along the right bank of the Kiya River at Shestakovo village (Kemerovo Province, West Siberia, Russia), corresponding to the Shestakovo 1 vertebrate locality in the current nomenclature, first produced vertebrate remains in 1953 when two skeletal fragments of *Psittacosaurus* were found by geologists A.A. Mossakovsky and I.V. Lebedev (Rozhdestvensky, 1955, 1960). In the early 1960s, the remains of a distinctly larger dinosaur were found at Shestakovo 1, but the fate of this material is unknown (Bulynnikova and Trushkova, 1967). The recent exploration of the Shestakovo 1 locality started in 1994-1995, when E.N. Maschenko found there a tritylodontid tooth, a sauropod phalanx, and a mammal jaw, the latter representing the first Mesozoic mammal discovered in Russia (Maschenko and Lopatin, 1998; Tatarinov and Maschenko, 1999; Averianov et al., 2002). Nowadays, the Shestakovo 1 and nearby Shestakovo 3 localities produce a rich vertebrate fauna including fishes, salamanders, turtles, lizards, choristoderes, crocodylomorphs, pterosaurs, non-avian dinosaurs, birds, tritylodontids, and various mammals (Maschenko and Lopatin, 1998; Alifanov et al., 1999; Tatarinov and Maschenko, 1999; Efimov and Leshchinskiy, 2000; Averianov and Fayngertz, 2001; Averianov and Voronkevich, 2002; Averianov et al., 2002, 2003a, 2003b, 2006; Maschenko et al., 2003; Lopatin et al., 2005, 2009, 2010a, 2010b, 2015; Averianov and Lopatin, 2008; Kurochkin et al., 2011; O'Connor et al., 2014; Skutschas, 2014; Skutschas and Vitenko, 2015).

Alifanov et al. (1999) identified Titanosauridae indet. based on a peg-like tooth with a circular cross-section from the Shestakovo locality. Leshchinskiy et al. (2000: fig. 2) figured an unprepared, poorly preserved vertebra and reported on a juvenile spoon-like tooth from Shestakovo 1. Averianov et al. (2002) described a

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partially preserved sauropod foot from Shestakovo 1, referring it to Titanosauriformes indet. Isolated *Pleurocoelus*-like sauropod teeth have also been reported from Shestakovo 1 (Averianov et al., 2002, 2004). Here we describe the sauropod material from Shestakovo 1 that can be referred to a single taxon, the new titanosaurian *Sibirotitan astrosacralis* nov. gen., nov. sp. These specimens include isolated teeth, one middle and two posterior cervical vertebrae, one middle dorsal vertebra, a synsacrum, and a partial foot already described by Averianov et al. (2002). Currently there are no sauropod remains described from the Shestakovo 3 locality. *Sibirotitan astrosacralis* nov. gen., nov. sp., is the second sauropod dinosaur from Russia to receive a scientific name, after *Tengrisaurus starkovi* from the Early Cretaceous of Transbaikalia (Averianov and Skutschas, 2017). *Arkharavia heterocoelica*, based on isolated caudal vertebrae from the Upper Cretaceous of Amur Province, Russia, and referred originally to Sauropoda (Alifanov and Bolotsky, 2010), has since been re-identified as a member of the Hadrosauridae (Alifanov, 2012).

## 2. Geographic and geological settings

The locality of Shestakovo 1 is located along the right bank of the Kiya River and confined to a 20–35 m-high cliff which extends 800 m north-west from the Shestakovo village (Chebula District, Kemerovo Province, Russia; Fig. 1). The cliff is divided by a ravine into two unequal parts: the northern Bol'shoi Yar (Big Cliff), which is longer and higher, and the southern Malyi Yar (Small Cliff). The main microvertebrate site, producing most of the isolated sauropod teeth, is within the Bol'shoi Yar, although some sauropod teeth come from Malyi Yar as well. In contrast, all skeletal sauropod remains and a few isolated teeth come from a more consolidated level on a small area within the Malyi Yar (N 55°54′29.5″, E 87°57′06.5″). The posterior cervical (PM TGU 120/8-Sh1-3) and dorsal (PM TGU 120/10-Sh1-22) vertebrae were dug out from the outcrop in 2008 and 2011, respectively (Fig. 2); the remaining skeletal elements were found in the blocks of rock fallen down from the outcrop. It is probable that most bones belong to a single skeleton, which was cropped out over the years from the Malyi Yar, because all sauropod bones, collected *in situ* and from the fallen blocks come from the same stratigraphic layer. Large dinosaur bones reported by Bulynnikova and Trushkova (1967) may belong to this skeleton. However, bones of more than one individual are represented in the sample, as evidenced from a juvenile cervical centrum (PM TGU 120/13-Sh1-1). The other elements belong to an adult individual.

The Shestakovo vertebrate localities belong to the Ilek Fm. deposited in the Chulim-Yenisei sedimentary basin and occupying a vast territory in Western Siberia (Leshchinskiy and Fayngertz, 2001; Averianov and Lopatin, 2015). The sediments of the Ilek Fm. are exposed South of the Chulim-Yenisei Basin where they overlay northern spurs of the Kuznetsk Alatau mountain range. In the North, the Ilek Fm. becomes overlaid by Upper Cretaceous deposits. The Chulim-Yenisei sedimentary basin was formed as a separate geological structure during the second half of the Mesozoic era. It is the outermost structure of the West Siberian Basin, where sedimentary cover (including post-Jurassic deposits) pinches out to the South (to Kuznetsk Alatau, which is a part of Altay-Sayan folded region). The Jurassic and Cretaceous sedimentary rocks of this foreland basin overlay folded heterogeneous geological structures of pre-Cambrian and Paleozoic ages.

The Jurassic sediments (Makarovo, Itat, and Tyazhin formations) in the Chulim-Yenisei sedimentary basin are represented by continental terrigenous rocks which were formed predominantly in the extensive fluvial-lacustrine plain and contain abundant coal layers as well as coarse-grained material (Le Heron et al., 2008). The younger Lower Cretaceous deposits overlay unconformably Jurassic and Paleozoic rocks. These deposits include the Ilek and Kiya formations, both well exposed along the Kiya River near the Shestakovo village. The Ilek Fm. is represented at Shestakovo by a package of greenish and gray sands and sandstones with clays, marls, and calcareous silts.

The Ilek Fm. was deposited under continental environments in the fluvial-lacustrine semi-desert plain (Nesterov, 1976). The climate was semiarid (Gol'bert et al., 1968). Denudation of the southerly located Altay-Sayan folded region supplied the clastic material to the Chulim-Yenisei depression. The proximity of the feeder source led to the textural immaturity of the clastic sediments. The subsidence of the Chulim-Yenisei basin resulted in the deposition of thick Lower Cretaceous sediments.

The sediments of the Ilek Fm. have a rhythmic structure. The sequence starts with the erosion of underlying beds, which formed the basal conglomerates composed of argillite pebbles. The overlying layer is represented by coarse-grained sandstones with large vertebrate remains. Microscopic analysis of sands shows that clastic material is poorly sorted, predominantly made of angular and subangular rounded clasts and characterized by a high content of rock fragments (i.e., wacks, texturally immature rocks). As the force of the flow diminished, the size of grains reduced to medium and fine-grained. The terminal section of the sequence consists of siltstones and argillites, rarely comprising complete skeletons in articulation and their fragments (i.e., Shestakovo 3 locality). The sauropod remains are confined to the erosion surface (Figs. 1, 3).

The age of the Ilek Fm. at the Shestakovo 1 locality is poorly constrained. The lower part of the Ilek Fm. along the Uryup River, the tributary of Chulym River, produced gastropods and bivalves of Valanginian age (Bulynnikova and Trushkova, 1967). There are bivalves and ostracods of Barremian age in the upper part of the Ilek Fm. along the Uryup River (Bulynnikova and Trushkova, 1967). The upper part of the Ilek Fm. uncovered by a drilling core on the Chulym River contains Hauterivian-Barremian gastropods and bivalves (Bulynnikova and Surkov, 1962). The age of the Kiya Fm. that overlays the Ilek Fm. is upper Albian on the basis of plant remains (Golovneva and Shchepetov, 2010). Leshchinskiy et al. (2000) correlated the Shestakovo 1 vertebrate locality with the Aptian-Albian Khoboor locality in Mongolia, based on the presence of the widespread species of eutriconodontan mammal *Gobiconodon*. However, it is now clear that gobiconodontids from Shestakovo 1 differ from the Khoboor *Gobiconodon* species (Lopatin and Averianov, 2015). Therefore, a Barremian age for the Shestakovo 1 locality is not definitive.

## 3. Systematic paleontology

The nomenclature of the vertebral fossae and laminae follows Wilson (1999, 2012) and Wilson et al. (2011). The described specimens are housed in the Paleontological Museum, Tomsk State University (PM TGU) and in the collection of the Laboratory of Mesozoic and Cenozoic Continental Ecosystems, Tomsk State University (LMCCE).

Dinosauria Owen, 1842
Saurischia Seeley, 1887
Sauropoda Marsh, 1878
Titanosauriformes Salgado et al., 1997
Genus ***Sibirotitan*** nov. gen.

**Derivation of the name**: from Siberia and Greek Τιτάν (titan), a member of the second order of divine beings, descended from the