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On the Find of a Primitive Hadrosauroid Dinosaur (Ornithischia, Hadrosauroidea) in the Cretaceous of the Belgorod Region

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Abstract—An isolated maxillary tooth and opisthocoelous anterior thoracic or posterior cervical vertebral centrum of a duck-billed dinosaur, Hadrosauroidea indet., are described. These parts originate from the marine Albian–Cenomanian deposits of the Stoilo iron ore quarry near the town of Staryi Oskol, Belgorod Region. This is the oldest record of a hadrosauroid dinosaur in Eastern Europe and one of the oldest representatives of this group in the world.

INTRODUCTION

Dinosaur remains from European Russia are extremely scarce. Nessov (1995, 1997) mentioned the bones presumably belonging to dinosaurs found by A.A. Yarkov in the Campanian–Maastrichtian deposits in the vicinity of the Polunino farm in the Volgograd Region (see also Yarkov, 2000). A series of sauropod vertebrae of the family Brachiosauridae was described by Efimov (1997) from the Hauterivian (*Speetoniceras versicolor* Zone) of the Ulyanovsk Region on the Volga River. Isolated specimens (phalanges and teeth) of carnivorous dinosaurs from the Coelurosauria were recently found in the Middle Jurassic (Bajocian–Bathonian) of the Moscow Region (Alifanov, 2000; Alifanov and Sennikov, 2001). Articulated bones of the hind limb of a primitive hadrosauroid, *"Orthomerus" weberae*, were found in the Maastrichtian of the Crimea (Ryabinin, 1945).

Glauconite–quartz sands, including beds and lenses of phosphorite nodules dated as the Albian–Cenomanian interval, are widespread in the Belgorod and Kursk regions (see Gabdullin, 2000). These deposits have been famous for a long time because of the co-occurrence of such marine reptiles as ichthyosaurs, plesiosaurs, and turtles. Kiprianoff (1883) described *Poekilopleuron schmidti* on the basis of a fragmentary humerus and ribs from the so-called Seversk Osteolith near Kursk. He took these parts for crocodile remains. Later, Maleev (1964) assigned these bones to a dinosaur, probably close to carnosaurs. However, the bones identified by Kiprianoff as ribs (1883, pl. 4) are rather reminiscent of the ichthyosaur jugal. From the early 1980s, fossil vertebrates were regularly collected by Nessov (1984, 1995, 1997, etc.) in the Albian–Cenomanian interval close to the towns of Gubkin and Staryi Oskol in the Belgorod Region in the quarries of the Stoilo and Lebedi iron ore plants. Among the numerous remains of sea reptiles, he identified a fragmentary femoral diaphysis of a theropod and a tooth of a primitive hadrosauroid (Nessov, 1995).

MATERIALS

The present paper describes a hadrosauroid tooth found by Nessov in 1994 and a fragmentary vertebra belonging to the same species found by E.V. Popov and E.B. Razumovskaya (Research Institute of Geology of Saratov State University) in 1998. Both specimens come from loose deposits of the Stoilo quarry and are dated as Albian–Cenomanian (Gabdullin, 2000). The material is stored at the paleoherpetological collection of the Zoological Institute of the Russian Academy of Sciences (ZIN PH) and the collection of Saratov State University (SGU).

DESCRIPTION

Specimen ZIN PH, no. 1/30 (Fig. 1) is a maxillary tooth, since the central carina is in the middle of the crown (whereas in the lower teeth of hadrosauroids, it is displaced distally). The tooth is relatively small, the maximum height of its crown is 18 mm, the maximum length mesiodistally is 6.5 mm. The crown is leaflike, considerably elongated, and short mesiodistally; its diamond shape is very poorly expressed. Apically, the crown slightly curves distally (?) and is virtually unworn. The enamel covers only the labial side, it is damaged along the carina and at the tooth edges. The carina is well developed and lacks central depression. There are no additional crests on the labial side of the crown. Only five lateral denticles are distinguishable at one edge, the others were lost together with the enamel. The lingual side of the tooth is slightly concave. Dis-

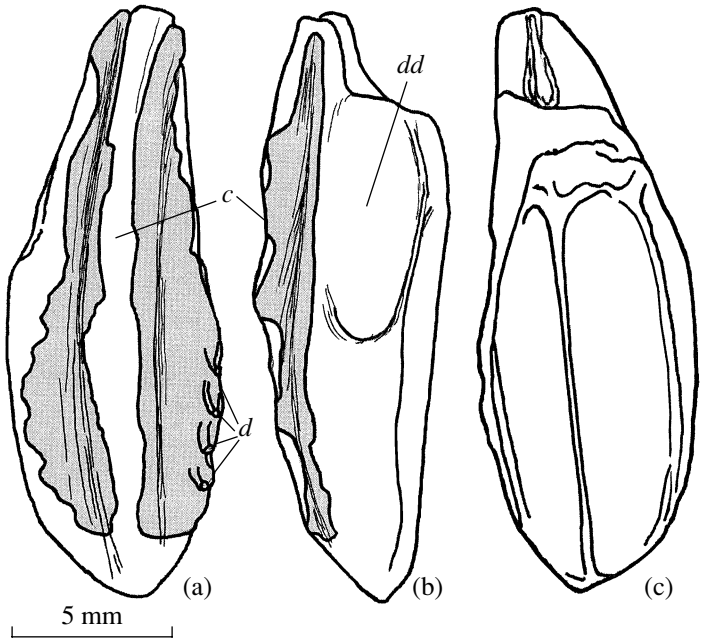

Fig. 1. Hadrosauroidea indet., maxillary tooth, ZIN PH, no. 1/30: (a) labial, (b) anterior or rear, and (c) lingual views. Designations: (*c*) carina, (*d*) lateral denticles, and (*dd*) depression for the crown of the anteriorly or posteriorly adjoining tooth of the next tooth series.

tally and mesially, half of the tooth height is occupied by relatively deep depressions for more posterior and more anterior teeth of the next tooth series. The root is absent; however, the angle between the crown and the root was most likely 165°–170°.

The vertebra is presented by a strongly rounded centrum with the base of the neural arch (SGU no. 104a/33; Fig. 2). Judging from the relatively small size and some erosion of the centrum edges, which might be a result of incomplete ossification, this specimen apparently belongs to a juvenile. A cross section of the centrum is subtriangular because of strong ventral tapering. The maximum width is 70 mm, and the maximum length is 63 mm. The vertebral centrum, taking into account a substantial destruction of its ventral edge, was at least 63 mm deep. The lateral surfaces are slightly concave and bear depressions at the base of the neural arch. The centrum is probably opisthocoelous. This is supported by the strongly oblique edge of the neural arch contacting its concave articular surface, as well as the vertical orientation of the opposite edge. This is usually characteristic of the posterior and anterior edges of the neural arch, respectively. Presumably broken parapophysis is observed near the convex articular surface on the right side of the vertebra at the neural arch base. A short crest runs posterodorsally from the parapophysis. There is a depression above the crest, the space above which was probably occupied by the diapophysis. Thus, the asymmetry of the neural arch and the arrangement of the processes for ribs attachment (as the parapophysis was positioned relatively close to the anterior edge of the vertebral centrum) suggest the opisthocoelous type of vertebra. The arrangement of the parapophyses and diapophyses and their isolation suggest that the vertebra most likely belongs to the anterior part of the thoracic region or to the posterior part of the cervical region. In the primitive Early Cretaceous iguanodontoid *Tenontosaurus*, the parapophysis of the posterior cervical vertebra is still located on the vertebral centrum and shifts to the neural arch only starting from the anterior thoracic vertebra (Forster, 1990, text-figs. 1, 3). The same is observed in the more advanced Iguanodontoidea and the majority of the Hadrosauroidea (e.g., Normal, 1980, text-figs. 22, 34; Norman and Hilpert, 1987, text-fig. 35; Godefroit *et al.*, 1998, text-figs. 21, 22). In *Telmatosaurus* from the Maastrichtian of Romania, the parapophysis of the posterior cervical vertebra is placed on the neural arch (Weishampel *et al.*, 1993, text-fig. 4B).

The presence of a single stout crest (carina) lacking central depression on the labial side of the maxillary tooth, the absence of additional (lateral) crests, and relatively small marginal denticles are evidence for the assignment of this tooth to the Hadrosauroidea rather than to an iguanodontoid or a more primitive ornithopod. The maxillary teeth of hadrosauroids are more difficult to identify than the lower teeth. This hampers a more precise determination of the taxonomic position of the dinosaur in question.

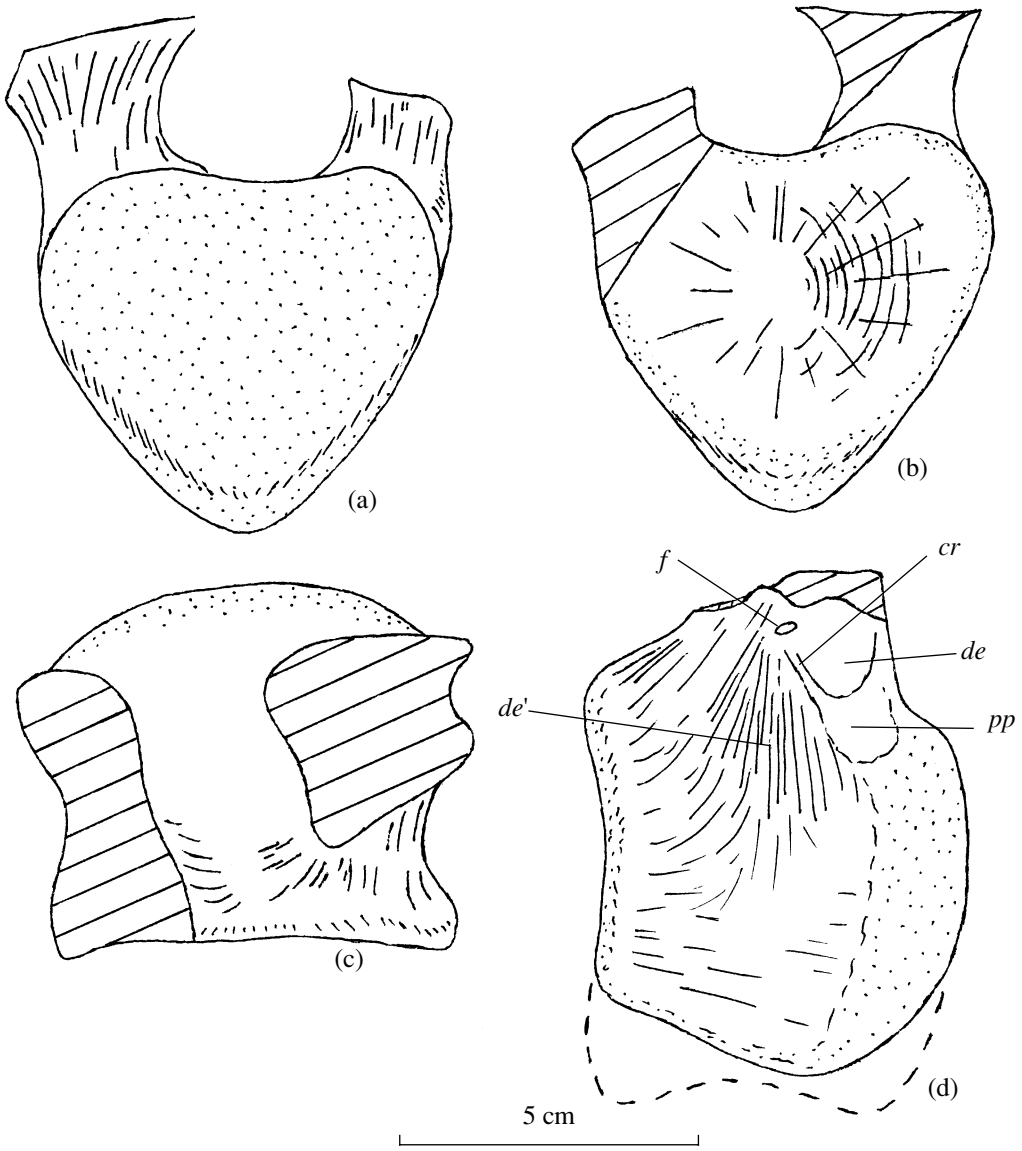

Fig. 2. Hadrosauroidea indet., posterior cervical or anterior thoracic vertebra (SGU, no. 104a/33): (a) anterior articular surface, (b) posterior articular surface, (c) dorsal surface, and (d) lateral surface. Designations: (*cr*) crest, (*de*) subcircular depression, (*de*') lateral depression, (*f*) foramen, and (*pp*) parapophysis.

DISCUSSION

Among dinosaurs, the opisthocoelous vertebrae are observed in sauropods, some theropods, and ornithopods. In sauropods, opisthocoelous cervical and thoracic vertebrae are much more gracile than in the other groups, in particular, owing to the presence of special large lateral depressions on the centrum (pleurocoels); in addition, they are frequently elongated and characterized by an original bone structure sharply different from that in the vertebra under study. In theropods, opisthocoelous vertebrae are also distinguished by bone structure and show more or less pronounced pneumatisation, which is not observed in the vertebra from Belgorod. Among ornithopods, opisthocoelous cervical and anterior thoracic vertebrae are characteristic of the group comprising the Iguanodontoidea and Hadrosauroidea (Sereno, 1986). The vertebra under description demonstrates obvious similarity to hadrosauroid vertebrae (see, e.g., Rozhdestvenskii, 1964, text-figs. 607a, 607b), although its attribution to the Iguanodontoidea cannot be completely excluded. A more exact identification of the available material seems impossible. Thus, the taxonomic position of the Belgorod dinosaur may be tentatively determined as Hadrosauroidea indet.

Along with hadrosauroids from the transitional Albian–Cenomanian beds of Utah, USA (*Eolambia*: Kirkland, 1998); Cenomanian of Texas, USA (*Protohadros*: Head, 1998), and Late Albian–Early Cenomanian of Karakalpakistan, Uzbekistan (*"Gilmoreosaurus" atavus*: Nessov, 1995), the duck-billed dinosaur

from the Belgorod Region is one of the earliest members of the Hadrosauroidea. A highly advanced position of *Probactrosaurus* from the Lower Cretaceous of China (Rozhdestvenskii, 1966) belonging to the family Iguanodontidae, which is ancestral to duck-billed dinosaurs, may suggest the Asian origin of the Hadrosauroidea; at the Early–Late Cretaceous boundary, they rapidly expanded over the entire Northern Hemisphere. According to Nessov (1995), hadrosaurs had time to penetrate into Europe from Asia before the emergence of the Turgai Strait, which separated these landmasses beginning with the Turonian for a long time. Subsequently, European hadrosauroids obviously developed separately from Asian and North American members of this group for the rest of the Late Cretaceous. Possibly, the evolutionary rates of the European Late Cretaceous island Hadrosauroidea were lower than those of Asian and North American forms inhabiting the continents. This might explain the extreme primitiveness of *Telmatosaurus* from the Maastrichtian of Romania (Weishampel *et al.*, 1993).

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