

A New Species of Bothriolepidid Antiarch (Pisces, Placodermi) from the Zadonskian Horizon (Upper Devonian) of the Central Devonian Field

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Abstract—A new placoderm species, *Bothriolepis sosnensis* sp. nov., from the Zadonskian Horizon (Lower Famennian) of the gravelly sands in the Lime Factory quarry situated at the southwestern outskirts of the town of Livny (Orel Region) is described. The new species sharply differs from all known *Bothriolepis* species in the shape and proportions of the nuchal and anterior median dorsal plates and elongate paired supraotic pits on the nuchal plate. It also differs from the majority of Famennian members of the genus *Bothriolepis* by the character of the passage of the infraorbital groove on the external surface of the head plates.

Key words: Placodermi, Bothriolepidoidei, Devonian, Famennian, Russia.

INTRODUCTION

The Central Devonian Field (CDF) is an extensive region of outcrops of the Devonian deposits, which covers the territories of the Tula, Orel, Lipetsk, Voronezh, Kursk, and Bryansk regions. The first purposeful search for the remains of agnathans and fish from the Devonian deposits of this region was undertaken by the expedition of D.V. Obruchev in 1960. Subsequently, the ichthyofaunal remains were collected by the expeditions of O.P. and E.D. Obruchevs in 1960 and 1961, N.L. Grombchevskaya in 1960, A.A. Astrova and I.I. Chudinova in 1966, V.V. Dobrokhotova in 1976, N.I. Krupina in 1977 and 1980, and O.A. Lebedev in 1982 to 1984. During this field research, the remains of large antiarch were found in the vicinity of the town of Livny in the sandy deposits of the Zadonskian Horizon. Later, this antiarch was described by Obrucheva (1983) as *Bothriolepis zadonica* H. Obrucheva. The collecting and studying of the ichthyofaunal remains from the deposits of the CDF were continued by O.A. Lebedev from 1997 to 2001. During this time, extensive material on antiarchs tentatively identified as *Bothriolepis zadonica* H. Obr., *B. sp. 1*, *B. sp. 2*, *B. sp. 3* and *Remigolepis?* sp. (Moloshnikov, 2001) were found in the gravelly sand of the Lime Factory (or Gornostae-

vskii, Livenskii) quarry. The subsequent study of this collection allowed the author to define, in detail, antiarchs of the genus *Bothriolepis*, one of which is allocated in a new species, *B. sosnensis* sp. nov. (originally, it was determined as *B. sp. 1* and *B. sp. 2*), *B. zadonica* H. Obr., *Bothriolepis* cf. *B. leptocheira* Traquair (which was originally determined as *B. sp. 3*), and *Bothriolepis* sp. indet.

The new species of the bothriolepidid antiarch is described below. The collection of the Zadonskian antiarchs is housed at the Paleontological Institute of the Russian Academy of Science (PIN), collection no. 3725.

SYSTEMATIC PALEONTOLOGY

Family Bothriolepididae Cope, 1885

Genus *Bothriolepis* Eichwald, 1840

Bothriolepis sosnensis Moloshnikov, sp. nov.

Plate 6, figs. 1–8

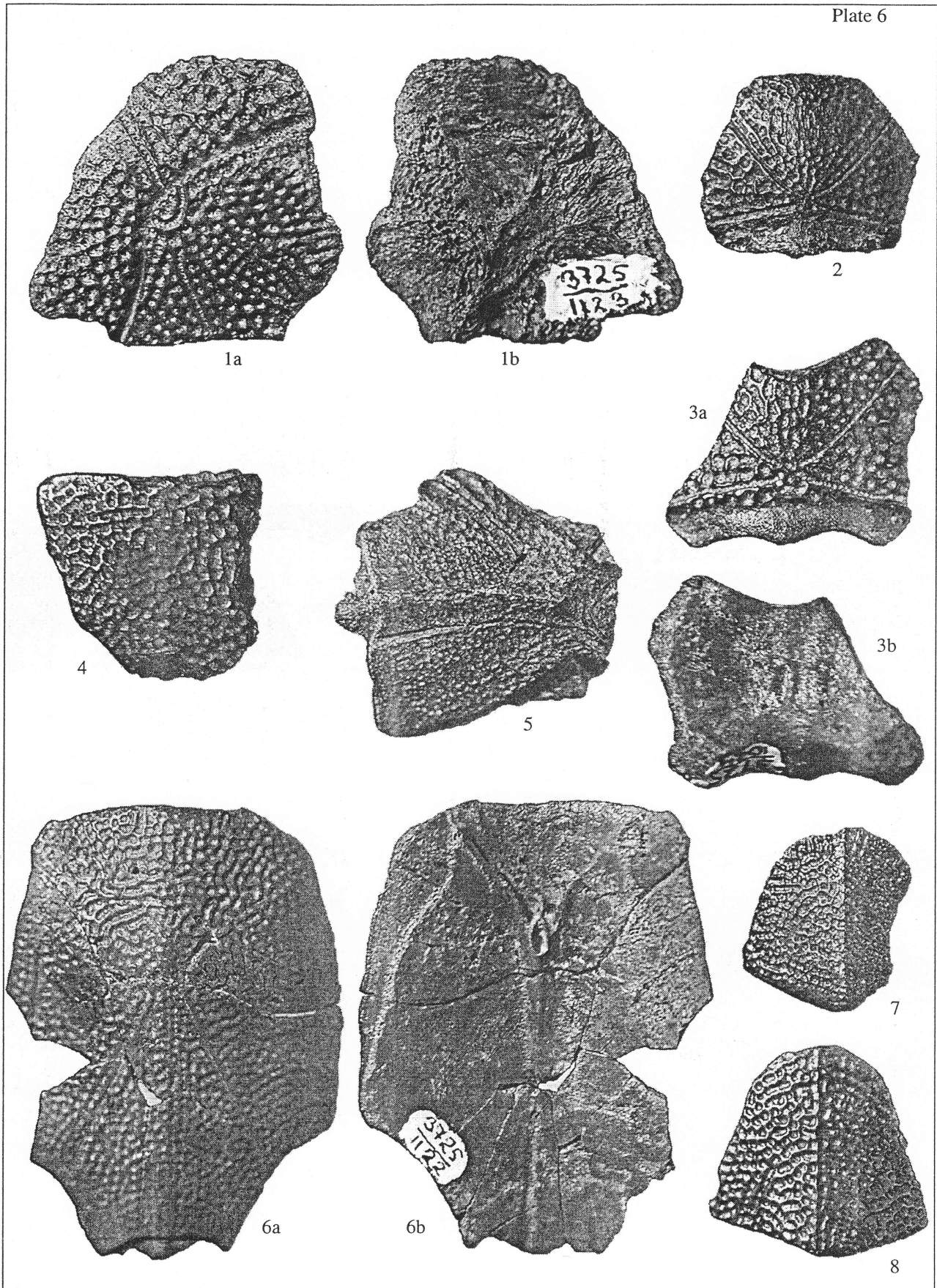
Etymology. From the Sosna River on whose bank the locality of Devonian fish is situated.

Holotype. PIN, no. 3725/1122, anterior median dorsal plate; Orel Region, Livny District, southwestern outskirts of the town of Livny, right bank of the Sosna

Explanation of Plate 6

Figs. 1–8. *Bothriolepis sosnensis* sp. nov.: (1a, 1b) specimen PIN, no. 3725/1123, laterale, $\times 2.4$: (1a) dorsal and (1b) ventral views; (2) specimen PIN, no. 3725/1022, nuchale and postpineale, dorsal view, $\times 2.6$; (3a) and (3b) specimen PIN, no. 3725/1024, nuchale, $\times 2.2$: (3a, 3b) ventral views; (4) specimen PIN, no. 3725/1104, fragment of anterior dorso-laterale, external surface, $\times 2.4$; (5) specimen PIN, no. 3725/1019, mixilaterale, external surface, $\times 2.5$; (6a, 6b) holotype PIN, no. 3725/1122, anterior medio-dorsale, $\times 1.7$: (6a) dorsal and (6b) ventral views; (7) specimen PIN, no. 3725/1128, posterior medio-dorsale of subadult, dorsal view, $\times 2.4$; (8) specimen PIN, no. 3725/1124, fragment of posterior medio-dorsale, dorsal view, $\times 2$. Orel Region, southwestern outskirts of the town of Livny; Lime Factory quarry; Upper Devonian, Lower Famennian, Zadonskian Horizon.

Plate 6



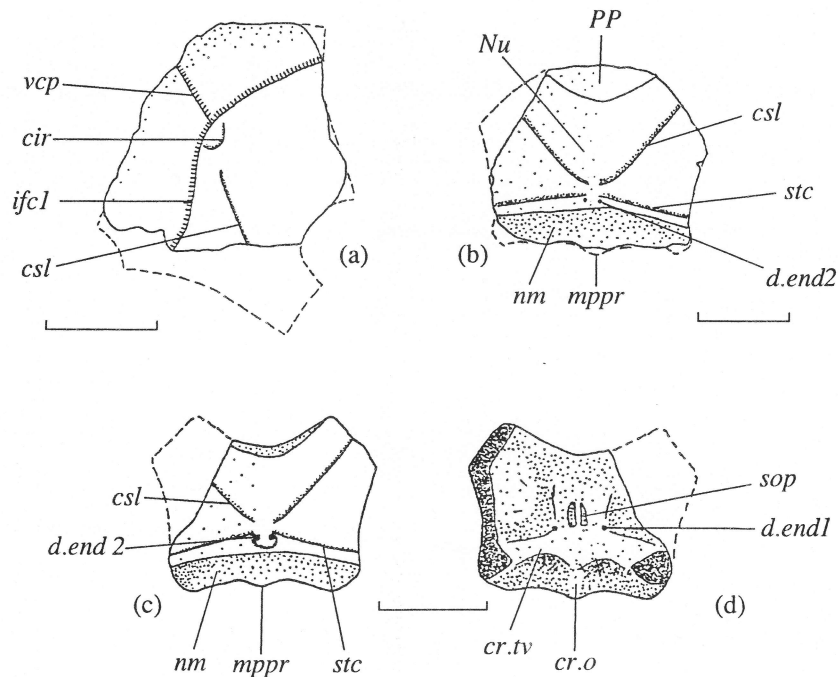


Fig. 1. *Bothriolepis sosnensis* sp. nov., plates of the head shield: (a) laterale, specimen PIN, no. 3725/1123, dorsal view; (b) nuchale and postpineale, specimen PIN, no. 3725/1022, dorsal view; (c, d) nuchale, specimen PIN, no. 3725/1024: (c) dorsal and (d) ventral views. Designations: (*cir*) semicircular pit-line groove, (*cr.o*) median occipital ridge, (*cr.tv*) transverse nuchal crista, (*cs1*) posterior central sensory pit-line groove, (*d.end1*) and (*d.end2*) internal and external endolymphatic ducts, (*ifcl*) infraorbital groove, (*mppr*) posterior median process, (*nm*) obtected nuchal area, (*Nu*) nuchale, (*PP*) postpineale, (*sop*) supraotic pits, (*stc*) supratemporal pit-line groove, and (*vcp*) vertical groove. Scale bar, 1 cm.

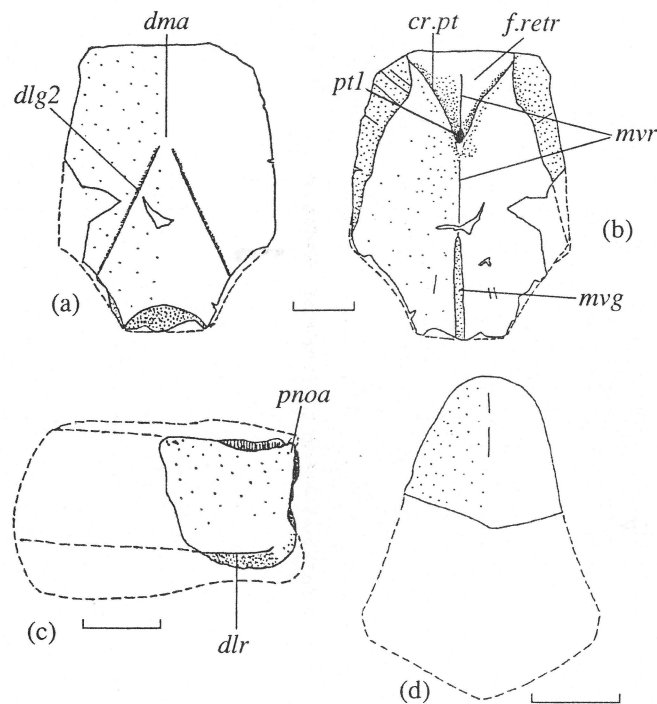


Fig. 2. *Bothriolepis sosnensis* sp. nov., plates of the trunk shield: (a, b) anterior medio-dorsale, holotype PIN, no. 3725/1122: (a) dorsal and (b) ventral views; (c) anterior dorso-laterale, specimen PIN, no. 3725/1104, external surface; (d) posterior medio-dorsale, specimen PIN, no. 3725/1124, dorsal view. Designations: (*cr.pt*) postlevator crista, (*dlg2*) posterior oblique sensory pit-line groove, (*dlr*) dorsolateral ridge, (*dma*) tergal angle, (*f.retr*) levator fossa, (*mvg*) median ventral groove, (*mvr*) median ventral ridge, (*pnoa*) postnuchal ornamented angle, and (*ptl*) anterior ventral pit. Scale bar, 1 cm.

River, Lime Factory (or Gornostaevskii) quarry; Upper Devonian, Lower Famennian, Zadonskian Horizon.

Description (Figs. 1, 2). *Cranial skeleton*.

The lateral plate (laterale, *L*; Fig. 1a; Pl. 6, fig. 1) is wide. The edge bounded by the praemediale is slightly concave. The anterior (rostral) margin is wide. The posterior central sensory pit-line groove (*csl*) is long and reaches the anterior margin of the orbital incisure. The semicircular pit-line groove (*cir*) and vertical groove (*vcp*) are well pronounced. The preorbital recess (*prh*) is possibly of the trifid type (trifid type: Young, 1988; "groenlandica-type": Stensiö, 1948; Miles, 1968), but a very poor preservation of the internal surface of this plate (specimen PIN, no. 3725/1123) does not allow us to define the type of structure precisely.

The nuchal plate (nuchale, *Nu*; Figs. 1b–1d; Pl. 6, figs. 2, 3) is wide, the ratio of length to width (between the lateral corners) $\times 100$ ranges from 50 to 70. The plate is arched and its median angle is about 140–145°. The greatest width of the plate is between the lateral corners. The postpineal notch is shallow. The anterolateral, lateral, and posterolateral corners are clearly pronounced. The anterolateral edge is 1.6 times shorter than the posterolateral one. The posterior edge of the nuchal is straight or slightly concave; in some specimens (PIN, nos. 3725/1024 and 1127), a weakly developed posterior median process (*mppr*) is present. The obtected nuchal area (*nm*) extends along the entire posterior edge on the external surface of this plate. Apparently, this area does not pass onto the paranuchalia. The posterior central (*csl*) and supratemporal (*stc*) sensory pit-line grooves are well developed. The foramina of the endolymphatic ducts (*d.end*) are distinct and the distance between them on the internal surface of the plate is 2.5 times larger than this distance on the external surface.

On the internal surface, the supraotic thickening (*sot*) is very small. Two small elongated oval supraotic pits (*sop*) are present in the center of the supraotic thickening (specimen PIN no. 3725/1024; Fig. 1d; Pl. 6, fig. 3b). In specimen PIN, no. 3725/1022, these pits are poorly pronounced. Such supraotic pits were described in *B. gigantea* Traquair (Miles, 1968, p. 26, text-fig. 7B); however, in this species, they are located closer to the occipital edge of the nuchale. Probably, these pits are situated under the elevations on the dorsal surface of the endocranium. The postorbital cristae (*cr.pto*) are poorly pronounced. The transverse nuchal crista (*cr.tv*) is low and looks like a ridge. The area located posterior to it is very short. In specimen PIN, no. 3725/1024, the median occipital crista (*cr.o*) is only slightly developed and shaped into a low tubercle.

The postpineal plate (postpineale, *PP*; Fig. 1b; Pl. 6, fig. 2) is wide, the ratio of length to width $\times 100$ is 35 (specimen PIN, no. 3725/1022). The anterior edge of the plate is straight and the posterior edge is convex. The paired pits on the internal surface are shallow and located close to the anterior edge.

Postcranial Skeleton

The anterior median dorsal plate (anterior medio-dorsale, *AMD*; Figs. 2a, 2b; Pl. 6, fig. 6) is narrow and long, the ratio of length to width $\times 100$ is 124. The plate is arched in the anterior region and flattened in the posterior region. The angle between the right and left sides of the plate at the level of the anterolateral corners is 135°. The anterior edge of the plate is slightly convex, its length is 1.7 times smaller than the total plate width and 1.6 times longer than the posterior edge. The posterior edge of the plate is strongly concave. The anterior region is 2.3 times as long as the posterior region. The anterolateral margin of the plate is convex and the posterolateral one is concave. The tergal angle (*dma*) is located at a distance of one-third of the plate length from the anterior edge. The median dorsal ridge is developed posterior to the tergal angle and poorly pronounced. A suture with an anterior dorso-laterale and mixilaterale is typical for bothriolepidids. The posterior oblique sensory pit-line groove (*dlg2*) is distinct.

On the internal surface of the plate, the elongated levator fossa (*f.retr*) is well pronounced. The median ventral ridge of the levator fossa is low and poorly pronounced. It terminates short of reaching the anterior edge of the plate. The postlevator cristae (*cr.pt*) are low. The anterior ventral pit (*pt1*) is high, narrow, and short. It is located under the tergal angle. The median ventral ridge (*mvr*) of the plate is low and smooth. At the level of the lateral corners, it passes into the median ventral groove (*mvg*), which is developed along the entire length of the posterior region of the plate.

The posterior median dorsal plate (posterior medio-dorsale, *PMD*; Fig. 2d; Pl. 6, figs. 7, 8) is narrow, the ratio of length to width $\times 100$ is 93–100 in young individuals. This plate is almost flat in the anterior region and arched in the posterior region. The median angle between the posterolateral corners is 130°. The anterior edge of the plate is strongly convex. The posterior margin of the plate of subadults has a slightly projecting posterior corner. The median dorsal ridge is developed on the plates of subadults along the entire plate length (specimens PIN, nos. 3725/51, 1128, 1129), and it is strongly smoothed in adults (specimen PIN, no. 3725/1124). The posterior median process is only slightly developed. The suture with anterior medio-dorsale and mixilaterale is normal for the bothriolepidids.

On the internal surface of the plates of subadults (specimen PIN, nos. 3725/51, 1128, 1129), the median ventral groove is well developed. The posterior ventral pit (*pt2*) is deep and elongate. The crista transversalis interna posterior is low and smooth. The area situated posterior to it is very short.

The anterior dorsolateral plate (anterior dorso-laterale, *ADL*; Fig. 2c; Pl. 6, fig. 4) has a wide dorsal lamina. The postnuchal ornamented angle (*pnoa*) is wide and short.

The mixilateral plate (mixilaterale, *MxL*; Pl. 6, fig. 5) is wide and its lateral lamina is 1.1 times as wide as the

dorsal one. The length of the lateral lamina is 1.4 times larger than its width. The angle between these laminae is 120° . The dorsolateral ridge (*dlr*) is high and forms a crest, which is developed on the whole length of the plate. The posterior oblique sensory pit-line groove (*dlg2*) and the main lateral line groove (*lcg*) are well pronounced. The posteroventral ornamented angle (*cu*) is distinct, short, and wide. The anterior edge adjoining the anterior dorso-laterale is zigzag. The posterior medio-dorsale and the posterior ventro-laterale overlapped the mixilaterale over the entire length of their contact. The contact of the mixilaterale with the anterior medio-dorsale is at typical of bothriolepidids, i.e., the anterior medio-dorsale overlaps the mixilaterale in the anterior part of their contact, and in the posterior part, the mixilaterale overlaps the anterior medio-dorsale.

The sculpture on the external surface of the plates of subadults and adults is typically pitted. Small tubercles, which are connected by low ridges, are present in the anterior part close to the rostral edge on the laterale (specimen no. PIN, 3725/1123) of an adult individual.

Dimensions, mm: (PIN, no. 3725/1024) nuchale: length, 16.5; width at the posterolateral corners, 19.75; (PIN, no. 3725/1022) postpineale: length, 3; width, 8.5; (holotype PIN, no. 3725/1122) anterior medio-dorsale: length, 46.5; width, 37.5; (PIN, no. 3725/1128) posterior medio-dorsale: length, 13.75; width, 17.4; and (PIN, no. 3725/1019) mixilaterale: length, 20.5; width, 19.65.

Comparison. The new species sharply differs from all known members of the genus *Bothriolepis* by a narrower anterior medio-dorsale, with a long anterior region and a shorter posterior region; a wider nuchale; the general shape of these plates; and by the presence of paired supraotic pits on the nuchale. *B. sosnensis*, sp. nov. also differs from the majority of Famennian *Bothriolepis* species by the character of the passage of the upper infraorbital groove on the external surface of the cranial plates.

B. sosnensis, sp. nov. is similar to *B. stensoni* Miles, 1968 in the shape of the anterior medio-dorsale and differs from the latter species by the position of the tergal angle (in *B. sosnensis* sp. nov., this angle is closer to the anterior edge of the anterior medio-dorsale), a wider and shorter fossa for the levator on the internal surface of the anterior medio-dorsale, the shape and proportions of the nuchale, and the absence of paired supraotic pits on the latter plate.

The new species is similar to some *B. cellulosa* (Stensiö, 1948, p. 417, text-figs. 224C and 224J) and *B. canadensis* (Stensiö, 1948, p. 282, text-fig. 121.I) in the shape of the anterior medio-dorsale. It differs from *B. cellulosa* by the shape and proportions of the postpineale, nuchale, and posterior medio-dorsale and the sculpture of the external surface of plates. It differs

from *B. canadensis* by the shape of the posterior region of the anterior medio-dorsale and the absence of a median dorsal ridge on the dorsal surface of the trunk shield.

The paired supraotic pits are present in *B. gigantea* Traq. (Miles, 1968). *B. sosnensis* sp. nov. sharply differs from this species by the smaller size; the shape and proportions of the plates of the head and trunk shields, especially the nuchale and anterior medio-dorsale; the arrangement of the seimosensory grooves on the external surface of the plates; and the shape and position of the supraotic pits on the nuchale.

Material. Seven plates of the head shield and 11 complete and fragmentary plates of the trunk shield are from the type locality; one specimen (PIN, no. 3725/1022) has articulated nuchal and postpineal plates.

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