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A Review of the Early Jurassic Belemnites of Crimea, with the First Record of *Simpsonibelus* (Megateuthididae) Described from the Toarcian

O. S. Dzyuba[a], *, V. N. Komarov[b], **, and A. V. Ovchinnikov[c], ***

[a] *Trofimuk Institute of Petroleum Geology and Geophysics, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 630090 Russia*

[b] *Sergo Ordzhonikidze Russian State University for Geological Prospecting, Moscow, 117997 Russia*

[c] *Belgorod State National Research University, Belgorod, 308015 Russia*

**e-mail: dzyubaos@ipgg.sbras.ru*

***e-mail: komarovmgri@mail.ru*

****e-mail: ovchinnikov@bsu.edu.ru*

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Abstract—The Toarcian species *Simpsonibelus dorsalis* (Phillips), first established outside Western Europe, is discussed. A single rostrum of this belemnite species was found in the clay flysch (not in situ) of the Upper Tauric (Yaman) formation of the Yaman Ravine located in the vicinity of the village of Prokhladnoe in the southern part of the Crimean Peninsula. Based on the revision and overview of the available data on the Lower Jurassic belemnites of the Crimea, it was found that the stratigraphic intervals to which their records are confined (Lower Pliensbachian, uppermost Lower Toarcian–Upper Toarcian) fall on the phases of the maximum taxonomic diversity of Early Jurassic belemnites in European seas. The mid-*Bifrons* chron (*Fibulatum* subchron) of early Toarcian appears to have been the most likely time for the migration of the *S. dorsalis* (Megateuthididae) to the Crimean margin of the Tethys Ocean.

Keywords: Lower Jurassic, Toarcian, belemnites, Crimea, European paleobasins

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INTRODUCTION

Lower Jurassic outcrops are confined to the southern part of the Crimean Peninsula, and have been studied by many geologists. These deposits are relatively poor in fossils, which are also extremely unevenly distributed throughout the succession, making dating of individual intervals of the section difficult. The Lower Jurassic is represented here in two tectonically isolated zones (Mountainous Crimean and Lozovoe), separated by the sublatitudinal Bodrak fault. In the Bodrak River basin (eastern part of the Bakhchisaray Region) within the Mountainous Crimean Zone (south of the Bodrak fault) it is composed of sandstones of the Chenka Formation and flysch of the Upper Tauric (Yaman) Formation, which together with the Lower Tauric Formation are combined into the Tauric Group (Upper Triassic–lower Middle Jurassic). The interpretation of the origin of the Lower Jurassic deposits of the Lozovoe Zone has been a subject of debate. According to one point of view, the Lower Jurassic deposits throughout the Lozovoe Zone represent a stratified series, mainly composed of the Eski Orda Formation, or Group. This interpretation is best justified by Panov et al. (1994, 2004, 2009). According to this view, the lower part of the Lower Jurassic section in the Lozovoe Zone of the Bodrak River valley is represented by the Mender clayey series of the Eski Orda Formation (upper Sinemurian–Pliensbachian), which to the northwest, in the area of the Konsky Ridge, is conformably overlain by the Dzhidair Formation (Toarcian–lower Aalenian). According to another point of view, the Eski Orda Formation (Group) within the Lozovoe Zone is a tectonic mélange—a highly ground clay matrix with a large number of blocks of different sizes and ages (Koronovsky and Mileev, 1974; Yudin, 1993, 2011; Mileev et al., 2009; Ippolitov et al., 2015; Zaitsev, 2021; Zaitsev and Ippolitov, 2023).

Upper Triassic and Lower Jurassic deposits contain a relatively diverse fossil assemblage including foraminifers, bivalves, cephalopods (nautiloids, ammonoids, belemnoids), brachiopods, crinoids, as well as spore-pollen associations. The fossils listed are described in varying degrees of detail. Compared to others, ammonites and brachiopods have been systematically studied best. Other groups are low in number and taxo-

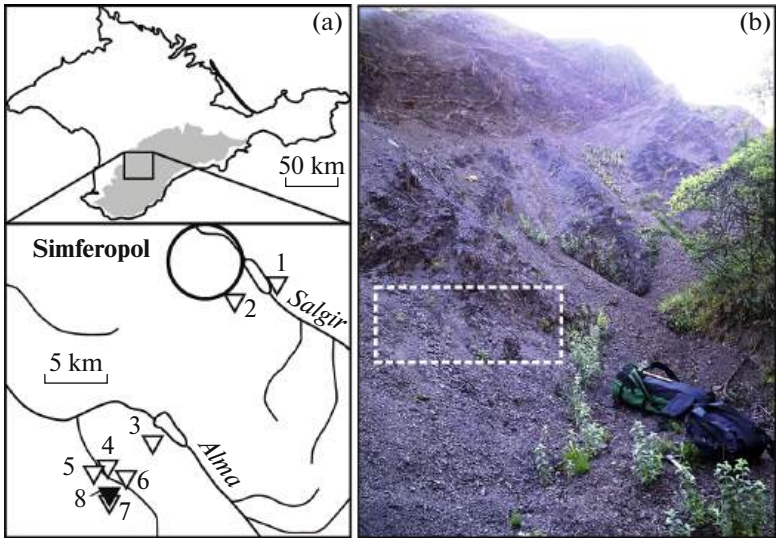

Fig. 1. The belemnite localities discussed in the article (a), a photograph of a section of clayey flysch of the Upper Tauric (Yaman) Formation in the Yaman Ravine with the marked area in the talus of which the described rostrum was found (b): (1) Lozovoe Quarry on the right bank of the Salgir River in the vicinity of Simferopol; (2) Greek (old Kurtsovsky) quarry on the southern outskirts of Simferopol; (3) Volkovskaya Arroyo on the left bank of the Alma River; (4) Ammonite ravine in the area of the village of Trudolyubovka; (5) northern slope of Mount Patil (Tatyanina Gorka) in the area of the village of Trudolyubovka; (6) northern slope of Mount Bolshoy Kermen; (7) southwestern and southeastern slopes of Mount Sheludivaya in the area of the village of Prokhladnoe; (8) Yaman Ravine in the vicinity of the village of Prokhladnoe. The territory of the Crimean Mountains is shaded gray.

nomic diversity and are sometimes represented by such fragmentary material that its identification is almost impossible. Many fossils mentioned in the literature are not illustrated. In the area of educational geological practice in the eastern part of the Bakhchisaray district, outcrops have been examined and new clearings have been carried out year after year for many decades by students and teachers from different universities. However, there is no consensus on the stratigraphic range and structure of the Lower Jurassic deposits. Additional difficulties are imposed by significant facies variability and insufficient exposure, which complicates the stratigraphic interpretation of fossil records.

One of the least studied groups of fossils of the Tauric Group and the Eski Orda Formation/Group are belemnites. This paper summarizes and analyzes the available information on belemnite records in the Lower Jurassic of the Crimean Peninsula. All these finds come from a relatively small area of the Crimean Mountains (Fig. 1a). The species *Simpsonibelus dorsalis* (Phillips, 1867), discovered for the first time outside Western Europe, is systematically described.

A REVIEW OF PREVIOUS RESEARCH ON BELEMNITES

M.V. Muratov found a small incompletely preserved rostrum, "barely noticeably spindle-shaped", which was later described as *Nannobelus? pavlowiensis* sp. nov. (Menner and Erlanger, 1954, p. 230, pl. 1, figs. 1–4, fig. 3) in the shales of the Tauric Group (Upper Tauric Formation) near the village of Verkhorechye. The rostrum is unusual in that it has numerous grooves: a long dorsal groove running from the edge of the rostrum, a short alveolar ventral groove, as well as paired dorsal-lateral and ventral-lateral grooves. The authors of the species noted that in the number of grooves it clearly differed from other species of the genus *Nannobelus*: "the presence of grooves almost along the entire length of the rostrum so distinctly separates the described belemnite from all forms known to date that it would be most correct to assign it to a separate genus, close to *Nannobelus*, but differing from the latter in a number of derived characters that bring it closer to *Megateuthis* or even to Belemnopsinae. However, the extreme limitations of the material, which do not allow us to evaluate the stability of these characters, force us to refrain from establishing a new genus for now" (Menner and Erlanger, 1954, p. 232). It is noteworthy that in *Nannobelus* (Passaloteuthididae) grooves are usually absent, only lateral lines can be developed in the form of two weakly expressed subparallel depressions. The smooth surface of the rostrum in representatives of the genus *Nannobelus* was also referred to by Krimholz (1965), who doubted the generic placement of the specimen in question. The description of the specimen also provides other characters that contradict its affiliation with "true" belemnites (belemnitids): a very rough radial structure visible on the transverse fractures of the rostrum and turning into irregular granularity of the wall—these are the

characters known in aulacoceratids, the last representatives of which, according to Mariotti et al. (2021), can be found in the Lower Jurassic. The rostrum in question was also attributed to aulacoceratids by Ippolitov et al. (2009).

The first description and illustration of a belemnite from the Lower Jurassic of Crimea was published by Krimholz and Shalimov (1961, p. 81, pl., fig. 6). The only fairly large, well-preserved rostrum of *Megateuthis rhenana* (Oppel), described by these authors under the generic name *Mesoteuthis* Lissajous, 1915 (junior subjective synonym of *Megateuthis* Bayle, 1878 (Doyle, 1992; Dzyuba et al., 2015; and others)), was discovered on the left bank of the Alma River in the Volkovskaya Arroyo (Fig. 1a) 0.5 km from the mouth in the clay shales of the Eski Orda Formation together with late Toarcian ammonites of the *Thouarsense* Zone: *Grammoceras subquadratum* Buckman, *G.* cf. *thouarsense* (d'Orbigny) and *G. saemanni* (Dumortier).

A "relatively well-preserved" rostrum identified as *Dactyloteuthis* cf. *attenuata* Ernst, was described and illustrated by Naidin (1964, p. 67, text-fig. 1). It is small in size and relatively short and was found in a siltstone bed of the Tauric Group, exposed at the base of the southwestern slope of Mount Sheludivaya near the village of Prokhladnoe (Fig. 1a). According to Naidin, the studied rostrum had a very distinct ventral groove, deep and narrow near its apex, but did not exclude the possibility of a secondary deepening due to erosion of the initially shallow groove. According to Gustomesov (1967), the identification of this specimen should be revised. This conclusion should be fully agreed with, given that the rostrum is cylindriconical in outline and conical in profile, and in its better-preserved upper part is characterized by a cross-section close to circular. These traits do not correspond to the diagnostic characters of the genus *Dactyloteuthis*. The upper layers of the rostrum are significantly destroyed near the ventral groove, preventing a well-founded conclusion about its taxonomic placement without additional material. Judging by the size and shape of the rostrum, the presence of an apical ventral groove, and also taking into account the apical grooves on its lateral sides, which Naidin (1964) describes as small and wide, the belemnite is most closely related to the genus *Odontobelus* (Toarcian–Lower Aalenian). Like *Megateuthis* mentioned above, this genus is a member of the family Megateuthididae (Dzyuba et al., 2015; and others). From the Tauric Group, exposed in the area of the village of Trudolyubovka (the more precise location is unknown), Naidin (1964, p. 68, text-fig. 2) described and illustrated another specimen, which also clearly belongs to the megateuthidids. This specimen is represented by a fragment of the lower half of the rostrum and was provisionally identified as *Passaloteuthis* (?) sp. Note that Gustomesov (1967) also agreed with this provisional identification. However, this rostrum differs from representatives of the genus *Passaloteuthis* and the family Passaloteuthididae in general in its well-developed dorsal-lateral grooves and the presence (albeit weakly expressed) of an apical ventral groove. Compared to the form found in the vicinity of the village of Prokhladnoe, the rostrum in question is noticeably laterally compressed and, in all likelihood, represents a different species (or even a different genus) of megateuthidids.

According to Gustomesov (1967), belemnites of the Eski Orda Formation in the area of the village of Trudolyubovka are found in bioclastic limestones on the northern slope of Mount Patil[1], as well as in "sandstones and conglomerates" (apparently meaning limestone conglomerate-breccias) on the right side of the Ammonite Ravine very near the village (Fig. 1a). Rostra are difficult to extract from solid rock. Based on the studied material, collected mainly in limestones on Mount Patil, it was concluded that the formation contains only one species, and one of the most archaic species of the genus *Passaloteuthis*–*P. kamkinae* Gustomesov (Gustomesov, 1967, p. 121, pl. 1, figs. 1–7, 9–13, 15, 16), represented by 11 specimens (incompletely preserved rostra and their fragments). A great similarity was shown between this species and *P. armata* (Dumortier), a Pliensbachian species (Weis et al., 2018), which was considered by Gustomesov (1967) to be late Sinemurian. On this basis, as well as taking into account previously known finds of a late Sinemurian (Lorraine) ammonite *Echioceras raricostatum* (v. Zieten) in the limestones of the Eski Orda Formation on the northern slope of Mount Patil (Kazakova, 1962), a conclusion was made about the late Sinemurian age of *Passaloteuthis kamkinae*. It is noteworthy that later, a large assemblage of both late Sinemurian (Tatyanina Gorka, northern slope of Mount Patil) and early Pliensbachian (Ammonite Ravine) ammonites was identified from the limestone blocks of the area under consideration (Zaitsev, 2021). Considering the Pliensbachian–early Toarcian age range of the genus *Passaloteuthis* (Weis et al., 2018; etc.), it should be assumed that the species *P. kamkinae* is not older than the Pliensbachian, which contradicts the data on ammonites from Tatyanina Gorka. Ippolitov et al. (2015) assigned this species to the genus *Nannobelus*, but this is hardly justified, since the rostrum of the latter is relatively shorter and more conical. In addition to ammonites and belemnites, records of late Sinemurian crinoids (Klikushin, 1988), Sinemurian–Pliensbachian spiriferid brachiopods (Komarov et al., 2014), and Pliensbachian brachiopods in the middle and upper parts of the section (Slavin, 1986) were also reported in the limestones of Mount Patil. Apparently, for both localities *P. kamkinae* indicates Lower Pliensbachian. The section of Ammonite Ravine limestones was compared by Zaitsev (2021) based on ammonites with the boundary

[1] The locality is also known as "Tatyanina Gorka" (Ippolitov et al., 2015; Zaitsev, 2021).

interval of the Lower Pliensbachian *Jamesoni–Ibex* zones.

The species *Acrocoelites quenstedti* (Oppel) (Gustomesov, 1967, p. 124, pl. 1, fig. 8: *Mesoteuthis quenstedti* auct.) was described and illustrated from the Upper Tauric Formation. It was found on the southeastern slope of Mount Sheludivaya (near the village of Prokhladnoe) (Fig. 1a) and is represented by a single well-preserved rostrum. This species of megateuthidids is known from the upper parts of the Upper Toarcian and Lower Aalenian (Doyle, 1990; Schlegelmilch, 1998; etc.).

The results of the initial stage of research are reflected in a reference book on the Jurassic cephalopods of Ukraine (Paryshev and Nikitin, 1981), which lists the names of all the Early Jurassic belemnites found in Crimea, and publishes their images and data on their stratigraphic distribution.

Numerous belemnite rostra were found in red-brown limestone blocks in the vicinity of Simferopol (Dekhtyareva et al., 1978; Ippolitov et al., 2008; Zaitsev and Ippolitov, 2015). The first of the works (Dekhtyareva et al., 1978) only provides a list of five taxa, determined from collections in a quarry near the village of Petropavlovka; descriptions and images are not provided. The host beds were dated by the authors as Toarcian. More extensive lists of taxa are contained in the other two works, in which belemnites were identified by Ippolitov. These same works provide information on ammonites.

For instance, based on a study of 625 specimens collected in the Lozovoe quarry, located on the right bank of the Salgir River in the upper reaches of the Simferopol Reservoir (Fig. 1a), a rich assemblage of Toarcian belemnites was recovered from a block of cherry-red crinoid limestone, numbering 20 species belonging to the genera *Acrocoelites, Odontobelus (=A. (Odontobelus)* auct.), *Megateuthis* (including *Mesoteuthis*, listed as a separate genus), *Brevibelus* (Megateuthididae), *Rhabdobelus* (Hastitidae), *"Catateuthis"* (Passaloteuthididae) and *Holcobelus* (Holcobelidae) (Ippolitov et al., 2008). In most cases, the names of the species were not given. *Odontobelus ernsti* (Schlegelmilch), *O. curtus* (d'Orbigny), *Acrocoelites stimulus* (Dumortier) [=*A. subtenuis* (Simpson) after: Doyle, 1990], *Rhabdobelus* aff. *exilis* (d'Orbigny) and *R. serpulatus* (Quenstedt) were listed and illustrated.

In the Greek (old Kurtsovsky) quarry, located on the southern outskirts of Simferopol (Fig. 1a), based on the study of 72 specimens, two belemnite assemblages were established (Zaitsev and Ippolitov, 2015). The first assemblage includes *Passaloteuthis* aff. *ima* (Lang), *Nannobelus delicatus* (Simpson) = ? *N. demissus* (Simpson) and *Coeloteuthis* sp. juv. (Passaloteuthididae), the second—*Bairstowius scolops* (Simpson) (Hastitidae), "*Coeloteuthis*" *oravica* (Činčurová) sensu Weis et Thuy, *Passaloteuthis* cf. *cuspidata* (Simpson) (assigned by Ippolitov to the genus *Nannobelus*). A fragment of the apical part of the rostrum was also found in the talus, belonging to a representative of the genus *Gastrobelus* and identified as *G.* cf. *teres* (Stahl) (Passaloteuthididae). Species of the genus *Nannobelus* and *Passaloteuthis* cf. *cuspidata* are not illustrated. It is worth noting the rather large similarity of *P.* aff. *ima* with the species *P. kamkinae* Gustomesov, established in Crimea and discussed above. It seems that these are the same species. The composition of both belemnite assemblages suggests the presence of the Sinemurian–Pliensbachian boundary beds. However, they also contain purely Pliensbachian (*Bairstowius scolops*) or Pliensbachian–Lower Toarcian taxa (*Passaloteuthis, Gastrobelus*) (Schlegelmilch, 1998; Doyle, 2003; Weis et al., 2018; etc.), and therefore the host deposits should be attributed to the Lower Pliensbachian. This opinion generally confirms Ippolitov's identifications, with the exception of the interpretation of the age of the rostrum of *Gastrobelus*, which was conditionally assigned to the species *G. teres*, characteristic of the Upper Pleansbachian. The discovered specimen is similarly tentatively comparable to *G. ventroplanus* (Voltz), characteristic of the boundary lower-upper Pliensbachian deposits of Europe (Weis et al., 2018; and others). The presence of the lower Pliensbachian in the section does not contradict the data on ammonites (Zaitsev and Ippolitov, 2015).

Ippolitov (Ippolitov et al., 2015) also identified and illustrated the Late Toarcian belemnites *Odontobelus ernsti, O. curtus, Dactyloteuthis levidensis* (Simpson) sensu Schlegelmilch (Megateuthididae) and *Rhabdobelus exilis* (Hastitidae), discovered in brown-red micritic limestones on the northern slope of Mount Bolshoy Kermen (Fig. 1a). The rostrum illustrated under the name *D. levidensis* (Ippolitov et al., 2015, pl. 1, fig. 1), like the specimen with which it is identified (Schlegelmilch, 1998, pl. 11, fig. 4), appears to be a variety of *D. incurvata* (v. Zieten) poorly characterized by apical grooves, hence, a targeted study of the limits of variability of the latter species is needed. According to the same paper, at the above-mentioned Tatyanina Gorka locality in the Bodrak River valley to the south of the village of Trudolyubovka, a block of Late Sinemurian–Pliensbachian limestone from the Mender Series contained a belemnite assemblage of the late Toarcian–Aalenian appearance: *Megateuthis* (=*Mesoteuthis* auct.) spp. (15 specimens), *Holcobelus* ex gr. *tschegemensis* (Krimholz) (three specimens) and *Rhabdobelus* aff. *exilis* (one specimen). Belemnites are found in close proximity to blocky limestones. Images are provided and a conclusion is made about the mélange nature of the Eski Orda Formation.

The present study shows that the established taxonomic diversity of Early Jurassic belemnites is relatively small, with the exception of the Early Pliensbachian and Late Toarcian assemblages. In most of the Lower Jurassic, records are rare or completely absent. Specific collection levels in the sections of some of them are not precisely known. The identification of a

Fig. 2. *Simpsonibelus dorsalis* (Phillips, 1867), specimen GEOKHRON 2097/2: (a) cross-section at the anterior end, (b) right lateral view, (c) ventral view, (d) left lateral view; southwestern Crimea, environs of the village of Prokhladnoe, right side of the Yaman Ravine; Upper Taurian (Yaman) Formation, talus.

number of them also raises many questions. It seems appropriate to quote two outstanding researchers of Jurassic cephalopods who wrote about Crimean belemnites: "The rarity of belemnites and the absence, sometimes, of other fauna force us to strive to use every grain of available material, despite its usually very poor preservation" (Krimholz, 1931, p. 3); "In view of the poverty of fossils in the Tauric Group, each find of organic remains and its study are of interest, allowing us to judge more definitely the age and division of the series in each separate area" (Gustomesov, 1967, p. 121).

Of particular interest are fossils with localities and taxonomy are precisely known, as they allow more reasonably date and correlate the sediments. In 2021, during a field course geological practice in the eastern part of the Bakhchisarai District of Crimea, A.Yu. Davydov, a student of the National Research University of Belgorod found a belemnite rostrum, described below.

SYSTEMATIC PALEONTOLOGY

Family Megateuthididae Sachs et Nalnjaeva, 1967

Genus *Simpsonibelus* Doyle, 1992

Simpsonibelus dorsalis (Phillips, 1867)

Belemnites dorsalis: Phillips, 1867, p. 58, pl. 10, fig. 24.

Simpsonibelus dorsalis: Doyle, 1992, p. 54, pl. 20, figs. 11–16; pl. 21, fig. 8 (cum syn.).

L e c t o t y p e. Oxford University Museum of Natural History, specimen OUMNH no. J15203 (Phillips, 1867, pl. 10, fig. 24, *l'*); North Yorkshire, Saltwick Bay near Whitby; Upper Lias (probably bituminous shales of the *Falciferum* Subzone); designated in: Riegraf et al. (1984).

D e s c r i p t i o n (Fig. 2). The rostrum is small-sized, elongated. The outline is cylindriconical. The profile is subhastate, somewhat asymmetrical. The apical region is moderately elongated. The apical dorsolateral and ventral grooves are well defined, they are slightly deepened due to leaching. The cross section is rounded subquadrate, dorso-ventrally depressed on the entire length of the rostrum. The tip of the alveolus is prominently ventrally displaced.

D i m e n s i o n s i n m m a n d r a t i o s[2]

L	l	Dv	Dl	l/Dv ×100%	Dl/Dv ×100%
48.5	42.3	7.3	8.5	580	116

C o m p a r i s o n. It is clearly distinguished from other species of the genus *Simpsonibelus*–*S. expansus* (Simpson, 1855) and *S. lentus* (Simpson, 1855)—by its depressed cross-section, and, in comparison with *S. lentus*, it is also less elongated.

R e m a r k s. Due to the incomplete preservation of the alveolar part of the rostrum, it is not possible to determine whether the studied belemnite had a short median alveolar groove on the dorsal side, the development of which was noted for individual specimens of the described species (Phillips, 1867; Doyle, 1992). Depressed cross section of the rostrum is extremely rare in representatives of the family Megateuthididae, and therefore the studied specimen, despite some deformation, is easily identified to the species level. Representatives of the genus *Simpsonibelus* (Toarcian–early Aalenian) are known from Western Europe and East Greenland, while the species *S. dorsalis* was previously reliably identified only in England and southern Germany (Phillips, 1867; Riegraf et al., 1984; Doyle, 1991, 1992; Rita et al., 2021). This find points to the Lower–Upper Toarcian boundary deposits. In England, *S. dorsalis* is most numerous and has the greatest range of stratigraphic distribution (Doyle, 1990, 1992). It has been shown that since its first appearance in the *Serpentinum* chron, following the major Toarcian oceanic anoxic event (T-OAE), the abundance of this species there has steadily increased, which led to its dominance in belemnite communities, especially in the *Bifrons–Variabilis* chrons (De Baets et al., 2021). Meanwhile, in southern Germany this species is known from a very narrow stratigraphic interval—the *Fibulatum* Subzone of the *Bifrons* Zone and was identified based on 40 specimens (Riegraf et al., 1984). Hence, it seems reasonable to assume that the geographic range of *S. dorsalis* expanded to its maximum in the *Fibulatum* Subchron. Accordingly, it is quite likely that this species reached the Crimean margin of the Tethys Ocean at the same time.

[2] Measurements were made of the total preserved length of the rostrum (L), length from apex to tip of alveolus (l), dorsoventral diameter at the tip of the alveolus (Dv), lateral diameter at the tip of the alveolus (Dl).

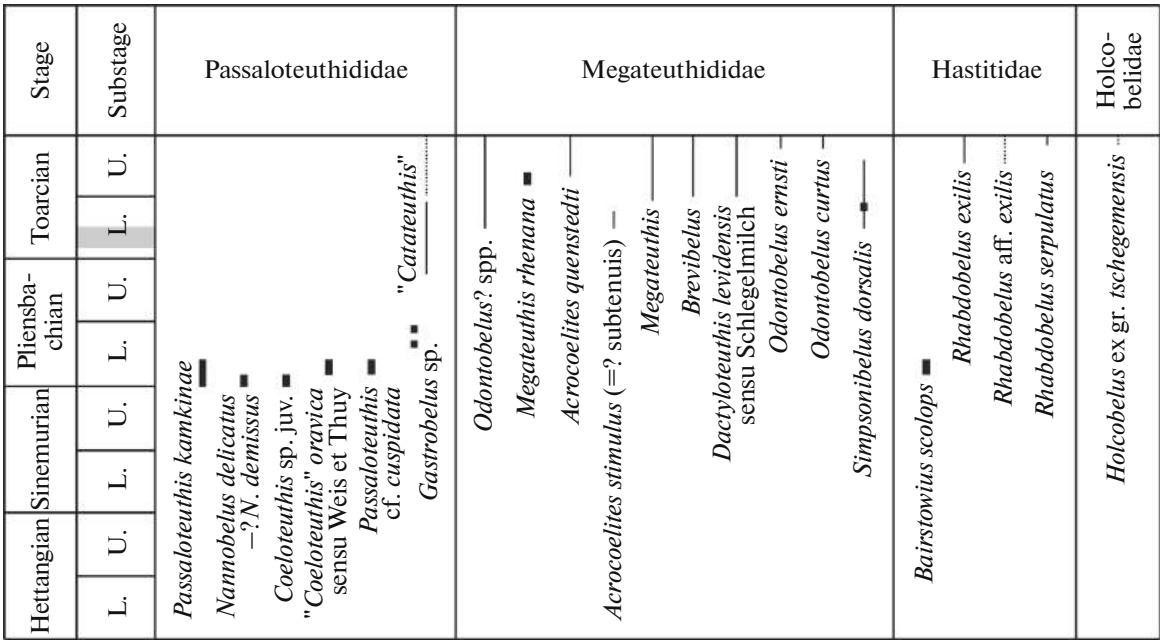

Fig. 3. Stratigraphic ranges of belemnite taxa known from the Lower Jurassic of Crimea. Compiled from numerous sources (see text). For taxa with unclear stratigraphic position, ranges are shown taking into account data on their distribution in European sections (thin lines). The interval corresponding to the major Toarcian oceanic anoxic event (T-OAE), which had the most dramatic effect on the biota of the seas of Central and Northwestern Europe, is highlighted in grey. L.—lower, U.—upper.

One must agree with Doyle (1992) that "*Mesoteuthis dorsalis* Phill." from the Toarcian Cherek Bezingievsky locality in the Northern Caucasus (Krimholz, 1931, p. 18, pl. 1, figs. 9–11) most likely belongs to a representative of the genus *Hastites* (family Hastitidae). The rostra, which are close to subhastate in shape and described under this name, are laterally compressed and completely lack grooves.

Occurrence. Lower–Upper Toarcian, *Falciferum* Subzone of the *Serpentinum* Zone–*Dispansum* Zone of England; Lower Toarcian, *Fibulatum* Subzone of the *Bifrons* Zone of Southern Germany and presumably the same stratigraphic interval in Crimea.

Material. Specimen GEOKHRON, no. 2097/2; Crimea, vicinity of the village of Prokhladnoe, the right side of the apertural region of the Yaman Ravine in the area of development of clayey flysch of the Upper Tauric (Yaman) Formation in the upper part of the talus, not far from bedrock outcrops with expressive folds of submarine landslide (Figs. 1a; 1b); collection of A.Yu. Davydov, 2021; housed in the Collective Use Center "GEOKHRON Collection" at the A.A. Trofimuk Institute of Petroleum Geology and Geophysics SB RAS (IPGG SB RAS, Novosibirsk).

RESULTS AND DISCUSSION

As follows from the above analysis of the results of previous studies, in the Lower Jurassic of Crimea there are only two intervals characterized by belemnites: the lower Pliensbachian (the most probable interval of the *Jamesoni–Ibex* ammonite zones) and the upper part of the lower–upper Toarcian with a bipartite subdivision of the latter (Fig. 3). It is noteworthy that these stratigraphic intervals are precisely the phases of maximum taxonomic diversity of Early Jurassic belemnites in the European seas, for which they are generally known since the Hettangian (Dera et al., 2016). The following major phases of diversification of this cephalopod group in the Jurassic were recognized by the authors of the latter study for the Early Bajocian and Oxfordian. It is assumed that the diversification of belemnites could have been facilitated by moderately warm seawater temperatures, which had a positive effect on the rate of their metabolism, population changes, and the evolutionary rates.

With the exception of the family Holcobelidae (genus *Holcobelus*) from the suborder Belemnopseina, all other taxa identified in Crimea are from the suborder Belemnitina, mainly the families Passaloteuthididae and Megateuthididae. Despite the relatively large number of belemnite records in the Toarcian, there is no clear evidence yet that the resumption of mass colonization of the Crimean margin of the Tethys Ocean by belemnites could be associated with the spread of anoxic conditions in the seas of Central and Northwestern Europe caused by the T-OAE at the end of the *Tenuicostatum* chron–beginning of the *Serpentinum* chron. For example, it was at this time that the mass colonization of belemnites of the Arctic seas occurred for the first time, which, as suggested, could have been

associated with a strong reduction in their usual food source (benthic organisms) in the European seas (Dzyuba et al., 2015).

The species *Simpsonibelus dorsalis*, identified for the first time from the territory of Crimea, supplements the paleontological characteristics of the Upper Taurican (Yaman) Formation. Based on the results of the study, including the analysis of known localities of *S. dorsalis*, it was concluded that the most likely time for the migration of the species to the Crimean margin of the Tethys Ocean was the early Toarcian *Fibulatum* subchron (middle of the *Bifrons* chron).

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This work does not contain any studies involving human or animal subjects.

CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

REFERENCES

De Baets, K., Nätscher, P.S., Rita, P., et al., The impact of the Pliensbachian–Toarcian crisis on belemnite assemblages and size distribution, *Swiss J. Palaeontol.*, 2021, vol. 140: 25, pp. 1–14.

Dekhtyareva, L.V., Nerodenko, V.M., Komarova, O.V., and Mikhailova, I.A., On the nature of the blocky limestone horizon in the vicinity of Simferopol, *Izv. Akad. Nauk SSSR. Ser. Geol.*, 1978, no. 3, pp. 64–67.

Dera, G., Toumoulin, A., and De Baets, K., Diversity and morphological evolution of Jurassic belemnites from South Germany, *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, 2016, vol. 457, pp. 80–97.

Doyle, P., The British Toarcian (Lower Jurassic) belemnites, part 1, *Palaeontogr. Soc. Monogr.* 1990, vol. 144 (584), pp. 1–49.

Doyle, P., Belemnites from the Lower Jurassic of East Greenland and their biostratigraphical and biogeographical significance, *Bull. Geol. Soc. Denmark*, 1991, vol. 39, pp. 123–141.

Doyle, P., The British Toarcian (Lower Jurassic) belemnites, Part 2, *Palaeontogr. Soc. Monogr.* 1992, vol. 145(587), pp. 50–79.

Doyle, P., Type belemnites of Simpson's fossils of the Yorkshire Lias, *PYGS*, 2003, vol. 54, no. 3, pp. 147–184.

Dzyuba, O.S., Weis, R., Nalnjaeva, T.I., and Riegraf, W., *Rarobelus* nom. nov. from the Boreal Toarcian–Aalenian and its systematic position (Belemnitida, Belemnitina, Megateuthididae), *N. Jb. Geol. Paläontol. Abh.*, 2015, vol. 275, pp. 305–315.

Gustomesov, V.A., Notes on Jurassic and Lower Cretaceous belemnites of the Bakhchisarai region of Crimea, *Byull. Mosk. Obshch. Ispyt. Prir., Otd. Geol.*, 1967, vol. 42, no. 3, pp. 120–134.

Ippolitov, A.P., Tishchenko, A.I., Rogov, M.A., et al., On the discovery of a block of Upper Toarcian limestones in the vicinity of Simferopol and its significance for the interpretation of the geological structure of the Crimean Mountains, in *Novoye v regional'noy geologii Rossii i blizhnego zarubezh'ya, Mater. Soveshch.* (New in Regional Geology of Russia and Neighboring Countries. Proc. Conf.), Moscow: RGGRU, 2008, pp. 43–46.

Ippolitov, A.P., Yakovishina, E.V., Bordunov, S.I., and Nikishin, A.M., The Eski Orda "Formation" of the Crimean Mountains—tectonic mélange. New finds of macrofauna against the classical scheme of stratigraphy, *Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii. VI Vseross. soveshch.: nauchnyye materialy* (Jurassic System of Russia: Problems of Stratigraphy and Paleogeography. Proc. VI All-Russ. Conf.), Zakharov, V.A., Ed., Makhachkala: ALEF, 2015, pp. 144–148.

Ippolitov, A.P., Zibrov, I.A., and Tishchenko, A.I., New finds of aulacoceratid phragmocones (Coleoidea) in the lower Jurassic of the Crimea, in *Contributions to Current Cephalopod Research: Morphology, Systematics, Evolution, Ecology and Biostratigraphy.* Moscow: Paleontol. Inst, Ross. Akad. Nauk, 2009, pp. 61–65.

Kazakova, V.P., On the stratigraphy of the Lower Jurassic deposits of the Bodrak River basin (Crimea), *Byull. Mosk. Obshch. Ispyt. Prir., Otd. Geol.*, 1962, vol. 37, no. 4, pp. 36–51.

Klikushin V.G. On the Triassic and Early Jurassic crinoids of Crimea, *Byull. Mosk. Obshch. Ispyt. Prir., Otd. Geol.*, 1988, vol. 63, no. 4, pp. 71–79.

Komarov, V.N., Volkova, G.D., and Gribovskaya, O.A., New data on the Lower Jurassic spiriferids of the southwestern Crimea, *Izvestiya Vuzov. Geol. Razved.*, 2014, no. 6, pp. 12–18.

Koronovsky, N.V. and Mileev, V.S., On the relationship between the deposits of the Tauric Group and the Eski Orda Formation in the valley of the Bodrak River (the Crimean Mountains), *Vestn. Mosck. Gos. Univ. Ser. 4. Geol.*, 1974, no. 1, pp. 80–87.

Krimholz, G.Ya., Jurassic belemnites of Crimea and the Caucasus, Trudy Glavn. Geol. Razved. Uprav. VSNKh – SSSSR, 1931, no. 76, pp. 1–54.

Krimholz, G.Ya., Belemnites as age indicators in the Mesozoic of the Carpathian–Crimean–Caucasian region, Carpathian-Balkan Geological Association, in *VII Congr. Reports, Pt. II, Vol. 1*, Sofia, 1965, pp. 223–226.

Krimholz, G.Ya. and Shalimov, A.I., New data on the stratigraphy of the Lower–Middle Jurassic deposits of the Alma River basin (Southwestern Crimea), *Vestn. Lening. Gos. Univ.*, 1961, no. 6, pp. 73–82.

Mariotti, N., Pignatti, J., and Riegraf, W., Part M, Chapter 23B: Systematic descriptions: Aulacoceratida, *Treatise Online*, 2021, no. 148, pp. 1–18.

Menner, V.V. and Erlanger, A.A., New find of Triassic belemnites in the Trudy Mosk. *Geolog. Razved. Inst.*, 1954, vol. 26, pp. 229–234.

Mileev, V.S., Baraboshkin, E.Yu., Rozanov, S.B., Rogov, M.A., Tectonics and geodynamic evolution of the Crimean Mountains, *Byull. Mosk. Obshch. Ispyt. Prir., Otd. Geol.*, 2009, vol. 84, no. 3, pp. 3–22.

Naidin, D.P., New finds of Lower Jurassic belemnites in the Tauric Group of Crimea, *Vestn. Mosck. Gos. Univ. Ser. 4: Geol.*, 1964, no. 6, pp. 67–64.

Panov, D.I., Bolotov, S.N., Kosorukov, V.L., et al., Stratigraphy and structure of the Tauric Group (Upper Triassic – Lias) of the Kachin Uplift of the southwestern Crimea, *Byull. Mosk. Obshch. Ispyt. Prir., Otd. Geol.*, 2009, vol. 84, no. 5, pp. 52–73.

Panov, D.I., Bolotov, S.N., Samarin, E.N., et al., Gaps in the section of Triassic–Jurassic deposits of the Crimean Mountains and their historical and geological significance, *Vest. Mosk. Gos. Univ. Ser. 4. Geol.*, 2004, no. 2. pp. 21–31.

Panov, D.I., Gushchin, A.I., Smirnova, S.B., and Stafeev, A.N., New data on the geological structure of the Triassic and Jurassic deposits of the Lozovoe Zone of the Crimean Mountains in the Bodrak River basin. *Vest. Mosk. Gos. Univ. Ser. 4: Geol.*, 1994, no. 3, pp. 19–29.

Paryshev, A.V. and Nikitin, I.I., *Cephalopods of the Jurassic of Ukraine in Paleontol. Spravochnik* (Paleontological Handbook), Kyiv: Nauk. Dumka, 1981.

Phillips, J., A monograph of British Belemnitidae, Pt. 3, *Palaeontogr. Soc. Monogr.*, 1867, pp. 53–88.

Riegraf, W., Werner, G., and Lörcher, F., *Der Posidonienschiefer—Cephalopodenfauna, Biostratigraphie und Fazies des Südwestdeutschen Untertoarciums (Lias Epsilon),* Stuttgart: Ferdinand Enke, 1984.

Rita, P., Weis, R., Duarte, L.V., and De Baets, K., Taxonomical diversity and palaeobiogeographical affinity of belemnites from the Pliensbachian–Toarcian GSSP (Lusitanian Basin, Portugal), *Pap. Palaeontol.*, 2021, vol. 7, no. 3, pp. 1321–1349.

Schlegelmilch, R., *Die Belemniten des Süddeutschen Jura*, Stuttgart: G. Fischer Verlag, 1998.

Simpson, M. *The Fossils of the Yorkshire Lias, 1st ed.*, London: Whittaker; Whitby: S. Reed, 1855.

Slavin, V.I., New data on the Sablyn Formation in the Lozovoe zone of the Crimean Mountains, *Vest. Mosk. Gos. Univ. Ser. 4. Geol.*, 1986, no. 2, pp. 29–35.

Weis, R., Neige, P., Dugué, O., et al., Lower Jurassic (Pliensbachian–Toarcian) belemnites from Fresney-le-Puceux (Calvados, France): Taxonomy, chronostratigraphy and diversity, *Geodiversitas*, 2018, vol. 40, no. 4, pp. 87–113.

Yudin, V.V., Simferopol mélange, *Dokl. Ross. Akad. Nauk*, 1993, vol. 333, no. 2, pp. 250–252.

Yudin, V.V., *Geodinamika Kryma* (Geodynamics of Crimea), Simferopol: DIAYPI, 2011.

Zaitsev, B.A., Early Jurassic (Late Sinemurian–Early Pliensbachian) ammonites from the limestone boulders of Bodrak River basin, Southwest Crimea, *Stratigr. Geol. Correl.*, 2021, vol. 29, no. 4, pp. 411–433.

Zaitsev, B.A., and Ippolitov, A.P., On the discovery of an assemblage of fossil cephalopods of the upper Sinemurian – Pliensbachian in Crimea, in *Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii. VI Vseross. soveshch.: nauchnyye materialy* (Jurassic System of Russia: Problems of Stratigraphy and Paleogeography. Proc. VI All-Russ. Conf.), Zakharov, V.A., Ed., Makhachkala: ALEF, 2015, pp. 114–119.

Zaitsev, B.A. and Ippolitov, A.P., Early Jurassic (Sinemurian) ammonoids from the boulders of the Greek Quarry, Central Crimea, *Stratigr. Geol. Correl.*, 2023, vol. 31, no. 4, pp. 221–274.

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