ISSN 0869-5938, Stratigraphy and Geological Correlation, 2018, Vol. 26, No. 3, pp. 298–332. © Pleiades Publishing, Ltd., 2018.
Original Russian Text © A.P. Ippolitov, 2018, published in Stratigrafiya, Geologicheskaya Korrelyatsiya, 2018, Vol. 26, No. 3, pp. 62–98.

Marine Early Bajocian Deposits of the Lower Volga Region (Volgograd Region) and Their Belemnite-Based Stratigraphy

A. P. Ippolitov

Geological Institute, Russian Academy of Sciences, Pyzhevskii per. 7, Moscow, 119017 Russia
e-mail: ippolitov.ap@gmail.com

Received March 24, 2017; in final form, November 13, 2017

Abstract—A representative early Bajocian belemnite assemblage containing four genera and 11 species (two identified in open nomenclature and five new: *Eocylindroteuthis weisi* sp. nov., *E. mariottii* sp. nov., *E. yarkovi* sp. nov., *Homaloteuthis volgogradensis* sp. nov., and *Hastites orphana* sp. nov.) is described from a section near the Dubovoi hamlet in the Greater Don Bend area (southern termination of the Don-Medveditsa dislocations). Some members of this assemblage were previously known from the Caucasus; however, it is possible to state the discovery of a Euroboreal belemnite fauna completely new for Russia, previously described only from Central Europe and almost unknown for Eastern Europe. The age of the studied assemblage collected from the lower part of the section, traditionally considered to be Upper Bajocian, corresponds to the Laeviuscula ammonite Chronozone and is the first reliable evidence of marine settings in the Volga Region for the early Bajocian. Two new biostratigraphic units, Beds with Eocylindroteuthis weisi and Beds with H. orphana, are introduced. The former, judging from the occurrences of its characteristic species in Western Europe, has a broad correlative potential. On the basis of datings obtained, the scheme of the formational subdivision of the Middle Jurassic of the Volga Region near Volgograd is revised, and the formerly abandoned Bakhtemir Formation is reinstated as a valid unit. Its total range is reestablished as corresponding to the upper part of the Discites (?)/Laeviuscula Chronozone (lower Bajocian)–Garantiana Chronozone (upper Bajocian).

Keywords: early Bajocian, belemnites, *Homaloteuthis*, *Eocylindroteuthis*, *Hastites*, Russian Plate, Volgograd Region, Bakhtemir Formation

DOI: 10.1134/S0869593818030073

INTRODUCTION

Jurassic deposits exposed on the southern termination of the Don-Medveditsa dislocations, in the Greater Don Bend area (Volgograd region, Ilovlya district; Fig. 1), were recognized over 100 years ago, but remain poorly studied paleontologically. S.N. Nikitin was the first to establish their presence in the natural outcrops to the west of the village of Sirotinskaya at the end of the 19th century. He identified "*Belemnites Pouzosi* d'Orb., fragments of *Gryphaea*, *Ostrea*, *Nucula*, etc.," from the "light-gray laminated clay ... in the lower [part containing] a bed of argillaceous limestones, locally having the appearance of conglomerate and containing very poorly preserved organic remains" (Lebedev, 1893, p. 40). On the basis of the presence of *"Belemnites Pouzosi"* [=*Cylindroteuthis puzosiana* (d'Orbigny, 1842), according to recent classification—author's comm.]—belemnite species, widely spread in the middle–upper Callovian of the Russian Plate—the deposits were assigned to the Callovian.

Kamensky (1924) specificated the lithological characteristics of the Jurassic sequence by recognizing the lower sandy member and the upper clayey member and also extended the paleontological characteristics of the succession with records of the Bajocian bivalve "*Pseudomonotis* cf. *doneziana* Boriss." He proposed that the upper (clayey) member should mostly be assigned to the Bajocian, and a schematic log by him was published in (Mazarovich, 1923, p. 54). Panteleev (1947), who studied mainly Triassic deposits in the Don Bend area, mentioned "abundant fauna of Late Bajocian age, characteristic of the Parkinsonia doneziana Zone" from the upper clayey member, also providing an identification of the ammonite *Parkinsonia* cf. *eimensis* (Panteleev, 1947, p. 2031, pl. 1).

Finally, the Saratov geologist Rykov (1951, 1953) listed the following identifications for the belemnites collected from the concretions in the clayey part of the sequence (according to Smirnov's (1966) indication, performed by P.A. Gerasimov): *Megateuthis aalensis* Voltz, *Megateuthis quinquesulcata* Bl., *Megateuthis* cf. *elliptica* Mill., *Megateuthis* sp. indet.—both genus and species listed are common for the Bajocian. Referring to the similarity of his assemblage to that of the "Cherkasskaya Formation" of the Donets Basin, Rykov (1953) suggested an early Bajocian age of the host deposits, noting that the belemnites occur in the lower

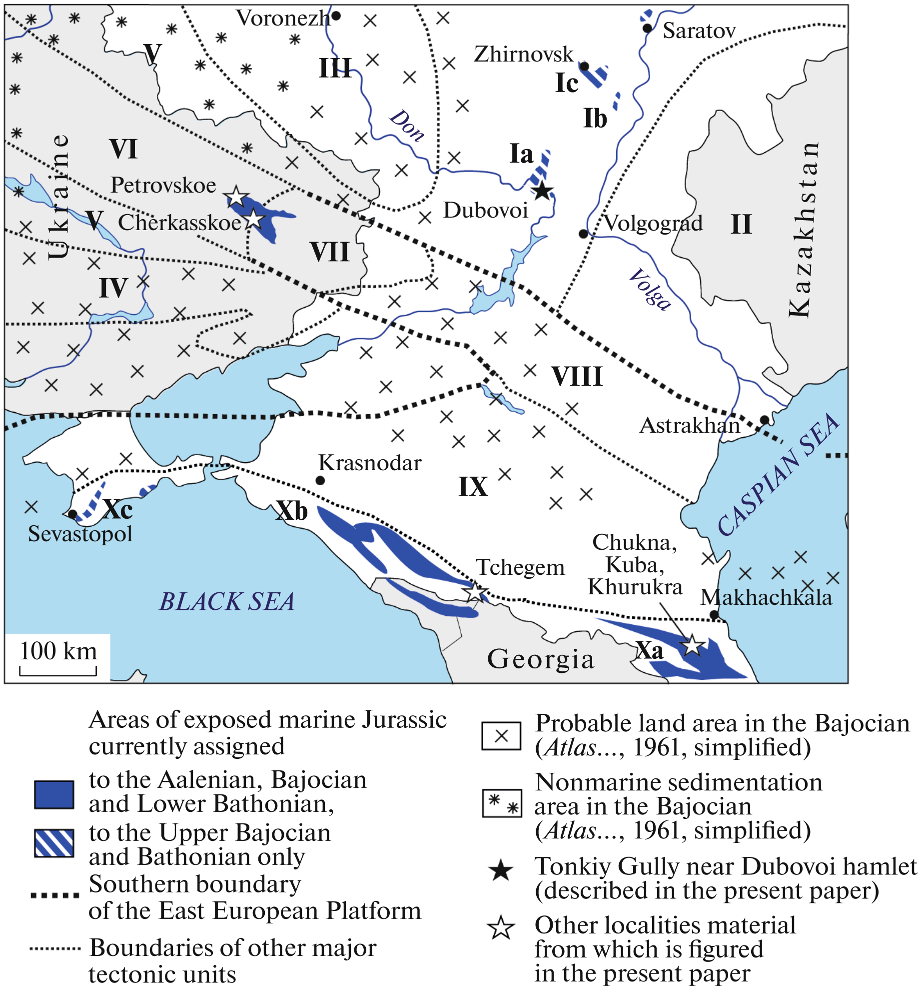


Fig. 1. Studied area in the regional tectonic and paleogeographic context. Legend: I—Don-Medveditsa dislocations (Ia—southern termination; Ib—northern termination, upper reaches of the Ilovlya River; Ic—northern termination, vicinity of Zhirnovsk); II—Peri-Caspian Depression; III—Voronezh Anteclise; IV—Ukrainian Shield; V—Ukrainian Syneclise; VI—Dnieper-Donets Depression; VII—Donets Folded Structure; VIII—subsurface Karpinsky Ridge; IX—Scythian Plate and Ciscaucasian Depression; X—Crimea-Caucasus Folded Structure (Xa—Eastern Caucasus; Xb—Central and Western Caucasus; Xc—Crimea).

horizons of the clay member, whereas the remains of "*Pseudomonotis doneziana*" are found above. It remains unknown whether Rykov had comparative lower Bajocian material from the Donets Basin in his possession, or whether his comparison was based on incorrectly dated material from late Bajocian beds (Garantiana Zone; Borissjak, 1908; Nikitin, 1975, 1981) exposed near the village of Cherkasskoe and erroneously (Yamnichenko, 1969) included in the Cherkasskaya Formation of early Bajocian age by Lungersgauzen (1942). Sasonov (1958, p. 150) proposed an alternative opinion on the age of belemnites collected by Rykov, considering them as belonging to the lower/upper Bajocian boundary interval.

All the aforementioned records, of both belemnites and bivalves, remained unfigured. The micropaleontological studies by Sarytcheva (1958) conducted in the same years in the Don Bend area revealed the presence of an original assemblage of foraminifers and ostracodes (8 species) at the same levels from where belemnites were previously reported. This assemblage was dated as late Aalenian–early Bajocian, thereby supporting the conclusion by Rykov (1953) on the age. The viewpoint that the marine lower Bajocian strata are present in the Lower Volga Region became widespread among geologists in the 1950s, as is reflected in publications of those years (Kamysheva-Elpatievskaya, 1958; Smirnov, 1958; etc.). However, a few years later, a single find of the late Bajocian ammonite "*Garantia* sp." [*Garantiana*—author's comm.] (Smirnov, 1962) originating from a borehole near Volgograd and recorded from a sandstone member correlated by electric logging with the lower sandy member of the Don Bend sequence triggered a fundamental revision of the age of deposits.

Hence, in 1965, A.I. Sarytcheva assigned the upper (clayey) member of the Don Bend sequence to the "Planularia and Ostracoda Zone," characterized in the adjacent areas by a rich foraminiferal assemblage and correlated in its full range with the upper Bajocian Garantiana ammonite Zone (Sarytcheva, 1965). Notably, none of the eight "Aalenian—early Bajocian" species of foraminifers and ostracodes previously listed in the Don Bend sequence was mentioned in the faunal list of the newly recognized biostratum. In a discussion section, Sarytcheva (1965, p. 49) also referred to G.Ya. Krimholz's opinion that the belemnite species listed by Rykov (1951, 1953) are common not only in the lower but also in the upper Bajocian, and hence they do not contradict her updated microfauna-based dating.

Starting from that time, the opinion on the late Bajocian age of the upper clay member containing belemnites was firmly established in the literature (Ivanitskaya and Sarytcheva, 1970; Kamysheva-Elpatievskaya, 1972; Troitskaya and Khabarova, 1986; Saltykov, 2008), notwithstanding that several years later in Astrakhan region, in the equivalent of the lower sandy member that had previously yielded the late Bajocian *Garantiana* sp., A.N. Ivanova found an early Bajocian ammonite "*Witchella* sp. (?)" in a borehole core (Ivanitskaya and Sarytcheva, 1970, p. 267). Although that record cast some doubts on the reliability of the dating based on *Garantiana*, it did not result in a new revision of the age of the overlying clay series.

Almost none of the researchers provided an explanation of the original record of the invariably Callovian belemnite species "*Belemnites Pouzosi* d'Orb." from the Don Bend area. Only Kamensky (1924) accepted the presence of thin Bathonian-Callovian strata near the top of the clay member, and Voronin (1945) suggested that the historical find of a Callovian belemnite could have originated from a basal Cretaceous conglomerate, whereas the main portion of the Jurassic sequence should be dated as Bajocian. No further Callovian fossils have been ever reported.[1]

This paper presents the results of the reexamination of the belemnite assemblage from the Middle Jurassic clay series exposed in the Don Bend area. The obtained data allow the assignment the lower part of this series to the lower Bajocian (upper part of the Discites(?) Chronozone—Laeviuscula Chronozone). Exactly this part of the succession yielded all the historical finds of belemnites, previously dated as Callovian or Bajocian.

SECTION DESCRIPTION

The studied section is located in the Tonkiy Gully ("Tonkiy Yar"), with the mouth opening towards the western end of the Dubovoi hamlet, 5.5 km west of the village of Sirotinskaya (Fig. 2a). The description is compiled from three closely spaced sites: 49°16.173′ N, 43°35.405′ E (interval 0—11 m above the base of Member II), 49°16.041′ N, 43°35.470′ E (interval 7—22 m above the base of Member II), and 49°16.198′ N, 43°35.276′ E (starting from the level of 17 m above the base of Member II and up to the end of the section).

The lower portion of the succession is exposed approximately 300 m above the mouth of the gully, on the left border of the largest, western, branch. Seemingly, this site is mentioned by Rykov (1951, photograph 1; also this paper, Fig. 3) and schematically described by Smirnov (1966, p. 153). The following description is from bottom to top:

Member I. Light yellow sands, almost white near the top, medium-grained, bedded, well-sorted, composed mainly of quartz. The topmost part contains gravel material and small-sized semiangular pebbles, mostly of quartz, but also of limestones and other rocks, and bedded flattened concretions of gray calcareous sandstone. Measured thickness 5 m.

Member II. Alternation of silty, thinly laminated dark gray clay with a brownish purple tint and light gray argillaceous silts, with a green tint ("ryabchik clay" according to Smirnov, 1962). The member is variegated owing to the ferrugination along bedding planes and in certain centers. There is a basal bed of strongly ferruginous brownish orange sand, redeposited from Member I, with lenses and thin interlayers of dark gray thinly laminated clay, up to 0.1 m thick. The overlying 0.5 m of the sequence is mainly clayey in composition. Upsection, from the level of 0.6 m above the base, the ratio of the clay and siltstone layers becomes even; abundant twin and solitary gypsum crystals appear in fractures and bedding surfaces, often forming crusts around concretions and macrofossils. The following marker levels can be recognized within the generally monotonous series (numbers at the beginning of each section below denote distances above the base):

4.0 m—first appearance of bivalve imprints, encountered upwards across the entire Member II.

4.8 m—"belemnite level" (Fig. 3c): silty bed with numerous strongly leached and gypsum-coated rostra of large belemnites oriented in a southeastern direction, locally cemented by gypsum crystals into the lenses of "belemnite conglomerate" up to 80 cm in diameter and up to 5—8 cm thick. Locally around the accumulations of belemnites, concretions of laminated gray-green siltstone with carbonate cement are formed, having flattened shapes of various sizes, maximum diameter of 50—70 cm and 20 cm tall. The concretion surface is uneven, sometimes cavernous. The concretions contain bivalve shells, fragments of bel-

---

[1] The characteristics of the Jurassic sequence of the Don Bend area provided by Sterlin (1964, p. 263), who indicated the presence of a complete Bajocian—Callovian succession, contradict both the observations of other authors and our data. It seems obvious that this researcher incorrectly applied the toponym "Don Bend" for describing a generalized succession at the northern termination of the Don-Medveditsa dislocations—either in the upper reaches of the Ilovlya River or near the town of Zhirnovsk.

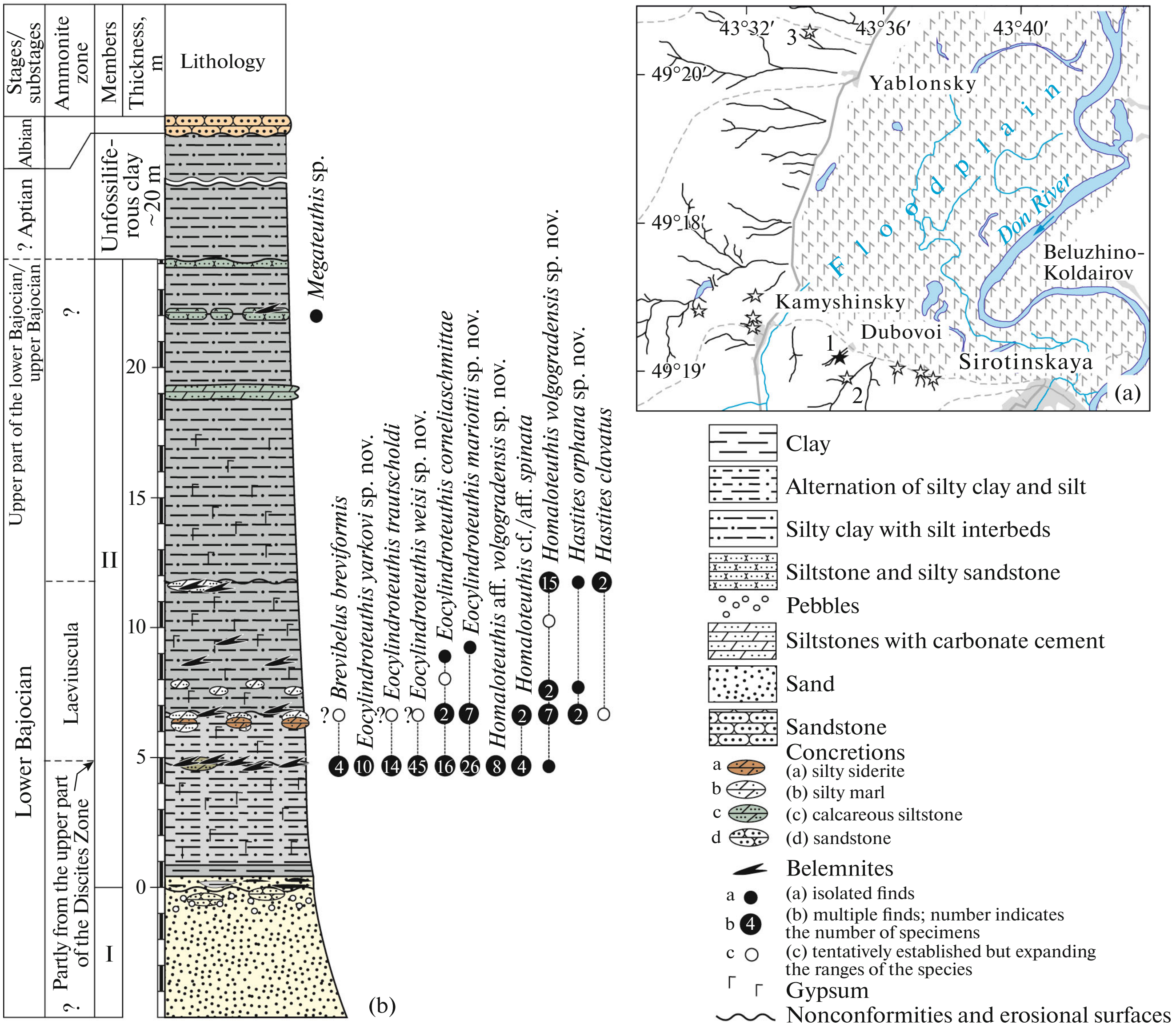


Fig. 2. Section of the Jurassic near Dubovoi hamlet east of the village of Sirotinskaya (Volgograd region). (a) Location of the main outcrops in the studied area (indicated by asterisks, the most important outcrops are numbered: (1) Tonkiy Gully, described in the present paper; (2) Dubovaya Gully; (3) Malaya Pakhotnaya Gully); (b) lithological log and belemnite occurrences in the Tonkiy Gully section near Dubovoi hamlet.

emnite rostra, accumulations of plant remains, and fish scales. Imprints of large bivalves were also found near this level. Above this level, the coloration of the series becomes more even. At 4.9 m, the section also contains small isolated lenses with belemnites.

6.6 m—concretions of bright ginger sideritized argillaceous siltstone, dark brown with a cherry tint on the surface owing to strong ferrugination, with scattered shell detritus, up to 0.5 m in diameter (mainly 0.2–0.3 m) and 0.1–0.15 m high. Immediately above the concretions, and less commonly beneath them, there are concretions of light gray siltstone with a greenish tint, similar in shape and size, pierced by numerous bioturbations, with scattered shell remains, sometimes forming accumulations.

6.8 m—rare small lenses with belemnites and oysters in general similar to those occurring at 4.8 m and marking an erosional level; a marine reptile tooth was found in one of these lenses. This level corresponds to the boundary between the "laminated series of clay and silt" and "clay" sensu Smirnov (1958): above that level, rocks sharply change color to a slightly darker color owing to a decrease in the number and thickness of silty layers.

7.6–7.8 m (interval)—scattered carbonate concretions of light gray siltstone up to 0.4 m in diameter

Fig. 3. Outcrop of a clay series containing belemnites in the Tonkiy Gully. (a) General view of the outcrop; (b) Member II, enlarged; (c) accumulation of leached belemnite rostra (level 4.8 m) (photo by D.B. Gulyaev).

(mainly 0.2–0.3 m), 0.1–0.15 m high, usually gypsum-coated.

9.2 m—level with relatively rare nestlike accumulations of very poorly preserved belemnite rostra, also indicating a concealed unconformity.

11.9 m—scattered septarian concretions of gray-green, irregularly colored carbonate siltstone with scattered pyrite, strongly ferruginous on the surface and gypsum coated. The diameter is from 5 to 75 cm; the height reaches 30–40 cm. The lower part of the concretions sometimes contains an accumulation of well-preserved belemnites and rare bivalve shells. Belemnites are also rarely found outside the concretions, but in that case have a strongly weathered appearance. The top of the level is slightly ferruginous. Similar to other levels characterized by mass occurrences of rostra, this one apparently corresponds to a sedimentation gap.

12.5 m—rare small concretions of siltstone not exceeding 5–10 cm in diameter.

18.1 m—prominent bed of carbonate siltstone of gray-green color with a brown tint, weakly lumpy, 0.7 m thick. Small bivalves are present in abundance.

22.1 m—concretions of arenaceous siltstone with ferruginous-carbonate cement. The diameter of concretions is up to 70 cm, and they are up to 40 cm high. The bed contains occasional bivalves and belemnite rostra. The top of the bed is ochraceous; apparently, it corresponds to an unconformity level.

24.1 m—bed of silty sandstone, gray-green, with thin horizontal bedding, with small bivalves, 0.15 m thick.

The total thickness of Member II is 24.3 m.

This is overlain by a poorly exposed part of the section represented by silty clay without macrofossil remains, about 20–25 m thick, possibly of the Aptian Stage (Lower Cretaceous) (Rykov, 1960); it is followed by loose cavernous Albian sandstones.

It is quite possible that the highest level with macrofossils in the studied section (22.1 m above the base of Member II) corresponds to the "horizon of sands with quartz pebbles and fragments of belemnites and wood" of G.K. Kamensky (in Mazarovich, 1923).

Historical occurrences of belemnites published by Rykov (1951), according to the indication by Smirnov (1966), come from sideritic concretions collected in the Dubovaya Gully, 700 m southeast of the described section (Fig. 2a). The succession here duplicates the succession in the Tonkiy Gully described above, but at present is somewhat less well exposed. I did not find concretions with belemnites in this section, and can only suggest that Rykov's finds correspond to concretions from the level either 4.8 or 11.9 m above the base of Member II in the Tonkiy Gully.

Outcrops of the lower part of the clay series were also observed in several gullies near Dubovoi hamlet (small nameless gullies 1.3 and 1.7 km east and 0.5 km west of it), in rills running down from the west to the northern margin of Shokhinsky hamlet, near a pond in the Krutaya Gully, and also in the upper part of the extensive sublatitudinal ravines to the west and north of Yablonski hamlet (Fig. 2a). However, all of them are currently exposed worse than the described section, representing only small fragments of the succession, whereas belemnites, if present, have a strongly weathered appearance and cannot be identified to species. An outcrop in the Malaya Pakhotnaya Gully northwest of Yablonsky hamlet (49°21.337′ N, 43°35.191′ E) is of particular interest because the transition from sandy Member I to clayish Member II is represented here by an interval of alternating sand and clay. This agrees with the observation by Smirnov (1962, p. 115), who mentioned a transitional series slightly to the north, within the Saushinsky and Verkhovsky domes (~15 km to the north; see Tsygankov, 1958). This indicates a close geohistorical relationship between Members I and II and, probably, the absence of a significant stratigraphic gap between them.

RESULTS AND DISCUSSION

A belemnite assemblage collected in the lower part of Member II (interval 4.8–11.9 m above the base) contains 11 species assigned to four genera—*Eocylindroteuthis* Riegraf, 1980, *Homaloteuthis* Stolley, 1919, *Brevibelus* Doyle, 1992, and *Hastites* Mayer-Eymar, 1883; their distribution across the section is shown in Fig. 2b.

The fossil material is mainly poorly preserved: the rostra are strongly leached on the surface and are partly replaced by gypsum, deriving from an initially high content of dispersed pyrite in the clay series. The analysis of rostra from the level of 4.8 m is most problematic, since the cross section is often distorted by gypsum crystals growing along the apical line and the plane of symmetry and also because of the erosion of the lateral sides and the apical part, which often cannot be discerned by the examination of the outer surface. Nevertheless, all the species established in the assemblage have characters preserved (on at least a single specimen) that allow positive identification, in total among collected 420 rostra only 159 were identified to species level. The best preserved rostra come from the concretions at 11.9 m.

Substantiation of the Generic Assignment for Eocylindroteuthis and Homaloteuthis

Representatives of the above genera are dominant in the assemblage throughout the entire fossiliferous part of the section, are very diverse morphologically, and are represented by eight species: *Eocylindroteuthis weisi* sp. nov., *E. mariottii* sp. nov., *E. yarkovi* sp. nov., *E. corneliaschmittae* Riegraf, 1980, *E. trautscholdi* (Oppel, 1862), *Homaloteuthis* cf./aff. *spinata* (Quenstedt, 1848), *H. volgogradensis* sp. nov., and *H.* aff. *volgogradensis* sp. nov. Rostra of this group apparently were originally identified by Nikitin (in Lebedev, 1893) as the Callovian "*Belemnites Pouzosi*" and later by Gerasimov (in Rykov, 1951, 1953) as the Bajocian *Megateuthis* spp.

Representatives of the Aalenian-early Bajocian genera *Homaloteuthis* Stolley, 1919 and *Eocylindroteuthis* Riegraf, 1980 are indeed very similar in size and shape to *Megateuthis* Bayle, 1878 (incl. *Mesoteuthis* Lissajous, 1915), large-sized varieties of which are common beginning from the lower Bajocian Humphreisianum Zone, but can also be found in the slightly lower horizons (Laeviuscula–Propinquans zones; see Weis and Mariotti, 2008). It appears that the large size of the rostra observed in the most abundant species of studied assemblage was the main reason for Gerasimov's assignments. Differences between the genera listed above can be relatively readily established from the cross sections behind the protoconch (Weis and Mariotti, 2008, fig. 6; this paper, Plate VI, figs. 1a–1e).

I examined and compared series of cross sections of the rostra from the Don Bend area (Plate VI, figs. 7a, 8a, 9, 11, 13a, 12, 16f, 16g, 16i—in standard sections behind the protoconch; figs. 7b, 8b, 10, 13b, 16j—in other sections) and rostra of large-sized megateuthids, originating from the upper part of the lower Bajocian (Humphriesianum Zone) and upper Bajocian (Parkinsoni Zone) of Dagestan and also upper Bajocian (Garantiana Zone) of the Donets Basin (Plate VI, figs. 2a, 4a, 5, 6, 16a–16e—in standard sections behind the protoconch; figs. 2b, 3, 4b—in other sections). This comparison positively indicates that all occurrences from the lower part of the Don Bend section should be classified within the genera *Eocylindroteuthis* and *Homaloteuthis*. Their differences from the studied large-sized belemnites from the upper part of the lower Bajocian and upper Bajocian (genus *Megateuthis*) are as follows:

—Absence of the paired dorsolateral apical grooves, revealed in the cross section near the protoconch at early ontogenetic stages.[2]

— Presence in *Eocylindroteuthis* of a wide and shallow mid-ventral groove, which is observed only in the middle of the postalveolar part of the rostrum, disappearing toward both the apex and the alveolus. In *Homaloteuthis*, this groove is sometimes also present, but is extremely weakly expressed and is either fixed only at the apex or appears as a poorly discernible flattening.

The external similarity of the belemnite genera *Eocylindroteuthis* and *Homaloteuthis* from the Don Bend area to the Callovian *Cylindroteuthis puzosiana*, which was previously identified from the studied section (Lebedev, 1893), is reflected in the elongated rostrum shape in some species (in particular, *Eocylindroteuthis weisi* sp. nov. and *Homaloteuthis volgogradensis* sp. nov.) and in the presence of a deep ventral groove extending forward from the posterior end and sometimes reaching the alveolus (Plate I, fig. 6a) in some specimens of *Eocylindroteuthis* spp. The polished sections show that this groove is usually considerably secondarily re-deepened by the leaching of a weak zone of the rostrum at the mid-ventral flattening/groove (Plate I, fig. 6e).

Comments on the Belemnite Species Established in the Assemblage

***Eocylindroteuthis* spp.** (Plates I–III). These taxa are analyzed in detail in the paleontological section of this paper, including three new species descriptions. The assemblage contains morphotypes comparable with two Western European species—*E. trautscholdi* [=*E.* sp. 4: Ippolitov, 2017a] (Plate I, figs. 3–5) and *E. corneliaschmittae* [=*E.* sp. 3: Ippolitov, 2017a] (Plate I, figs. 1, 2). The former are identified more or less tentatively: no specimens morphologically identical to the holotype have been found from the studied section, whereas specimens nevertheless assigned to *E. trautscholdi* are poorly preserved or incomplete. Among the rostra identified as *E. corneliaschmittae*, some (Plate I, fig. 1) are similar to the paratype from the lower Bajocian Discites Zone of the Swabian Alb, whereas other (Plate I, fig. 2) are close to the holotype originating from the higher horizons in the Bajocian, supposedly (Riegraf, 1980) the Humphreisianum Zone.

Homaloteuthis* cf./aff. *spinata (Plate IV, fig. 5) is represented by the reliably identified rostrum of a well-preserved specimen, two other rostra somewhat different in appearance, and several poorly preserved fragments. This species differs from the co-occurring *Eocylindroteuthis* spp. in the absence of the flattening/groove in the middle of the postalveolar region: its cross section is oval in shape with a convex ventral side. The best preserved specimen is more similar to the lectotype from the Murchisonae Zone of the Swabian Alb (see Quenstedt, 1849, pl. 27, fig. 8; Schlegelmilch, 1998, pl. 12, fig. 12) than the specimens previously identified in the Russian literature under the same name and coming from the "upper" [=middle or upper] Aalenian of Dagestan (Krimholz, 1947, 1953). It is quite possible that the specimens found in the studied section should be assigned to a separate species, but presently there is insufficient material to evaluate the range of variability of the characters, whereas poor state of preservation complicates the differentiation from the co-occurring *Eocylindroteuthis* spp. (especially *E. corneliaschmittae*). Other species of the genus *Homaloteuthis*, ***H. volgogradensis* sp. nov.** (Plate IV, figs. 1–4) and ***H.* aff. *volgogradensis*** (Plate V, figs. 2), possessing a cylindrical rostrum, not typical of the genus, and comparable in this character to *Eocylindroteuthis* spp., are discussed in detail in the systematic section of this paper.

Brevibelus breviformis (Plate IV, fig. 6) has small to medium-sized rostra of recognizable subcylindrical shape with a rounded-square cross section and lacking apical grooves. It is found infrequently, but its identification among *Eocylindroteuthis* spp., which always have laterally compressed rostra, does not cause difficulties even for poorly preserved specimens.

Hastites clavatus (Plate V, fig. 4) is positively identified from the shape of the rostrum and its cross section and also on the basis of the lateral lines having the appearance of two widely spaced grooves axially separated by a weak longitudinal elevation, characteristic of this genus (Schlegelmilch, 1998, pl. 12, figs. 2, 4, 8, 9—compare with Plate V, figs. 4b, 4d in this paper). This species is represented by a single complete specimen, almost identical in all features to the lectotype (Riegraf, 2001, figs. 5, 6, 16), and one fragment. To add, the generic name *Hastites* Mayer-Eymar, 1883, widely applied in the literature, including the Russian sources, to Pliensbachian taxa and erroneously to some Bathonian forms (Pugaczewska, 1961), is interpreted in this paper in a narrower sense to include only the Toarcian–Aalenian species assigned in the literature of the end of the 20th century to *Neoclavibelus*

---

[2] Note that in recent years many authors (see Dzyuba et al., 2015) place numerous late Toarcian–early Bajocian species previously assigned to *Mesoteuthis* Lissajous, 1915 to *Megateuthis* (=*Megateuthis* s. lat.) on the basis of the recognition of two main definitive characters of the genus *Megateuthis* (Lissajous, 1915; Riegraf, 1980; Schlegelmilch, 1998)—i.e., large size and epirostra—in the late Toarcian taxa (Doyle, 1992). Our data show that the genera *Megateuthis* and *Mesoteuthis* should preferably be separated by the number of apical grooves as was suggested by Soviet authors (only dorsolateral—in *Mesoteuthis*; dorsolateral and ventrolateral—in *Megateuthis*; cf. Krimholz, 1947; Gustomesov, 1960; Nalnjaeva, 1974; Sachs and Nalnjaeva, 1975; etc.). The presence of two pairs of lateral grooves is fixed near the phragmocone at the earliest growth stages in the elongated specimens from both the early Bajocian (*Megateuthis gigantea* (von Schlotheim, 1820); Plate VI, figs. 2, 16a) and the late Bajocian (*Megateuthis* cf. *elliptica*; Plate VI, figs. 3, 16b). This suggests a long range of such taxa and the possibility of the taxonomic segregation of the group of species having these features (=*Megateuthis* s. str.).

Riegraf, 1980 (cf. Schlegelmilch, 1998). The type species of the genus *Hastites* Mayer-Eymar, 1883 (Riegraf et al., 1998; Riegraf, 2001) belongs to this group; hence, these genera should be considered as synonyms. Pliensbachian taxa similar in shape and size should be assigned to the genus *Subhastites* Gustomesov, 1977.

Hastites orphana **sp. nov.** (Plate V, figs. 5, 6) is the second species of the genus *Hastites* present in the assemblage. Occurrences of this species are represented by a few specimens, but they are sufficient to substantiate the status of this species even considering their imperfect preservation.

The only occurrence from the upper part of the section originates from an arenaceous horizon with concretions near the top of Member II. This find is represented by a large semi-rolled specimen, dissolved on the surface and representing only the apical fragment of the rostrum. It was determined as ***Megateuthis*** **sp.** In contrast to *Eocylindroteuthis* spp. and *Homaloteuthis* spp. from the lower part of the section, this rostrum demonstrates a folded cross section of the apical zone showing relatively deeply incised dorsolateral apical grooves (Plate VI, figs. 15, 16h) and poorly pronounced ventrolateral grooves. Although in the apical part of *Eocylindroteuthis* and *Homaloteuthis* these grooves also can be discernible (Plate IV, fig. 1e; Plate VI, figs. 10, 16j), by their degree of prominence in combination with only a slightly compressed shape of the cross section near the apex, the specimen is closer to the genus *Megateuthis*, in particular, to the species *M. elliptica* (Miller, 1826) (Plate VI, figs. 6, 16c), which is similar in the general outline, than to *Eocylindroteuthis* or *Homaloteuthis*.

THE AGE OF THE STUDIED BEDS AND ITS SIGNIFICANCE FOR STRATIGRAPHY

Age of Member II. The described section near Dubovoi hamlet did not yield ammonites, and micropaleontological samples from several levels examined by E.M. Tesakova (Moscow State University/Geological Institute, Russian Academy of Sciences) did not contain carbonate microfossils; hence, currently the biostratigraphic dating of this sedimentary series is only possible using belemnites.

At the genus level, the studied assemblage from the interval of 4.8–11.9 m (*Homaloteuthis*, *Brevibelus*, *Eocylindroteuthis*) corresponds to the Aalenian–early Bajocian *Subboreal* (Mariotti et al., 2010; Weis et al., 2012) or *Euroboreal* (Weis et al., 2017) association, occurring in the north of Central Europe (Germany, Luxembourg). This association differs considerably from the *Submediterranean* (Mariotti et al., 2010; Weis et al., 2012) or *Mediterranean* association (Weis et al., 2017), occurring to the south and mainly characterized by representatives of the genera *Holcobelus* Stolley, 1927 and *Calabribelus* Weis, Mariotti et Riegraf, 2012. This restricts the possibility of the direct comparison with the Caucasus, where the middle Aalenian–early Bajocian belemnite assemblage has an ecotonic appearance (dominated by *Holcobelus* and *Brevibelus*, with infrequent *Megateuthis* and *Eocylindroteuthis*; see Weis et al., 2012; Ippolitov et al., 2015).

The determination of the precise age of the lower part of the clay series by belemnites collected from the interval of 4.8–11.9 m is somewhat difficult. The main problem is the co-occurrence of the representatives of the genera *Hastites*, *Homaloteuthis*, and *Eocylindroteuthis*, which indicate different ages of the deposits—late Toarcian–early Aalenian, middle–late Aalenian, and early Bajocian, respectively (Fig. 4).

The species *Hastites clavatus* found at the level 11.9 m above the base of Member II is considered to belong to the terminal Toarcian and lower Aalenian Opalinum Zone (Schlegelmilch, 1998, as *Neoclavibelus compactus* (Kolb, 1942); Arp, 2010, as *N. compactus* and *N. neumarktensis* (Oppel, 1857)). However, the holotype of this species, most similar to our specimen, comes from the historical collection of E.F. von Schlotheim and does not have precise indication of locality, and its assignment to the lower Aalenian strata (Riegraf, 2001) is just a guess. *Homaloteuthis spinata* is a zonal index for northwestern Europe indicating a middle–late Aalenian age (Combémorel in Biostratigraphie..., 1997; Combémorel in Hardenbol et al., 1998), but in the recent revision (Weis and Mariotti, 2008), the distribution of this species was confined only to the middle Aalenian Murchisonae Zone, whereas the material from the upper Aalenian Concavum Zone, characterized by strongly elongated rostra, was assigned to a separate species *H. murielae* Weis et Mariotti, 2008. Representatives of the genus *Eocylindroteuthis* are considered typical of the early Bajocian strata. Although both nominal European species of *Eocylindroteuthis* were also mentioned from the upper Aalenian Concavum Zone (*E. corneliaschmittae*, see Riegraf, 1980; Weis and Mariotti, 2008 [as "cf."]; *E. trautscholdi* with a question mark, see Schlegelmilch, 1998; see Fig. 4), no occurrences from this interval have ever been illustrated in the literature.

The second interesting feature of the observed distribution is that, in the studied section, the "ancient" *Hastites* appear above the "young" *Eocylindroteuthis*. The subautochthonous nature of all our finds is almost certain; hence, the discrepancies of the observed distributions of these genera with the existing data on their distribution in Western Europe can be explained by the isolated evolution of the Euroboreal belemnite fauna in the south of the Russian Plate in relation to Western Europe. In other words, either "Toarcian and Aalenian" *Hastites* and *Homaloteuthis* in the Volga Region survived significantly longer than in Western Europe or, vice versa, "Bajocian" *Eocylindroteuthis*

Plate I


1a
1b
1c
1d
1e
1f
10 mm
2a
2b
3a
3b
4a
4b
4c
4d
5a
5b
5c
5d
6a
6b
6c
6d
6e

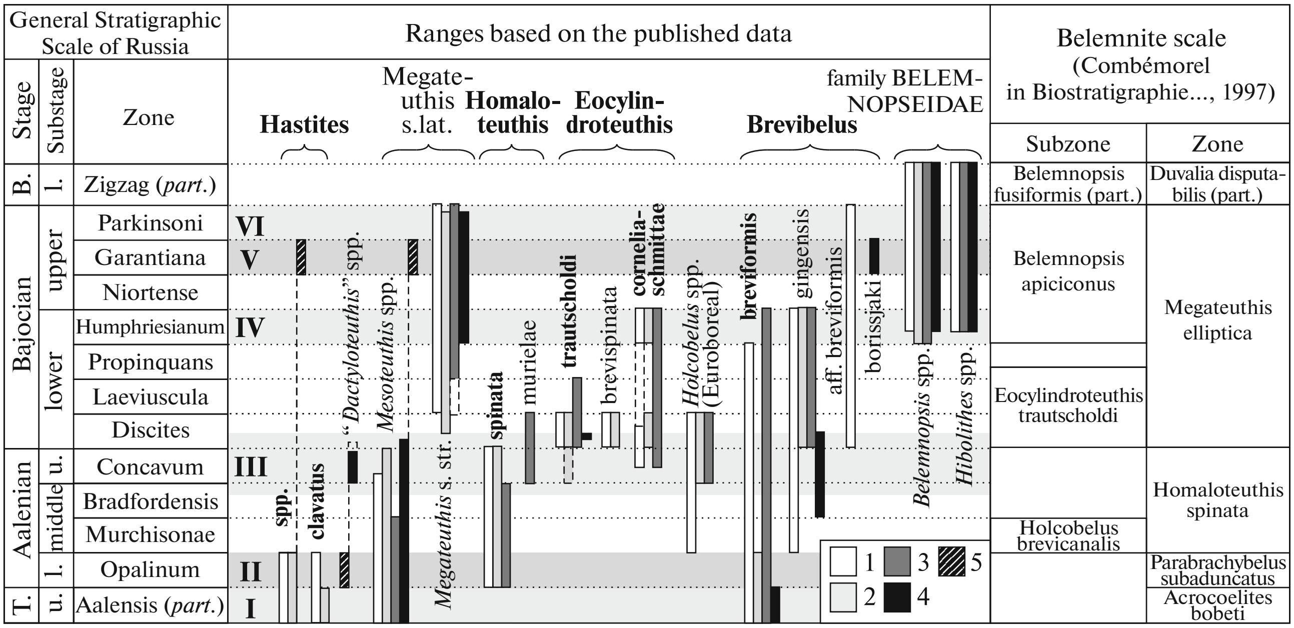


Fig. 4. Stratigraphic occurrences of the belemnite taxa in the Aalenian–Bajocian "Euroboreal" deposits of Europe compiled from the data by various authors: (1) Schwegler, 1965, 1971; Riegraf, 1980, 1981; (2) Schlegelmilch, 1998; (3) Weis and Mariotti, 2008; Weis et al., 2012; (4) the present author (Ippolitov et al., 2008, 2015 and unpublished; Gulyaev et al., 2015a, 2015b); (5) indications by Borissjak (1908) and Nikitin (1981) expanding the ranges of known genera). Only the data employing accuracy up to ammonite zones are used. Taxa that became extinct at the end of the Toarcian–early Aalenian are not shown. Bold font shows genera and species established in the studied assemblage. (I–VI): Intervals in the adjacent regions characterized by the representative belemnite assemblages allowing comparison with the studied assemblage: (I) Crimea, Lozovoe village (Ippolitov et al., 2008); (II) Donets Basin, Kozhukhov ravine (Nikitin, 1975, 1981); (III) Dagestan, Chukna village (Ippolitov et al., 2015); (IV) Dagestan, Kuba village (Gulyaev et al., 2015a); (V) Donets Basin, Cherkasskoe village (Borissjak, 1908; Nikitin, 1975, 1981; Ippolitov, unpublished); (VI) Dagestan, Khurukra village (Gulyaev et al., 2015b). Abbreviations: T.—Toarcian; B.—Bathonian; u.—upper, l.—lower.

appeared and evolved in the Volga Region as early as the early–middle Aalenian, and its appearance in Western Europe at the Aalenian/Bajocian boundary resulted from immigration. The existing data unequivocally support the former interpretation.

Firstly, the early Aalenian assemblage in the adjacent region of the Donets Basin has a completely different composition at the generic level: it contains only subcylindrical, laterally compressed rostra, identified as *Dactyloteuthis* spp. (Nikitin, 1975, 1981), and also known from the Aalenian–Bajocian boundary interval of the Eastern Caucasus (Ippolitov et al., 2015).

Secondly, in the classical section of the upper Bajocian near the village of Cherkasskoe (Donetsk region, Ukraine) at the base of the coquina sandstone of the Garantiana Zone, I found a single redeposited rolled and bored specimen, in all characters corresponding to the formal diagnosis of the genus *Homaloteuthis* (Plate V, fig. 9; Plate VI, figs. 5, 16d) and closely similar to *H. spinata*. Although the nature of preservation allows various interpretations, it should be said that the Garantiana Zone in the Cherkasskoe section overlies not the Aalenian, but a relatively thick series of the clayey-sandy rocks assigned to the basal upper Bajocian Strenoceras niortense Zone (see Nalivkin, 1899 and comments in Mitta et al., 2004). Therefore, a late Bajocian age is most likely for this specimen. Next, in the collection of Borissjak (1908) from the Garantiana Zone of another Donets Basin section—Petrovskoe, I found a specimen very close to *Hastites orphana* sp. nov. described below (Plate V, fig. 7; identified by Borissjak as *Belemnites fusiformis*

Plate I. Here and in Plates II–V, all sizes are natural and all figured specimens, except those specially indicated, come from the section in the Tonkiy Gully. Dot (•) shows the approximate position of the tip of the alveolus, while asterisk (*) shows the position of transverse polished sections illustrated in Plate VI. In all cases, except for those specially marked: (a) ventral view; (b) left-side view; (c) alveolar view; (d) cross section in the postalveolar region. (1, 2) *Eocylindroteuthis corneliaschmittae* Riegraf, 1980: (1) specimen VSGM SIR/113, 4.8 m above the base of Member II (1d; 1e) cross sections; (1f) longitudinal section); (2) specimen VSGM SIR/350, loosely collected 8.0 m above the base of Member II; (3–5) *Eocylindroteuthis trautscholdi* (Oppel, 1862): (3) specimen VSGM SIR/187; (4) specimen VSGM SIR/50, both collected 4.8 m above the base of Member II; (5) specimen VSGM SIR/68, loosely collected; (6) *Eocylindroteuthis* cf. *mariottii* sp. nov., specimen VSGM SIR/104, 4.8 m above the base of Member II, specimen with a ventral groove strongly re-deepened by erosion (indicated by arrow): (6d, 6e) cross section at the groove area, (6e) enlarged 4.6 times.

Voltz), whereas unfigured finds identified from the same level in the Cherkasskoe section as *Belemnites subclavatus*/cf. *subclavatus* (Nalivkin, 1899; Borissjak, 1908) [=*Hastites subclavatus* (Voltz, 1830), in the modern understanding—author's comm.] do not belong to the genus *Hastites* (Ippolitov, unpublished data).

The above finds indicate that both the "Toarcian-early Aalenian" *Hastites* and "middle–late Aalenian" *Homaloteuthis* in Eastern Europe have wider ranges than in Western Europe and existed up to the late Bajocian. Consequently, dating of the studied assemblage should be exclusively based on *Eocylindroteuthis* spp., which has a substantially more complex morphology than *Hastites* and *Homaloteuthis*, and consequently, a higher rate of morphological evolution is anticipated for this taxon.

The condensed level 4.8 m above the base of Member II contains morphs of *Eocylindroteuthis*, identical to those figured from the lower Bajocian Discites and Laeviuscula Zones of Western Europe. The former is characterized by *E. trautscholdi* (see Schlegelmilch, 1998, pl. 15, figs. 1, 2), and the latter by *E. weisi* sp. nov. (=*E. corneliaschmittae* in Weis and Mariotti, 2008, pl. 1, fig. 2; pl. 2, fig. 1), while the range of another species (*E. corneliaschmittae*) corresponds to both of these zones. The only species in common with the Aalenian–Bajocian boundary assemblage described from the Eastern Caucasus (Chukna section) (Ippolitov et al., 2015) is *E. trautscholdi*, found there in the topmost of the studied succession. Consequently, even the most archaic elements from 4.8 m (*E. trautscholdi*) indicate an age no older than the upper part of the Discites Chronozone and possibly the Laeviuscula Chronozone (Weis and Mariotti, 2008), whereas other most abundant species (*E. weisi* sp. nov.) clearly point to the Laeviuscula Chronozone. Some indirect evidence (presence of transitional morphs; see species descriptions) suggests that this level contains heterochronous elements.

At the level of ~8.5 m, a rostrum of characteristic shape (Plate I, fig. 2) identical to *E. corneliaschmittae* figured from the Laeviuscula Zone (Sadki et al., 2015, pl. 19, figs. A, B) was collected loosely. This age can be extrapolated to the entire interval of 6.8–11.9 m, characterized by the same belemnite assemblage.

Additionally, considering the complete absence in the assemblage from the interval of 4.8–11.9 m of large-sized *Megateuthis* s. str., common in the lower Bajocian Propinquans Zone (Weis and Mariotti, 2008), the age determined on the basis of the members of the genus *Eocylindroteuthis* should be restricted to the interval of the Discites Chronozone (?, only in the lower condensed level)–Laeviuscula Chronozone.

The existing interpretations on the correlation of the lower part of the clay series of the Don Bend area with the upper Bajocian Garantiana Zone are finally disproved by the completely different structure of the assemblage at the genus and family levels compared to that of the Garantiana Zone assemblage of the Donets Basin (see Borissjak, 1908; Nikitin, 1975, 1981). In particular, the studied assemblage completely lacks representatives of the family Belemnopseidae Naef, 1922 (genera *Hibolithes* de Montfort, 1808 and *Belemnopsis* Bayle 1878), which became widespread in the northern margin of the Tethys beginning from the *Humphreisianum* Zone, and also the characteristic and most abundant species *Brevibelus borissjaki* (I. Nikitin, 1975).

A single occurrence of *Megateuthis* sp. from the level of 22.1 m in Member II indicates a younger age than established above for the interval of 4.8–11.9 m, but does not allow a precise dating. The genus *Megateuthis* s. str., e.g., the species *M. elliptica*, to which this specimen may belong, has a very wide range—from the lower Bajocian Laeviuscula (?) and Propinquans Zones (Weis and Mariotti, 2008) to the upper Bajocian Parkinsoni Zone (Riegraf, 1980).

Thus, the age of the oldest fossiliferous beds in the studied section is probably the beginning of the early Bajocian (lower part of the Laeviuscula Chronozone), while the age of the youngest fossiliferous beds is probably the latest early Bajocian/late Bajocian.

Correlation with the data from the adjacent regions. Owing to the paucity of data on the belemnites from the early Bajocian of adjacent regions (the Donets Basin and Caucasus), it is possible to neither emend nor verify the obtained age for the lower part of the marine Jurassic series in the Don Bend area. In the Caucasus, belemnite occurrences in the interval of the upper part of the Discites Zone–lower part of the Humphreisianum Zone are extremely scarce; in addition, this region is located further south, and as noted above, judging from the well-studied Aalenian–Bajocian boundary interval in Dagestan (Krimholz, 1947, 1953; Ippolitov et al., 2015), it should be characterized by an ecotonic rather than Euroboreal belemnite assemblage. The only occurrence from the Northern Caucasus confidently comparable with the studied material comes from the thick series of the lower Bajocian deposits of the Chegem River valley in Kabardino-Balkaria (*Cylindroteuthis* sp. in Krimholz, 1931; =*Homaloteuthis volgogradensis* sp. nov.), but its

→

Plate II. (1–3) *Eocylindroteuthis weisi* sp. nov.: (1) holotype VSGM SIR/211; (2) VSGM SIR/49 (sections are shown in Plate VI, figs. 7, 16g); (3) VSGM SIR/334, young specimen; all collected 4.8 m above the base of Member II; (4, 5) *Eocylindroteuthis mariottii* sp. nov.: (4) holotype VSGM SIR/357, 6.5 m above the base of Member II; (5) VSGM SIR/67, 4.8 m above the base of Member II (cross sections are shown in Plate VI, figs. 8, 16i, 16j).

Plate II

Plate III

precise age is unknown because of the absence of accompanying ammonite occurrences.

Considering the Donets Basin, the occurrences of the lower Bajocian belemnites were mentioned for the first time by Borissjak (1908), who identified three species (*Belemnites ellipticus* Mill., *Belemnites aalensis* Voltz. and *Belemnites* sp.) from a so-called "*Witchellia* conglomerate" in the Sukhaya Kamenka Gully. Apart from *Belemnites* sp., none of the above identifications was accompanied by illustrations, and it is not possible to identify the generic assignment of these occurrences within the modern classification; it is only possible to state that they belong to some large-sized megateuthidid taxa. Although the "*Witchellia* conglomerate" is often considered in the Russian language literature as the reference section for the lower Bajocian of the Donets Basin, partly corresponding to the Laeviuscula Zone (cf. Krimholz, 1982), Ukrainian geologists interpret it as a condensed basal horizon at the base of the upper Bajocian sequence (Lungersgauzen, 1942; Yamnichenko, 1969; Nikitin et al., 1983) and containing redeposited lower Bajocian fauna. This viewpoint is apparently correct: the only belemnite illustrated by Borissjak ("*Belemnites* sp.": Borissjak, 1908, pl. 4, fig. 14), judging from a strongly dorsoventrally compressed cross section and a groove flattening out far from the apex, does not agree with characters of any known species of the Aalenian–early Bajocian *Holcobelus*, but closely resembles the representatives of *Belemnopsis*, which became widespread in Central Europe starting from the Humphriesianum time. The ammonite assemblage of the "*Witchellia* conglomerate" is apparently heterochronous; thus, *B. ellipticus* and *B. aalensis* mentioned by Borissjak may in fact represent either an older *Eocylindroteuthis/Homaloteuthis* or a younger *Megateuthis* s. str.

The lower Bajocian beds in the Donets Basin, characterized by the ammonites *Witchellia* spp., are also known in an uncondensed state. These deposits are recognized as the Witchellia rossica Regional Zone (Nikitin et al., 1983), tentatively correlated to the Otoites sauzei Zone (≈Propinquans Zone). In the faunal list for this regional zone, Nikitin et al. (1983) indicate *Megateuthis elliptica* and *M. aalensis*, but it is unclear whether these are re-identifications of the above-mentioned finds by Borissjak from the "*Witchellia* conglomerate" or indications of some new occurrences. From the lower levels of the succession (≈"Sonninia sp. Regional Zone" of Permyakov et al., 1987), Lungersgauzen (1942) mentioned the occurrences of *Megateuthis elliptica* Mill., *M. aalensis* Volz., and *M. quinquesulcata* Blainv., but none of them is supported by descriptions or illustrations and cannot be reinterpreted at the generic level.

Thus, the published literature does not contain direct evidence suggesting the presence of the studied belemnite fauna in the Donets Basin. Nevertheless, its presence there appears likely, especially considering that some authors suggested the existence of a Donets Strait directly connecting this territory with the Lower Volga region in the Bajocian time (Sarytcheva, 1958; Sasonova and Sasonov, 1967; Fig. 1 in this paper). In conclusion, note that the dominants of the studied assemblage, *Eocylindroteuthis* spp. and *Homaloteuthis volgogradensis* sp. nov., if they existed in Eastern Europe, should be referred to in older publications exclusively as *Megateuthis* spp. (cf. Kamenov, 1936—record of varieties of "*M. elliptica*" lacking grooves; Nutsubidze, 1966—conical "*M.* cf. *elliptica*" with a ventral groove, fundamentally similar to *E. trautscholdi*) and cannot be positively identified on the basis of the published data.

Significance of the discovery of early Bajocian marine deposits in the Volga Region for paleogeography of the East European Platform. Old publications (Rykov, 1953; Lungergauzen, 1956; Kamysheva-Elpatievskaya, 1958; Sarytcheva, 1958; Smirnov, 1958; etc.) mention lower Bajocian marine deposits in the Volga Region, but today it is widely accepted that the pre-late Bajocian marine deposits in the East European Platform are present only within the Donets Folded Structure and southeastern part of the Dnieper-Donets Depression (Sterlin, 1964; Yamnichenko, 1969; Nikitin et al., 1983; Fig. 1). At present, the ammonite *Sphaeroceras* sp. (coming from the mainly continental Orelo Formation (Sterlin, 1964) and found in the borehole core) is considered to be the oldest record of the Jurassic marine fauna in the Russian part of the Ukrainian Syneclise (*Unifitsirovannaya*..., 1993, 2012). This find again points to the margin of Dnieper-Donets Depression and suggests the lower–upper Bajocian boundary interval (Humphriesianum–Niortense zones). A barren series at the border of Ulyanovsk region and the Republic of Tatarstan underlying the fossiliferous clayey-silty series of the late Bajocian (Mitta and Dietl, 2012; Mitta et al., 2014) or the late Bathonian (Gulyaev, 2013) was also provisionally assigned to the lower Bajocian (Mitta et al., 2014). Apart from that, marine early Bajocian deposits in the Russian part of Russian plate are scarcely mentioned in the recent papers of Siberian geologists (Meledina, 2014, pl. 1; de Lagausie and Dzyuba, 2017, text-fig. 5), but they do not contain references to any primary data.

Plate III. (1, 2) *Eocylindroteuthis mariottii* sp. nov.: (1) VSGM SIR/48, elongated variety ((1c) dorsal view; (1d) cross section); (2) VSGM SIR/145, massive variety ((2c) cross section); (3–5) *Eocylindroteuthis yarkovi* sp. nov.: (3) VSGM SIR/207; (3d) longitudinal section; cross sections illustrated in Plate VI, figs. 13a, 13b; (4) holotype VSGM SIR/212; (5) VSGM SIR/103, (?) transitional form from *E. corneliaschmittae* ((5c) cross section); all the specimens are from 4.8 m above the base of Member II.

The literature of the mid-20th century contains indications on the presence of an even earlier horizons of the marine Middle Jurassic in the Volga region. There are records of the lower Aalenian ammonites in the boreholes of the Saratov Trans-Volga Region (vicinity of the village of Ozinki, "similar to *Leioceras opalinum*": Kamysheva-Elpatievskaya, 1956; Novouzenskaya Reference Borehole, *L. opalinum*: Sasonov, 1961, pl. 6). Taken together, these two mentions were the basis for the drawing of a deep marine gulf penetrating from the Peri-Caspian on the paleogeographic reconstructions of the Aalenian Age (*Atlas*..., 1961, 1968; Sasonova and Sasonov, 1967). However, none of these records was illustrated, and at present, the presence of the marine Aalenian deposits for the entire eastern part of the East European Platform is considered unconfirmed (Olferiev, 1997).

Thus, the early Bajocian belemnite assemblage described in this paper (corresponding to the Laeviuscula ammonite Zone and containing in the lower part redeposited taxa suggesting the upper part of the Discites Zone) becomes the oldest confirmed Middle Jurassic marine assemblage in the Volga region and likely corresponds to the initial stage of the Bajocian–early Bathonian transgression into this part of the East European Platform. In the existing reconstructions, including those suggesting the existence of marine environments during the Aalenian (Sasonova and Sasonov, 1967), early Bajocian time was interpreted as a regressive phase. Note that S.P. Rykov, well acquainted with the belemnite material from the Don Bend area, mentioned the same assemblage in the Explanatory Note to the State Geological Map, sheet M-38-XX (northern part of the Don Bend area and the Archeda River valley: Rykov et al., 1979) and also a single find of "*Megateuthis aalensis*," belonging to the same assemblage, from the upper reaches of the Ilovlya River (Rykov, 1953, p. 111). As large megateuthids are not reliably known yet in the upper Bajocian of the northern termination of the Don-Medveditsa dislocations (Ippolitov, 2017b), it is possible that the northern border of the early Bajocian marine basin reached the southern margin of the Saratov Region.

Significance of the dating of the clay series for update of the local stratigraphic scheme. For the studied section located at the border of different structural-facies regions (*Unifitsirovannaya*..., 2012), several different schemes of the formational subdivision were proposed in the literature (Fig. 5). The scheme proposed in this paper generally follows the scheme of Olferiev (1997) and interpretation of lateral interrelations of units by Sarytcheva (1958, p. 137).

Member II of the studied section is assigned to the Bakhtemir Formation, originally recognized on the southern margin of the platform, in the Kalmykia-Astrakhan Volga Region (Levina and Prokhorova, 2002). Saltykov (2008, p. 237) substantiated the application of this name for Member II instead of previously used "Perevoloki Beds" (Olferiev, 1997; Levina and Prokhorova, 2002; presently this unit is considered as a nomen dubium and rejected—see *Unifitsirovannaya*..., 2012). In turn, the Bakhtemir Formation was recently rejected by the Regional Interdepartmental Stratigraphic Commission (RISC) in 2012, being interpreted as a lateral equivalent of the lower part of the Pochinki Formation (a local unit recognized for the marine upper Bajocian–lower Bathonian of the Volga Region) (*Unifitsirovannaya*..., 2012). There are two arguments supporting the reinstatement of the Bakhtemir Formation as a valid unit.

Firstly, the obtained dating of the lower part of Member II clay series in the Don Bend area by the beginning of the early Bajocian is in striking contrast with the late Bajocian age of the base of the Middle Jurassic marine series in the north of the Don-Medveditsa dislocations (vicinity of the town of Zhirnovsk; see Saltykov, 2006, 2008; Pervushov et al., 2011). The latter is characterized by the find of the ammonites *Pseudocosmoceras michalskii* and is assigned to the eponymous Zone, corresponding to the Parkinsoni Zone of the standard scale. Recent discoveries of belemnites directly at the base of this series (Ippolitov, 2017b) allow the possibility that the basal horizons can be assigned to some older but still upper Bajocian Garantiana Zone.

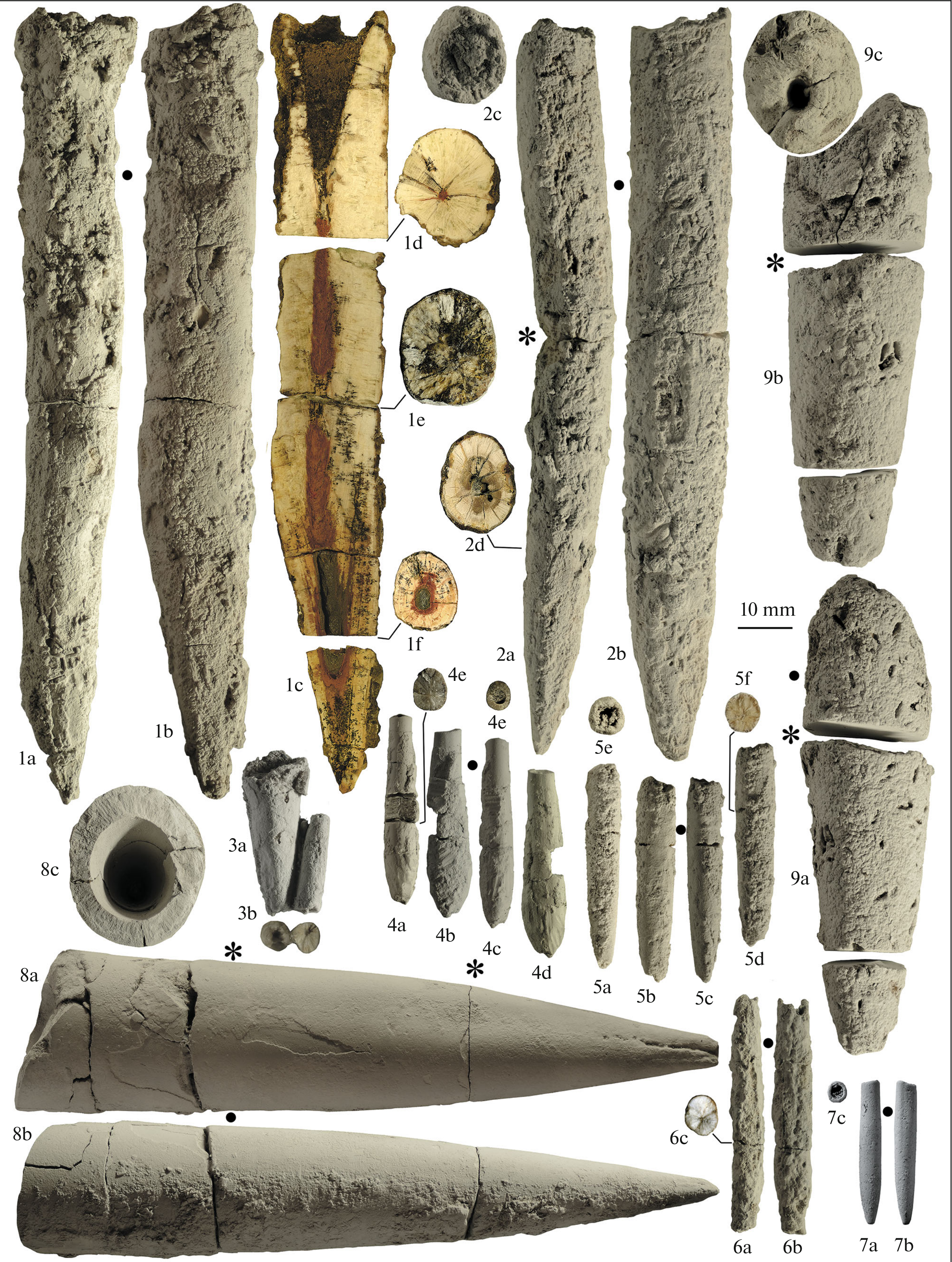
Secondly, all researchers who employed well log data on the southern part of Volgograd region (Smirnov, 1962; Sarytcheva, 1965; Levina and Prokhorova, 2002) agree on the presence of the sandy member separating the lower part of the clay series (equivalents of Member II of the Don Bend area; =clay member of the Garantia garantiana Zone sensu Smirnov, 1962) and its upper part (equivalents of almost the entire upper Bajocian–lower Bathonian clay series in the north of the Don-Medveditsa dislocations, except its basal part; = Parkinsonia doneziana Zone sensu Smirnov, 1962). In the studied section, this intermediate sandy member was destroyed by erosion during the Early Cretaceous time (Smirnov, 1962, Fig. 3). On the basis of foraminifers, this sandy member is confidently correlated with the lower arenaceous portion of the marine succession in the north of the

→

Plate IV. (1–4) *Homaloteuthis volgogradensis* sp. nov.: (1) VSGM SIR/311, from concretions at the level 11.9 m above the base of Member II ((1c-1e): cross sections, an additional one, indicated by asteriks is figured in Plate VI, figs. 11, 16f); (2) holotype VSGM SIR/40; (3) VSGM SIR/390, rostrum of a young specimen ((3d) cross section); (4) VSGM SIR/17; all from the level 6.8 m above the base of Member II: (4d) longitudinal section, cross section figured marked by asterisk in Plate VI, fig. 12; (5) *Homaloteuthis* cf./aff. *spinata* (Quenstedt, 1848), VSGM SIR/41, 6.8 m above the base of Member II: (5c) cross section near the tip of the alveolus; (6) *Brevibelus breviformis* (Voltz, 1830), VSGM SIR/21, 4.9 m above the base of Member II ((6c) cross section).

Plate IV

Plate V


1a
1b
1c
1d
1e
1f
2a
2b
2c
2d
3a
3b
4a
4b
4c
4d
4e
4e
5a
5b
5c
5d
5e
5f
6a
6b
6c
7a
7b
7c
8a
8b
8c
9a
9b
9c
10 mm

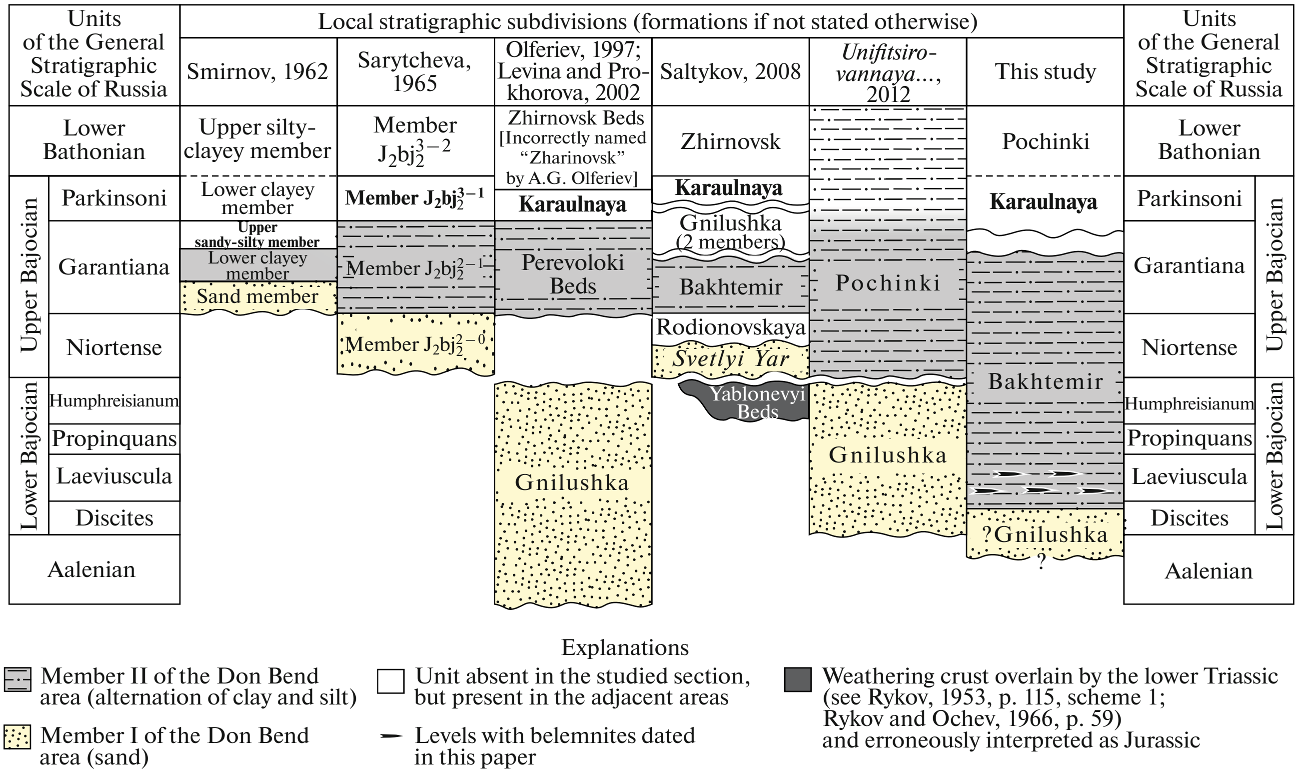


Fig. 5. Local stratigraphic subdivisions of the studied section and their correspondence to subdivisions recognized in the north of the Don-Medveditsa dislocations (vicinity of Zhirnovsk). Yablonskaya Formation recognized by Panteleev (1947, pp. 2030–2031), underlying Member I and having problematic Triassic–Aalenian age, is not shown on the scheme. Lithostratigraphic units employed in the papers of Smirnov (1962) and Sarytcheva (1965) are correlated to the current ammonite zonal scale using the correlation of the foraminiferal assemblages after Saltykov (2008, p. 235). The regional marker level Karaulnaya Formation is shown in bold. The unit provisionally proposed by Saltykov (2008) is shown in italics.

Don-Medveditsa dislocations (Smirnov, 1966, p. 152)—a so-called Karaulnaya Formation (also rejected by the RISC in 2012 as a lateral equivalent of the lower part of the Pochinki Formation). The latter in that case becomes an important regional marker unit, indicating for the south of Volgograd region an episode of a partial regression between two long episodes of marine sedimentation—early Bajocian and late Bajocian–early Bathonian; thus, it also should be reinstated as a valid unit. Although Mazarovich (1923) did not find any fossils in the stratotype of his "Karaulnaya Group" recognized in the upper reaches of the Ilovlya River, Lungersgauzen (1956, pp. 207–208) mentioned from there ammonites identical to those from the lower part of the marine succession in the vicinity of the town of Zhirnovsk ("*Pseudocosmoceras* A"). Hence, the parallelization of the "Karaulnaya Group" of Mazarovich with the lower (arenaceous) part of the marine succession near Zhirnovsk, to which the name "Karaulnaya Formation" was widely applied by Saratov geologists (Saltykov, 2006, 2008; Saltykov and Kiseleva, 2006; Pervushov et al., 2011 and many others), is most likely correct.

As follows from the original description of the stratotype of the Bakhtemir Formation (lower part sandy with plant remains, upper part clayey with *pyritized*

Plate V. (1) *Homaloteuthis volgogradensis* sp. nov., VSGM SIR/39, atypical form with a long epirostrum ((1c) longitudinal section, (1d–1f) cross section at different regions of the rostrum), 6.8 m above the base of Member II; (2) *Homaloteuthis* aff. *volgogradensis*, VSGM SIR/117, 4.8 m above the base of Member II; (3) Megateuthididae indet. and *Hastites* cf. *orphana* sp. nov., specimen VSGM SIR/20: (3a) general view, (3b) view from the apex of Megateuthididae indet., 6.8 m above the base of Member II; (4) *Hastites clavatus* (von Schlotheim, 1820), VSGM SIR/11: (4c) dorsal view, (4d) right view; (4e) alveolar view, (4f) cross section, concretions at the level of 11.9 m above the base of Member II; (5, 6) *Hastites orphana* sp. nov.: (5) holotype VSGM SIR/391: (5c) dorsal view, (5d) right-side view, (5e) alveolar view, (5f) cross section; (6) VSGM SIR/44, both 6.8 m above the base of Member II; (7) *Hastites* sp. nov., CCRGM 163/314, coll. of A.A. Borissjak (1908), Ukraine, Kharkov region, Petrovskoe village, upper Bajocian, Garantiana Zone; (8) *Mesoteuthis compressa* (Blainville, 1827) sensu I. Nikitin, 1981 (=*Belemnites quinquesulcatus* Blainv. sensu Borissjak, 1908), specimen VSGM CHER/100; (9) *Homaloteuthis* sp., VSGM CHER/32, redeposited from the Niortense? Zone; both from Ukraine, Donetsk region, Cherkasskoe village, upper Bajocian, base of the coquina of the Garantiana Zone.

shells), this formation corresponds to both Member I and Member II of the described section; and the proposition of Saltykov (2006, p. 27; 2008, pp. 26–27) to restrict the range of the Bakhtemir Formation only to the upper, clayey, part of the stratotype seems sensible. Records of the zonal ammonite *Garantiana garantiana* in the literature (Troitskaya and Khabarova, 1986, as "cf."; Levina and Prokhorova, 2002; etc.) directly from this part of the succession do not contain geographic data on the localities or the indications of the precise position within the sections. There are reasons to assume that all these records appeal to a single find from the borehole on the Subsurface Karpinsky Ridge originating from the *topmost part* of the clay series (Sarytcheva, 1971, pp. 78–79). As for the microfauna, Sarytcheva, who provided the most comprehensive substantiation of the correlation of the foraminiferal assemblage from the clay member with the Garantiana Zone, extrapolated the microfaunal characteristics over the entire interval of the clay series (Sarytcheva, 1965, 1971), but nowhere indicated the precise levels of the occurrences of the species typical particularly of the Garantiana Chronozone. Levina and Prokhorova (2002) reported the occurrences of species characteristic of the Garantiana Chronozone from a single sample from the *terminal part* of the Bakhtemir Formation stratotype. The above discussion shows that the belemnite-based dating of the *lower* part of the Bakhtemir Formation as early Bajocian (upper part of the Discites?–Laeviuscula Chronozones) does not necessarily contradict the existing micro- and macropaleontological data and that the upper age limit of the formation apparently includes the Garantiana Chronozone.

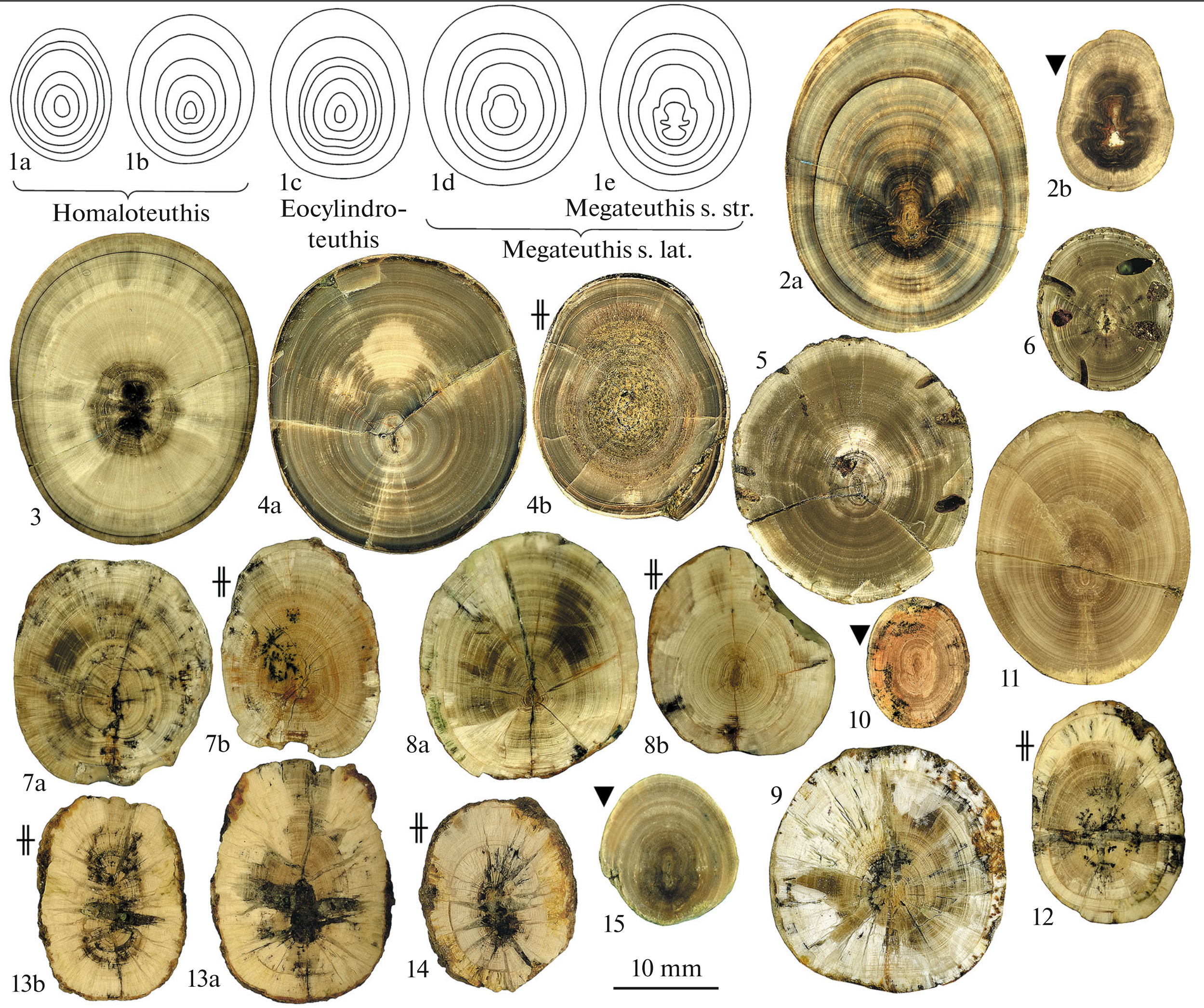
<u>The boundary between Members II and I</u> in this paper is accepted as provisionally conformable, taking into account the presence of transitional beds in the northern part of the Don Bend area (see above), which agrees with the observations of Smirnov (1962) and Sarytcheva (1965). The preservation of redeposited belemnites from the level of 4.8 m, which could possibly be affiliated with the Discites Chronozone, clearly points to their origin from a clayish rather than sandy original matrix; therefore, on our scheme, the boundary between Members I and II is placed slightly below the boundary of the Discites/Laeviuscula chronozones.

Following the interpretation by Rykov (1953), most geologists parallelize the sandy <u>Member I</u> of the Don Bend area with the presumably continental Gnilushka Formation recognized in the northern termination of the Don-Medveditsa dislocations (Mazarovich, 1923), although, strictly speaking, their isochronous age is not confirmed, and the lateral relationships have not been traced. This parallelization is also employed in the actual version of the Unified Scheme of the Jurassic Deposits of the East European Platform (*Unifitsirovannaya*..., 2012). Partly on the basis of the geological position and partly on the floral assemblage, the Gnilushka Formation is traditionally dated as Aalenian–early Bajocian (see historical reviews in Saltykov and Kiseleva, 2006; Saltykov, 2008), but some authors restrict its age to the Bajocian only on the basis of spore-pollen data (Saltykov and Kiseleva, 2006).

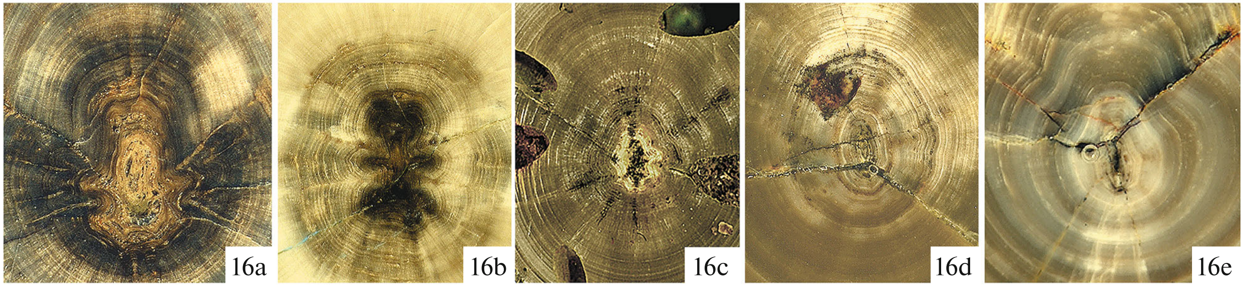
→

Plate VI. Cross sections of the Aalenian and Bajocian belemnites of the genera *Homaloteuthis*, *Eocylindroteuthis*, *Megateuthis* s. lat. All figures are enlarged 1.5 times, except fig. 16 (enlarged 3.75 times). Sections in the middle of the postalveolar region are marked by (╫); sections near the posterior end are marked by a triangle (▼) unmarked sections are provided just behind the alveolar tip. (1) Schematic cross sections of the genera *Megateuthis* s. lat., *Eocylindroteuthis*, and *Homaloteuthis* (after Weis and Mariotti, 2008, figs. 6a–6d, modified by the present author): (1a) *Homaloteuthis murielae* Weis et Mariotti, 2008; (1b) *Homaloteuthis spinata* (Quenstedt, 1848); (1c) *Eocylindroteuthis weisi* sp. nov. (=*E. corneliaschmittae sensu* Weis, Mariotti, 2008); (1d) *Megateuthis suevica* (Klein, 1773) sensu Weis and Mariottti, 2008; (1e) *Megateuthis gigantea* (von Schlotheim, 1820)); (2–6) cross sections of the megateuthid rostra from the Humphriesianum Zone and upper Bajocian of Dagestan and the Donets Basin: (2) *Megateuthis gigantea* (von Schlotheim, 1820), VSGM KUB-III/01 (figured by Gulyaev et al. (2015a, pl. 13, fig. 3) as *M. suevica* (Klein, 1773)); (2a) at the tip of the alveolus; (2b) near the posterior end, Dagestan, Kuba village, lower Bajocian, Humphriesianum Zone; (3) *Megateuthis* cf. *elliptica* (Miller, 1826), VSGM KHUR/05, Dagestan, Khurukra, upper Bajocian, Parkinsoni Zone, Densicosta Subzone; (4) *Mesoteuthis compressa* (Blainville, 1827) sensu I. Nikitin, 1981, VSGM CHER/100 (figured in Plate V, fig. 8), Ukraine, Donets Basin, Cherkasskoe village, upper Bajocian, Garantiana Zone; (5) *Homaloteuthis* sp., specimen VSGM CHER/32 (figured in Plate V, fig. 9), rostrum, redeposited from the Niortense? Zone, the same age and locality; (6) *Megateuthis* cf. *elliptica* (Miller, 1826), cross section near the protoconch, VSGM CHER/77; the same age and locality, from the base of the coquina; (7–12) rostra from the section in the Tonkiy Gully in the Don Bend area: (7) *Eocylindroteuthis weisi* sp. nov., VSGM SIR/49 (figured in Plate II, fig. 2; (7a) section near the protoconch, (7b) section in the middle of the postalveolar region); (8, 9) *Eocylindroteuthis mariottii* sp. nov.: (8) VSGM SIR/67 (figured in Plate II, fig. 5): (8a) section near the protoconch, (8b) section in the middle of the postalveolar region; (9) VSGM SIR/363, large rostrum from the level of 6.5 m above the base of Member II; (10–12) *Homaloteuthis volgogradensis* sp. nov.: (10) VSGM SIR/257, section of the apical part of the rostrum, from concretions at 11.9 m above the base of Member II; (11) VSGM SIR/311 (figured in Plate IV, fig. 1), section near the protoconch; (12) *Homaloteuthis volgogradensis* sp. nov., VSGM SIR/17 (figured in Plate IV, fig. 4), section in the middle of the postalveolar region; (13) *Eocylindroteuthis yarkovi* sp. nov., VSGM SIR/207 (figured in Plate III, fig. 3): (13a) section near the protoconch, (13b) section in the middle of the postalveolar region; (14) *Homaloteuthis* aff. *volgogradensis*, VSGM SIR/117 (figured in Plate V, fig. 2); (15) *Megateuthis* sp., VSGM SIR/13, section near the posterior end, from the level of 22.1 m above the base of Member II; (16) details of the cross sections: (16a) *Megateuthis gigantea* (von Schlotheim, 1820), details of the section figured in fig. 2a; (16b) *Megateuthis* cf. *elliptica*, details of the section figured in fig. 3; (16c) *Megateuthis* cf. *elliptica*, details of the section figured in fig. 6; (16d) *Homaloteuthis* sp., details of the section figured in fig. 5; (16e) *Mesoteuthis compressa* (Blainville, 1827) sensu I. Nikitin, 1981, details of the section figured in fig. 4a; (16f) *Homaloteuthis volgogradensis*, details of the section figured in fig. 11; (16g) *Eocylindroteuthis weisi* sp. nov., details of the section figured in fig. 7a; (16h) *Megateuthis* sp., details of the section figured in fig. 15; (16i, 16j) *Eocylindroteuthis mariottii* sp. nov., details of the sections figured in figs. 8a, 8b.

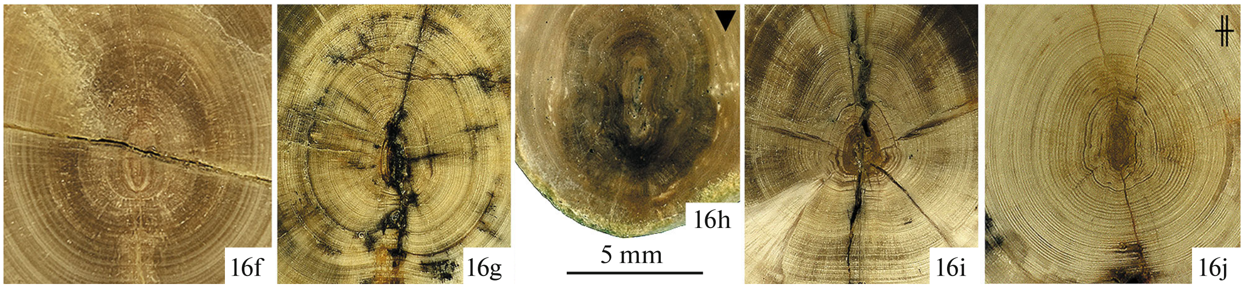
Plate VI



Rostra from the uppermost lower Bajocian- upper Bajocian (Humphreisianum-Parkinsoni Zones)



Rostra from the studied section



There is also an alternative interpretation of the geological position of Member I. Saltykov (2004; Saltykov and Kiseleva, 2006) interpreted the Gnilushka Formation as the deposits filling a river paleovalley localized in the northern part of the Don-Medveditsa dislocations and running in a southeastern direction. The Gnilushka Formation was considered by the same authors as supposedly isochronous with the marine Bakhtemir Formation (Saltykov, 2004; Saltykov and Kiseleva, 2006), judging from the fact that clearly marine deposits overlying both units (=Karaulnaya Formation) are characterized by the same foraminiferal assemblage of the Ammodiscus subjurassicus Zone. But in the summarizing stratigraphic chart published in a later paper by the same author, the Gnilushka Formation was placed *above* the Bakhtemir Formation and dated as the boundary interval of the Garantiana/Parkinsoni zones (Saltykov, 2008, p. 233). Considering all the argumentation above, Saltykov concluded that the sands of Member I of the Don Bend area represent the deposits of another, older, river valley (Saltykov, 2008), proposing the provisional name "Svetlyi Yar Formation" for them.

The problem of the correlation of the Gnilushlka Formation with the units of the Don Bend succession cannot presently be finalized. Note that a strong lithological similarity to Member II of the Don Bend succession is demonstrated by clay beds lying below the first paleontologically characterized strata of the Karaulnaya Formation in the Zhirnovsk area and separated from them by a well-defined erosional level marked with pebbles (Ippolitov, 2017b). This member is accessible for study in the Paruba ravine section (Bed 2 in Ippolitov, 2017b; =Bed 11, "banded clays" in Lungersgauzen, 1956); apparently, it partly corresponds to the upper clay member of the Gnilushka Formation in the interpretation by Saltykov and Kiseleva (2006) (recognized on the basis of the borehole core material). Like Member II of the Don Bend area, this clay contains sideritic concretions and is unlikely to be one of the facies of the alluvial series. It is possible that Members I and II in the Don Bend area are lateral equivalents of the lower sandy and upper clayey members of the Gnilushka Formation (sensu Saltykov, 2008) from the Zhirnovsk area, respectively. Both regions in the Middle Jurassic were located along the eastern margin of the Voronezh landmass, and the stages in their sedimentary evolution could be similar, especially if one considers the hypothesis by Sasonova and Sasonov (1967, pp. 123–124, Figs. 12, 13) that, in the Aalenian and early Bajocian, there was a large accumulative plain covering all this area.

BELEMNITE-BASED BIOSTRATIGRAPHY OF THE LOWER BAJOCIAN OF THE DON BEND AREA

The studied section contains *E. trautscholdi*, which is a nominal zonal index for the most part of the lower Bajocian in Western Europe (Combémorel in Biostratigraphie..., 1997; Combémorel in Hardenbol et al., 1998); however, practical use of this Trautscholdi Zone is difficult. The most problematic is the incorrect identification of the single specimen of *E. trautscholdi*, which was illustrated by R. Combémorel, the author of the unit, only from the ventral side. Judging from the subcylindrical outline and relatively small elongation, it belongs either to *E. corneliaschmittae* (cf. Weis and Mariotti, 2008, p. 154) or to *E. mariottii* sp. nov. The present study illustrates that early Bajocian representatives of *Eocylindroteuthis* are very morphologically diverse and in some cases have a considerable flexibility of characters. It remains completely unlear what range of variability Combémorel meant for *E. trautscholdi*, as he did not support his scheme either with the description of the index species or with the indication of the stratotype section.

It is proposed to recognize two biostrata based on belemnites in the studied section near Dubovoi hamlet.

I. Beds with Eocylindroteuthis weisi, nov.

Index. *Eocylindroteuthis weisi* sp. nov.

Stratotype. Section in the Tonkiy Gully near Dubovoi hamlet, condensed level at 4.8 m above the base of Member II.

Belemnite assemblage. *Eocylindroteuthis weisi* sp. nov., *E. mariottii* sp. nov., *E. corneliaschmittae*, *E. trautscholdi*, *E. yarkovi* sp. nov. (infrequent), *Homaloteuthis* cf./aff. *spinata* (rare), *H.* aff. *volgogradensis* (rare), (?) *H. volgogradensis* sp. nov. (exceptionally rare), *Brevibelus breviformis* (rare).

Lower boundary. Not established.

Upper boundary. Entry of *Hastites orphana* sp. nov. (immigration event).

Age and correlation. Lower Bajocian (upper part of the Discites (?)–Laeviuscula ammonite chronozones).

Occurrence. South of European Russia (Lower Volga Region), Western Europe (Luxembourg, ?Swabian Alb).

Localities. Stratotype and sections in the Dubovaya Gully, 700 m east of the stratotype.

Remarks. Apart from the index species, several species have not been recorded in the overlying unit: *Eocylindroteuthis yarkovi* sp. nov., *E. trautscholdi*, *Homaloteuthis* aff. *volgogradensis* sp. nov. The following considerations preclude all these species from being regarded as the main or auxiliary indices of the recognized stratigraphic unit:

- for *E. trautscholdi*, the absence of large-sized specimens unequivocally comparable with the holotype of the species and the fact that distinguishing of poorly preserved specimens of young rostra from other species of *Eocylindroteuthis* is difficult;

- for *E. yarkovi* sp. nov., the rarity of occurrences, which, taking into account the general scarcity of fossil occurrences in the overlying unit, leaves a nonzero probability for subsequent discoveries in these beds;
- for *Homaloteuthis* aff. *volgogradensis* sp. nov., the rarity of occurrences, unclear taxonomic status of the species.

It is possible that the assemblage characteristic of this unit is composed of heterochronous elements condensed at the same level. For this reason, recognition of double, triple, or any other multi-indices is undesirable—later they can be found to be heterochronous.

II. Beds with Hastites orphana, nov.

Index. *Hastites orphana* sp. nov.

Stratotype. Section in the Tonkiy Gully near Dubovoi hamlet (interval 6.5–11.9 m above the base of Member II).

Belemnite assemblage. *Hastites orphana* sp. nov., *H. clavatus* (in the upper part, rare), *Homaloteuthis volgogradensis*, *H.* cf./aff. *spinata* (rare), *Eocylindroteuthis mariottii* sp. nov., *E. corneliaschmittae*.

Lower boundary. Entry of *Hastites orphana* sp. nov. (immigration event).

Upper boundary. Not established.

Age and correlations. Lower Bajocian (Laeviuscula Chronozone); precise correlation with detailed ammonite units (subzones, biohorizons) is uncertain.

Occurrence. South of European Russia (Lower Volga Region).

Localities. Stratotype only.

Remarks. Using *Hastites orphana* sp. nov. as an index species is supported by the following considerations. Firstly, this species is certainly absent at the abundantly fossiliferous level 4.8 m above the base of Member II (=Beds with Eocylindroteuthis weisi). Secondly, *H. volgogradensis* sp. nov., which is a second common species from the same interval, occurs in the underlying unit, or that unit contains morphologically similar species (e.g., *E. corneliaschmittae*; identification of some finds is difficult owing to poor preservation).

The upper part of Member II, characterized by a single find of *Megateuthis* sp., cannot be assigned to any certain biostratum because of insufficient material.

DESCRIPTION OF NEW BELEMNITE SPECIES

For characterizing the studied rostra, measurements accepted in the Russian literature on the family Cylindroteuthididae were used (see Gustomesov, 1964; Sashs and Nalnjaeva, 1964; Dzyuba, 2012), with changes and additions.

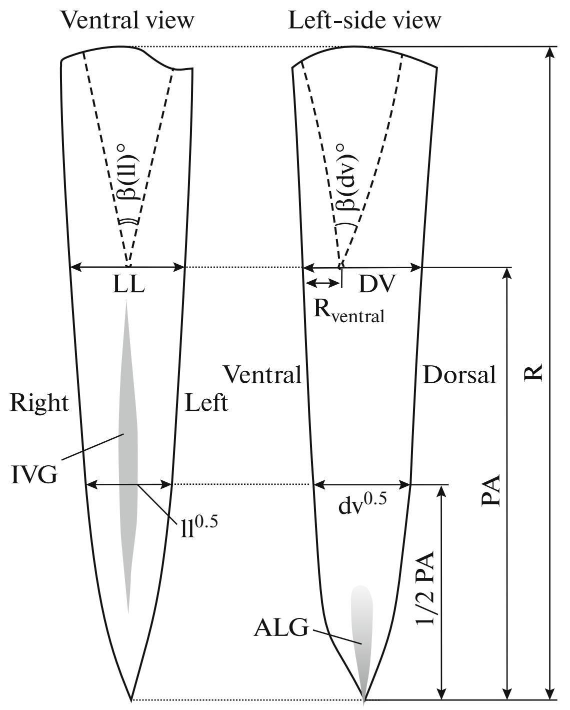


Fig. 6. Scheme of the rostrum measurements employed in this study. Rostrum margins: R—right, L—left, V—ventral, D—dorsal; IVG—intermediate ventral groove; ALG—apical lateral groove. Other explanations are in the text.

Measurements (Fig. 6): R—total preserved length; DV—dorsoventral diameter at the alveolar tip; LL—lateral diameter at the alveolar tip; PA—length of the postalveolar part of the rostrum (“rostrum solidum”) (reconstructed in cases of a missing apex); dv$^{0.5}$—dorsoventral diameter in the middle of the postalveolar part; ll$^{0.5}$—lateral diameter at the same section; DV'—dorsoventral diameter near the alveolar tip (in the ideal case, it coincides with DV, and the cross section coincides with the section at the alveolar tip, but in fact can be located slightly anterior or posterior of it); RV—distance from apical line to ventral side (ventral radius) near the alveolar tip; β (ll)°—alveolar angle in outline.

Ratios: $D = \sqrt{(DV \times LL)}$—basic diameter at the alveolar tip; $d^{0.5} = \sqrt{(dv^{0.5} \times ll^{0.5})}$—basic diameter in the middle of the postalveolar part; $E = PA/\sqrt{(DV \times LL)} \times 100\%$—relative elongation of the postalveolar part; LL/DV—compression ratio at the alveolar tip; $ll^{0.5}/dv^{0.5}$—compression ratio in the middle of the postalveolar part; $d^{0.5}/D$—tapering coefficient (=0.5 in ideally conical rostra, = 1 in ideally cylindrical rostra, >1 in fusiform rostra; *approximately* corresponds to the coefficient F in Schlegelmilch, 1998); R_V/DV'—apical line displacement.

As the main characteristic of the size, instead of the traditional dorsoventral diameter (DV), a new parameter was used—basic diameter (D), which is calculated from both the values of the dorsoventral (DV) and the lateral (LL) diameters in a cross section at the alveolar tip.

The measurements were obtained both from specimens and from published photographs, in latter case using CorelDraw software. The position of the alveolar tip was determined both in the specimens and in the photographs by application of templates, according to which the alveolar angle in the outline β (ll)° in the elongated *Eocylindroteuthis* and *Homaloteuthis* was accepted as equal to 25°, whereas in *E. yarkovi* sp. nov., which has a very short rostrum, the value was 29°; these values were established from a few sectioned specimens.

Graphs of the dependence of three major ratios (E, LL/DV, and $d^{0.5}/D$) on the size (Fig. 7) serve only for the visual evaluations of parameters and cannot be considered as truly statistical, because morphological isolation of species, readily recognized by the naked eye, is obscured on the graphs by significant distortions of measurements and ratios resulting from the poor preservation of the material.

The material described below is housed in the Vernadsky State Geological Museum (VSGM), Moscow. Important additional conclusions were also obtained from studying the collections of Borissjak (1908) and Krimholz (1931) housed in the Chernyshev Central Research Geological Museum (CCRGM), St. Petersburg.

FAMILY MEGATEUTHIDIDAE SACHS ET NALNJAEVA, 1967

Genus *Eocylindroteuthis* Riegraf, 1980

Remarks. Western European representatives of this genus were described from scattered material and classified (see Riegraf, 1980; Schlegelmilch, 1998; Weis and Mariotti, 2008) to accommodate three species—*E. trautscholdi* (Oppel, 1862), *E. corneliaschmittae* Riegraf, 1980, and *E. brevispinata* (Waagen, 1867), the last of which is based on a juvenile rostrum. The assignment to *Eocylindroteuthis* of another nominal species, *E. (?) yokoyamai* Iba, Sano et Mutterlose, 2014, described from a very poorly preserved rostrum from the Sinemurian of Japan is apparently erroneous: phylogenetic connection of *Eocylindroteuthis* with the Toarcian–Aalenian *Acrocoelites* Lissajous, 1915 is a well-justified hypothesis (Riegraf, 1980; Sadki et al., 2015), although the idea of their origin from late Aalenian–early Bajocian *Homaloteuthis murielae* (Guérin-Franiatte, Weis, 2010, p. 93) has also been introduced. In contrast, the genus *Eocylindroteuthis* might also include specimens described as *Megateuthis* cf. *elliptica* from the "Aalenian" [=Aalenian or the lower part of the Bajocian] of the Western Caucasus (Nutsubidze, 1966): in their main parameters, they are comparable to *E. trautscholdi*, although not identical.

Since the early ontogenetic stages of almost all rostra have a conical shape comparable to that of *E. brevispinata* (e.g., see Plate II, figs. 2c, 5c; Plate III, fig. 3d), no adequate comparison of the latter species with other representatives of *Eocylindroteuthis* is possible, and the above name is considered in this paper to be a nomen dubium.

Material collected from a section near Dubovoi hamlet east of the Sirotinskaya village, although not well-preserved, because of its abundance can be used to substantiate for the first time a detailed species subdivision of the genus *Eocylindroteuthis* (primarily, of the clearly collective species *E. corneliaschmittae* within the meaning of the European authors) into species on the basis of different ontogenetic trends of main characters, first of all, the degree of elongation (Fig. 7a). Only adult rostra of large size can be confidently identified, whereas the medium-sized specimens form an uninterrupted continuum of variability, and in some cases substantiation of their identification to species is problematic (e.g., in the case of "*E.* cf. *corneliaschmittae*" by Riegraf (1980)).

Eocylindroteuthis weisi **sp. nov.**

Plate II, figs. 1–3; Plate VI, figs. 7, 16g

Eocylindroteuthis corneliaschmittae: Weis, 2006, pp. 159–160, figs. 11E, 11F; (pars) Weis and Mariotti, 2008, p. 154, pl. 1, figs. 2–3; pl. 2, fig. 1 [non pl. 1, fig. 1; pl. 2, fig. 2 = *E. mariottii* sp. nov.].

Eocylindroteuthis sp. 1: Ippolitov, 2017a, Fig. 1, pl. I, figs. 1a–1f.

Etymology. In honor of Robert Weis (National Museum of Natural History (Luxembourg)), who described in detail representatives of this species from Western Europe (Weis, 2006; Weis and Mariotti, 2008).

Holotype: VSGM SIR/211, Volgograd region, Ilovlya district, Tonkiy Gully near Dubovoi hamlet; Member II, level 4.8 m; lower Bajocian, Beds with E. weisi.

Diagnosis. *Eocylindroteuthis* with elongated to strongly elongated rostra (E = 472–650%), subcylindrical in shape, in alveolar region weakly compressed (LL/DV usually ≥0.91), near the posterior end with considerable lateral compression.

Description. The rostrum is medium-sized to large, varying from elongated to strongly elongated (E = 472–650%), from subcylindrical to subconical both in outline and in profile through all the growth stages; the rostrum margins straightened in the anterior half, gradually becoming more convex toward the apex. The apical part is pronounced differently—its length is 1/3 to 3/5 of the total length of the postalveolar region, and the transition to it is gradual. The apex is subcentral.

The cross section in the alveolar part is rounded, weakly laterally compressed (LL/DV is usually ≥0.91;

in poorly preserved specimens, it can be more compressed, up to 0.83), becoming oval toward the posterior end; the degree of the lateral compression gradually increases towards the apex, reaching different values in different specimens from the studied set. The dorsal and ventral sides have the same width.

The ventral side of the rostra always, at all growth stages, shows a pronounced long mid-ventral groove, which has an appearance of a shallow U-like depression (Plate VI, figs. 7, 16g), flattening out only in the alveolar region.

The alveolus occupies about 1/4–1/5 of the total length of the rostrum and has a rounded cross section. The alveolar angle in profile measured in specimen VSGM SIRP/166 and VSGM SIR/49 is 28° and 25°, respectively, whereas the alveolar tip is shifted ventrally (R_v/DV' = 0.34 and 0.39). The apical line is diffuse.

Dimensions and ratios. See Table 1 and Fig. 7.

Variability. The variability is observed in the rostrum outline and profile varying from cylindrical to subconical, in elongation, and in the shape of the transverse section near the alveolus (from slightly compressed to rounded). At early stages, rostra are short, subconical, later growing in length progressively.

Comparison. This species is distinguished from other species of *Eocylindroteuthis* by the pronounced and elongated ventral groove and the cylindrical shape of the rostrum. It differs from the most similar species *E. mariottii* sp. nov. in the greater elongation of the postalveolar region, which is readily observed in large specimens (D > 18 mm), whereas young rostra show overlapping ranges of variability. It is distinguished from *E. corneliaschmittae*, to which the rostra of the described species were assigned previously (Weis, 2006; Weis and Mariotti, 2008), by the considerably more elongated rostrum and rounded cross section of the alveolar region. It is different from the similarly elongated *Homaloteuthis volgogradensis* sp. nov., apart from the presence of the prominent ventral groove, in a smaller degree of compression ($LL/DV \geq 0.91$ in *E. weisi* sp. nov. against 0.74–0.81 in *H. volgogradensis* sp. nov.).

Remarks. In its characters, *E. weisi* sp. nov., like *E. mariottii* sp. nov. described below, falls within the range of variability of *E. corneliaschmittae* as previously interpreted by European authors (Weis and Mariotti, 2008) who place in this species all relatively cylindrical members of *Eocylindroteuthis*. The separation of all the species listed above is supported not only by the different ontogenetic trends of the terminal stage (for the pair *E. weisi* sp. nov.–*E. mariottii* sp. nov.; Fig. 7a) but also by somewhat different occurrences across the succession. For instance, *E. weisi* sp. nov. occurs only at the level of 4.8 m, where it dominates, whereas *E. mariottii* sp. nov., apart from that level, is relatively frequently found at 6.8 m. Finally, a single rostrum with characteristic lateral compression (*E. corneliaschmittae*) was found loosely at 8.0 m, i.e., in the interval of the section where *E. weisi* sp. nov. is absent.

Occurrence. Apart from the type locality, lower Bajocian of Luxembourg.

Material. 45 rostra of varying states of preservation from the level of 4.8 m and two problematic finds from the level of 6.8 m.

Eocylindroteuthis mariottii sp. nov.

Plate I, fig. 6; Plate II, figs. 4, 5; Plate III, figs. 1, 2; Plate VI, figs. 8, 9, 16i, 16j

Eocylindroteuthis corneliaschmittae: (pars) Weis and Mariotti, 2008, p. 154, pl. 1, fig. 1; pl. 2, fig. 2 [non pl. 1, figs. 2–3; pl. 2, fig. 1 = *E. weisi* sp. nov.].

Mesoteuthis cf. *rhenana*: Ippolitov, 2017a.

Etymology. In honor of Nino Mariotti (Sapienza University of Rome), a co-author of the revision of the genus *Eocylindroteuthis* from Western Europe (Weis and Mariotti, 2008).

Holotype: VSGM SIR/357; Volgograd region, Ilovlya district, Tonkiy Gully near Dubovoi hamlet; Member II, 6.5 m above the base; lower Bajocian, Beds with Hastites orphana.

Diagnosis. *Eocylindroteuthis* from subconical to subcylindrical in shape, with elongation E = 267–456% and with compression at alveolar tip LL/DV = 0.90–0.96, rounded-subquadrate in cross section.

Description. The rostrum is large, moderately elongated (E = 267–456%), at later ontogenetic stages from subcylindrical to subconical both in profile and in outline; in young specimens, conical or subconical; all rostrum margins are weakly convex. The transition to the apical region is gradual and is clearly observable only in profile. The length of the apical region is 1/2 of the length of the postalveolar region. The apex is subcentral.

The cross section at all growth stages is rounded-subquadrate, weakly compressed laterally (LL/DV = 0.90–0.96). Toward the apex, the lateral compression grows.

The ventral side is flattened in the middle of the postalveolar region, whereas a shallow and wide ventral groove is present at the early growth stages. Other grooves are absent, but the apical region of large specimens sometimes shows weak apical lateral grooves (Plate II, fig. 4b). However, they result from erosional re-deepening of poorly defined dorsolateral and ventrolateral grooves, observed in the cross sections near the apex (Plate VI, fig. 16j).

The alveolus occupies approximately 1/3 of the total rostrum length. Its angle in profile measured in specimen VSGM SIR/67 is 26°, whereas the tip is shifted ventrally (R_v/DV' = 0.33–0.37).

Table 1. Measurements of rostra of the studied species of *Eocylindroteuthis* and *Homaloteuthis*

No/status	MM	Position above the base of Member II, m	R, mm	PA, mm	LL, mm	DV, mm	$ll^{0.5}$, mm	$ll^{0.5}$, mm	D, mm	$d^{0.5}/D$	LL/DV	E, %	R_v/DV'	Notes/ source
Eocylindroteuthis weisi sp. nov.														
VSGM SIR/211	**A**	**4.8**	**155**	**128**	**19.6**	**19.8**	***17.7***	***19.0***	**19.7**	***0.93***	**0.99**	**650**	**0.39**	**Plate II, fig. 1**
VSGM SIR/49	A	4.8	116	96	18.2	21.2			19.6		0.86	*487*	0.38	Plate II, fig. 2
VSGM SIR/166	A	4.8	135	*123*	*18.3*	*21.9*	*16.0*	*19.9*	20.0	*0.89*	*0.83*	*615*	0.34	
VSGM SIR/167	A	4.8	144	*120*	*18.1*	*19.7*			18.9		*0.91*	*636*		
VSGM SIR/334	A	4.8	97	*72*	14.4	14.4	11.9	14.2	14.4	0.90	1.00	*499*		Plate II, fig. 3
VSGM SIR/294	A	4.8	134	*97*	17.7	20.8	16.5	18.3	19.2	0.91	0.85	*507*		
VSGM SIR/141	A	4.8	133	99	18.8	21.0	*14.9*	*17.4*	19.9	*0.81*	0.89	*496*		
VSGM SIR/189	A	4.8	126	*94*	*17.9*	*18.0*	*13.7*	*15.6*	18.0	*0.82*	*0.99*	*525*		
VSGM SIR/99	A	4.8	121	*102*	*19.3*	*19.0*	*14.6*	*16.1*	19.1	*0.80*	*1.02*	*533*		
VSGM SIR/132	A	4.8	134	*115*	*21.4*	*23.4*	*16.6*	*22.1*	22.4	*0.85*	*0.91*	*514*		
VSGM SIR/119	A	4.8	119	*103*	*17.7*	*18.9*	*15.9*	*16.3*	18.3	*0.88*	*0.93*	*562*		
VSGM SIR/106	A	4.8	127	*96*	*18.9*	*20.5*			19.7		*0.93*	*488*		
VSGM SIR/107	A	4.8	101	*84*	*17.6*	*17.9*	*13.1*	*15.4*	17.7	*0.80*	*0.98*	*472*		
	B	–	90	61	12.9	15.2			14.0		0.85	436		Weis and Mariotti, 2008: tabl
	B	–	176	141	20.7	24.6	18.1	22.7	22.6	0.90	0.84	624		Weis and Mariotti, 2008: pl. 1, fig. 2
	B	–	196	124	20.1	22.4	15.0	20.1	21.2	0.82	0.90	585		Weis and Mariotti, 2008: pl. 2, fig. 1
Eocylindroteuthis mariottii sp. nov.														
VSGM SIR/357	**A**	**6.5**	**108**	***75***	***23.1***	**24.4**	***17.8***	***20.5***	**23.7**	***0.80***	***0.94***	***316***		**Plate II, fig. 4**
VSGM SIR/377	A	4.8	116	71	*20.5*	*21.9*	*17.5*	*18.5*	*21.1*	*0.85*	*0.94*	*335*		
VSGM SIR/81	A	4.8	129	*85*	*22.5*	*24.5*	*18.7*	*19.5*	*23.4*	*0.81*	*0.92*	*363*		
VSGM SIR/48	A	4.8	121	79.0	18.6	20.5	15.6	17.9	19.5	0.85	0.91	404	0.37	Plate III, fig. 1
VSGM SIR/144	A	4.8	157	114	25.1	26.0	19.3	22.9	25.5	0.82	0.96	445		
VSGM SIR/150	A	4.8	153	*111*	23.8	25.7	18.2	23.4	24.7	0.83	0.93	*449*		
VSGM SIR/67	A	4.8	95	65	18.8	21.7	15.3	16.5	20.2	0.00	0.87	*322*	0.33	Plate II, fig. 5
VSGM SIR/313	A	4.8	143	*125*	*26.0*	*28.9*	*22.8*	*27.1*	27.4	*0.91*	*0.90*	*456*	0.36	
VSGM SIR/145	A	4.8	129	*81*	*26.7*	*31.0*	*24.5*	*24.6*	28.7	*0.85*	*0.86*	*282*		Plate III, fig. 2
VSGM SIR/259	A	4.8	81	*57*	*21.2*	*21.5*	*17.6*	*18.6*	21.3	*0.85*	*0.99*	*267*		
VSGM SIR/54	A	4.8	*108*	*65*	*24.5*	*23.5*			24.0		*1.04*	*271*		
	B	–	187	147	27.6	29.6	23.9	28.3	28.6	0.91	0.93	516		Weis and Mariotti, 2008: pl. 1, fig. 1
Eocylindroteuthis trautscholdi														
VSGM SIR/50	A	4.8	85	*59*	16.2	18.2	?	13.9	17.2		0.89	*344*	0.34	Plate I, fig. 4
VSGM SIR/187	A	4.8	106	*66*	*18.0*	*19.2*	*13.2*	*14.3*	18.6	*0.74*	*0.94*	*355*		Plate I, fig. 3
VSGM SIR/353	A	4.8	88	*55*	*18.3*	*21.8*	*12.8*	*15.3*	20.0	*0.70*	*0.84*	*273*		
VSGM SIR/82	A	4.8	105	*70*	*19.6*	*23.8*	*15.9*	*17.5*	*21.6*	*0.77*	*0.82*	*324*		
Holotype	**B**	**–**	**138**	**75**	**19.3**	**21.5**	**13.4**	**14.8**	**20.3**	**0.69**	**0.90**	***368***		**Schlegelmilch, 1998: pl. 15, fig. 1**

Table 1. (Contd.)

No/status	MM	Position above the base of Member II, m	R, mm	PA, mm	LL, mm	DV, mm	$ll^{0.5}$, mm	$ll^{0.5}$, mm	D, mm	$d^{0.5}/D$	LL/DV	E, %	R_v/DV'	Notes/ source
Paratype	B	–	91	47	11.7	12.5	8.1	8.6	12.1	0.69	0.94	392		Schlegelmilch, 1998: pl. 15, fig. 2
Eocylindroteuthis corneliaschmittae														
VSGM SIR/303	A	4.8	87	*62*	*17.6*	*20.7*	*16.8*	*19.1*	19.1	*0.94*	*0.85*	*325*		
VSGM SIR/370	A	4.8	100	*68*	*18.4*	*22.1*	*15.2*	*18.4*	20.2	*0.83*	*0.83*	*337*		
VSGM SIR/376	A	4.8	121	80	21.5	24.8	19.3	21.1	23.1	0.87	0.86	346		
VSGM SIR/165	A	4.8	118	83	18.9	25.3	*17.1*	*20.8*	21.9	*0.86*	*0.74*	*380*		
VSGM SIR/100	A	4.8	93	*62*	*18.0*	*21.0*	*13.9*	*18.2*	19.4	*0.82*	*0.85*	*319*		
VSGM SIR/113	A	4.8	102	*73*	*18.0*	*21.0*	*14.9*	*17.6*	19.4	*0.83*	*0.86*	*376*		Plate I, fig. 1
VSGM SIR/204	A	4.8	96	*74*	*14.8*	*18.6*	*13.8*	*17.7*	16.6	*0.94*	*0.80*	*446*		
VSGM SIR/350	A	8.0	136	87	*20.5*	*25.9*	19.7	24.9	23.0	*0.96*	*0.79*	*376*		Plate I, fig. 2
VSGM SIR/312	A	11.9	92	*82*	*20.3*	*25.8*	*?*	*?*	*22.9*		*0.78*	*359*		
Holotype	**B**	**–**	**124**	**69**	**20.7**	**23.9**	**14.9**	**19.2**	**22.2**	**0.76**	**0.87**	**312**		**Schlegelmilch, 1998: pl. 15, fig. 4**
Paratype	B	–	134	76	18.5	20.7	14.4	16.2	19.6	0.78	0.89	390		Schlegelmilch, 1998: pl. 15, fig. 5
	B	–	190	93	24.1	28.0	19.9	24.7	26.0	0.85	0.86	359		Sadki et al., 2015: pl. 19, A-B
Eocylindroteuthis yarkovi sp. nov.														
VSGM SIR/212	A	**4.8**	**84**	**39**	**17.0**	**23.0**	**14.5**	**19.5**	**19.8**	**0.85**	**0.74**	**199**		**Plate III, fig. 4**
VSGM SIR/147	A	4.8	80	*39*	*19.7*	*23.8*	17.2	20.9	21.7	*0.87*	*0.83*	*182*		
VSGM SIR/249	A	4.8	74	*38*	*17.1*	*20.9*	13.9	17.1	18.9	*0.82*	*0.82*	*202*		
VSGM SIR/103	A	4.8	90	*55*	*16.9*	*23.0*	13.8	19.5	19.7	*0.83*	*0.73*	*281*		Plate III, fig. 5
VSGM SIR/207	A	4.8	72	*32*	*15.1*	*20.0*	13.6	17.6	17.4	*0.89*	*0.76*	*185*	*0.31*	Plate III, fig. 3
VSGM SIR/124	A	4.8	50	*26*	*13.0*	*15.9*	10.4	13.2	14.4	*0.82*	*0.82*	*181*		
Homaloteuthis volgogradensis sp. nov.														
VSGM SIR/40	**A**	**6.8**	**135**	**105**	**18.0**	**23.1**	**15.5**	**19.7**	**20.4**	**0.86**	**0.78**	**515**	**0.41**	**Plate IV, fig. 2**
VSGM SIR/117	A	4.8	138	*106*	*15.4*	*17.5*	*14.0*	*17.9*	16.4	*0.96*	*0.88*	*645*		
VSGM SIR/39	A	6.8	150	*108*	*18.1*	*21.1*	*14.9*	*19.9*	19.5	*0.88*	*0.86*	*553*	0.41	Plate V, fig. 1
VSGM SIR/16	A	6.8	121	*92*	*15.5*	*19.3*	*13.7*	*19.0*	17.3	*0.93*	*0.81*	*529*		
VSGM SIR/390	A	6.9	95	65	13.1	17.4	11.5	14.7	15.1	0.86	0.76	429		Plate IV, fig. 3
VSGM SIR/61	A	7.7	111	120	17.7	24.0	17.8	24.3	20.6	1.01	0.73	583	0.34	
VSGM SIR/235	A	11.9	94		19.3	24.8			21.9		0.78		0.39	
VSGM SIR/311	A	11.9	177	130	20.3	25.7	18.3	23.7	22.8	0.91	0.79	569		Plate IV, fig. 1
Homaloteuthis aff. *volgogradensis* sp. nov.														
VSGM SIR/117		4.8	138	*106*	*15.4*	*17.5*	*14.0*	*17.9*	16.4	*0.96*	*0.88*	*645*		Plate V, fig. 2
Hastites orphana sp. nov.														
VSGM SIR/391		**6.8**	**38**	***28***	***6.3***	***7.3***	**5.6**	**6.8**	**6.8**	***0.91***	***0.86***	***418***		**Plate V, fig. 5**
VSGM SIR/44		6.8	43	*38*	*5.4*	*6.9*	5.8	7.4	6.1	*1.08*	*0.78*	*627*		Plate V, fig. 6
VSGM SIR/394		7.5	41	*30*	*6.2*	*6.7*	?	?	6.5		*0.92*	*464*		

Low precision measurements and ratios based on them are shown in italics. The holotype and lectotype are shown in bold. Abbreviations: MM—measurement method (A—based on samples; B—based on published photographs).

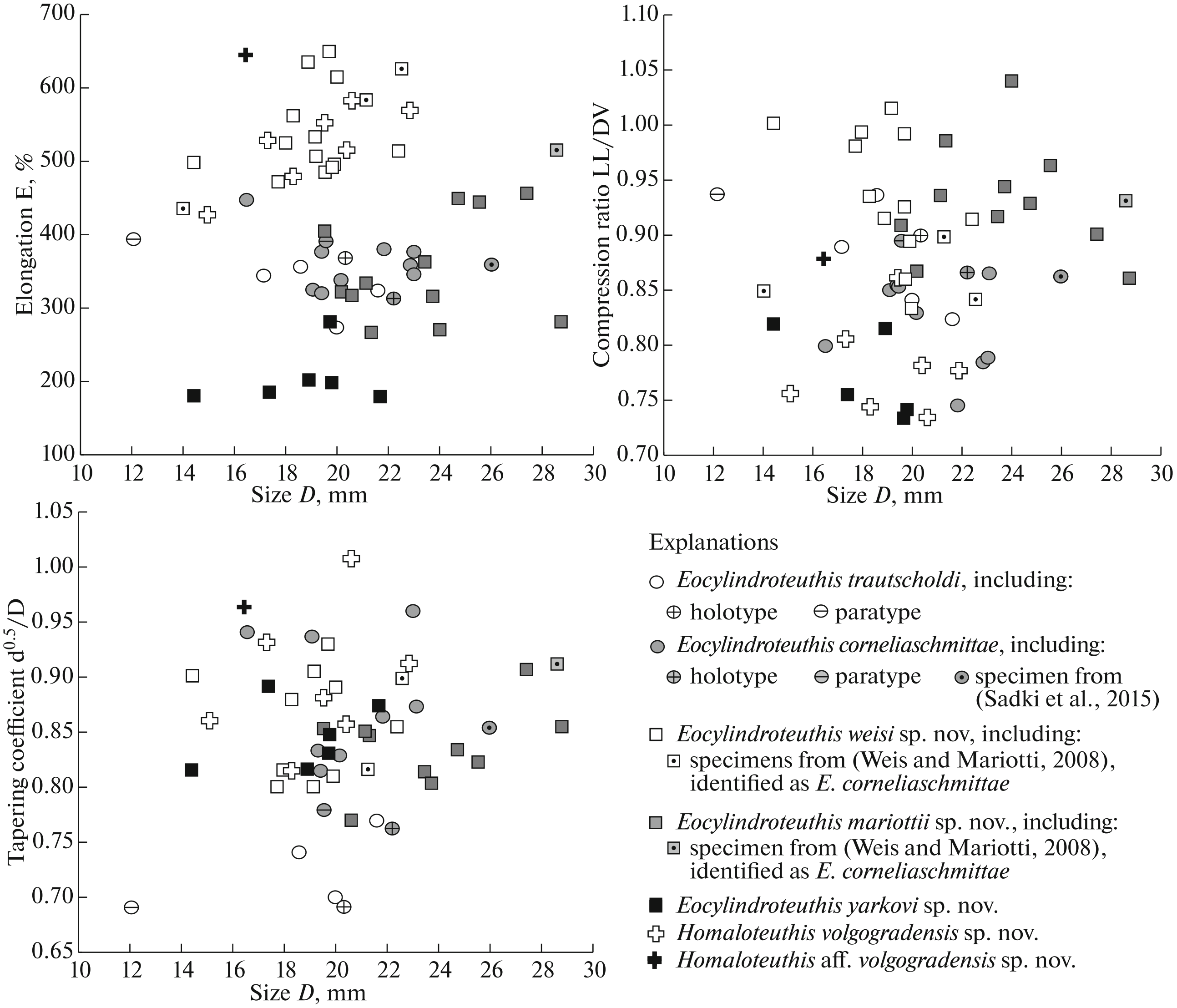


Fig. 7. Differences between different species of *Eocylindroteuthis* and *Homaloteuthis* by principal ratios and the heterogenous nature of *E. corneliaschmittae* from Western Europe.

Dimensions and ratios. See Table 1 and Fig. 7.

Variability. Large specimens of this species vary at all growth stages from short subcylindrical (see Plate II, figs. 4, 5; Plate III, fig. 2) to moderately elongated subconical (Plate III, fig. 1), but currently there is not sufficient material to consider these morphs as separate species.

Comparison. *E. trautscholdi* is the most similar species, from which the newly described species differs in a smaller tapering coefficient ($d^{0.5}/D = 0.77–0.91$, usually ~0.81–0.85 in *E. mariottii* sp. nov. against $d^{0.5}/D = 0.69$ in the type series of *E. trautscholdi* and 0.70–0.74 in the set from the Dubovoi section) at a comparable size. While there might be some doubts on the specimens of *E. trautscholdi* in my set, considering their imperfect preservation (these specimens are nevertheless similar to *E. mariottii* sp. nov. in their main proportions), the holotype of *E. trautscholdi* is a clearly separate from *E. mariottii* sp. nov., which is supported by its rounded-triangular shape of the cross section with a narrowed upper side and a relatively deeply incised ventral groove. These characters are not observed in any specimens of *E. mariottii* sp. nov. of comparable size.

E. mariottii sp. nov. is distinguished from *E. corneliaschmittae* by the sub-isometric rather than compressed cross section in the alveolar region and by having a more massive rostrum. It differs from the co-occurring *E. weisi* sp. nov. in having a shorter rostrum and in the absence of a pronounced ventral groove in adult rostra. The above two species are clearly separated by adult specimens (D > 18 mm; see Fig. 7) and less confidently by young specimens.

Remarks. The paratype of *E. corneliaschmittae* is very similar to *E. mariotti* sp. nov. (see Riegraf, 1980, text-fig. 143; Schlegelmilch, 1998, pl. 15, fig. 5), while the correctness of the assignment of both holotype and paratype of *E. corneliaschmittae* to one species is questionable (the holotype shows an apex shifted dorsally and a considerably shorter rostrum; almost all the specimens of *E. corneliaschmittae* in my set show similarly stable characters). The paratype of *E. corneliaschmittae* can represent a direct transitional form to the elongated variety of *E. mariottii* sp. nov.

Occurrence. Type locality, interval 4.8–9.15 m above the base of Member II (Beds with Eocylindroteuthis weisi–Beds with Hastites orphana). Western Europe (Luxembourg), Laeviuscula Chronozone–?Humphreisianum Chronozone (Weis and Gross, 2005, p. 69, fig.).

Material. 34 rostra in various states of preservation from the interval 4.8–9.15 m above the base of Member II.

***Eocylindroteuthis yarkovi* sp. nov.**

Plate III, figs. 3–5; Plate VI, fig. 13

Dactyloteuthis? sp. nov.: Ippolitov, 2017a.

Etymology. This species is named in honor of the Volgograd paleontologist Alexander Arkadievich Yarkov (Volga Humanitarian Institute, Volgograd), who rediscovered the locality described in the present paper.

Holotype: VSGM SIR/212, Volgograd region, Ilovlya district, Tonkiy Gully near Dubovoi hamlet; Member II, 4.8 m above the base; lower Bajocian, Beds with E. weisi.

Diagnosis. *Eocylindroteuthis* with short to very short rostrum (E = 181–202%, sometimes up to 281%) subconical in shape, strongly compressed (LL/DV = 0.73–0.83) along the entire length.

Description. The rostrum is medium-sized to large, short or very short (E = 333–526%, sometimes up to 400%), subconical both in profile and in outline at all growth stages; the rostrum margins are weakly convex; the dorsal margin is usually noticeably convex. The apical region is approximately half the length of the postalveolar region, slightly rounded in profile; the transition to it is gradual. The apex of the rostrum is shifted ventrally.

The transverse section is strongly compressed laterally (LL/DV = 0.73–0.83); the degree of compression is consistent along the entire length of the rostrum. The cross section is oval, with flattened lateral sides; the latter character is most noticeable in adult specimens. The dorsal side is narrower than the ventral side.

The ventral side of young rostra possesses a shallow and wide mid-ventral groove, which has the appearance of a flattened area and rapidly disappears toward the posterior end, and considerably less rapidly toward the anterior margin. At later stages, this flattening is absent.

The alveolus occupies about a half of the rostrum length; it has a strongly compressed oval cross section (Plate VI, fig. 13a). The alveolar angle in profile measured in the specimen VSGM SIR/207 is about 28°, whereas the apex is displaced ventrally ($R_v/DV' = 0.31$). The apical line is diffuse.

Dimensions and ratios. See Table 1 and Fig. 7.

Variability. Most rostra are uniform except for several finds that possess a more strongly elongated rostrum. The only rostrum of a young specimen available in the collection (VSGM SIR/124) is similar in general appearance and proportions to the rostra of adult specimens and differs only in more convex lateral sides.

Comparison. This species is distinguished from all known members of the genus *Eocylindroteuthis* by a short rostrum, being a deviant form within the genus.

Remarks. The similarity to the Toarcian genus *Dactyloteuthis* Bayle, 1878, to which *E. yarkovi* sp. nov. was initially assigned by the present author (Ippolitov, 2017a), is convergent. The study of the polished cross sections of *E. yarkovi* sp. nov. revealed that, firstly, our new species does not show a narrowing of the lower half of the rostrum, which is characteristic of *Dactyloteuthis* (see Schlegelmilch, 1998, pp. 65–67); secondly, rostra of the initial stages of *E. yarkovi* sp. nov. have a conical shape (Plate III, fig. 3d) rather than subcylindrical as in *Dactyloteuthis* (Schlegelmilch, 1998, pl. 4, figs. 4, 6, 9); and thirdly, *E. yarkovi* sp. nov. has a midventral flattening which does not reach the apex, whereas in all *Dactyloteuthis* the ventral groove, if present, starts from the apex.

The similarity in rostrum shape is also observed to the members of the genus *Arcobelus* Sachs in Sachs et Nalnjaeva, 1967 (Toarcian of northern Eurasia and less commonly of Western Europe), but the latter has a strongly convex ventral side.

E. yarkovi sp. nov. is a highly specialized representative of the genus, most likely originating from *E. corneliaschmittae*, which can demonstrate a similar degree of compression but has a considerably greater elongation of the rostrum. Specimen VSGM SIR/103 (Plate III, fig. 5) can be considered as a transitional form; it is possible that this variety was heterochronous to the typical *E. yarkovi* sp. nov., and their occurrence at the same level in the section is a result of condensation.

Occurrence. This species is known only from the type locality, level 4.8 m above the base of Member II (Beds with Eocylindroteuthis weisi).

Material. 13 relatively well-preserved rostra, including 3 elongated specimens (transitional forms from *E. corneliaschmittae*).

Genus *Homaloteuthis* Stolley, 1919

Remarks. In the studied section, specimens lacking an intermediate ventral groove (*Homaloteuthis*) and with a groove (*Eocylindroteuthis*) co-occur over the entire fossiliferous interval (4.8–11.9 m above the base of Member II) and are relatively confidently distinguished by the major delineating character in the polished sections. However on closer consideration, the genus *Homaloteuthis* appears to be heterogeneous: the species *H. volgogradensis* sp. nov. described below and satisfying the diagnostic features of the genus *Homaloteuthis* by the general shape of the rostrum and slightly flattened venter in some specimens is more similar to representatives of the genus *Eocylindroteuthis* than to genuine *Homaloteuthis* (*H.* cf./aff. *spinata*) from the same assemblage. This means that the demarcation of these genera on the basis of the principal character becomes ambiguous and should be redefined in the future. It is quite possible that the genera *Eocylindroteuthis* and *Homaloteuthis* should be considered not just as closely related taxa, but synonyms, as was proposed by Dzyuba (2004, 2011).

Homaloteuthis volgogradensis sp. nov.

Plate IV, figs. 1–4; Plate V, fig. 1; Plate VI, figs. 10–12, 16f

Cylindroteuthis sp.: Krimholz, 1931, pp. 41–42.

Eocylindroteuthis sp. 2: Ippolitov, 2017a, Fig. 1.

Etymology. From Volgograd.

Holotype: VSGM SIR/40, Volgograd region, Ilovlya district, Tonkiy Gully near Dubovoi hamlet; Member II, 6.8 m above the base; lower Bajocian, Beds with Hastites orphana.

Diagnosis. *Homaloteuthis* with a rostrum subcylindrical to cylindrical in shape, elongated (E = 429–569%), with strong compression consistent along the entire length of the postalveolar region (LL/DV = 0.73–0.81, rarely up to 0.86); with a hardly noticeable flattening on the ventral side.

Description. The rostrum of large specimens (D can be up to 30 mm) is elongated (E = 429–529%); in adult specimens, cylindrical both in profile and in outline, and in young specimens, subcylindrical; all margins of the rostrum are straight. The transition to the apical part is well defined in the profile by the presence of smooth shoulders in the ventral and dorsal margins and less strongly pronounced in the outline. The length of the apical part is 1/3 of the postalveolar region length. The apex is shifted dorsally and is slightly attenuated.

The cross section of young specimens is ovate, laterally compressed, with a narrowed upper side. However, it relatively rapidly becomes strongly compressed (LL/DV = 0.73–0.79), regularly elliptical, with slightly flattened lateral sides. The degree of compression remains almost consistent along the entire length of the rostrum.

The ventral side in adult rostra is convex, but at early stages and only in a cross section behind the protoconch, it may show a quickly disappearing flattening (Plate VI, figs. 11, 16f). In the apical part of very large rostra in the middle of the lateral sides, there are sometimes wide, shallow grooves (Plate IV, figs. 1b, 1e). The cross sections in the apical regions of the rostrum show an irregular tiny folding (Plate VI, fig. 10).

The alveolus occupies approximately 1/4 length of the rostrum and has an elliptical cross section. Its tip is ventrally displaced ($R_v/DV' = 0.34–0.41$).

Dimensions and ratios. See Table 1 and Fig. 7.

Variability. The existing rostra are uniform, except for some variations in general shape (from subcylindrical to truly cylindrical). In addition, one of the specimens has a long epirostrum (Plate V, fig. 1), absent in all other available specimens.

Comparison. This species is distinguished from the type species of the genus, the middle Aalenian *H. spinata*, as well as from co-occurring forms, identified in this paper as *H.* cf./aff. *spinata*, by a considerably more elongated rostrum of cylindrical shape. It differs from *H. murielae* from the upper Aalenian–lowermost Bajocian of Western Europe, which is possibly an indirect ancestor of the described species, in the cylindrical rather than subconical shape of the rostrum with a relatively short apical region.

The new species differs from the convergently similar *Eocylindroteuthis weisi* sp. nov., which also possess an elongated rostrum, in the absence of the ventral groove at all growth stages and in the more strongly developed compression near the alveolus. These species are readily distinguished already at their early growth stages (compare Plate II, fig. 3 and Plate IV, fig. 3). Other species of the genus *Eocylindroteuthis* do not reach elongation characteristic of *H. volgogradensis* sp. nov.

Remarks. The described species is only tentatively assigned to the genus *Homaloteuthis*, since its origin is not entirely clear. On one hand, *H.* aff. *volgogradensis* from the level of 4.8 m may represent a transitional form between the late Aalenian species *H. murielae* and *H. volgogradensis* sp. nov. On the other hand, some specimens of *H. volgogradensis* from the lower part of its range (Plate IV, fig. 4c; Plate V, fig. 1e) show a flattening on the ventral side, which is characteristic of representatives of the genus *Eocylindroteuthis* and can indicate a connection, in particular, to *E. corneliaschmittae*, which is characterized by a weakly pronounced groove and lateral compression.

The general shape of the rostrum, large size, and presence of indistinct apical grooves in the new species resemble those of the early representatives of *Megateuthis elliptica* from the Propinquans Zone (Weis and Mariotti, 2008, pl. 7, fig. 1) and should superficially be classified within the genus *Megateuthis*. However, the shape of the rostrum at early ontogenetic stages in

H. volgogradensis (Plate IV, fig. 3) is strongly different from that in *M. elliptica* (Weis, 2006, fig. 10), whereas small apical folds are also present both in *Eocylindroteuthis* (Weis and Mariotti, 2008, pl. 3, fig. 1a) and in *Homaloteuthis* (Weis and Mariotti, 2008, pl. 4, fig. 6a) despite their presence was not discussed previously.

Occurrence. Apart from the type locality, Bajocian of the Central Caucasus (Kabardino-Balkaria, Chegem River, specimen CCRGM 415/2898, *Cylindroteuthis* sp. in Krimholz, 1931).

Material. 25 identifiable adult specimens and numerous fragments from the interval 4.8–11.9 m above the base of Member II.

FAMILY HASTITIDAE NAEF, 1922

Genus *Hastites* Mayer-Eymar, 1883

Hastites orphana sp. nov.

Plate V, figs. 5, 6

Etymology. From the Latin orphana (orphan), to emphasize the morphological and stratigraphic isolation of this species from other representatives of the genus.

Holotype: VSGM SIR/391; Volgograd region, Ilovlya district, Tonkiy Gully near Dubovoi hamlet; Member II, 6.8 m above the base; lower Bajocian, Beds with Hastites orphana.

Diagnosis. A species of *Hastites* without a pronounced fusiform shape, with elongation E ≈ 400–650%, with a rounded-trapezoid cross section with a slightly narrowed upper side in the alveolar region, becoming oval and laterally compressed toward the apex.

Description. The rostrum is small ($R \leq 45$ mm), elongated (E ≈ 400–650%), cylindrical in profile and subcylindrical in outline. All rostrum margins are straight in the anterior half, but become convex nearer to the posterior end.

The length of the apical part in the profile is 2/5 of the length of the postalveolar region, and in the outline, it is considerably larger, 1/2–3/5; the transition to it is gradual. The apex of the rostrum is subcentral.

The cross section in the alveolar region is rounded-trapezoid, laterally compressed ($LL/DV \approx 0.86$ in the holotype); the lateral sides are slightly flattened, whereas the dorsal and ventral sides are convex. Posteriorly, the cross section of the holotype becomes oval, and closer to the apex, it shows the highest degree of lateral compression; in other specimens, the degree of lateral compression remains consistent.

No grooves are present on the rostrum.

The alveolus occupies approximately 1/7–1/6 of the rostrum length; its tip is noticeably shifted ventrally ($R_v/DV' \approx 0.43$ in the holotype); the apical line is also shifted ventrally.

Dimensions and ratios. See Table 1.

Variability. Poor state of preservation does not allow evaluation of variability.

Comparison. *H. orphana* sp. nov. differs from all the late Toarcian–Aalenian representatives of the genus in the absence of a distinct fusiform shape and in the somewhat shortened rostrum. It is distinguished from an undescribed species from the Garantiana Zone of the Donets Basin (Plate V, fig. 7) by the absence the dorsoventral compression in the postalveolar region.

Remarks. The small-sized rostra are extremely susceptible to leaching, and of the numerous rostra in the collection, only the holotype has a state of preservation allowing the main characters to be established, so these are extrapolated to other specimens. The authenticity of the described species (degree of elongation, shape of the cross section) does not cast much doubt: very similar rostra, also with subquadrate anterior region, and differing only in dorsoventral rather than lateral compression near the posterior end were found in the Garantiana Zone (upper Bajocian) of the Donets Basin (Plate V, fig. 7).

The assignment of the new taxon to the genus *Hastites* is a little bit tentative. It differs from all the known species of the genus *Hastites* in a shorter rostrum not having fusiform shape and in angular cross section of the alveolar region, resembling that of some representatives of the genus *Rhabdobelus* Naef, 1922 (also included into the family Hastitidae). However, *H. orphana* sp. nov. does not demonstrate deeply incised lateral grooves, characteristic of the genus *Rhabdobelus*, and is more similar to the genus *Hastites* than to any other generic taxa.

Occurrence. This species is known only from the type locality, interval 6.8–11.9 m above the base Member II (=Beds with Hastites orphana).

Material. Four relatively complete identifiable rostra from the interval 6.8–11.9 m above the base of Member II, tens of poorly preserved fragments, specific characters of which cannot be established with confidence.

CONCLUSIONS

(1) A diversified early Bajocian belemnite assemblage is described for the first time from the territory of the Volga Region. It includes four genera and 11 species (five new and two described in open nomenclature). Some elements of this assemblage were previously found at the Caucasus; however, in general, it is possible to state the discovery for Russia of a completely new Euroboreal belemnite fauna, previously known only from Central Europe and almost unknown (except for finds of separate species) in Eastern Europe.

(2) The presence of the normally marine lower Bajocian strata is established confidently for the first time in the Lower Volga Region, and this can be indi-

rect evidence of the authenticity of the ammonite *Witchellia* sp. record (Ivanitskaya and Sarytcheva, 1970) from the Astrakhan region. The age of the clay series in the Don Bend area determined from belemnites coincides with earlier dating of these deposits by Rykov (1953) on the basis of belemnites and Sarytcheva (1958) on the basis of microfauna. These datings were later rejected on the basis of a single unfigured record of the late Bajocian ammonite *Garantiana* sp. (Smirnov, 1962), which was, apparently, erroneously identified or incorrectly located within the succession.

(3) Two new biostratigraphically belemnite-based units are recognized—Beds with Eocylindroteuthis weisi and Beds with Hastites orphana, in total approximately corresponding to the ammonite Hyperlioceras discites (uppermost part; questionably)–Witchellia laeviuscula chronozones. Many species in the assemblage characteristic of the first of the above-listed belemnite units were found not only in the Caucasus but also in Western Europe, and potentially this provides a wide correlative potential for the recognized unit.

(4) The datings determined from the belemnites allow reconsidering and updating the scheme of the formational subdivision of the Middle Jurassic of the Lower Volga Region. In particular, it is necessary to reinstate the Bakhtemir Formation previously rejected by RISC as a valid unit. The total range of Bakhtemir Formation is the upper part of the lower Bajocian Discites (?)/Laeviuscula Chronozone–upper Bajocian Garantiana Chronozone. Considering that the boundaries of the examined clay series are traced by well logs across the entire western and possibly eastern part of the Peri-Caspian Region (Demchuk and Kocharyants, 1970), as well as in the subsurface Karpinsky Ridge (Sarytcheva, 1971), where no lower Bajocian is present according to current interpretation (Rostovtsev, 1992), our results trigger the age revision for the Middle Jurassic complex in the entire region.

(5) It becomes evident at present that the first episode of the Middle Jurassic marine transgression from the Tethys into the Volga Region area took place during the early Bajocian, rather than late Bajocian. Taking into account the record of "*Megateuthis aalensis*" from the northern termination of the Don-Medveditsa dislocations (Rykov, 1953), it is possible that the northern border of the marine basin at that time reached the southern margin of Saratov region.

ACKNOWLEDGMENTS

I am deeply indebted to A.A. Yarkov (Volga Humanitarian University, Volgograd), who indicated the exact site studied in this paper; D.B. Gulyaev (Yaroslavl), who took part in the fieldwork at the locality; T.V. Kurazheva (CCRGM Museum, St. Petersburg) for helping with access to the historical collections of G.Ya. Krimholz and A.A. Borissjak; and A.N. Kuzmin (Karpinsky All-Russia Research Geological Institute, St. Petersburg) for helping with several difficult-to-access publications. I am sincerely grateful to the reviewers O.S. Dzyuba (Trofimuk Institute of Petroleum Geology and Geophysics, Siberian Branch of the Russian Academy of Sciences, Novosibirsk) and M.A. Rogov (Geological Institute, Russian Academy of Sciences, Moscow), who provided many useful comments which helped to considerably improve the manuscript.

The study was performed within the framework of the Government Contract 0135-2018-0035 GIN RAS and supported by the Russian Foundation for Basic Research, project nos. 15-05-03149 A, 16-05-01088 A, and 18-05-1070 A.

Reviewers O.S. Dzyuba,
V.A. Zakharov, and M.A. Rogov

REFERENCES

Arp, G., Ammonitenfauna und stratigraphie des Grenzbereichs Jurensismergel/Opalinuston-Formation bei Neumarkt i.d. Opf. (oberstes Toarcium, Frankische Alb), *Zitteliana. Ser. A*, 2010, vol. 50, pp. 25–54.

Atlas litologo-paleogeograficheskikh kart Russkoi platformy i ee geosinklinal'nogo obramleniya. Chast' II. Mezozoi i kainozoi (Atlas of Lithological–Paleogeographical Maps of the Russian Platform and its Geosynclinal Framing. Pt. II: Mesozoic and Cenozoic), Ronov, A.B. and Khain, V.E., Eds., Moscow–Leningrad: Gos. Nauchno-Tekhn. Izd. Lit. po Geol. Okhrane Nedr, 1961 [in Russian].

Atlas litologo-paleogeograficheskikh kart SSSR. T. III. Triasovyi, yurskii i melovoi periody (Atlas of Lithological–Paleogeographical Maps of the USSR. Vol. III: Triassic, Jurassic and Cretaceous), Vereshchagin, V.N. and Ronov, A.B., Eds., Moscow: Vsesoyuz. Aerogeol. Trest Min. Geol. SSSR, 1968 [in Russian].

Bayle, E., Fossiles principaux des terrains, in *Explication de la Carte Géologique de France*, vol. 4, Pt. 1, Paris: Imprimérie Nationale, 1878.

Biostratigraphie du Jurassique Ouest-Européen et Méditerranéen: zonations parallèles et distribution des invertébres et microfossiles, Bull. Centre Rech. Elf Explor. Prod., Cariou, E. and Hantzpergue, P., Eds., 1997, vol. 17.

de Blainville, M.H.D., *Mémoire sur les Bélemnites, Considérées Zoologiquement et Géologiquement.* Paris: F.G. Levrault, 1827.

Borissjak, A., Die Fauna des Donez-Jura. I. Cephalopoda, *Tr. Geol. Kom. Nov. Ser.*, 1908, vol. 37. pp. 1–94.

Demchuk L.V. and Kocharyants, S.B., Correlation of the Jurassic Deposits in the Cis-Caspian Depression, in *Tr. VNIGNI* (Trans. All-Union Geol. Oil Explor. Inst.), vol. 101, pp. 80–134.

Doyle, P., The British Toarcian (Lower Jurassic) belemnites. Part 2, *Monogr. Palaeontogr. Soc., London*, 1992, no. 587 (1991), pp. 50–79, pls. 18–28.

Dzyuba, O.S., *Belemnity (Cylindroteuthidae) i biostratigrafiya srednei i verkhnei yury Sibiri* (Belemnites (Cylindroteuthidae) and biostratigraphy of the Middle and Upper Jurassic of Siberia), Novosibirsk: Izd. Sib. Otd. RAN, Fil. "Geo", 2004 [in Russian].

Dzyuba, O.S., Subfamily classification within the Cylindroteuthididae (Belemnitida). *News Palaeontol. Stratigr. (Suppl. Russ. Geol. Geophys. Vol. 52)*, 2011, vols. 16–17, pp. 103–108.

Dzyuba, O.S., Belemnites and biostratigraphy of the Jurassic-Cretaceous boundary deposits of northern East Siberia: New data on the Nordvik Peninsula, *Stratigr. Geol. Correl.*, 2012, vol. 20, no. 1, pp. 53–72.

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. Paläont. Abh.*, 2015, vol. 275, no. 3, pp. 305–315.

Guérin-Franiatte, S. and Weis, R., Le passage Aalénien-Bajocien près de Rumelange: la série biostratigraphique dans le Bassin d'Eschsur-Alzette (Grand-Duché de Luxembourg), *Ferrantia*, 2010, no. 62, pp. 73–96.

Gulyaev, D.B., On ammonite zonal scale of the uppermost Bajocian, Bathonian and lowermost Callovian of the East European Platform, in *Nauchn. Mat. V Vseross. Soveshch. "Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii"* (Proc. V All-Russ. Conf. "Jurassic System of Russia: Problems of Stratigraphy and Paleogeography"), Zakharov, V.A., Rogov, M.A., Shurygin, B.N., Eds., Ekaterinburg: OOO Izd. Dom IzdatNaukaServis, 2013, pp. 58–64.

Gulyaev, D.B., Ippolitov, A.P., and Glinskikh, L.A., Kuba (turn from the main road), in *Yurskie otlozheniya tsentral'noi chasti Gornogo Dagestana. Putevoditel' geologicheskikh ekskursii VI Vserossiiskogo soveshchaniya "Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii", 15–20 sentyabrya 2015 g., g. Makhachkala* (Jurassic Deposits of the Central Part of the Mountain Dagestan. Field guide to the VI all-Russian conference "Jurassic system of Russia: problems of stratigraphy and paleogeography", September 15–20, 2015, Makhachkala), Makhachkala: ALEF, 2015a, pp. 50–63.

Gulyaev, D.B., Ippolitov, A.P., and Glinskikh, L.A., Khurukra, in *Yurskie otlozheniya tsentral'noi chasti Gornogo Dagestana. Putevoditel' geologicheskikh ekskursii VI Vserossiiskogo soveshchaniya ""Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii", 15–20 sentyabrya 2015 g., g. Makhachkala* (Jurassic Deposits of the Central Part of the Mountain Dagestan. Field guide to the VI all-Russian conference "Jurassic system of Russia: problems of stratigraphy and paleogeography", September 15–20, 2015, Makhachkala), Makhachkala: ALEF, 2015b, pp. 64–80.

Gustomesov, V.A., New Callovian belemnites of Timan, in *Novye vidy drevnikh rastenii i bespozvonochnykh SSSR. Ch. 2* (New Species of Ancient Plants and Invertebrates of the USSR. Pt. 2), Moscow: Gosgeoltekhizdat, 1960, pp. 190–192.

Gustomesov, V.A., Boreal Late Jurassic belemnites (Cylindroteuthinae) of the Russian Platform, in *Boreal'nye pozdneyurskie golovonogie. Tr. GIN AN SSSR* (Boreal Late Jurassic Cephalopods. Trans. Geol. Inst. USSR Acad. Sci.). 1964, Vol. 107, pp. 89–216

Gustomesov, V.A., To the revision of Jurassic belemnites, *Byull. Mosk. Ob-va Ispyt. Prir. Otd. Geol.*, 1977, vol. 52, no. 2, pp. 103–117.

Hardenbol, J., Thierry, J., Farley, M.B., et al., Mesozoic and Cenozoic sequence chronostratigraphic framework of European basins, in *Mesozoic and Cenozoic Sequence Stratigraphy of European Basins, SEPM Spec. Publ.*, De Graciansky, P.-C., Hardenbol, J., Jacquin, T., and Vail, P.R., Eds., 1998, no. 60, pp. 3–29.

Iba, Y., Sano S.-i, and Mutterlose, J., The early evolutionary history of belemnites: new data from Japan, *PLOS ONE*, 2014, vol. 9, no. 5, e95632.

Ippolitov, A.P., Discovery of marine Aalenian?–Lower Bajocian strata in the Volga region, *Nauchn. mater, VII Vseross. soveshch. "Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii"* (Proc. VI All-Russ. Conf. "Jurassic System of Russia: Problems of Stratigraphy and Paleogeography"), Zakharov, V.A., Rogov, M.A., and Shchepetova, E.V., Eds., Moscow: GIN RAS, 2017a, pp. 69–73.

Ippolitov, A.P., Late Bajocian belemnites of the Volga region: biodiversity and paleobiogeographical significance, in *Nauchn. Mater. VII Vseross. Soveshch. "Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii"* (Proc. VII All-Russ. Conf. " Jurassic System of Russia: Problems of Stratigraphy and Paleogeography"), Zakharov, V.A., Rogov, M.A., and Shchepetova, E.V., Eds., Moscow: GIN RAS, 2017b, pp. 74–77.

Ippolitov, A.P., Tishchenko, A.I., Rogov, M.A., et al., On the record of boulder of Upper Toarcian limestone in the vicinities of Simferopol and its implication for interpretation of geological structure of Crimean Mountain, in *Nauchn. chteniya, posvyachennyie 100 letiyu so dnya rozhdeniya prof. M.V. Muratova "Novoe v regional. geologii Rossii i blizhnego zarubezh'ya"* (Proc. Conf. Dedicated to 100th Anniversary of Prof. M.V. Muratov "News in Regional Geology of Russia and Adjacent Foreign Countries"), Moscow: Ross. Gos. Geologorazved. Univ., 2008, pp. 43–46.

Ippolitov, A.P., Gulyaev, D.B., and Glinskikh, L.A., Chukna (turn from the main road), in *Yurskie otlozheniya tsentral'noi chasti Gornogo Dagestana. Putevoditel' geologicheskikh ekskursii VI Vseross. soveshch. "Yurskaya sistema Rossii: problemy stratigrafii i paleogeografii", 15–20 sentyabrya 2015 g., g. Makhachkala* (Jurassic Deposits of the Central Part of the Mountain Dagestan. Field guide to the VI all-Russian conference "Jurassic system of Russia: problems of stratigraphy and paleogeography", September 15–20, 2015, Makhachkala), Makhachkala: ALEF, 2015, pp. 35–49.

Ivanitskaya, V.B. and Sarycheva, A.I., Jurassic system, in *Geologiya SSSR. T. XLVI. Rostovskaya, Volgogradskaya, Astrakhanskaya oblasti i Kalmytskaya ASSR. Geologicheskoe opisanie* (Geology of the USSR. Vol. XLVI. Rostov, Volgograd, Astrakhan Regions and Kalmyk ASSR. Geological Description), Belov, F.A., Ed., Moscow: Nedra, 1970, pp. 255–287.

Kamenov, B.G., La géologie des environs d'Etropolé, *Spisanieto na B"lgarskoto Geologichesko Druzhestvo*, 1936, vol. 8, no. 2, pp. 30–137.

Kamensky, G.N., Sur la structure géologique de la rive droite du Don entre les vil. Oust-Medveditzkaia et Trekh-Ostrovianskaia, *Byull. MOIP. Otd. Geol.*, 1924. Nov. Ser., vol. XXVII, pp. 227–241.

Kamysheva-Elpatievskaya, V.G., Stratigraphy and fauna of the Jurassic deposits of the Saratov Volga Region, in *Tr. Vsesoyuz. Soveshch. po razrabotke unifitsirovannoi skhemy stratigrafii mezozoiskikh otlozhenii Russkoi platformy, sozvannogo 3–10 fevralya 1954 g.* (Proc. All-Union Conf. on Development of Unified Stratigraphic Scale for the Mesozoic Deposits of the Russian Platform, February 3–10, 1954), Leningrad: Gostoptekhizdat, 1956, pp. 143–147.

Kamysheva-Elpatievskaya, V.G., The general geological essay of the Lower Volga Region, *Tr. nauchn. konf. po stratigrafii mezozoya i paleogena Nizhnego Povolzh'ya i smezhnykh oblastei* (Proc. Sci. Conf. on Mesozoic and Paleogene Stratigraphy of the Lower Volga Region and Adjacent Areas), Vol'sk, 1958, pp. 135–141.

Kamysheva-Elpatievskaya, V.G., The southern part of the Ulyanovsk–Saratov trough and the southwestern areas of the Volga–Ural anteclise, in *Stratigrafiya SSSR. Yurskaya sistema* (Stratigraphy of the USSR. Jurassic System)*, Krimholz, G.Ya.*, Moscow: Nedra, 1972, pp. 67–81.

Klein, J.T., *Descriptiones Tubulorum Marinorum in Quorum Censum Relati Lapides Caudae Cancri Gesneri et his Similes Belemnitae Eorumque Alveoli Secundum Dispositionem Musei Kleiniani Addita est Dissertatio Epistolaris de Pilis Marin*, 2nd ed., Danzig, Leipzig: Gleditsch, 1773.

Kolb, H., Die Belemniten des jungeren Lias ζ in Nordbayern, *Z. Dtsch. Geol. Ges.*, 1942, vol. 94, nos. 3/4, pp. 145–168.

Krimholz, G.Ya., Jurassic Belemnites of the Crimea and Caucasian, *Tr. Glavn. Geol.-Razv. Upr. SSSR*, 1931, vol. 76, pp. 1–52.

Krimholz, G.Ya., Subclass Endocohlia, in *Atlas rukovodyashchikh form iskopaemykh faun SSSR. T. VIII. Nizhnii i srednii otdel yurskoi sistemy* (Atlas of Guide Forms of Fossil Faunas of the USSR: Vol. 8. Lower and Middle Jurassic), Krimholz, G.Ya., Ed., Moscow–Leningrad: Gos. Izd. Geol. Liter. Min. Geol. SSSR, 1947, pp. 195–207.

Krimholz, G.Ya., Materials to the stratigraphy and fauna of the Lower and Middle Jurassic of Caucasus, *Uch. Zap. LGU*, 1953, no. 159, pp. 25–58.

Krimholz, G.Ya., Bajocian Stage, in *Zony yurskoi sistemy v SSSR* (Zones of the Jurassic System in the USSR), Krimholz, G.Ya., Ed., Leningrad: Nauka, 1982, pp. 57–69.

de Lagausie, B. and Dzyuba, O.S., Biostratigraphy of the Bajocian–Bathonian boundary interval in northern Siberia: new data on belemnites from the Yuryung–Tumus peninsula, *Bull. Soc. Geol. Fr.*, 2017, vol. 188, nos. 1–2, pp. 1–9.

Lebedev, N., Compte rendu préliminaire sur les recherches géologiques faites en 1891 dans le basin de la rivière Medveditza et note sur l'arbre pétrifié dans le district de Senguilej du gouv. de Simbirsk, *Izv. Geol. Kom.*, 1893, vol. XI, no. 2 (for 1892), pp. 39–55.

Levina, V.I. and Prokhorova, N.P., Regional stratigraphic subdivisions of the Lower and Middle Jurassic in the Cis-Caspian Region, in *Nedra Povolzh'ya i Prikaspiya* (Volga and Pricaspian Region Resources), 2002, vol. 29, pp. 6–13.

Lissajous, M., Quelques remarques sur les bélemnites jurassiques, *Bull. Soc. Hist. Nat. Mâcon*, 1915, no. 6, pp. 1–32.

Lungersgauzen, L.F., Bajocian and Bathonian deposits of the Donetsk Range, *Dokl. Akad. Nauk SSSR*, 1942, vol. 34, no. 6, pp. 186–189.

Lungersgauzen, L.F., Materials on the stratigraphy of the Mesozoic and Paleogene deposits in the northen branch of the Don–Medveditsa dislocations, *Tr. Vsesoyuz. aerogeol. tresta*, 1956, vol. 2, pp. 190–255.

Mariotti, N., Sanantonio, M., and Weis, R., Aalenian–Early Bajocian belemnite assemblage from Peri-Mediterranean Tethyan sediments (Calabria, Southern Italy), *Geol. Rom.*, 2007, vol. 40, pp. 1–19.

Mayer-Eymar, K., Die grundzüge der classification der Belernniten, *Zeitschr. Deut. Geol. Ges.*, 1883, vol. XXXV, pp. 640–643.

Mazarovich, A.N., Middle Jurassic deposits of the Ilovlya River, *Vestn. Mosk. Gorn. Akad.*, 1923, vol. 2, no. 1, pp. 29–60.

Meledina, S.V., Correlation of the Bajocian and Bathonian zones in light of new paleontological data, *Stratigr. Geol. Correl.*, 2014, vol. 22, no. 6, pp. 594–605.

Miller, J.S., Observations on belemnites, *Trans. Geol. Soc. London*, 1826, N.S., vol. 2, no. 1 (for 1823), pp. 45–62, pls. VII–IX.

Mitta, V.V. and Dietl, G., The Garantiana beds in the Upper Bajocian of the Middle Volga area, in *Sovremennye problemy izucheniya golovonogikh mollyuskov. Morfologiya, sistematika, evolyutsiya, ekologiya i biostratigrafiya* (Contributions to Current Cephalopod Research: Morphology, Systematics, Evolution, Ecology, and Biostratigraphy), Moscow: PIN RAN, 2012, pp. 91–94.

Mitta, V.V., Barskov, I.S., Gründel, I., et al., The Upper Bajocian and Lower Bathonian in the section near Saratov, Vernadsky Mus.-Novit., 2004, no. 12, pp. 1–39 [in Russian].

Mitta, V.V., Kostyleva, V.V., Glinskikh, L.A., et al., Middle Jurassic stratigraphy in the southwestern part of the Republic of Tatarstan, *Stratigr. Geol. Correl.*, 2014, vol. 22, no. 1, pp. 28–43.

De Montfort, P.D., *Conchyliologie Systématique, et Classification Méthodique des Coquilles; Offrant leurs Figures, Leur Arrangement Générique, leurs Descriptions Caractéristiques, leurs Noms; Ainsi que leur Synonymie en Plusieurs Langues. Tome 1*, Paris: F. Schoell, 1808.

Naef, A., *Die fossilen Tintenfische; Eine Palaozoologische Monographie*, Jena: Fischer, 1922.

Nalnjaeva, T.I., Stratigraphic and geographic distribution of the genus *Paramegateuthis*, in *Biostratigrafiya boreal'nogo mezozoya* (Biostratigraphy of Boreal Mesozoic). *Tr. Inst. Geol. geofiz. SO AN SSSR*, 1974, vol. 136, pp. 101–105.

Nalivkin, V., Recherches géologiques faites en 1898 au district d'Isioum, gouv. de Kharkow (Compte-rendu préliminaire), *Izv. Geol. Kom.*, 1899, vol. XVIII, no. 3, pp. 107–138.

Nikitin, I.I., New belemnite species from Jurassic deposits of the northwestern margin of Donbass, *Geol. Zh.*, 1975, vol. 35, no. 6, pp. 72–80.

Nikitin, I.I., Section II, Belemnites, in Golovonogie mollyuski yury Ukrainy. Paleontol. spravochnik (Jurassic Cephalopoda of Ukraine. Paleontological Reference Book), Kyiv: Naukova Dumka, 1981, pp. 74–101 [in Russian].

Nikitin, I.I., Permyakov, V.V., Permyakova, M.N., et al., *Novye dannye po stratigrafii yurskikh otlozhenii Donbassa i Dneprovsko-Donetskoi vpadiny. Preprint 83-3 Instituta geologicheskikh nauk AN USSR* (New data on the stratigraphy of the Jurassic deposits of Donbass and Dnieper–Donetsk depression. Preprint no. 83-3 of Inst. Geol. Sci. USSR Acad. Sci.), Kiev, 1983 [in Russian].

Nutsubidze, K.Sh., Lower Jurassic fauna of Caucasus, in *Tr. Geol. Inst. Akad. Nauk Gruz. SSR. Nov. ser.*, 1966, vol. 8, pp. 5–212 [in Russian].

Olferiev, A.G., Jurassic deposits in the East Russian Platform, in *Voprosy sovershenstvovaniya stratigraficheskoi osnovy fanerozoiskikh otlozhenii neftegazonosnykh regionov Rossii* (Problems of Improving the Stratigraphic Background of the Phanerozoic Deposits in Petroliferous Regions of Russia), St. Petersburg: Vseross. Neft. Naucho-Issled. Geol. Inst., 1997, pp. 95–107.

Oppel, A., Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands, nach ihren einzelnen Gliederen eingeteilt und verglichen. Teil 2, *Jahreshefte des Vereins für Vaterländische Naturkunde Württemberg*, 1857, vol. 13, pp. 141–396.

Oppel, A., Über jurassische Cephalopoden, in *Palaeontologische Mitteilungen aus dem Museum des Koenigl. Bayer. Staates. 1862. III. Theil I*, pp. 127–162.

d'Orbigny, A.D., *Paléontologie Française. Description Zoologique et Géologique de Tout les Animaux Mollusques et Rayonnés Fossiles de France. Terrains Oolitiques ou Jurassiques. Tome 1. Céphalopodes. Part 2,* Paris: V. Masson, 1842–1851, pp. 113–120 (1842).

Panteleev, F.P., On the Discovery of Lower Triassic labyrinthodonts in the Don Bend area, *Dokl. Akad. Nauk SSSR*, 1947, vol. LVIII, no. 9, pp. 2029–2032.

Permyakov, V.V., Sterlin, B.P., and Yamnichenko, I.M., The new stratigraphic scheme of the Jurassic deposits of the platform part of Ukraine, in *Biostratigrafiya, paleontologiya osadochnogo chekhla Ukrainy* (Biostratigraphy and Paleontology of the Sedimentary Cover of Ukraine), Kyiv: Naukova Dumka, 1987, pp. 56–62.

Pervushov, E.M., Saltykov, V.F., Seltzer, V.B., et al., The Bajocian-Bathonian Key Section from the Malyj Kamennyj Gully (the North of the Volgograd Region), *Izv. Saratov. Univ. Ser. Nauki o Zemle*, 2011, vol. 11, no. 1, pp. 24–39.

Pugaczewska, H., Belemnoids from the Jurassic of Poland, *Acta Palaeont. Polon.*, 1961, vol. 6, no. 2, pp. 103–236.

Quenstedt, F.A., 1 Band. Cephalopoden, in *Petrefactenkunde Deutschlands. 1 Abt.*, Tübingen: Laupp, 1845–1849. pp. 265–472 (1848), Atlas (1849).

Riegraf, W., Revision der belemniten des Schwabischen Jura. Part 7, *Palaeontographica. Abt. A*, 1980, vol. 169, nos. 4–6, pp. 128–206.

Riegraf, W., Revision der belemniten des Schwabischen Jura. Part 8, *Palaeontographica. Abt. A*, 1981, vol. 173, nos. 1–4, pp. 64–139.

Riegraf, W., The belemnites described by Baron Ernst Friedrich von Schlotheim (1764–1832), *Paläont. Z.*, 2001, vol. 74, no. 3 (for 2000), pp. 281–303.

Riegraf, W., Janssen, N., and Schmitt-Riegraf, C., Cephalopoda dibranchiata fossiles (Coleoidea) II. Supplementum ad mandibula fossiles ammonitorum et nautilorum (Rhyncholithi et Rhynchoteuthes, excl. aptychi et anaptychi), *in Fossilium Catalogus. I: Animalia. Pt. 135*, Leiden: Backhuys Publ., 1998.

Rostovtsev, K.O., Kalmyk trough, in *Yura Kavkaza. Tr. Mezhved. Stratigr. kom.* (Jurassic of Caucasus. Proc. Interdepart. Stratigr. Com.), 1992, vol. 22, pp. 12–13.

Rykov, S.P., *To the stratigraphy of Mesozoic deposits in the northern part of the Donskaya Luka area, Uch. zap. SGU*, 1951, vol. XXVIII, Ser. Geol, pp. 158–164.

Rykov, S.P., *To the age of "Gnilushka Beds", Uch. zap. SGU*, 1953, vol. XXXVII, Ser. Geol., pp. 111–119.

Rykov, S.P., *Geologicheskaya karta SSSR. Masshtab 1 : 200 000. List M-38-XXVI (The 1 : 200 000 Geological Map of the USSR. Sheet M-38-XXVI)*, Leningrad: Vseross. Nauchno-Issled. Geol. Inst., 1960 [in Russian].

Rykov, S.P. and Ochev, V.G., About the locality of Triassic vertebrates in the Don Bend Area, in *Voprosy geologii Yuzhnogo Urala i Povolzh'ya. Ch. II (Mezozoi)* (Problems of Geology of the Southern Urals and Volga Region. Pt. II: Mesozoic), 1966, vol. 3 (for 1965), pp. 58–62.

Rykov, S.P., Khlystova, V.N., and Kozlov, O.G., *Geologicheskaya karta SSSR. Masshtab 1 : 200000. List M-38-XX* (The 1 : 200 000 Geological Map of the USSR. Sheet M-38-XX), Moscow: Vseross. Nauchno-Issled. Geol. Inst., 1979 [in Russian].

Sadki, D., Weis, R., and Haas, R., Ammonites et belemnites des "Couches à Sonninia" (Bajocien inférieur) du Grand-duché de Luxembourg, *Ferrantia*, 2015, no. 71, pp. 53–86.

Sachs, V.N. and Nalnjaeva, T.I., *Verkhneyurskie i nizhnemelovye belemnity Severa SSSR. Rody Cylindroteuthis i Lagonibelus* (The Upper Jurassic and Lower Cretaceous Belemnites of the North of the USSR. Genera Cylindroteuthis and Lagonibelus), Moscow: Nauka, 1964 [in Russian].

Sachs, V.N. and Nalnjaeva, T.I., Recognition of the superfamily Passaloteuthaceae in the suborder Belemnoidea (Cephalopoda, Dibranchia, Decapoda), *Dokl. Akad. Nauk SSSR*, 1967, vol. 173, no. 2, pp. 438–441.

Sachs, V.N. and Nalnjaeva, T.I., *Ranne- i sredneyurskie belemnity severa SSSR. Megateuthinae i Pseudodicoelitinae* (The Early and Middle Jurassic Belemnites of the North of the USSR. Megateuthinae and Pseudodicoelitinae), Leningrad: Nauka, 1975 [in Russian].

Saltykov, V.F., Paleogeomorphology of the northern part of the Don–Medveditsa dislocation in the Bajocian time, *Geomorfologiya*, 2004, no. 4, pp. 78–86.

Saltykov, V.F., The state of stratigraphic knowledge of the Upper Bajocian deposits of the Lower Volga Region. Pt. 3. State of knowledge of the upper substage of the Bajocian, in *Nedra Povolzh'ya i Prikaspiya* (Volga and Pricaspian Region Resources), 2006, vol. 47, pp. 24–33.

Saltykov, V.F., *Srednyaya yura severnoi okonechnosti Dono-Medveditskikh dislokatsii* (The Middle Jurassic from the Northern Terminations of the Don–Medveditsa Dislocations), Saratov: Izd. Tsentr "Nauka", 2008 [in Russian].

Saltykov, V.F. and Kiseleva, O.I., Middle Jurassic continental Gnilushkinskyi Formation of Povolzhie, *Byull. Mosk. Ob-va Ispyt. Prir. Otd. Geol.*, 2006, vol. 81, no. 1, pp. 16–35.

Sarytcheva, A.I., Stratigraphy of the Jurassic of Stalingrad Volga area by foraminifera, *Tr. nauchn. konf. po stratigrafii mezozoya i paleogena Nizhnego Povolzh'ya i smezhnykh oblastei* (Proc. Sci. Conf. on Mesozoic and Paleogene Stratigraphy of the Lower Volga Region and Adjacent Areas), Vol'sk, 1958, pp. 135–141.

Sarytcheva, A.I., New data on stratigraphy of the Jurassic deposits of the Volgograd Region, in *Tr. Volgograd. NIING*, 1965, vol. 3 (for 1964), pp. 48–58.

Sarytcheva, A.I., Microfaunistic characteristics of the Bajocian and Upper Jurassic deposits of the Buzga block, in *Tr. VNIGRI* (Trans. All-Russ. Petrol. Res. Explor. Inst.), 1971, vol. 84, pp. 76–83.

Sazonov, N.T., Lower- and Middle Jurassic deposits of the Volga Region and tasks for further study, *Tr. nauchn. konf. po stratigrafii mezozoya i paleogena Nizhnego Povolzh'ya i smezhnykh oblastei* (Proc. Sci. Conf. on Mesozoic and

Paleogene Stratigraphy of the Lower Volga Region and Adjacent Areas), Vol'sk, 1958, pp. 143–161.

Sazonov, N.T., The unified stratigraphic scheme of the Jurassic deposits of the Russian Platform (project), in *Tr. Vsesoyuz. soveshch. po utochneniyu unifitsirovannoi skhemy stratigrafii mezozoiskikh otlozhenii Russkoi platformy. Tom vtoroi. Yurskaya sistema. Tr. VNIGNI* (Proc. All-Union Conf. on the Improvements of the Unified Stratigraphic Scheme of the Mesozoic Sediments of the Russian Platform. Vol. 2: Jurassic System. Trans. All-Russ. Petrol. Res. Explor. Inst.), 1961, vol. XXIX, pp. 5–47.

Sazonova, I.G. and Sazonov, N.T., *Paleogeografiya Russkoi platformy v yurskoe i rannemelovoe vremya* (Paleogeography of the Russian platform in the Jurassic and early Cretaceous time), Leningrad: Nedra, 1967 [in Russian].

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

Schlotheim, E.F., von, *Die Petrefaktenkunde auf Ihrem Jetzigen Standpunkte Durch die Beschreibung Seiner Sammlung Versteinerter und Fossiler Überreste des Thier- und Pflanzenreichs der Vorwelt Erläutert*, Gotha: Becker, 1820.

Schwegler, E., Revision der belemniten des Schwäbischen Jura. Teil 4, *Palaeontographica. Abt. A*, 1965, vol. 124, nos. 4–6, pp. 75–115.

Schwegler, E., Revision der belemniten des Schwäbischen Jura. Teil 6, *Palaeontographica. Abt. A*, 1971, vol. 138, nos. 1–4, pp. 81–129.

Smirnov, A.V., Lithology of the Jurassic and Lower Cretaceous deposits in the Stalingrad region, in *Tr. nauchn. konf. po stratigrafii mezozoya i paleogena Nizhnego Povolzh'ya i smezhnykh oblastei* (Proc. Sci. Conf. on Mesozoic and Paleogene Stratigraphy of the Lower Volga Region and Adjacent Areas), Vol'sk, 1958, pp. 319–328.

Smirnov, A.V., Lithology and lithofacies of the Jurassic deposits in the Volgograd Volga Region, in *Tr. Volgograd. NIING*, 1962, vol. 1, pp. 111–129.

Smirnov, A.V., New data on the age of the Gnilushka Series and its analogues, in *Voprosy geologii Yuzhnogo Urala i Povolzh'ya* (Problems in Geology of the Southern Urals and Volga Region), 1966, vol. 3 (for 1965), Pt. II (Mesozoic), pp. 138–156.

Sterlin, B.P., Jurassic stratigraphy and facies in the South of the Russian Platform, in *Tr. soveshch., posvyashchennogo izucheniyu osadochnykh formatsii Bol'shogo Donbassa i svyazannykh s nimi poleznykh iskopaemykh* (Proc. Conf. Devoted to Study of the Bolshoi Donbass Sedimentary Formations and Related Mineral Resources), Kharkov: Kharkov. Gos. Univ., 1964, pp. 261–270.

Stolley, E., *Die systematik der belemniten*, in *Jahresber. Niedersächsischen Geol. Ver.*, 1919, vol. 11, pp. 1–59.

Stolley, E., Zur systematik und stratigraphie median gefurchter belemniten, in *Jahresber. Niedersächsischen Geol. Ver.*, 1927, vol. 20, pp. 111–136.

Troitskaya, E.A. and Khabarova, T.N., The Middle Jurassic stratigraphy of the Lower Volga Region, in *Sb. nauchn. tr. "Yurskie otlozheniya Russkoi platformy"* (Coll. Sci. Works. "*Jurasic Deposits of the Russian Platform*"), Leningrad: Vseross. Neft. Naucho-Issled. Geol. Inst., 1986, pp. 23–30.

Tsygankov, A.V., The reflection of local anticline structures in the bedrock relief of the Don–Medveditsa dislocation zone, *Geol. Nefti i Gaza*, 1958, no. 9, pp. 62–64.

Unifitsirovannaya stratigraficheskaya skhema yurskikh otlozhenii Russkoi platformy (Unified Stratigraphic Scheme of Jurassic Deposits in the Russian Platform), Yakovlev, S.P., Ed., St. Petersburg: Vseross. Neft. Naucho-Issled. Geol. Inst., 1993 [in Russian].

Unifitsirovannaya regional'naya stratigraficheskaya schema yurskikh otlozhenii Vostochno-Evropeiskoi platformy. Ob''yasnitel'naya zapiska (Unified regional stratigraphic scheme of the Jurassic of East European Platform. Explanatory note), Mitta, V.V., Ed., Moscow: Paleontol. Inst. Ross. Acad. Nauk–All-Russ. Res. Geol. Inst., 2012 [in Russian].

Voltz, P.L., *Observations sur les bélemnites*, *Mém. Soc. Hist. Nat. Strasbourg*, 1830, vol. 1, pp. I–IV, 1–70.

Voronin, N.I., On the Geological Structure the Don-Bend, *Byull. Mosk. Ob-va Ispyt. Prir. Otd. Geol., Nov. Ser. L*, 1945, vol. XX, nos. 3–4, pp. 72–95.

Waagen, W., Über die Zone des Ammonites Sowerbyi, *Geognostisch-Paläontologische Beiträge*, 1867, vol. 1, no. 2, pp. 507–668.

Weis, R., Bélemnites (Cephalopoda, Coleoidea) du Bajocien de Rumelange (Luxembourg), *Bull. Soc. Nat. Luxembourgeois*, 2006, no. 106, pp. 151–165.

Weis, R. and Gross, N., Les bélemnites, in *Fossiles et Minéraux de la Carrière d'Ottange-Rumelange*, Fayard, J.-P., Gross, N., Lajournade, J.-B., et al., Eds., Petange: GEOLOR et AGMP, 2005, pp. 67–72.

Weis, R. and Mariotti, N., A belemnite fauna from the Aalenian–Bajocian boundary beds of the Grand Duchy of Luxembourg (NE Paris Basin), *Boll. Soc. Paleont. Ital.*, 2008, vol. 46, nos. 2–3, pp. 149–174.

Weis, R., Mariotti, N., and Riegraf, W., The belemnite family Holcobelidae (Coleoidea) in the European Jurassic: systematics, biostratigraphy, palaeobiogeography and evolutionary trends, *Palaeodiversity*, 2012, vol. 5, pp. 13–49.

Weis, R., Sadki, D., and Mariotti, N., Aalenian–Bajocian belemnites from Middle and High Atlas, Morocco: taxonomy, biostratigraphy and palaeobiogeographical affinities, *N. Jb. Geol. Paläont. Abh.*, 2017, vol. 284, no. 2, pp. 215–240.

Yamnichenko, I.M., Dnieper-Donets depression, in *Stratigrafiya URSR. T.VII. Yura* (Stratigraphy of the URSR. Vol. VII: Jurassic), Yamnichenko, I.M., Ed., Kyiv: Naukova Dumka, 1969, pp. 71–101.

Translated by S. Nikolaeva