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Early Jurassic (Sinemurian) Ammonoids from the Boulders of the Greek Quarry, Central Crimea

B. A. Zaitsev[a], * and A. P. Ippolitov[b], **

[a] *Vernadsky Crimean Federal University, Simferopol, 295007 Russia*
[b] *Geological Institute, Russian Academy of Sciences, Moscow, 119017 Russia*
**e-mail: bogdan.a.zaitsev@gmail.com*
***e-mail: ippolitov.ap@gmail.com*

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Abstract—The Sinemurian ammonoids from the boulders in the Greek quarry (Salgir River basin, southeast of Simferopol) are described. The assemblages are represented by Phylloceratidae (*Phylloceras*, *Zetoceras*, and *Partschiceras*), Juraphyllitidae (*Juraphyllites* and *Paradasyceras*), Schlotheimiidae (*Phricodoceras*), Arietitidae (*Coroniceras*, *Metophioceras*, *Arnioceras*, and *Asteroceras*), Oxynoticeratidae (*Gleviceras*), Echioceratidae (*Plesechioceras*, *Orthechioceras*, *Echioceras*, and *Paltechioceras*), Eoderoceratidae (*Eoderoceras*), Epideroceratidae (*Epideroceras*), and, questionably, Coeloceratidae (?*Tetraspidoceras*). A new species *Asteroceras dommerguesi* sp. nov. is described. A sequence of biostratigraphic units (biohorizons and beds with fauna) was reconstructed and correlated with known biostratigraphic units (zones, subzones and biohorizons) of the Mediterranean area. The ammonite assemblages were found to be similar to those of the Northern Tethyan margin (Pontic and Austroalpine subprovinces).

Keywords: ammonites, Crimea, Sinemurian, Lower Jurassic, stratigraphy, paleobiogeography

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INTRODUCTION

Outcrops of the Lower Jurassic deposits occupy significant areas within the Main Ridge of the Crimean Mountains and on the Black Sea coast, as well as between the Main and Inner ridges in the Belbek, Kacha, Alma, and Salgir river basins. According to drilling data, faunistically characterized Lower Jurassic (Toarcian) rocks were also found in the south of the Crimean Lowland and in the Northern Sivash region (Matlay, 2018).

Lower Jurassic rocks have been known in Crimea since the first half of the 19th century (de Montpereux, 1837; Huot, 1842). The information about findings of Early Jurassic ammonoids on the Crimean Peninsula appeared as long ago as the mid-19th century (Baily, 1858). We assume, however, that Baily (1858) mistakenly reported as Jurassic findings from the Lower Cretaceous carbonate rocks near the village of Biasali (now Verkhorechye), in the vicinity of which the Lower Jurassic is represented only by thinly rhythmical flysch deposits (Baraboshkin, 1997; Nikitin and Bolotov, 2006, p. 116).

Thus, the Lower Jurassic of Crimea has had a more than 180-year history of study. However, despite the large body of information about the findings of Early Jurassic ammonoids in Crimea, very few images and descriptions have been published. The taxa recognized by different authors were often published in lists without any explanations. In addition, numerous stratigraphic units, which included the Lower Jurassic deposits of Crimea by different authors, do not meet the requirements of the Stratigraphic Code of Russia (*Stratigraficheskii*..., 2019), and the presence of the Lower Jurassic in their composition was often reported without sufficient paleontological justification (see Yudin and Zaitsev, 2020a).

Within the fold-thrust structure of the Crimean Mountains, Early Jurassic ammonoids are known mainly from deep-water thin-rhythmical flysch attributed to the Triassic—Early Jurassic Tavric series (distinguished by Vogdt (1901)). At the same time, such findings are extremely rare. Most of the ammonoids were collected in several localities on the northern slope of the Kacha Uplift (Muratov, 1960). This is largely due to a good state of geological knowledge of this territory (Zaitsev and Arkadiev, 2019; Zaitsev et al., 2022).

Thus, the Triassic—Early Jurassic sedimentary complex (Tavric series)—the lowermost level of the structure of the Crimean Mountains—is still not stratified. In most areas of its development, the position of the Triassic—Lower Jurassic boundary is either not established or is established conditionally.

Significantly more findings of Early Jurassic ammonoids are known from terrigenous and carbonate rocks of the Simferopol mélange (distinguished by Yudin (1993)), which is the largest chaotic complex of endogenous origin in Crimea. The mélange rocks represent a chaotic accumulation of boulders, varying in age, composition, and size (from tens of centimeters to hundreds of meters across), incorporated into the matrix of disintegrated schistose siltstones and mudstones, which sometimes grade to mylonites (Yudin, 1993).

The Lower Jurassic rock boulders are composed of shelf limestones, sandstones, and conglomerates, as well as bathyal siltstones, flysch fragments, and mudstones (Aspisov and Kostenko, 1982; Zaika-Novatsky and Soloviev, 1988; Yudin, 1993, 2011; Nenakhov et al., 1998). The tectonically brecciated rocks of the Simferopol mélange form a NE-trending linear structure, bounding from the north the development area of flysch deposits of the Tavric series. They extend almost continuously between the Kacha and Maly Salgir river basins (Yudin, 2018). The structure of the Simferopol mélange has recently been studied in detail in a small area within its tectonotype (Yudin and Zaitsev, 2020b).

This article is devoted to the study of the rich assemblage of Sinemurian ammonoids, collected from boulders of the so-called Greek Quarry, which is located in the Salgir River basin on the southern outskirts of Simferopol (Fig. 1a). The quarry is located in the left side of the Kurtsy Hollow and uncovers rocks of the Simferopol mélange at 500 m southwest of its tectonotype, which is located between the New Petropavlovka Quarry and the right coast of the Simferopol Reservoir (Yudin, 1993, 2011, 2014).

The fossil fauna of a wide stratigraphic range was collected from the boulders of terrigenous rocks in the Kurtsy Hollow. For example, ammonite *Dactylioceras tenuicostatum* (Y. et B.) (Permyakov, 1969, p. 104; Slavin, 1982, p. 73), which is the index species of the D. tenuicostatum biohorizon of the same-name Lower Toarcian Subzone of Europe, was found in mudstones of its left bank (Page, 2003). Toarcian–Aalenian bivalves were also found in these "sandy-clay rocks" (Komarova and Dekhtyareva, 1982), and Late Triassic ammonoids were found on both banks of the Kurtsy Hollow between the settlements of Petropavlovka and Lozovoe (Astakhova, 1968, p. 45; Teslenko et al., 1978, p. 73).

The fossil fauna of a wide stratigraphic range was collected from the boulders of carbonate rocks in the Simferopol melange. In the Salgir River valley, there are findings of Early Carboniferous (Miklukho-Maklai and Muratov, 1958) and Permian (Kotlyar et al., 1999) foraminifers, Middle Permian trilobites (Mychko and Alekseev, 2017, p. 69), and Late Triassic ammonoids (Moiseev, 1932, p. 592). Numerous boulders bearing the Early Jurassic fossil fauna of the Sinemurian (Moiseev, 1925, 1944; Zaitsev and Ippolitov, 2015), Pliensbachian (Moiseev, 1925, 1944), and Toarcian (Ippolitov et al., 2008, 2010) were also studied there.

To date, there are, as a minimum, four localities of carbonate rock boulders bearing Early Jurassic ammonoids in the Salgir River basin: Greek Quarry, Petropavlovka Quarry, Lozovoe Quarry, and an abandoned quarry in the village of Teploe (Cheshmezhdi) (Fig. 1). The discovery of the fossil cephalopod assemblage in the Greek Quarry was briefly described in (Zaitsev and Ippolitov, 2015), but detailed information about this locality has not yet been published.

HISTORY OF STUDY OF THE LOWER JURASSIC LIMESTONES IN THE SALGIR RIVER BASIN

Vogdt (1901) was the first to point out in a report for the St. Petersburg Society of Naturalists "the presence of limestone outcrops with Lower Lias fauna among the shales in the Salgir River valley" (*Otchet*..., 1911, p. 169). He noted that this fauna is "very similar to that of the Hirlats deposits on the northern slope of the Alps" (Vogdt, 1901, p. 303), but did not specify the exact position of the localities. P.A. Dvoichenko noted that, "on Vogdt's handwritten card, five outcrops of these limestones in the vicinity of Simferopol are indicated" and that, later, "their number has increased" owing to the field works of N.M. Prokopenko (Dvoichenko, 1926, p. 22). However, Vogdt's detailed report and his map and profiles remained unpublished (Vernadsky, 1997, p. 73).

According to P.A. Dvoichenko, it was Vogdt who first reported the findings of Early Jurassic ammonoids in the Salgir River valley. Ammonoids were collected in 1900 in the Aratuk gully near the village of Cheshmedzhi (now the village of Teploe) in "shell crystalline limestones lying among shales ... at the contact with porphyrite" (Dvoichenko, 1926, p. 22). In addition, Dvoichenko reported several other outcrops of Early Jurassic limestones "near the village of Petropavlovka" and two outcrops "at 8 versts of the Alushta highway" (now the village of Pionerskoe), in one of which ammonoids were also found.

Mukhin (1917) identified some ammonoids collected by Vogdt in limestone boulders to the south of Simferopol (without specifying their exact geographical reference) and established the presence of the following species: *Phylloceras meneghinii* Gemmellaro, *Ph*. cf. *frondosum* (Reynes), *Ph*. sp., *Ph. tenuistriatum* [=*Partschiceras tenuistriatum* (Meneghini)], and *Arietites semicostatus* [=*Arnioceras semicostatum* (Young et Bird)]. Mukhin attributes this assemblage partly to the upper Pliensbachian Spinatum Zone ("Middle Lias Amaltheus spinatus Zone," in Mukhin's terminology) and partly to the lower Sinemurian Semicostatum Zone ("Arietites semicostatus Zone"), although the listed definitions in the absence of images can be interpreted in different ways.

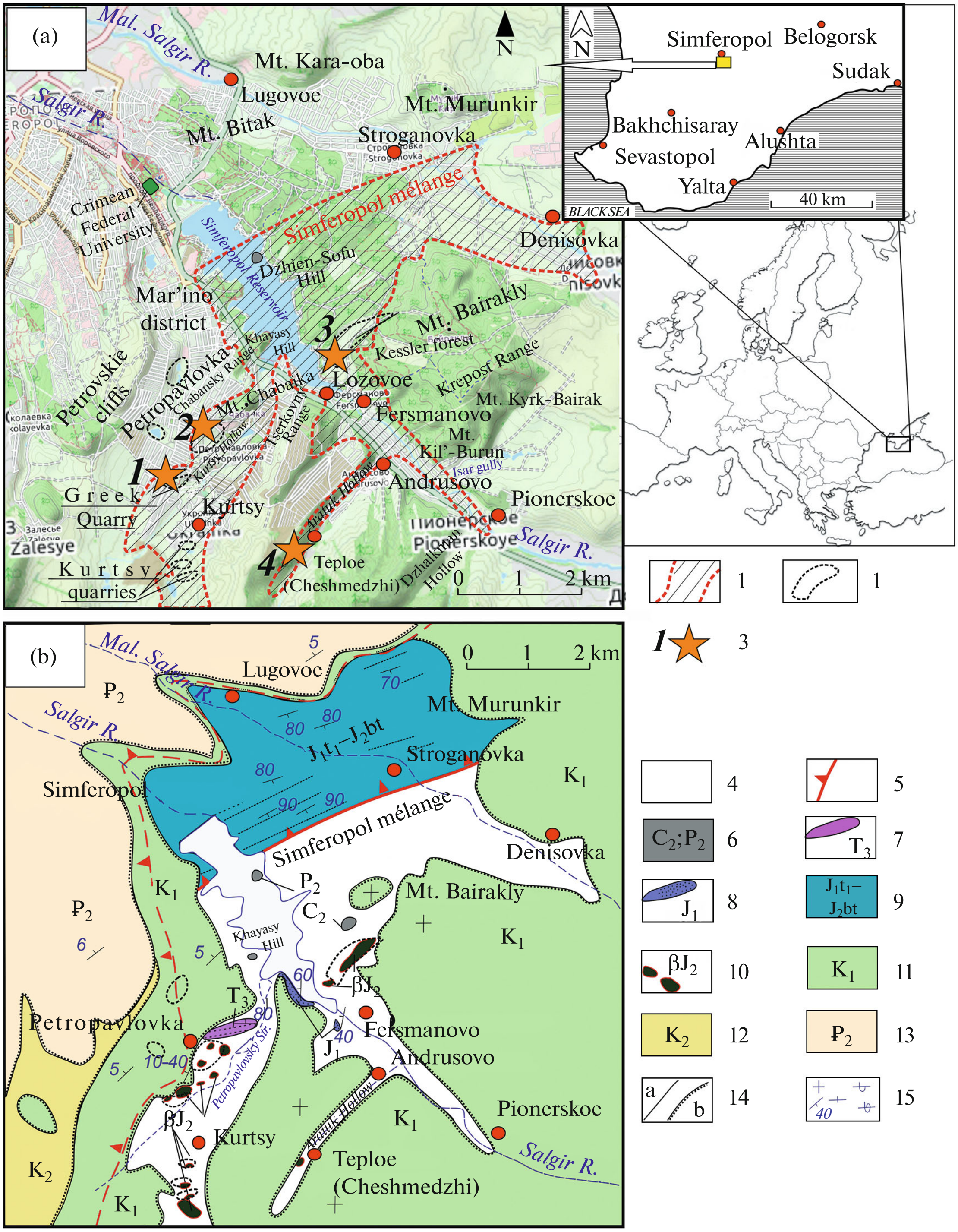


Fig. 1. Localities of Early Jurassic ammonoids in the Salgir River basin on the orographic map (a) and the geological map (b) (Yudin, 2018, with amendments). (a): (1) Zone of the Simferopol mélange; (2) quarries; (3) localities ((1) Greek Quarry; (2) Petropavlovka Quarry; (3) Lozovoe Quarry; (4) the quarry near the settlement of Teploe (Cheshmedzhi); (b): (4) zone of outcrops of the Simferopol mélange; (5) thrusts and strike slip-thrust faults; (6) single Late Paleozoic (Carboniferous–Permian) carbonate rock boulders in the mélange; (7) boulder of Triassic psephites near the village of Petropavlovka; (8) sandstones, attributed by A.S. Moiseev to "Eski-Orda" ones (Moiseev, 1932; Pchelintsev, 1937); (9) lower Toarcian–Bathonian Bitak Formation: conglomerates, gravellites, sandstones, and siltstones with coal-bearing interbeds; (10) Middle Jurassic: dolerites and diabase porphyrites; (11) Lower Cretaceous: clays, limestones, sandstones, and conglomerates; (12) Upper Cretaceous (Campanian and Maastrichtian marls); (13) Middle Eocene nummulitic limestones; (14) stratigraphic boundaries ((a) conformable, (b) unconformable); (15) dip and strike.

Later, Moiseev (1925) revised the collections described by Mukhin (1917) and supplemented them with his own findings. Moiseev noted that the finding from the environs of the village of Petropavlovka, which "was recognized by Mukhin (1917) as *A. semicostatus* Young, Bird ..., is much more similar to *A. raricostatus* Zieten" (Moiseev, 1925, p. 985) and mentioned his own finding of *A.* cf. *raricostatus* from the same locality as an argument (Moiseev, 1925, p. 963). According to modern concepts, the species *Arietites raricostatus* [=*Echioceras raricostatum* (Zieten)] characterizes the E. raricostatum/E. raricostatoides biohorizon of the upper Sinemurian Raricostatum Zone (Page, 2003).

A special study by A.S. Moiseev devoted to the Early Jurassic ammonoids of Crimea was published after his death (Moiseev, 1944). Moiseev mentioned three localities of the Lower Jurassic fauna in the Salgir River basin: (1) the village of Cheshmedzhi (now the village of Teploe)—clay brown limestone boulders; (2) the village of Petropavlovka—gray limestone boulders; (3) the area of the Salgirchik estate on the Alushta highway (now the village of Pionerskoe). Contrary to Dvoichenko (1926), Moiseev stated that no ammonoids were found in outcrops lining the Alushta highway, but a rich brachiopod fauna of the Lotharingian Stage (upper Sinemurian) was collected. Moiseev identified the ammonite *Seguenziceras* ex gr. *algovianum* [=*Arieticeras algovianum* (Oppel)] from the locality in the village of Teploe (Cheshmedzhi). According to modern concepts, it is an index species of the A. algovianum biohorizon of the Gibbosus Subzone of the upper Pliensbachian Margaritatus Zone (Page, 2003). Unfortunately, the images of ammonites from the collection described by Moiseev (1944) were not published, and his collection of Early Jurassic ammonoids was lost. Therefore, it is not yet possible to verify the validity of this definition.

During the 1955–1958 geological survey (Shalimov, 1960), ammonites identified by L.V. Sibiryakova as *Echioceras* sp. and *Schlotheimia* sp. were collected in limestone boulders in the area of the villages of Petropavlovka and Mar'ino (south of Simferopol) (Shalimov, 1962, p. 94). Apparently, the same specimens were redefined by G.Ya. Krymgolts as *Echioceras* cf. *gracile* (Quenstedt) and *Epideroceras* aff. *steinmanni* (Hug) (Shalimov, 1969, p. 93). Both species indicate upper Sinemurian, although the latter was mistakenly attributed by A.I. Shalimov to the Pliensbachian (Shalimov, 1969). *Echioceras* aff. *concinnum* Trueman et Williams (definition by G.Ya. Krymgolts) was found in another "limestone boulder, lying in conglomerates" (Shalimov, 1969, p. 93). This species is now considered a junior subjective synonym of *E. quenstedti* (Schafhautl) (Getty, 1972, p. 188), characteristic of the upper Sinemurian Raricostatum Zone of Western Europe (Page, 2003).

In addition, Shalimov mentioned the finding of Toarcian *Coeloceras crassum* (Phillips) (determination by V.I. Bodylevsky) in one of the limestone boulders in the area of the village of Lozovoe and Pliensbachian *Uptonia* sp. (definition by G.Ya. Krymgolts) in another boulder (Krymgolts and Shalimov, 1961, p. 74).

Then Furduy and Zagorodnyuk (1987) noted the findings of ammonoids in cherry red fine-grained limestone boulders uncovered in the northern side of the New Petropavlovka Quarry, but did not provide any definitions. In parallel, geological studies in the Salgir River basin were carried out by the specialists from Kiev University, who conducted educational geological training in the area of the Simferopol Reservoir (Zaika-Novatsky et al., 1976). Dekhtyareva et al. (1978) mention the findings of red-brown limestone boulders, in which Early Jurassic belemnites were identified. With reference to the "oral report of V.M. Nerodenko," they pointed out that "the belemnites found in [these] limestones determine the Upper Cretaceous age" (Furdui and Zagorodnyuk, 1987, p. 60). In the same year, V.G. Klikushin, a researcher from the Leningrad Mining Institute, pointed out the presence of "Middle Lias Ammonitico Rosso facies" in limestone boulders in the area of the village of Petropavlovka (Klikushin, 1987, p. 236).

It should be noted that none of the articles cited above presents images of ammonoids. As a result, the definitions of ammonites and, accordingly, the dates based on these definitions are, strictly speaking, hardly possible to verify. The situation changed only in the late 1990s, when a cherry red limestone block was uncovered in the southeastern tip of the Lozovoe Quarry and A.I. Tishchenko (KO UkrGGRI) drew attention to it. A rich assemblage of Middle–Late Toarcian cephalopods (ammonoids, nautiloids, belemnites, and aulacoceratids) was found in the boulder. Some ammonites were determined and depicted by M.A. Rogov (Ippolitov et al., 2008, 2010). In addition, A.P. Ippolitov suggested that the collected cephalopod assemblage is similar to previously collected ones from lithologically similar boulders from the Petropavlovka Quarry (Dekhtyareva et al., 1978; Furdui and Zagorodnyuk, 1987). Finally, preliminary data on the discovery of the Sinemurian–?Pliensbachian cephalopod assemblage in limestones in the Greek Quarry, including their images, were published in (Zaitsev and Ippolitov, 2015).

DESCRIPTION OF THE LOCALITY

Greek Quarry (coordinates: 44°53′35″ N, 34°08′10″ E; GPS altitude 342 m) is located on the left side of the Kurtsy Hollow, the northern outskirts of the village of Ukrainka (formerly Kurtsy). In previous publications and geological reports, it was also called the "Northern Kurtsy Quarry" (Fersman, 1907), "a quarry near the school in the village of Ukrainka" (Zaika-Novatsky et al., 1976). From the end of the 19th century, the rocks of the Kurtsy deposit were mined here. Fersman (1907, p. 254) was the first to report "eruptive limestone inclusions in the village of Kurtsy." The quarry is currently abandoned.

During the operation of the quarry, one of the bodies of the "Bodrak subvolcanic complex" composed of dolerites, spilites, diabase porphyrites, and their tuffs of Middle Jurassic age was uncovered (Zaika-Novatsky et al., 1989; Spiridonov et al., 1990; Sysolin and Pravikova, 2008; Spiridonov, 2017). Igneous rock bodies are enclosed in mélange (crushed, strongly folded) Triassic?–Lower Jurassic terrigenous rocks: mudstones and siltstones (Yudin, 2014). These rocks are overlain by the Lower Cretaceous deposits (Hauterivian; Zaika-Novatsky et al., 1976) of gently NW-dipping coral and bioclastic limestones (Figs. 2a–2c). The basal horizon of boulder-pebble conglomerates lies at the base of this stratum. Corals, gastropods, echinoid fragments, bivalves, and a large nautiloid *Cymatoceras* sp. were found in Cretaceous limestones and conglomerates. The overlap of the Lower Cretaceous strata on the mélange deposits is well expressed 150 m to the west of the quarry, near the highway (Fig. 2d).

Folded siltstones, mudstones, and greenish-yellow sandstones are observed, which, apparently, represent a matrix of mélange. At the northwestern end of the quarry, on its first bench, there are outcrops of crushed greenish-yellow siltstones, mudstones, and sandstones.

In the upper part of the western side of the quarry, there are outcrops of fine-grained sandstones with a platy parting, also probably belonging to the mélange matrix. On the second and third benches of the quarry, in its western part, there are numerous angular, more or less isometric carbonate and terrigenous-carbonate boulders with a diameter of up to 1.8 m (Figs. 2a, 2b).

Six lithological varieties (I–VI) can be distinguished among the rocks composing the boulders.

(I) Conglomerates, sometimes grading into pudding limestone. They consist of well- and moderately rounded dolerite and tuff fragments (up to 20 cm in diameter) and smaller pebbles of siltstones and variegated consertal sandstones. Pebbles are often flattened in shape (Fig. 3a). The cement is carbonate, consisting of gray-pink and yellowish (due to the ferrugination of pebbles) limestone and a large number of bioclasts. The fossil fauna is represented by fragments of brachiopods, crinoid stems, colonial corals, echinoid spines.

These rocks belong to the basal horizon of the Lower Cretaceous deposits (K_1h) overlying the subvolcanic body. In the rock exposures, they can be traced in separate areas in the upper part of the side of the first bench of the quarry, as well as to the west of it (Fig. 2d).

Boulders composed of rocks of the types listed below originate from the Simferopol melange:

Terrigenous rocks:

(II) Siltstones gray-green, layered, forming platy gravel. A single boulder of this type measuring about 0.6 m across was found here. No macrofaunal remains were found here.

Carbonate and terrigenous-carbonate rocks:

(III) Limestone massive, gray to gray-pink, bioclastic, with fine-grained and sometimes cryptocrystalline cement. It contains abundant brachiopod shells and crinoid stems, as well as small carbonate pebbles, visible only on weathered surfaces.

The boulders composed of these rocks are the largest in size and account for about 50% of the total number of boulders (Fig. 3b). Many boulders are cut by fractures up to 5 mm wide, filled with fine-grained white calcite.

(IV) Limestone, micritic, brecciated, red to cherry red, sometimes with light green spots (irregularly colored), lumpy, with interbeds of clay limestone, sometimes grades into crinoid limestone (Fig. 3c). It contains abundant brachiopod and bivalve shells, sea lily fragments, and belemnite rostra.

Boulders of similar rocks can be observed near the Petropavlovka Dam, in the Mar'ino-2 microdistrict, and, in addition, in the Petropavlovka and Lozovoe quarries, where middle–late Toarcian ammonoids and belemnites were previously described (Ippolitov et al., 2008, 2010). Also, a late Toarcian belemnite assemblage was identified in a similar boulder on Bolshoy Kermen Mountain in the Bodrak River basin (Ippolitov et al., 2015).

In the Greek Quarry, boulders composed of rocks of the lithological variety IV are rare. Their maximum size in this locality is 1.2 m.

(V) Sandstones with carbonate cement, greenish gray, ferruginated, often with efflorescences on bedding surface. They grade into highly sandy indistinctly layered limestones, brecciated at the base of the layers with poorly rounded limestone pebbles up to 4 cm across. They contain numerous belemnite rostra and moulds of poorly preserved ammonoids. Inside some boulders are multidirectional cracks with sliding planes.

Many blocks have a distinct layered structure, which allows reconstructing the primary sedimentary succession. In one of the blocks (about 1 m across), for example, one can observe the following sequence of layers according to the assumed primary stratification:

Bed 1. Limestone yellowish gray, sandy, indistinctly layered, with gravel and small weakly rounded carbonate pebbles up to 3 cm across. The exposed thickness is 30 cm.

Bed 2. Sandstone greenish yellow, ferruginated, fine-grained, with shell detritus. The cement is carbonate, fine-grained. At the base of the layer, there are separate flattened limestone pebbles, similar in material composition to the rocks of Bed 1. Ammonoid moulds (*Zetoceras* sp.) and belemnite rostra were found at the base of Bed 2. The exposed thickness is 50 cm.

Ammonoids characteristic of the upper Sinemurian Raricostatum Zone of Western Europe were collected in limestone interlayers from several boulders composed of alternating sandstones and sandy limestones on the sec-

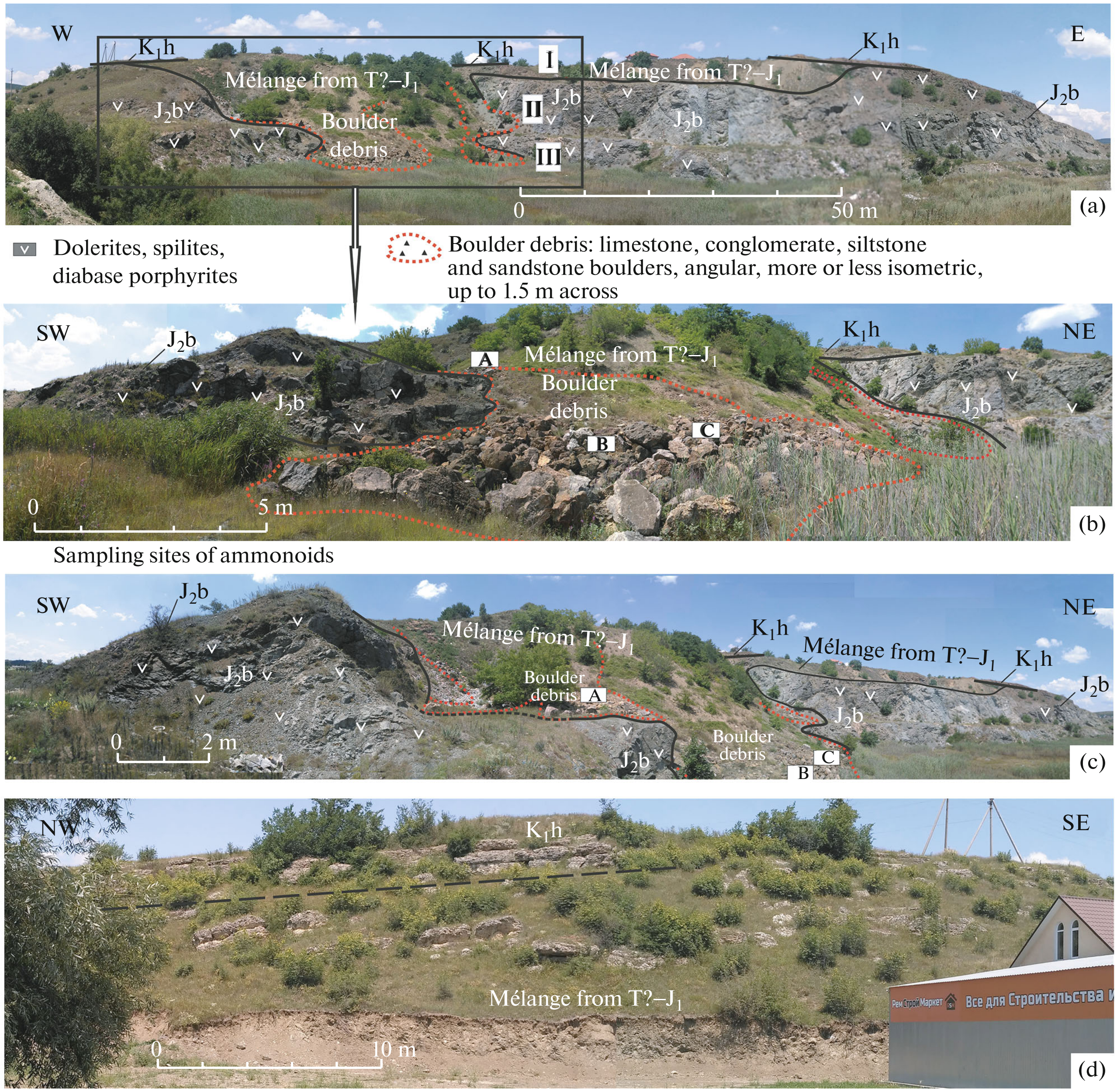


Fig. 2. Greek Quarry, panoramic view. (a) View of the quarry from the south; (b) view of the quarry side from the side of boulder debris; (c) view from the second bench, from the southwestern entrance to the quarry; (d) mélange outcrop 150 m to the west of quarry. (I–III) numbers of quarry benches. K_1h—Lower Cretaceous (Hauterivian): limestones coral and bioclastic, dolomitic, pinkish yellow, irregularly colored, massive, with a basal horizon of coarse-pebble conglomerates; J_2b—Middle Jurassic (Bajocian): mafic magmatic rocks (dolerites, spilites, diabase porphyrites); T?–J_1—mélange from Triassic?–Lower Jurassic rocks: matrix composed of folded terrigenous rocks (greenish gray mudstones, siltstones, and sandstones with platy parting), with a large amount of carbonate rock boulders. A, B, C—sampling sites of ammonoids in boulder debris on the second and third benches of quarry.

ond bench of the quarry (Fig. 2): *Paltechioceras oosteri* (Dumortier), *P. recticostatum* (Trueman et Williams), *P. romanicum* (Uhlig), *Phricodoceras lamellosum* (d'Orbigny), *Eoderoceras* sp. juv., *E. bispinatum* (Geyer), *E. praecursor* (Geyer), *Epideroceras lorioli* (Hug), *Ep. grande* Donovan, *Zetoceras zetes* (d'Orbigny), *Juraphyllites libertus* (Gemmellaro). The ammonoids from the sandstone interlayers are poorly preserved and are mainly represented by phylloceratids. The following faunal remains were recognized: ammonoids *Phylloceras* ex gr. *frondosum* (Reynes), *Zetoceras zetes* (d'Orbigny), *Juraphyllites* sp., *Eoderoceras praecursor* (Geyer), and *E.* sp. juv., as well as belemnites *Bairstowius scolops* (Simps.), *Nannobelus* cf. *cuspidatus* (Simps.), and "*Coeloteuthis oravica*" (Činč.). In addition, the Pliensbachian belemnite *Gastrobelus* cf. *teres* (Stahl) (Zaitsev and Ippolitov, 2015) apparently belonging to the described variety of boulders was found in the talus.

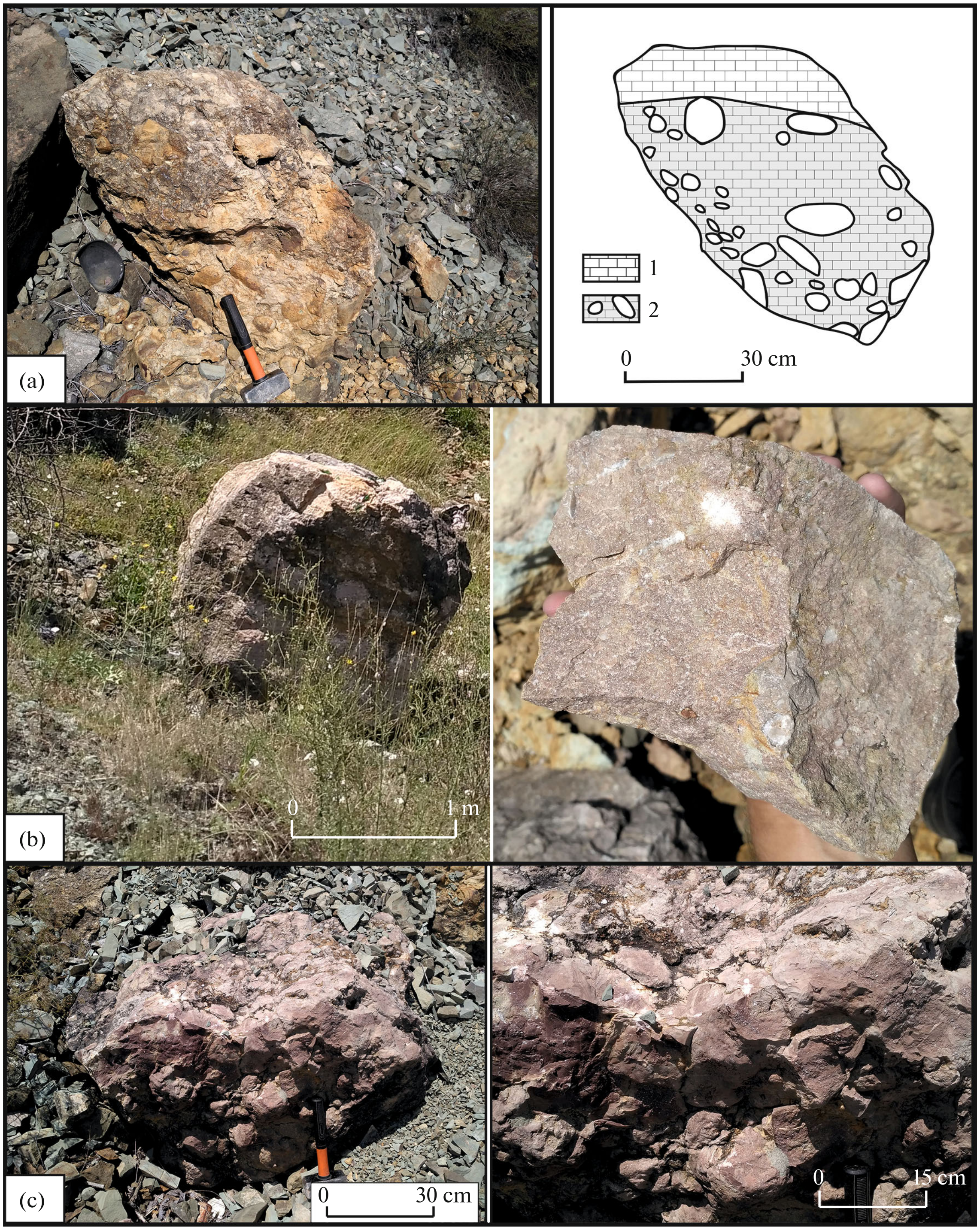


Fig. 3. Lithological types of boulders in the Greek Quarry. (a) The boulder of conglomerate which grades into pudding limestone (K_1h) in boulder debris on the second bench of the quarry (lithological type I): (1) brecciated bioclastic limestone, (2) carbonate-cemented conglomerate; (b) boulders, composed of bioclastic limestone (lithological type III); (c) boulder of dark cherry red micritic limestone (lithological type IV).

The number of blocks of lithological variety V is about 30% of their total number (Fig. 4a). It should be noted that some small blocks composed of similar rocks were also found in the Petropavlovka Quarry (Fig. 1) and on the slope of Tat'yanina Hill in the Bodrak River basin (Zaitsev, 2021).

(VI) Limestone yellowish pink and cream, micritic, dense, brecciated, with numerous weakly rounded limestone pebbles; in some intervals, it is almost entirely composed of ammonoid moulds—the "Ammonitico Rosso" facies, typical of the Lower Jurassic Tethys: Southern Alps, Northern Limestone

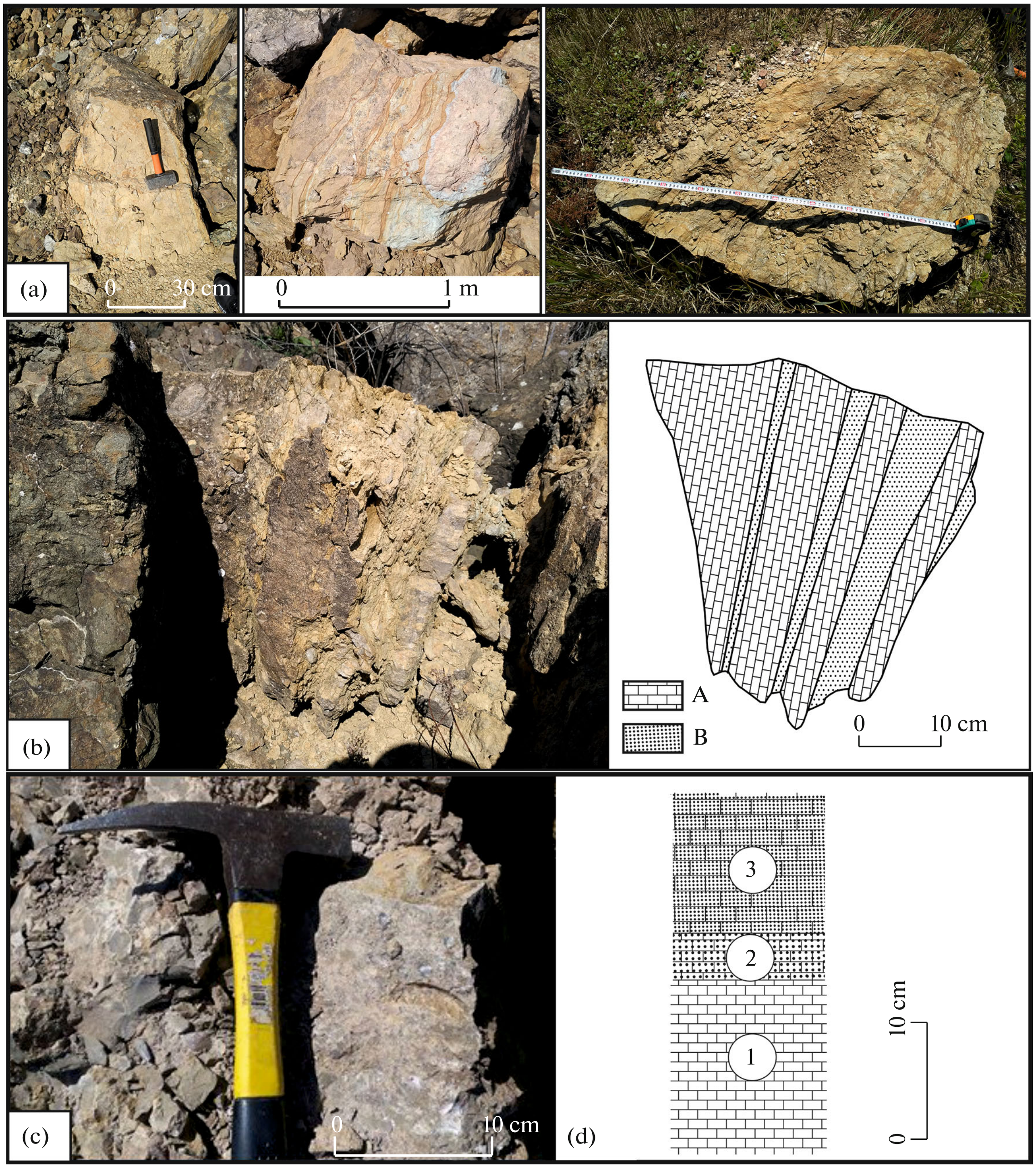


Fig. 4. Lithological types of boulders in the Greek Quarry. (a) boulders composed of sandstones and sandy limestones (lithological type V) on benches II and III of the quarry; (b) boulder representing the alternation of limestone (lithological type VI) and carbonate sandstone (lithological type V) on bench III of the quarry: A—limestone, B—sandstone (the proposed base of the beds, on the left); (c) boulder of ammonite limestone (lithological type VI) on bench II of the quarry; (d) a section in one of the boulders where limestones of lithological type VI are overlain by highly sandy limestones of lithological type V (see description of the section in the text).

Alps, Apennines, Bakony Mountains, and Pontic Mountains (Federici, 1967; Hallam, 1967; Mariotti and Schiavinotto, 1977; Nicosia et al., 1991; Géczy and Meister, 2007; Görög and Zsiborás, 2020; etc.).

The presence of the "Ammonitico Rosso" facies in boulders of Lower Jurassic limestones of the Simferopol mélange was previously noted in the Bodrak River basin (Klikushin, 1987, p. 236; 1988; Zaitsev, 2021), as well as in the described locality (Zaitsev and Ippolitov, 2015).

Judging by the size of boulders, the thickness of the limestone layer of lithological type VI in the assumed bedrock exposure was at least 1 m. In some boulders composed of such limestone, sliding planes and fractures filled with vein calcite are noted.

Numerous fauna remains are found in the limestones: ammonoids, belemnites, abundant crinoids, brachiopods, gastropods, bivalve mollusk moulds, nautiloids, aulacoceratid phragmocons, very rarely echinoids. More than 200 ammonoid specimens have been collected in these rocks. A rich assemblage characteristic of the Raricostatum Zone and the terminal part of the upper Sinemurian Oxynotum Zone has been identified among them: *Paltechioceras aureolum* (Simpson), *P. oosteri* (Dumortier), *P. romanicum* (Uhlig), *Echioceras raricostatoides* (Vadasz), *Orthechioceras* spp., *Plesechioceras* cf. *pierrei* (Spath), *Gleviceras iridescens* (Tutcher, Trueman, 1925), *Eoderoceras praecursor* (Geyer), *E. bispinatum* (Geyer), *Epideroceras lorioli* (Hug), *Ep. grande* Donovan, *Zetoceras zetes* (d'Orbigny), etc. In addition, the following belemnites were previously identified here: *Passaloteuthis* aff. ima (Lang), juvenile *Nannobelus delicatus* (Simp.), ?*N. demissus* (Simp.), and *Coeloteuthis* sp. juv. (Zaitsev and Ippolitov, 2015). In one of the boulders, the ammonites *Arnioceras rejectum* Fucini and *Asteroceras dommerguesi* Zaitsev sp. nov., which may indicate the upper Sinemurian Obtusum Zone, were collected, and in another boulder, *Arietites* sp. and *Metophioceras* sp., characteristic of the Lower Sinemurian Bucklandi Zone (probably, Rotiforme Subzone) of Western Europe, were collected.

It should be noted that rocks of lithological type VI in one of the blocks (about 30 cm across) lying on the third bench of the quarry are clearly overlapped by rocks of lithological type V (see above), forming the following section according to the assumed primary stratification (Fig. 4d):

Bed 1. Bioclastic limestone (type VI). Thickness 15 cm.

Bed 2. Limestone sandy, gray with a reddish tint, loose, forms a thinly plate parting (type V). Thickness 4 cm.

Bed 3. Limestone sandy, yellowish gray, indistinctly layered (an analog of Bed 1 in boulder V (see above)). Thickness 12 cm.

Another block (about 50 cm across) shows distinct alternation of limestones characteristic of boulders of type VI with sandstones and sandy limestones of type V (thickness of sandstone interlayers up to 8 cm) (Fig. 4b). The presence of boulders represented by alternation of rocks characteristic of types V and VI indicates that these rock varieties had direct contacts in a single section.

According to the above observations, it can be concluded that the primary section became sandier (with the predominance of rocks of lithological type V) in its upper part. On the basis of the data on the stratigraphic distribution of ammonoids, one can assume that there are a number of stratigraphic hiatuses in the primary section (Fig. 5). The presence of several separated biostratigraphic levels in limestones of the same lithological type (VI) indicates the condensation and small thickness of the primary section.

In conclusion, it should be noted that Lower Jurassic limestone boulders were observed ex situ. Accordingly, the features of their primary bedding and relationships of rocks in the mélange matrix remain unidentified. One can assume that they represent a single fractured large block, divided into boulders during development of the quarry. In this case, the possibility that they were initially located separately cannot be excluded.

AMMONITE BIOSTRATIGRAPHY

The most ancient ammonite assemblages belonging to the lower Sinemurian and the upper Sinemurian Obtusum Zone contain no index species of the most detailed subdivisions (biohorizons) of ammonite scales for Western Europe (see Rogov et al., 2012). The intervals of the ammonite scale present in the section are dated on the basis of the correlation with the position of ammonites in the scales for other regions. The biostratigraphic divisions distinguished for these intervals in the rank of beds with fauna are given below.

Lower Sinemurian

Beds with Arietites sp. and Metophioceras sp.

N o m e n c l a t u r e. These beds are distinguished for the first time.

B o u n d a r i e s. Determined by the stratigraphic distribution of the assemblage of *Arietites* sp. and *Metophioceras* sp.

D i s t r i b u t i o n. Limestone boulders of lithological type VI in the Greek Quarry. This or a similar stratigraphic interval may be present in black quartzite-like and calcareous sandstones of Oreanda, where A.S. Moiseev identified the ammonites *Coroniceras* ex gr. *bucklandi* (J. Sowerby) and *Arnioceras mendax taurica* Moiseev (Moiseev, 1944).

T y p i c a l a m m o n i t e s. *Arietites* sp. and *Metophioceras* sp. It is possible that the finding of early Sinemurian *Coroniceras* (Pararnioceras) sp. in the Greek Quarry belongs to this or a similar stratigraphic interval.

C o r r e l a t i o n. The faunal assemblage of *Arietites* sp. and *Metophioceras* sp. is typical of the lower Sinemurian Bucklandi Zone (Rotiforme Subzone) of Northwestern Europe (Page, 2003).

Upper Sinemurian

Beds with Arnioceras rejectum and Asteroceras dommerguesi

N o m e n c l a t u r e. These beds are distinguished for the first time.

B o u n d a r i e s. Determined by the stratigraphic distribution of the assemblage of *Asteroceras dommerguesi* Zaitsev, sp. nov. and *Arnioceras rejectum* Fucini.

D i s t r i b u t i o n. Limestone boulders in the Greek Quarry.

T y p i c a l a m m o n i t e s: *Asteroceras dommerguesi* sp. nov., *Arnioceras rejectum* Fucini, *Paradasyceras* cf. *stella* (J. de C. Sowerby).

C o r r e l a t i o n. The stratigraphic distribution interval of species *Asteroceras* spp. and *Arnioceras rejectum* Fucini seems to correspond to that in the Obtusum Zone (most likely, parts of the Stellare Subzone) in the ammonite scale for the Mediterranean (Tethys) area (Géczy and Meister, 2007, p. 172).

Beds with Plesechioceras cf. pierrei

N o m e n c l a t u r e. These beds are distinguished for the first time.

B o u n d a r i e s. The stratigraphic distribution interval of the species *Plesechioceras* cf. *pierrei* (Spath) determines the volume of beds.

D i s t r i b u t i o n. Limestone boulders in the Greek Quarry and, probably, in the Bodrak River valley.

T y p i c a l a m m o n i t e s. Along with *Plesechioceras* cf. *pierrei* (Spath), the findings of *Orthechioceras* aff. *edmundi* (Dumortier) and *Plesechioceras spirale* (Trueman et Williams), depicted by Repin (2017) from limestone boulders in the Bodrak River basin, probably belong to the same or similar stratigraphic interval.

C o r r e l a t i o n. The stratigraphic distribution interval of *Plesechioceras pierrei* (Spath) and similar species *P. spirale* (Trueman et Williams) corresponds to the upper part of the Oxynotum Zone of northwestern Europe and North America (Dommergues and Meister, 2017, p. 262).

Ammonite assemblages belonging to a higher stratigraphic interval contain index species of biohorizons of ammonite scales for Western Europe. Accordingly, their occurrence means the presence of coeval biohorizons in the section.

Echioceras raricostatoides Biohorizon

N o m e n c l a t u r e. The biohorizon was distinguished as hemera of raricostatoides (Buckman, 1918).

S t r a t o t y p e. Beds 102–104, "black Ven Marls," the coast of West Dorset (Lang and Spath, 1926).

I n d e x s p e c i e s. *Echioceras raricostatoides* (Vadasz).

P o s i t i o n i n s u c c e s s i o n. In the boulder section on Tat'yanina Hill (Zaitsev, 2021); the biohorizon is underlain by Beds with Echioceras rhodanicum (Buckm.) and is overlain by Beds with Echioceras crassicostatum T. et W.

D i s t r i b u t i o n. The limestone boulder on Tat'yanina Hill (the Bodrak River valley) and in limestone boulders in the Greek Quarry (the Salgir River basin). Beyond Crimea, the biohorizon is distributed in Burgundy (Dommergues, 1993), Alpine Front Range (Dommergues et al., 1990a), Austria (Lienz) (Blau, 1998), and Great Britain (Page, 1992), as well as in other regions where the index species is found (Romania, Western Ukraine, Slovakia, Germany, Lorraine, Northern Ireland, and Italy).

T y p i c a l a m m o n i t e s. *Echioceras raricostatoides* (Vadasz), *E. raricostatum* (Zieten).

C o r r e l a t i o n. It is correlated with the Echioceras raricostatum biohorizon of Northwestern Europe (Page, 2003).

Paltechioceras aureolum Biohorizon

N o m e n c l a t u r e. This biohorizon was distinguished by Getty (1973, p. 20) as the Paltechioceras aureolum Horizon and by Page (1992) as a biohorizon.

S t r a t o t y p e. Robin Hood's Bay (at least 0.2 m above the base of Bed 69).

I n d e x s p e c i e s. *Paltechioceras aureolum* (Simpson).

D i s t r i b u t i o n. Limestone boulders in the Greek Quarry (Salgir River basin). Beyond Crimea, the biohorizon is widespread in Great Britain (Page, 1992, 1994) and France (Meister et al., 2012); possibly, it occurs in Portugal and Georgia.

T y p i c a l a m m o n i t e s. *Paltechioceras aureolum* (Simpson).

C o r r e l a t i o n. The biohorizon is correlated with the coeval biohorizon of Western Europe.

Paltechioceras oosteri Biohorizon

N o m e n c l a t u r e. The biohorizon is distinguished by Blau (1998).

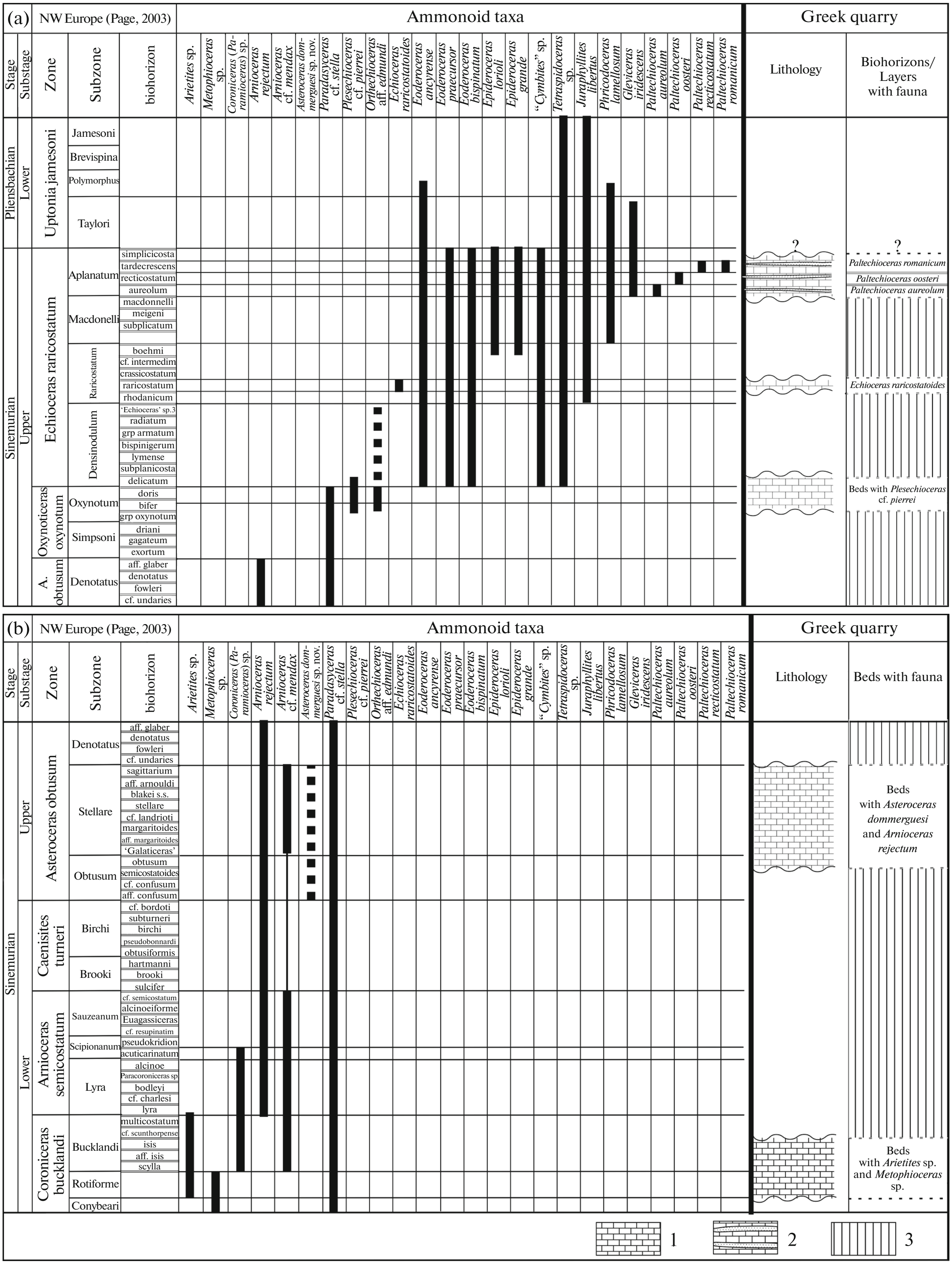
S t r a t o t y p e. The Dolomitenhütte section, Units 513–516 (Lienz, Austria).

I n d e x s p e c i e s. *Paltechioceras oosteri* (Dum.).

D i s t r i b u t i o n. Limestone and sandstone boulders in the Kurtsy deposit (the Salgir River basin). Beyond Crimea, the biohorizon is common in Great Britain (Page, 1992; Simms and Edmunds, 2021), France (Meister et al., 2012), and Austria (Lienz; Blau, 1998).

T y p i c a l a m m o n i t e s. *Paltechioceras oosteri* (Dum.), *P. recticostatum* Trueman et Williams, *Epideroceras lorioli* (Hug), and *Epideroceras grande* Donovan.

Fig. 5. Stratigraphic distribution intervals of ammonoid species found in the Greek Quarry, correlated with the zonal and infrazonal scales for the Sinemurian of Western Europe. (1) Limestones (lithological type VI); (2) alternation of limestones of lithological type VI and carbonate sandstones and sandy limestones of lithological type V; (3) hiatuses in the succession proposed in the primary section.


(a)
NW Europe (Page, 2003)
Ammonoid taxa
Greek quarry
Stage
Substage
Zone
Subzone
biohorizon
Arietites sp.
Metophioceras sp.
Coroniceras (Paramioceras) sp.
Arnioceras rejectum
Arnioceras cf. mendax
Asteroceras dommerguesi sp. nov.
Paradasyceras cf. stella
Plesechioceras cf. pierrei
Orthechioceras aff. edmundi
Echioceras raricostatoides
Eoderoceras ancyrense
Eoderoceras praecursor
Eoderoceras bispinatum
Epideroceras lorioli
Epideroceras grande
"Cymbites" sp.
Tetraspidoceras sp.
Juraphyllites libertus
Phricodoceras lamellosum
Gleviceras iridescens
Paltechioceras aureolum
Paltechioceras oosteri
Paltechioceras recticostatum
Paltechioceras romanicum
Lithology
Biohorizons/ Layers with fauna
Pliensbachian
Lower
Uptonia jamesoni
Jamesoni
Brevispina
Polymorphus
Taylori
Sinemurian
Upper
Echioceras raricostatum
Aplanatum
simplicicosta
tardecrescens
recticostatum
aureolum
Macdonelli
macdonnelli
meigeni
subplicatum
Raricostatum
boehmi
cf. intermedim
crassicostatum
raricostatum
rhodanicum
Densinodulum
'Echioceras' sp.3
radiatum
grp armatum
bispinigerum
lymense
subplanicosta
delicatum
Oxynoticeras oxynotum
Oxynotum
doris
bifer
grp oxynotum
Simpsoni
driani
gagateum
exortum
A. obtusum
Denotatus
aff. glaber
denotatus
fowleri
cf. undaries
?
Paltechioceras romanicum
Paltechioceras oosteri
Paltechioceras aureolum
Echioceras raricostatoides
Beds with Plesechioceras cf. pierrei
(b)
NW Europe (Page, 2003)
Ammonoid taxa
Greek quarry
Lithology
Beds with fauna
Sinemurian
Upper
Asteroceras obtusum
Denotatus
aff. glaber
denotatus
fowleri
cf. undaries
Stellare
sagittarium
aff. arnouldi
blakei s.s.
stellare
cf. landrioti
margaritoides
aff. margaritoides
'Galaticeras'
Obtusum
obtusum
semicostatoides
cf. confusum
aff. confusum
Caenisites turneri
Birchi
cf. bordoti
subturneri
birchi
pseudobonnardi
obtusiformis
Brooki
hartmanni
brooki
sulcifer
Lower
Arnioceras semicostatum
Sauzeanum
cf. semicostatum
alcinoeiforme
Euagassiceras
cf. resupinatim
Scipionanum
pseudokridion
acuticarinatum
Lyra
alcinoe
Paracoroniceras sp
bodleyi
cf. charlesi
lyra
Coroniceras bucklandi
Bucklandi
multicostatum
cf. scunthorpense
isis
aff. isis
scylla
Rotiforme
Conybeari
Beds with Asteroceras dommerguesi and Arnioceras rejectum
Beds with Arietites sp. and Metophioceras sp.
1
2
3

C o r r e l a t i o n. The described biohorizon corresponds to the Paltechioceras recticostatum biohorizon of Northwestern Europe (Page, 2003; Edmunds et al., 2003).

Paltechioceras romanicum Biohorizon

N o m e n c l a t u r e. Distinguished by Alkaya and Meister (1995).

S t r a t o t y p e is not marked.

I n d e x s p e c i e s. *Paltechioceras romanicum* (Uhlig).

D i s t r i b u t i o n. Limestone boulders in the Kurtsy Quarry (the Salgir River basin). Beyond Crimea, this horizon occurs in the Pontic Mountains in Turkey (Alkaya and Meister, 1995), Austria (Lienz; Blau, 1998), Italy (Venturi at al., 2004), and Portugal (Duarte et al., 2014); it possibly occurs in Hungary (Géczy and Meister, 2007) and North Africa (Dommergues and Meister, 2017).

T y p i c a l a m m o n i t e s: *Paltechioceras romanicum* (Uhlig), *Epideroceras lorioli* (Hug), *Zetoceras zetes* (d'Orbigny), and "*Cymbites*" sp.

C o r r e l a t i o n. It corresponds to the P. aplanatum/P. tardecrescens biohorizon of the ammonite scale for Northwestern Europe (Page, 2003).

DESCRIPTION OF AMMONOIDS

The following symbols are used in the descriptions: *—the first valid description of the species, D—shell diameter, Du—umbilicus diameter, H—height of the last whorl of shell, W—width of the last whorl of shell. The described ammonoid specimens (Plates I–VIII) are stored at the Earth Science Museum of Moscow State University (Moscow), collection no. 150.

O R D E R PHYLLOCERIDA SCHINDEWOLF, 1923

S U P E R F A M I L Y PHYLLOCERATOIDEA ZITTEL, 1884

FAMILY PHYLLOCERATIDAE ZITTEL, 1884

SUBFAMILY PHYLLOCERATINAE ZITTEL, 1884

Genus *Phylloceras* Suess, 1865

Phylloceras ex gr. *frondosum* (Reynes, 1868)

Plate II, figs. 2a, 2b, 3a, 3b, 4a, 4b

S h a p e. Shell is involute with a narrow funnel-shaped umbilicus. Whorls are elliptical with convex ventral and lateral sides. Umbilical wall convex, inclined toward the umbilicus.

S c u l p t u r e. Inner mould is not sculptured.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/1	92	49	8	39	53.3	42.4	8.7	126
150/2	75	43	7	23	57.3	30.7	9.3	187
150/3	41	23	5	17.5	56.1	42.7	12.2	131

C o m p a r i s o n a n d r e m a r k s. Sample no. 150/2 with high elliptical section is very similar to holotype *Ph. frondosum* (Reynès, 1868, pl. V, fig. 1). On the other hand, Sample no. 150/1 is characterized by a wider whorl section, according to which it is similar to *Ph. hebertinum* (Reynes). Géczy and Meister (1998, p. 92) consider these differences within the framework of variability of the same species, in which they also include *Ph. meneghinii* Gemmellaro. This point of view is accepted in the present paper.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. Upper Sinemurian–lower Toarcian of the Mediterranean province (Spain, Italy, Taurus Mountains, Morocco, Algeria, Tunisia). It is known from the Pontic subprovince (Pontic Mountains) in the upper Sinemurian (Raricostatum Zone)–upper Pliensbachian (Davoei Zone) interval and from the Austroalpine subprovince in the Pliensbachian of Hungary and Austria. It also occurs in the southern part of the Northwestern European (Subboreal) province (the Pliensbachian of South France).[1]

M a t e r i a l. Three inner moulds and two deformed and rounded fragments from a sandy interbed in the boulder representing the alternation of limestone and sandstone.

Genus *Zetoceras* Kovãcs, 1939

Zetoceras zetes (d'Orbigny, 1850)

Plate I, figs. 1a, 1b, 2a, 2b, 4a, 4b, 15a, 15b;
Plate II, figs. 1a, 1b, 4a–4c

Ammonites heterophyllus amalthei: Quenstedt, 1849, p. 100, pl. 6, fig. 1.

Ammonites zetes: d'Orbigny, 1850*, p. 247 (nom. nov. pro *Ammonites heterophyllus amalthei* Quenstedt); Hauer, 1856, p. 56, pl. 18, figs. 1–3.

Phylloceras zetes (d'Orbigny): Wright, 1883, p. 422, pl. LXXVII, figs. 1–3; Fucini, 1899, p. 148, pl. XIX, fig. 4; Fucini, 1901, p. 36, pl. 6, fig. 2; Géczy, 1967, p. 9, text-fig. 2, pl. II, fig. 4; pl. LXIII, fig. 1.

Phylloceras pseudo-zetes Fucini: Fucini, 1908, p. 12.

Zetoceras pseudozetes (Fucini): Castelli, 1980, p. 46, pl. 1, fig. 4.

*Phylloceras (Zetoceras) pseudoz*etes (Fucini): Alkaya, 1982; Levha. 2, şekilleri 1a–1c; Howarth, 2020, p. 5, figs. 6.2d–6.2e.

Phylloceras (*Zetoceras*) zetes (d'Orbigny): Alkaya, 1982, p. 36, Levha. 1, şekilleri 5a–5c; Schlegelmilch, 1992, p. 28, pl. 1, fig. 4.

Phylloceras (*Zetoceras*) ex gr. *zetes* (d'Orbigny): Meister and Böhm, 1993, p. 173, pl. 1, figs. 3–4; Guex et al., 2008, p. 22, pl. 1, fig. 4, text-figs. 3.2–3.3.

Zetoceras zetes (d'Orbigny): Arkell et al., 1957, p. L187, figs. 218, 7a–7b (= holotype); Alkaya and Meister, 1995, p. 136, pl. 2, fig. 6; pl. 3, fig. 4; Géczy and Meister, 1998, p. 94, pl. 2, figs. 2, 3; pl. 3, figs. 1, 4; Joly, 2000, p. 65, pl. 10, fig. 6; pl. 12, figs. 1, 2a, 2b; text-figs. 125–131; Meledina and Shurygin, 2001, c. 38, pl. I, fig. 1, pl. II, fig. 1; Turculet and Tibuleac, 2001, p. 428, pl. 1, figs. 1–4; Meister and Friebe, 2003, p. 23, pl. 2, figs. 1, 3, 5; Géczy and Meister, 2007, p. 149, pl. II, figs. 3, 7; Dommergues et al., 2008, p. 546, fig. 3F; Meister et al., 2011a, p. 117.e2, fig. 6 (1); Blau and Meister, 2011, p. 259, figs. 2f, 2g; Dommergues and Meister, 2017,

[1] Boundaries and nomenclature of biochores hereinafter are given after (Dommergues, 1982b; Dommergues and Meister, 1991b; Dommergues et al., 2009).

p. 199, fig. 8; Meister et al., 2017, p. 94, pl. 2, figs. 3, 4; Howarth, 2020, p. 5, figs. 6.2a–6.2c (= holotype).

H o l o t y p e by monotype. The specimen depicted in (Quenstedt, 1849, pl. 6, fig. 1). "Black Jurassic Delta" (upper Pliensbachian, Margaritatus Zone), Breitenbach (Reutlingen, Southwest Germany). Redepicted in the following works: Arkell et al., 1957, figs. 218, 7a–7b; Howarth, 2020, figs. 6.2a–6.2c. It is kept in the Quenstedt collection, at Institut und Museum für Geologie und Paläontologie der Universität Tübingen, specimen no. Ce 5/40/1.

S h a p e. Shell involute. Whorls high, suboval with the maximum width at umbilical margin, strongly compressed. Lateral sides are almost flat, subparallel or slightly converging toward narrow rounded ventral side. Umbilicus is very narrow (almost closed), funnel-shaped, with well-defined subrectangular umbilical margin.

S c u l p t u r e. Inner mould is not sculptured.

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/4	88	51	5.5	27	58	31	6	189
150/5	156	98	–	36	62.8	23.1	–	272
150/6	54	32	4	11.5	59.3	21.3	7.4	278
150/7	61	33	5	18	54.1	29.5	8.2	183
150/8	53	24	5	15	45.3	28.3	9.4	160
150/9	34	20	2	9	58.8	26.5	5.9	222

C o m p a r i s o n. It differs from other species of this genus in almost flat lateral sides and very narrow umbilicus (Du/D = 3–10%); it differs from *Z. oenotrium* (Fucini) in a narrower umbilicus and a suboval whorl section with the maximum width at the umbilical margin; it differs from *Z. lavizzarii* (Hauer) in a narrower section and a more rounded ventral side.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. This species is widespread in the Mediterranean (Italy, Spain, Morocco, Algeria; Blau and Meister, 2011; Dommergues and Meister, 2017), in the Pontic (North Turkey; Alkaya, 1982; Alkaya and Meister, 1995), and in the Austroalpine (Hungary, Austria; Géczy and Meister, 1998, 2007; Meister and Friebe, 2003) subprovinces in the lower Sinemurian–upper Pliensbachian (or even lower Toarcian) stratigraphic interval. It is known from the Subboreal province (Germany, France, Great Britain, Romania; Wright, 1883; Schlegelmilch, 1992; Joly, 2000; Turculet and Tibuleac, 2001). The species also occurs in the Arctic region (upper Pliensbachian in the Lena and Anabar river basins; Meledina and Shurygin, 2001).

M a t e r i a l. Abundant (more than 20 specimens) moulds and their fragments, often corroded. Some well-preserved moulds were found in limestones together with *Paltechioceras romanicum* and "*Cymbites*" sp. (P. romanicum biohorizon). More than ten specimens were found in sandstones and sandy limestones of the lithological type V.

Genus *Partschiceras* Fucini, 1923

Partschiceras striatocostatum (Meneghini, 1853)

Plate I, figs. 3, 5, 6a, 6b, 8

Ammonites partschi Stur: Stur, 1851, p. 26; Hauer, 1854, p. 881, pl. 4, figs. 1–8; Oppel, 1862, p. 138.

Ammonites striatocostatus: Meneghini, *1853, p. 28.

Ammonites sturi: Reynès, 1868 (sp. nov.), p. 95, pl. III, fig. 1.

Phylloceras partschi (Stur): Geyer, 1886, p. 216, pl. 1, figs. 6a, 6b, 7, 9.

Phylloceras anonymum Haas: Haas, 1913, p. 7, pl. I, figs. 1–5.

Partschiceras anonymum (Haas): Castelli, 1980, p. 47, pl. l, figs. 5, 6.

Partschiceras trauthi Kovacs: Kovács, 1941, p. 40, pl. I, fig. 3.

Partschiceras striatocostatum (Meneghini): Fantini Sestini, 1971, p. 386, pl. 31, figs. 2 (=lectotype), 3; pl. 32, figs. 1–3; pl. 33, figs. 3, 4; Wiedenmayer, 1977, p. 15, pl. 4, figs. 2b–2d; 5–8; Alkaya, 1983, p. 66, Levha. 1, şekilleri 1–4; Braga and Rivas, 1987, p. 12, pl. 1, figs. 5–8; Meister, 1989, p. 28, pl. 2, fig. 6; Blau and Meister, 1991, p. 177, pl. 2, figs. 2, 3; Meister and Böhm, 1993, p. 173, pl. 2, fig. 4; Alkaya and Meister, 1995, p. 138, pl. 1, fig. 4; pl. 2, figs. 1, 2; Blau, 1998, p. 196, pl. 1, figs. 8, 9, 14; Géczy and Meister, 1998, p. 95, pl. 4, figs. 1, 2; Rakus, 1999, p. 348, text-fig. 8, pl. 1, figs. 9, 10, 11; Dommergues et al., 2000, p. 332, fig. 4.3; Joly, 2000, p. 35, pl. 4, figs. 5a, 5b; text-figs. 56–57; Hillebrandt, 2006, taf. 1, figs. 7–9; Dommergues and Meister, 2017, p. 198, fig. 6; Lukeneder P., Lukeneder A., 2018, p. 98, figs. 7a, 7b.

Partschiceras ex gr. *striatocostatum* (Meneghini): Dommergues et al., 1995, p. 170, pl. 1, figs. 9, 12; Meister and Friebe, 2003, p. 23, pl. 1, figs. 8, 13, 14; pl. 2, figs. 4, 7; Géczy and Meister, 2007, p. 151, pl. III, figs. 3–6, 8; pl. IV, fig. 1; Meister et al., 2017, p. 94, pl. 2, figs. 5–6.

Partschiceras aff. *striatocostatum* (Meneghini): Dommergues et al., 2005, p. 415, fig. 6.10.

Procliviceras striatocostatum (Meneghini): Macchioni et al., 2006, p. 560, pl. 1, figs. 15–16; text-fig. 2D; Dommergues et al., 2008, p. 545, fig. 3D.

L e c t o t y p e is depicted in (Fantini-Sestini, 1971, p. 386, pl. 31, figs. 2a–2b). It comes from limestone "Ammonitico Rosso" facies (Sinemurian–lower part of upper Pliensbachian) from Monte Calvi, Campiglia Marittima, and Plaiae de MaremAme (Tuscany, Italy). It is stored at Museo di Storia Naturale della Certosa di Calci (Pisa, Italy).

S h a p e. Shell is involute, from small to medium-sized. Whorls high, elliptical or subrectangular. Lateral sides flattened, subparallel. Ventrolateral margin flat, smoothly rounded. Ventral side strongly convex. Umbilicus extremely narrow, almost closed. Umbilical margin well-defined subrectangular.

S c u l p t u r e. In the near-siphonal part of whorls are wide ribs-folds that become thicker on the ventral side and cross it without interruption. The surface of ribs-folds and their intercostal spaces are complicated by densely spaced striate ribs. There are 5–7 striate ribs between the adjacent ribs-folds. The presence of striation between ribs-folds on the inner mould makes it easy to diagnose the species even by small fragments.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/10	80	50	7	22	62.7	27.6	8.8	227
150/11	–	34	–	18	–	–	–	187

C o m p a r i s o n. It differs from *P. tenuistriatum* (Meneghini) in sparsely arranged ribs-folds, between which there is a distinctive thin striation.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. This species is widespread in the southwestern part of the Mediterranean–Caucasian region and at the southern margin of the Northwestern European (Subboreal) province. It is known from the Southern Limestone Alps in Italy (Meister et al., 2017) and Switzerland (Wiedenmeyer, 1977), the Kos Plateau in France (Joly, 2000), the Eastern Alps of Austria (Racus, 1999) and Hungary (Kovács, 1941), the Apennines of Italy (Meneghini, 1853), Slovakia, Germany (Haas, 1913), Turkey (Pontic and Taurus ranges) (Alkaya, 1983), South Spain (Cordellera Betica) (Braga and Rivas, 1987), Albania (Dommergues et al., 2000), and Algeria and Morocco (Dommergues and Meister, 2017). It is widespread in a wide stratigraphic interval: the upper part of lower Sinemurian (Semicostatum Zone (Wissner, 1958))–basal Toarcian (Wiedenmeyer, 1977). In addition, this species is known from British Columbia (Macchioni et al., 2006) and South America (Hillebrandt, 2006).

M a t e r i a l. One deformed mould and three small fragments from limestones of lithological type VI (specimens 150/12 and 150/13) and sandy limestones of type V (specimen no. 150/10).

FAMILY JURAPHYLLITIDAE ARKELL, 1950

Genus *Paradasyceras* Spath, 1923

Paradasyceras cf. *stella* (J. de C. Sowerby, 1833)

Plate I, figs. 14a–14c

S h a p e. Shell is small, discoidal. Whorls high, suboval. Lateral sides flattened, slightly converging toward the narrow ventral side. Umbilical margin well-defined, umbilical wall strongly convex and slightly inclined toward the umbilicus.

S c u l p t u r e is represented by very weak, irregularly arranged, sigmoid-curved striae of growth, which are distinguishable only in harsh side lighting. Constrictions are absent.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/14	35	14	10	8	40	23	27	175

C o m p a r i s o n. On the basis of the small size of a shell, narrow sections of whorls and lateral sides without constrictions, with barely visible striae of growth the material can be compared with *Paradasyceras stella* (J. de C. Sowerby).

D i s t r i b u t i o n. Upper Sinemurian of Crimea, Beds with Arnioceras rejectum and Asteroceras dommerguesi. *P. stella* is known from the upper Hettangian–lower Sinemurian of Austria, Sicily, and Italy (Liguria, Central Apennines, Southern Limestone Alps), (?) in the upper Sinemurian Oxynotum Zone of Austria (Rakus and Lobitzer, 1993), and in the upper Sinemurian Oxynotum (?or Raricostatum) Zone of Hungary (Bakony Mountains) (Géczy and Meister, 2007) and (?) the Caucasus (Nutsubidze, 1966). The species is probably present in the Pacific region (Timor Island and New Caledonia) (Krumbeck, 1923; Avias, 1953).

M a t e r i a l. One specimen from the limestone boulder, together with *Arnioceras rejectum* Fucini.

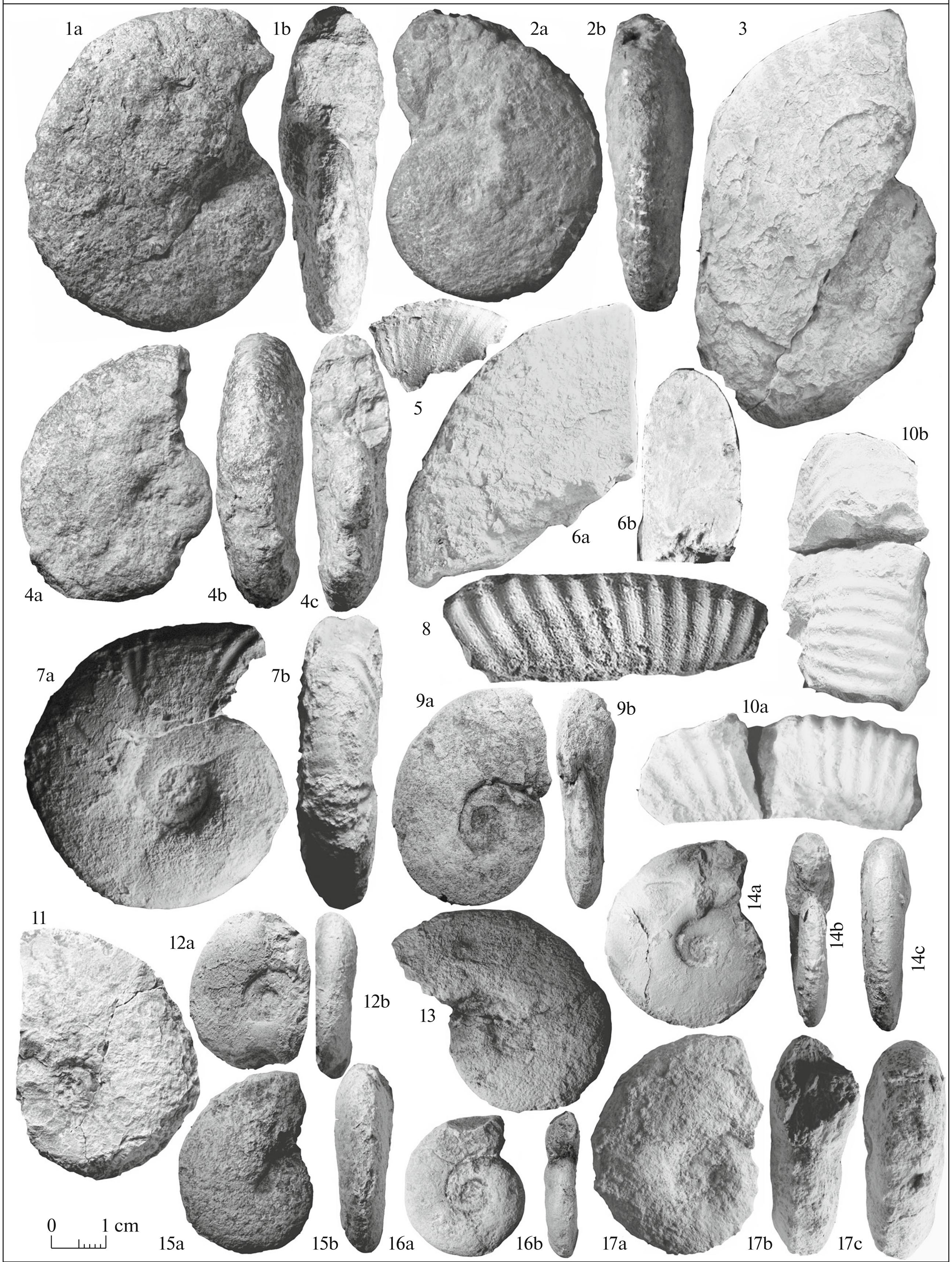
Juraphyllites libertus (Gemmellaro, 1884)

Plate I, figs. 7a, 7b

Phylloceras libertum: Gemmellaro, 1884*, p. 168, pl. 2, figs. 1–5.
Rhacophyllites libertus (Gemmellaro): Fucini, 1899, p. 152, pl. 20, fig. 1; Del Campana, 1900, p. 562, pl. VII, figs. 1–4; Fucini, 1901, p. 71, pl. 12, figs. 5, 8; Haas, 1913, p. 24, pl. I (III), figs. 16–17; Kovács, 1941, p. 103, pl. V, fig. 5.
Juraphyllites libertus (Gemmellaro): Nutsubidze, 1966, p. 55, pl. IX, figs. 4–5; Fantini-Sestini, 1974, p. 216; Wiedenmayer, 1977, p. 35, pl. 1, fig. 4, pl. 3, figs. 1, 2, 5; Castelli, 1980, p. 48, pl. 2, figs. 1, 2; Meister, 1986, p. 24, pl. II, fig. 8; Meister, 1989, p. 30, pl. 2, fig. 9; Cope, 1991, p. 305, pl. 2, figs. 5, 13; Dommergues et al., 1995, p. 171, pl. 1, fig. 5; Blau, 1998, p. 200, pl. I, figs. 4, 11, 18, text-figs. 18–19; Géczy and Meister, 1998, p. 96, pl. IV, figs. 3, 5, 6; Joly, 2000, p. 29; Meister and Friebe, 2003, p. 25, pl. 2, fig. 6; Venturi et al., 2005, p. 88, pl. 1, fig. 4, pl. 2, fig. 1; Géczy and Meister, 2007, p. 154, pl. VII, fig. 4; Blau and Meister, 2011, p. 260,

Plate I. Phylloceratidae, Juraphyllitidae, Schlotheimiidae, Lytoceratoidea. Life-size images. (1–2, 4, 15) *Zetoceras zetes* (d'Orbigny): (1) specimen no. 150/7: (1a) lateral view, (1b) apertural view; (2) specimen no. 150/6: (2a) lateral view, (2b) ventral view; (4) specimen no. 150/8: (4a) lateral view, (4b) ventral view, (4c) apertural view; (15) specimen no. 150/9: (15a) lateral view, (15b) ventral view; (3, 5–6, 8) *Partschiceras striatocostatum* (Meneghini): (3) specimen no. 150/10, lateral view; (5) specimen no. 150/12, lateral view; (6) specimen no. 02: (6a) lateral view, (6b) transverse section; (8) specimen no. 150/13, lateral view; (7) *Juraphyllites libertus* (Gemmellaro), specimen no. 150/15: (7a) lateral view, (7b) ventral view; (9, 13) *Juraphyllites* ex gr. *limatus* (Rosenberg): (9) specimen no. 150/16: (9a) lateral view, (9b) apertural view; (13) specimen no. 150/17, lateral view; (10) *Adnethiceras* sp., specimen no. 150/20: (10a) lateral view, (10b) ventral view; (11, 17) *Phricodoceras lamellosum* (d'Orbigny): (11) specimen no. 150/22, lateral view; (17) specimen no. 150/21: (17a) lateral view, (17b) apertural view, (17c) ventral view; (12, 16) *Juraphyllites* sp.: (12) specimen no. J.01: (12a) lateral view, (12b) ventral view; (16) specimen no. 150/18: (16a) lateral view, (16b) apertural view; (14) *Paradasyceras* cf. *stella* (J. de C. Sowerby), specimen no. 150/14: (14a) lateral view, (14b) apertural view, (14c) ventral view.

Plate I


1a
1b
2a
2b
3
5
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14a
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11
12a
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16a
16b
17a
17b
17c

figs. 2j, 2k, 2o, 2q; Meister et al., 2011a, p. 117.e7, fig. 5 (3, 9); Meister and Blau, 2014, p. 257, figs. 3o, 3p; Meister et al., 2017, p. 96, pl. 2, figs. 8, 11; Lukeneder P. And Lukeneder A., 2018, p. 99, figs. 7C, 7D.

Juraphyllites ex gr. *libertus* (Gemmellaro): Dommergues and Meister, 1990a, Fig. 3 (15); Meister and Böhm, 1993, p. 174, pl. 2, figs. 5, 9, pl. 3, fig. 5; Alkaya and Meister, 1995, p. 140, pl. III, figs. 1, 5, 7; Guex et al., 2008, p. 24, pl. 2, figs. 1–3, text-fig. 3.4.

Juraphyllites cf. *libertus* (Gemmellaro): Rakus and Guex, 2002, p. 42, pl. 19, figs. 3–5.

Meneghiniceras (*Juraphyllites*) *libertum* (Gemmellaro): *Macchioni* (in Pavia and Cresta, 2002), p. 80, figs. 40a, 40b; Macchioni and Meister, 2003, p. 378, pl. 1, figs. 13, 14.

L e c t o t y p e is depicted in (Gemmellaro, 1884, pl. 2, figs. 1–3) and designated by Fantini-Sestini (1974). Lower Pliensbachian (Beds with Terebratula aspasia) Contrada Rocche Rosse (commune of Galati Mamertino), Sicily.

S h a p e. Shell is semi-involute, flattened, medium-sized. Whorls elliptical, with slightly convex lateral sides and narrow, strongly convex ventral side. Umbilicus is shallow, moderately wide, bowl-shaped and polygonal-shaped owing to constrictions. Umbilical margin flat, regularly rounded.

S c u l p t u r e. Phragmocone is weakly sculptured. Sculpture is represented by shallow arched (parabolic) prorsiradiate constrictions (3–4 per half whorl). Constrictions begin at the umbilical margin and cross the ventral side with a strong weakening, bending slightly forward. On the body chamber and at the end of the phragmocon in its perisiphonal part, prorsiradiate irregularly arranged ribs-folds appear; the height of ribs increases toward the ventral side.

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/15	56	20	18	12	35.7	21.4	32.1	167	3

C o m p a r i s o n. It differs from *J. diopsis* (Gemmellaro) in the rounded umbilical edge, with slightly concave constrictions, giving it a polygonal shape. This feature makes it easier to identify the juvenile specimens. From *J. nardii* (Meneghini), it differs in irregularly arranged ribs-folds, which occur only in the near-siphonal part of a shell.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. It occurs mostly in the Mediterranean–Caucasian region, including its northern margins: Pontic (Northern Turkey: Alkaya and Meister, 1995), Austroalpine (Austria: Meister and Friebe, 2003; Hungary: Kovács, 1941; Switzerland: Wiedenmayer, 1977) subprovinces and Caucasus (upper Pliensbachian of Georgia: Nutsubidze, 1966; Topchishvili et al., 2006). The species is known from the upper Sinemurian (Raricostatum Subzone, E. quenstedti biohorizon) to the lower Toarcian.

M a t e r i a l. A single well-preserved inner mould and possibly that several juvenile specimens is also belong to this species. The specimens have been found together with upper Sinemurian ammonites (Echioceratidae).

Juraphyllites ex gr. *limatus* (Rosenberg, 1909)

Plate I, figs. 9a, 9b, 13

S h a p e. Shell is small, discoidal, semi-involute. Whorls elliptical, strongly compressed. Umbilicus moderately wide, bowl-shaped, very shallow. Umbilical margin flat, regularly rounded.

S c u l p t u r e. Shell is not sculptured.

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/16	41	18	15	11	44	27	37	164
150/17	45	18	16	11	40	24	36	164

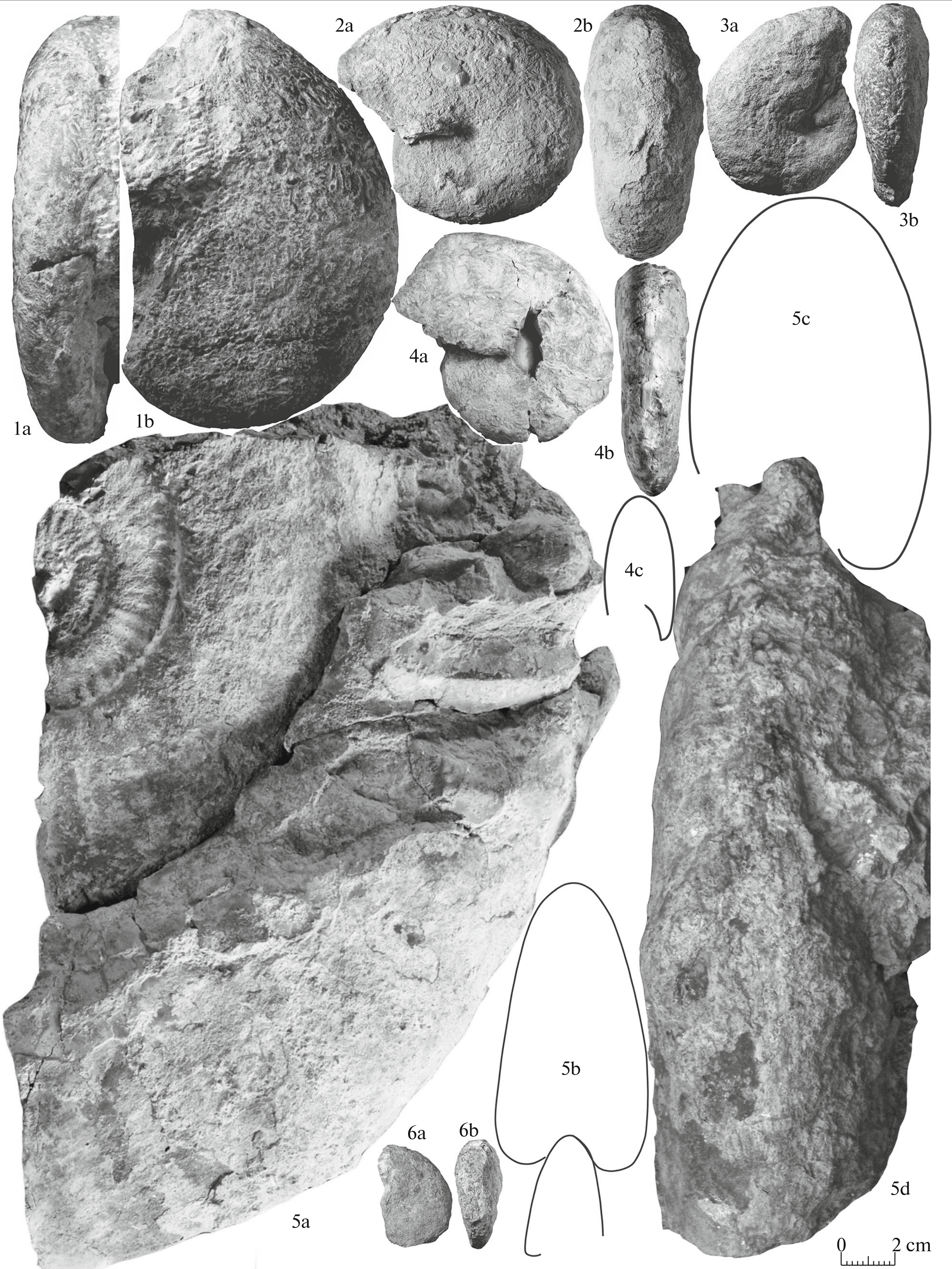
C o m p a r i s o n and r e m a r k s. This group includes specimens which are not sculptured at D > 40 mm (there are no ribs and constrictions), which distinguishes them from other species of the genus *Juraphyllites*.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. *J. limatus* is known from the lower Pliensbachian to the middle of the upper Pliensbachian. It is distributed mainly at the northern margin of the Tethys (Géczy and Meister, 2007). It is known from Hungary, Romania, Slovakia, Switzerland, and the Pontic Mountains (Turkey) and from the lower Pliensbachian of Austria. In the Northern Apennines (Italy), it is, probably, upper Sinemurian. Also, this species is known from North Africa (lower Pliensbachian Davoei Zone of Morocco). Probably, this species occurs in the Sinemurian of the Pacific region—in British Columbia (Palfy, 1991).

M a t e r i a l. Two specimens from sandstones of lithological type V.

Plate II. Phylloceratidae, Epideroceratidae. All images are reduced (×0.5). (1, 4) *Zetoceras zetes* (d'Orbigny): (1) specimen no. 150/5: (1a) ventral view, (1b) lateral view; (4) specimen no. 150/4: (4a) lateral view, (4b) ventral view, (4c) transverse section (D = 88 mm); (2–3, 6) *Phylloceras* ex gr. *frondosum* (Reynes): (2) specimen no. 01: (2a) lateral view, (2b) ventral view; (3) specimen no. 150/2: (3a) lateral view, (3b) ventral view; (6) specimen no. 150/3: (6a) lateral view, (6b) ventral view; (5) *Epideroceras grande* Donovan, specimen no. E.g. 150/73: (5a) lateral view, (5b) drawing of cross section of inner whorls, (5c) drawing of cross section of an outer whorl, (5d) ventral view.

Plate II



***Juraphyllites* sp.**

Plate I, figs. 12a, 12b, 16a, 16b

Shape. Shell is small (up to 30 mm in diameter), flattened, semi-involute. Whorls subelliptical, with convex ventral side and slightly convex lateral sides. Umbilicus moderately wide, shallow, bowl-shaped. Umbilical wall convex, low.

Sculpture. Preserved specimens are not sculptured (there are no ribs and constrictions).

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
J. 01	30	12	9	7	40	23	30	171
150/18	26	8	11	6	31	23	42	133

Comparison and remarks. The described specimens apparently belong to non-sculptured *Juraphyllites* (*J*. ex gr. *planispira* (Reynès) or *J. limatus* (Rosenberg)) or represent juvenile individuals of those species that become sculptured only at the late stages of growth.

Distribution. Upper Sinemurian of Crimea. Genus *Juraphyllites* is known from the Sinemurian–lower Toarcian of Europe, Caucasus, Russian Far East, China, the Himalayas, North America (Nevada, British Columbia, Mexico), and South America (Argentina).

Material. Three specimens from limestone boulders of lithological type VI, together with juvenile representatives of Echioceratidae.

ORDER LYTOCERIDA HYATT, 1889

SUBORDER LYTOCERINA HYATT, 1889

SUBFAMILY LYTOCERATOIDEA NEUMAYR, 1875

FAMILY LYTOCERATIDAE NEUMAYR, 1875

SUBFAMILY ECTOCENTRITINAE SPATH, 1926

Genus *Adnethiceras* Wiedmann, 1970

***Adnethiceras* sp.**

Plate I, figs. 10a, 10b

Shape. Whorls slowly expanding, rounded cross section. Ventral side wide, convex; lateral sides convex.

Sculpture is characterized by coarse ribbing of regularly spaced wide rounded ribs, crossing the ventral side without weakening.

Comparison and remarks. On the basis of coarse ribbing and lack of constrictions, the specimens can be attributed to the genus *Adnethiceras*. Specimens similar in morphology were found by Géczy and Meister (2007, pl. X, figs. 3, 4) in the Bakony Mountains (Hungary) and identified as *Adnethiceras* aff. *adnethicus* (Hauer).

Distribution. Upper Sinemurian of Crimea. This genus is known from the Sinemurian of Austria, Hungary, Romania, Italy, and Crimea.

Material. Six fragmentarily preserved specimens from limestone boulders of lithological type VI.

ORDER AMMONITIDA ZITTEL, 1884

SUBORDER PSILOCERINA SEHIDEWOLF, 1923

SUPRAFAMILY PSILOCERATOIDEA HYATT, 1867

FAMILY SCHLOTHEIMIIDAE SPATH, 1923

Genus *Phricodoceras* Hyatt, 1900

***Phricodoceras lamellosum* (d'Orbigny, 1844)**

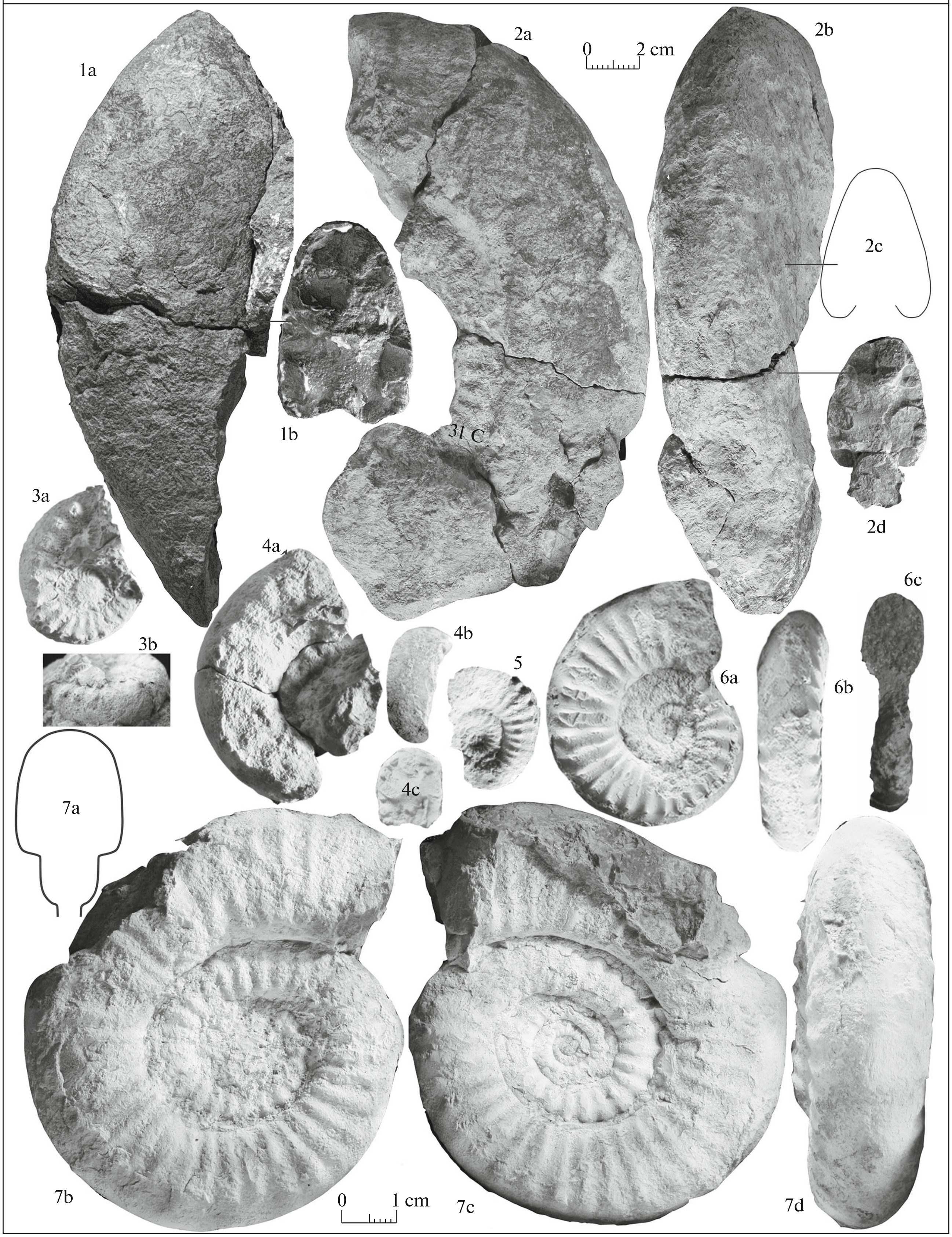
Plate I, figs. 11, 17a–17c

Ammonites lamellosum: *d'Orbigny, 1844, p. 283, pl. 84, figs. 1, 2.
Ammonites taylori Sowerby: (pars) Quenstedt, 1884, p. 213, pl. 27, figs. 17, 19.
Ammonites striatus bicornis: Quenstedt, 1884, p. 220, pl. 28, fig. 24.
Aegoceras subtaylori Krumbeck: Krumbeck, 1922, p. 194, pl. XVII, fig. 5.
Phricodoceras sp. indet. aff. *taylori* (Sowerby): Bremer, 1965, p. 176, pl. 15, fig. 5.
Phricodoceras taylori (Sowerby): (pars) Dommergues, 1978, pl. 1, fig. 2.
Phricodoceras taylori (Sowerby) *subtaylori* (Krumbeck): Wiedenmayer, 1980, p. 50, pl. 2, figs. 9, 10.
Phricodoceras cf. *bicornis* (Quenstedt): Hoffmann, 1982, p. 167, pl. 6, fig. 1; pl. 16, fig. 1.
Phricodoceras taylori forme lamellosum (d'Orbigny): Meister and Sciau, 1988, p. 262, pl. 1, fig. 2.
Phricodoceras aff. *taylori* (Sowerby): Dommergues and Meister, 1990b, pl. 2, fig. 3.
Phricodoceras ex gr. *taylori* (Sowerby): (pars) Alkaya and Meister, 1995, p. 151, pl. VII, fig. 1.
Phricodoceras bicornis (Quenstedt): Schlegelmilch, 1992, p. 70, pl. 27, fig. 4.
Phricodoceras lamellosum (d'Orbigny): Buckman, 1920 (in Buckman 1909–1930), pl. 149 A, B; Mouterde and Dommergues (in Fischer, 1994), p. 73, pl. 22, figs. 1a–1c (=holotype); Meister, 2007, p. 92, Figs. 2A–2F; Fig. 11M; Dommergues and Meister, 2013, Figs. 3A–3B; Figs. 9A–9C; Howarth, 2013, p. 48, figs. 34.1c–34.1d.

Holotype by monotype (Mouterde and Dommergues (in Fischer, 1994)) is depicted in (d'Orbigny, 1842–1851, pl. 84, figs. 1–2). It comes from the lower Pliensbachian (Jamesoni Zone, Taylori Subzone) of

Plate III. Epideroceratidae, Eoderoceratidae. Life-size images except as noted. (1, 2) *Epideroceras grande* Donovan: (1) specimen no. 150/72 (×0.5): (1a) lateral view (×0.5), (1b) transverse section (×0.5); (2) specimen no. 150/71 (×0.5): (2a) lateral view (×0.5), (2b) ventral view (×0.5), (2c) drawing of cross section (×0.5), (2d) transverse section (×0.5); (3, 5) *Eoderoceras* sp. juv.: (3) specimen no. 150/61: (3a) lateral view, (3b) ventral view; (5) specimen no. 150/62, lateral view; (4) *Eoderoceras bispinatum* (Geyer), specimen no. E.b. 150/57: (4a) lateral view, (4b) ventral view, (4c) transverse section (D = 47 mm); (6, 7) *Epideroceras lorioli* (Hug): (6) specimen no. 150/69: (6a) lateral view, (6b) ventral view, (6c) transverse section (D = 41 mm); (7) specimen no. 150/67: (7a) drawing of cross section (D = 79 mm), (7b, 7c) lateral view, (7d) ventral view.

Plate III



France (Lorraine, Meuse Department, Breux Municipality). It was depicted in (Fischer, 1994, pl. 22, figs. 1a–1c). It is stored at Muséum National d'Histoire Naturelle, Paris (specimen no. MNHN.FR.04087).

S h a p e. Shell is small, moderately thick, with a wide trapezoidal section of inner whorls (W/H ≈ 1.25), which increase in height during ontogenesis and become highly elliptical. Lateral sides convex (more convex on inner whorls than on outer ones). The maximum width of a whorl is coincides with the position of tubercles on the lateral sides (in the middle on the outer whorls; slightly shifted toward the umbilicus on the inner ones). The ventral side of inner whorls is flattened; that of outer whorls is convex. Umbilicus is bowl-shaped, moderately narrow. Umbilical margin well-defined, rounded.

S c u l p t u r e. There are several thin low prorsiradiate ribs on lateral and ventral sides. They become thinner, more densely arranged, and slightly concave during onthogenesis. Ribs bear two rows of tubercles: one row is approximately in the middle, and the second one is on the ventrolateral margin of thwe whorl. Tubercles are quite large, rounded at the base, and, apparently, they represent the bases of spines. Tubercles (especially the lateral ones) gradually decrease in size and are almost reduced on the outer whorl. Ribs are sometimes bifurcated between the rows of lateral and perisiphonal tubercles. The ribs with tubercles alternate with one or two thinner intercalated ribs on the middle and outer whorls.

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/21	40.4	18	9.1	14	44.6	34.7	22.5	129	10
150/22	47	24	10	–	51.1	–	21.3	–	–

C o m p a r i s o n. *Phricodoceras lamellosum* (d'Orbigny, 1844) differs from *Ph. taylori* (J. de C. Sowerby) only in the section of outer whorls, which are elliptical and more compressed in *Ph. lamellosum*. In addition, *Ph. lamellosum* is characterized by a weakening of ornamentation and reduction of the lateral row of tubercles during ontogenesis. On the basis of the similarity of inner whorls (up to D ≈ 30 mm) with a completely different structure of outer ones, Dommergues (1978) and Meister (2007) consider the two species mentioned as dimorphs (*Ph. taylori*—microconch, *Ph. lamellosum*—macroconch) based on its.

It differs from *Ph. cornutum* (Simpson, 1843) in a more involute shell with higher outer whorls and significantly less coarse ribbing, as well as in the development pattern of tubercles during ontogenesis (the first occurrence of them at the early stages and reduction at the late ones and not vice versa); it differs from *Ph. urkuticum* (Géczy, 1959) in a longer lumpy stage, wider whorls, and a more rounded umbilical margin.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. Upper Sinemurian, Raricostatum Zone, Macdonnelli Subzone of Italy; lower Pliensbachian, Jamesoni Zone, Taylori Subzone of Northwestern Europe, Turkey, and Hungary; Ibex Zone, Masseanum Subzone of Hungary; and Timor Island (Indonesia)—?Ibex Zone, Masseanum Subzone.

M a t e r i a l. Two satisfactorily preserved specimens: specimen no. 150/21—from sandy limestones; specimen no. 150/22—from massive limestones of lithological type VI in association with *Gleviceras iridescens*.

FAMILY ARIETITIDAE HYATT, 1874

SUBFAMILY ARIETITINAE HYATT, 1874

Genus *Coroniceras* Hyatt, 1867

Subgenus *Pararnioceras* Spath, 1922

***Coroniceras* (*Pararnioceras*) sp.**

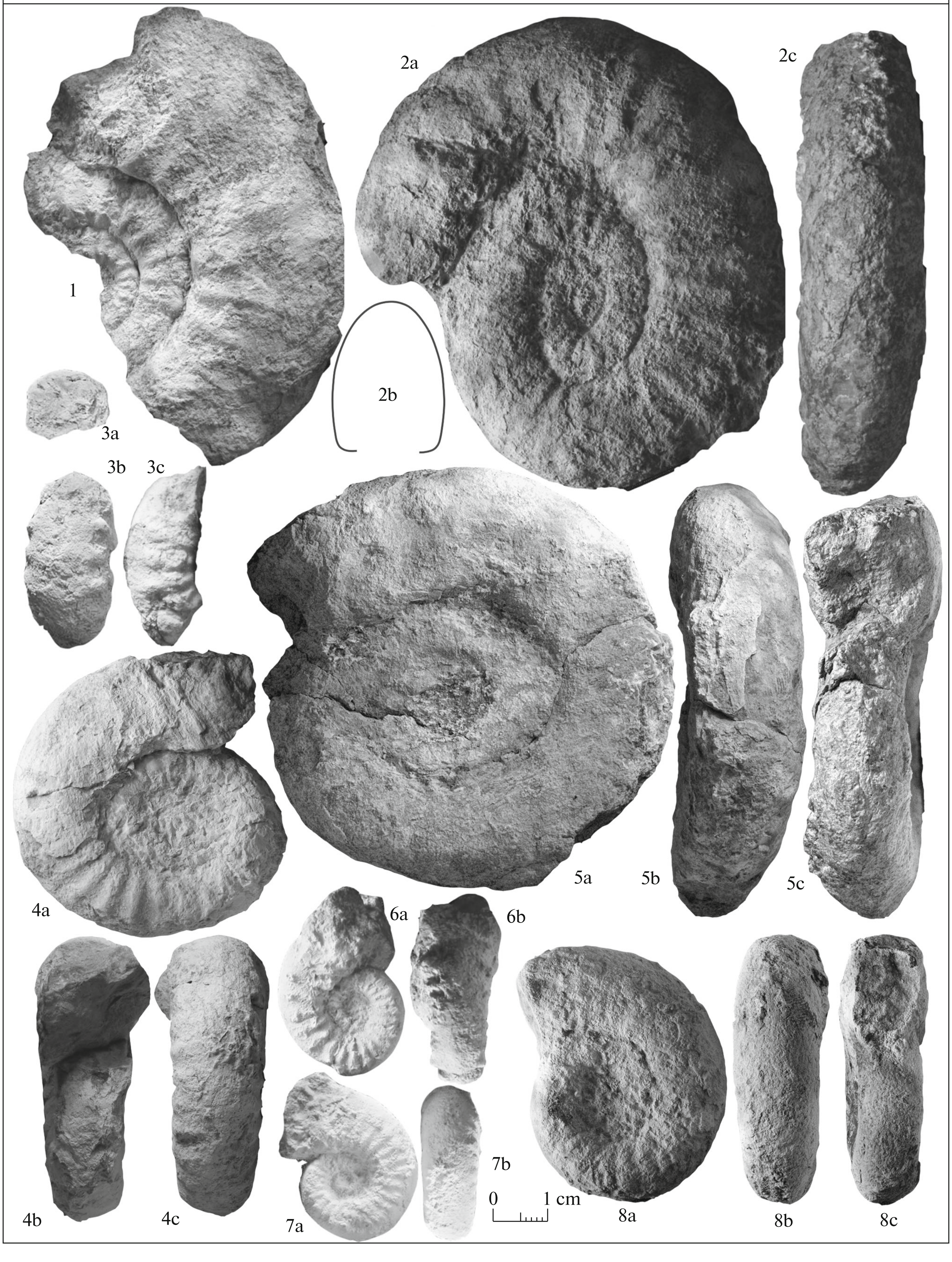
Plate VI, figs. 5a, 5b, 9a–9e

S h a p e. Shell is medium-sized, ophioconic. Whorls are moderately increasing during onthogenesis. Inner whorls are subquadrate (H ≈ W); outer whorls are subrectangular (H > W). Lateral sides are slightly convex. Ventral side is wide and flattened on the inner whorls; slightly convex on the outer ones. Umbilicus is wide, stepped; umbilical wall is convex.

S c u l p t u r e. Ventral side is three-keeled with wide (especially on inner whorls) ventral sulci. Ribs are prorsiradiate, slightly concave, curved forward passing to the ventral side, and wedge out, reaching the lateral keel. The ribs tend to be reduced on the outer whorl.

Plate IV. Epideroceratidae, Eoderoceratidae. Life-size images. (1, 2) *Epideroceras lorioli* (Hug): (1) specimen no. 150/68, lateral view; (2) specimen no. 150/70: (2a) lateral view, (2b) drawing of cross section (D = 88 mm), (2c) ventral view; (3) (?) *Tetraspidoceras* sp., specimen no. Tet.01: (3a) transverse section, (3b) lateral view, (3c) ventral view; (4–5, 8) *Eoderoceras praecursor* (Geyer): (4) specimen no. 150/54: (4a) lateral view, (4b) apertural view, (4c) ventral view; (5) specimen no. 150/55: (5a) lateral view, (5b) ventral view, (5c) apertural view; (8) specimen no. 150/56: (8a) lateral view, (8b) ventral view, (8c) apertural view; (6, 7) *Eoderoceras* sp. juv.: (6) specimen no. 150/63: (6a) lateral view, (6b) ventral view; (7) specimen no. 150/64: (7a) lateral view, (7b) ventral view.

Plate IV



Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/23	≈71	16.5	43.2	15.3	23.2	21.6	60.9	108	≈22
150/24	–	10.0	–	10.0	–	–	–	100	–

Comparison and remarks. The collected material is conditionally attributed to *Pararnioceras* based on its the subquadrate whorl section and the presence of a wide, flattened three-keeled ventral side with wide ventral sulci. The studied specimens are similar to *Coroniceras* (*Pararnioceras*) *paolinae* (Reynes) depicted in (Meister and Schlögl, 2013, Figs. 18h–18j), which are also characterized by a wide umbilicus and poorly developed tubercles on the ribs. At the same time, the material can be compared with the *Metophioceras cordieri* (Canavari) specimens depicted in (Wähner, 1882–1898, pl. XVII, figs. 1, 3), since of their outer whorls are also characterized by wide ventral sulci, or with *Metophioceras deffneri* (Oppel), which is characterized by a relatively high growth rate of whorls compared to other species of the genus.

Distribution. Lower Sinemurian, Beds with Arietites sp. and Metophioceras sp. of Crimea. Subgenus *Coroniceras* (*Pararnioceras*) is typical of the Bucklandi Subzone (Bucklandi Zone)—the lower part of Scipionianum Subzone (Semicostatum Zone) of Europe (Meister and Schlögl, 2013).

Material. Two incomplete specimens from limestones of type VI.

Genus *Metophioceras* Spath, 1924

Metophioceras sp.

Plate VI, figs. 13a–13d

Shape. Shell is ophiocone, medium-sized. Whorls are subquadrate. Lateral and ventral sides are slightly convex. Umbilical margin well-defined, rounded. Umbilicus is wide, shallow, bowl-shaped.

Sculpture. There are high, rather thin rursiradiate ribs on lateral sides, which are somewhat concave ventrolaterally on the outer whorl. Inner whorls densely ribbed with straight, rursiradiate ribs. The maximum height and width of ribs are at the ventrolateral margin. There is a single keel without the sulci on the ventral sides of inner whorls. The ventral side of outer whorls is distinctly three-keeled, with a high central keel and well-developed wide sulci.

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number ribs on 1/2 whorl
150/25	54	13	30	12	24.1	22.2	55.6	108	19

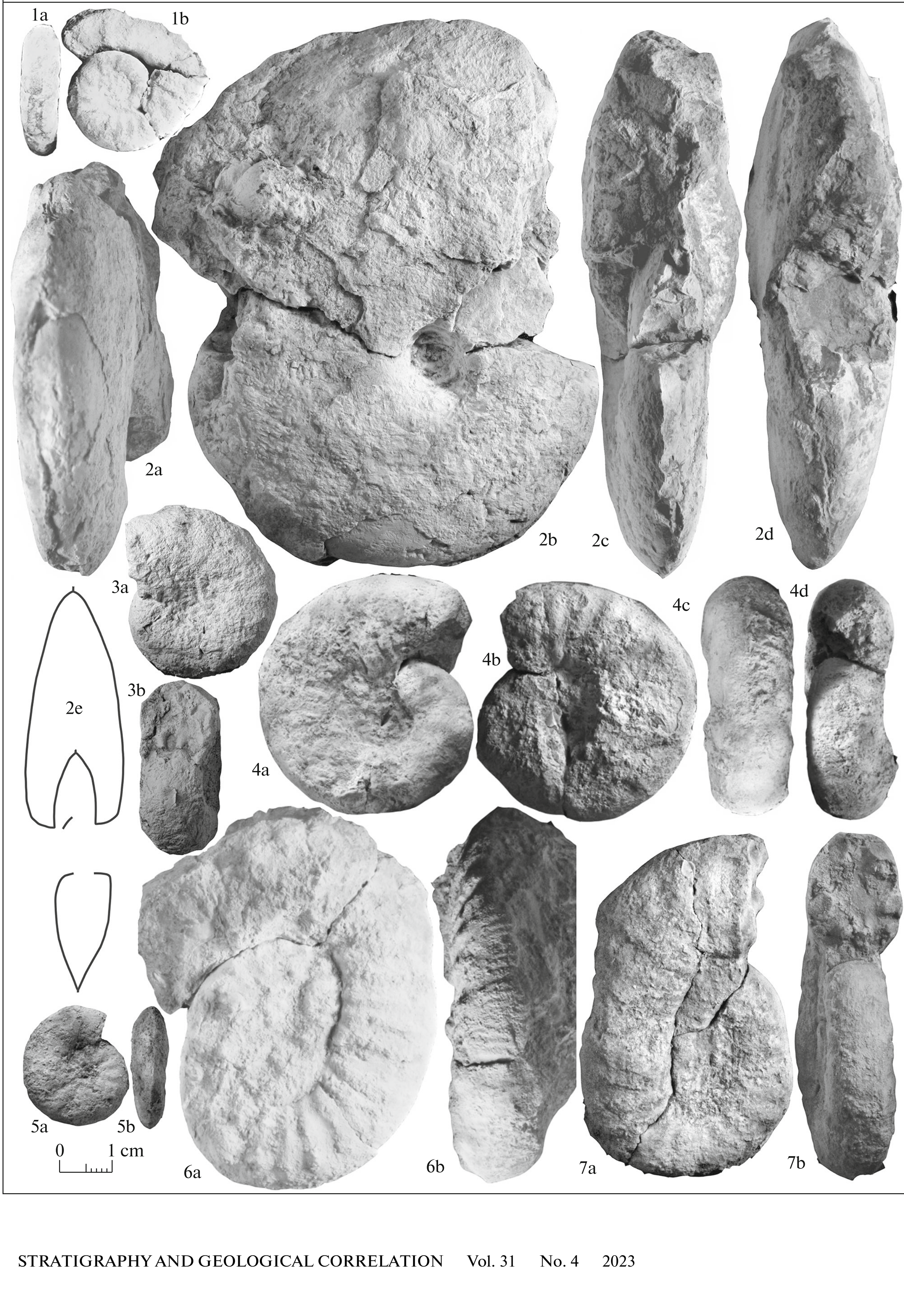
Comparison and remarks. The only studied sample found together with *Arietites* sp. is assigned to the genus *Metophioceras* on the basis of its three-keel ventral side with well-developed keels and pronounced ventral weakening of the ribs on the ventrolateral margin. Apparently, it represents inner whorls of one of the *Metophioceras* species with rursiradiate ribs (*M. longidomus* (Quenstedt), *M. rouvillei* (Reynès), *M. bonnardii* (d'Orbigny), *M. janus* Spath, or *M. cordieri* (Canavari)). This specimen is similar to *Metophioceras cordieri* (Canavari) from the Caucasus, depicted in (Topchishvili et al., pl. 2, fig. 4) and is also characterized by well-defined rursiradiate ribs and densely ribbed inner whorls.

Distribution. Lower Sinemurian, Beds with Arietites sp. and Metophioceras sp. of Crimea. Genus *Metophioceras* is typical of the terminal Hettangian, as well as the Conybeari and Rotiforme subzones of the Bucklandi Zone of Europe lower Sinemurian (Géczy and Meister, 2007, p. 169). The association of this species with *Arietites* sp. in Crimea apparently indicates the Rotiforme Subzone.

Material. One specimen from limestones of lithological type VI.

Plate V. Eoderoceratidae, Oxynoticeratidae. Life-size images. (1) "*Cymbites*" sp., specimen no. 150/53: (1a) ventral view, (1b) lateral view; (2) *Gleviceras iridescens* (Tutcher, Trueman), specimen no. 150/38: (2a, 2d) ventral view, (2b) lateral view, (2c) apertural view, (2e) drawing of cross section (D = 80 mm); (3, 4) *Eoderoceras ancyrense* (Bremer): (3) specimen no. 150/66: (3a) lateral view, (3b) apertural view; (4) specimen no. 150/65: (4a, 4b) lateral view; (4c) ventral view, (4d) apertural view; (5) *Gleviceras* sp. juv., specimen no. 150/39: (5a) lateral view, (5b) ventral view; (6, 7) *Eoderoceras bispinatum* (Geyer): (6) specimen no. 150/58: (6a) lateral view, (6b) ventral view; (7) specimen no. 150/59: (7a) lateral view, (7b) apertural view.

Plate V



Genus *Arietites* Waagen, 1869

***Arietites* sp.**

Plate VII, figs. 8a–8c

S h a p e. Shell is medium-sized ophiocon. Whorls are wide, subquadrate, with slightly convex lateral sides and wide flattened ventral side. Umbilicus wide, stepped. Umbilical wall convex.

S c u l p t u r e. Ventral side is three-keeled with wide ventral keel and wide shallow sulci. Inner whorls are densely ribbed. A decrease of ribs density is observed on outer whorls. Ribs are coarse, acute, slightly rursiradiate, club-shaped on the outer whorl (slightly widened towards the ventrolateral margin). The ribs are shortly concave at the ventrolateral margin and reduced on the ventral side, slightly before the lateral keels.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/26	52.5	12	30.5	12.5	22.9	23.8	58.1	96	19

C o m p a r i s o n a n d r e m a r k s. This species is assigned to *Arietites* because of its wide subquadrate whorl section, a three-keeled venter, and nonangular coarse slightly club-shaped ribs. However, the presence of only one incomplete specimen does not allow to establish its species affiliation. It may be close to *Arietites bisulcatus* (Bruguière) on the basis of it's densely ribbed inner whorls and rursiradiate ribbing (for example, the specimen depicted in Fischer, 1994, pl. 15, figs. 1–2).

D i s t r i b u t i o n. Lower Sinemurian, Beds with Arietites sp. and Metophioceras sp. of Crimea. The stratigraphic distribution of this genus includes the Rotiforme and Bucklandi subzones (Bucklandi Zone), as well as the base of the lower Sinemurian Semicostatum Zone (Meister and Friebe, 2003). This genus is known from Europe (France, Great Britain, Austria, Slovakia, Germany, Italy, Crimea), Northeastern Russia, Vietnam, Indonesia (Timor, Roti, Butung, Sulawesi), Canada (British Columbia), United States (Alaska), and Chili.

M a t e r i a l. One specimen from the limestone boulder of type VI, in association with *Metophioceras* sp.

SUBFAMILY ARNIOCERATINAE SPATH, 1924

Genus *Arnioceras* Hyatt, 1867

***Arnioceras rejectum* Fucini, 1902**

Plate VI, figs. 4a, 4b, 7, 8a, 8b, 10a, 10b, 11a, 11b

Arnioceras rejectum: Fucini, 1902*, p. 170 [130], pl. XIV [XVII], figs. 12, 14; pl. XVI [XIX], figs. 1–6; Kovács, 1941, p. 175, pl. IV, fig. 1; Dommergues et al., 1995, p. 173, pl. 3, figs. 12, 14–16; pl. 4, figs. 2–4; Meister and Friebe, 2003, p. 31, pl. 5, fig. 2; Géczy and Meister, 2007, p. 172, pl. XVII, figs. 1, 2 (aff.), 3, 5; Meister et al., 2017, p. 104, pl. 7, fig. 2.

Arnioceras cf. *rejectum*: Lachkar et al., 1998, p. 599, figs. 5.21–22, 6.3–5.

Arnioceras ex gr. *rejectum*: Guex et al., 2008, p. 51, pl. 5, fig. 2; fig. 3.33.

Arnioceras ex gr. *ceratitoides* (Quenstedt): Meister and Böhm, 1993, p. 175, pl. 4, figs. 3–6, 10.

Arnioceras ex gr. *ceratitoides* (Quenstedt) *rejectum* Fucini: Fauré et al., 2021, p. 105, Figs. 7C1–C3.

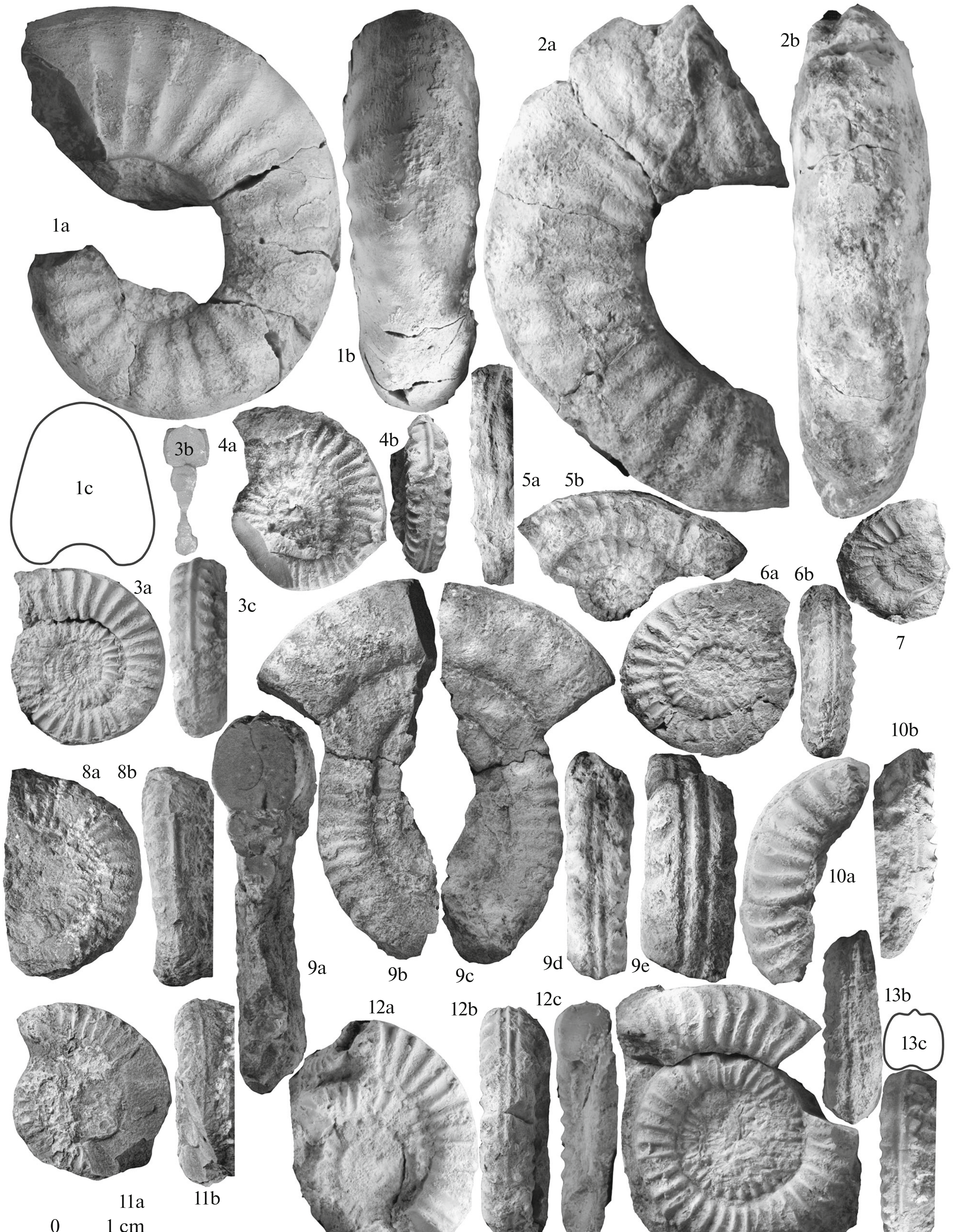
Syntypes. Five specimens from the gray limestone (upper Sinemurian; probably, Obtusum Zone) of Monte di Cetona (Tuscany, Italy). One specimen is kept at Museo di Pisa; other specimens are stored at Museo di Firenze (Fucini, 1902, p. 171).

S h a p e. Shell is ophioconic, small-sized. Whorl section is subquadrate. Ventral side is flat. Lateral sides are flattened or slightly convex. Umbilicus wide, shallow, bowl-shaped. Ventral and umbilical margins are well-defined, angular.

S c u l p t u r e. Ventral side bears a low but well-defined keel, bordered by shallow sulci. Juvenile smooth stage is not defined or very short. Lateral sides covered with a dens thin ridge-like ribs, strongly projecting upward at the ventrolateral margin. The ribs become concave passing the venter and reduce near the ventral sulci.

Plate VI. Arietitidae. Life-size images. (1, 2) *Asteroceras dommerguesi* Zaitsev, sp. nov.: (1) specimen no. 150/35 (holoytype): (1a) lateral view, (1b) ventral view, (1c) drawing of cross section (D = 80 mm); (2) specimen no. 150/36: (2a) lateral view, (2b) ventral view; (3) *Arnioceras* sp., specimen no. 150/34: (3a) lateral view, (3b) transverse section, (3c) ventral view; (4, 7–8, 10–11) *Arnioceras rejectum* Fucini: (4) specimen no. 150/27: (4a) lateral view, (4b) ventral view; (7) specimen no. 150/31, lateral view; (8) specimen no. 150/29: (8a) lateral view, (8b) ventral view; (10) specimen no. 150/28: (10a) lateral view, (10b) ventral view; (11) specimen no. 150/30: (11a) lateral view, (11b) ventral view; (5, 9) *Coroniceras* (*Pararnioceras*) sp.: (5) specimen no. 150/24: (5a) ventral view, (5b) lateral view; (9) specimen no. 150/23: (9a) transverse section, (9b, 9c) lateral view, (9d, 9e) ventral view; (6, 12) *Arnioceras* cf. *mendax* Fucini: (6) specimen no. 150/33: (6a) lateral view, (6b) ventral view; (12) specimen no. 150/32: (12a) lateral view, (12b) ventral view, (12c) transverse section; (13) *Metophioceras* sp., specimen no. 150/25: (13a) lateral view, (13b, 13d) ventral view, (13c) drawing of cross section (D = 47 mm).

Plate VI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Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/27	33.5	7.5	21	8.0	22.4	23.9	62.7	93.8	21
150/28	–	8.8	–	9.2	–	–	–	95.7	–
150/29	39	8.0	23	9,0	20.5	23.1	59.0	88.9	21
150/30	33	9.0	19	7.0	27.3	21.2	57.6	129	–

Comparison and remarks. Tethyan *Arnioceras* are characterized by the wide range of morphological variability. For example, Fucini (1902) identified more than 20 nominal species and varieties of *Arnioceras* only in the Monte di Cetona locality (Italy). However, the majority of researchers point it out that the age and origin of all Fucini's specimens are nearly identical and tend to believe that they should be considered as a few species or even a single highly variable species (Dommergues et al., 1994; Fauré et al., 2021).

The described species differs from other species of *Arnioceras* by its very short smooth juvenile stage, a flattened venter, and a dense ribbing strongly projecting upward at the ventrolateral margin.

Distribution. Upper Sinemurian, Beds with Arnioceras rejectum and Asteroceras dommerguesi of Crimea. The species is often mentioned in articles from Mediterranean sections. According to Dommergues and Meister (2017), its distribution is probably limited to this paleobiogeographic region. In the most detailed interpretation, the species is distributed in the stratigraphic interval from the base of the Semicostatum Zone to the end of the Obtusum Zone. It is known from the Turneri Zone to the basal part of the Obtusum Zone of North Africa, from the Obtusum Zone of the Central European (Southern Alpine) subprovince (Austria, Hungary), from the Obtusum Zone in Spain, and from the Stellare Subzone in Northern Italy. In Crimea the occurrence of this species in association with *Asteroceras* indicates that it belongs to the Stellare Subzone.

Material. Five specimens from limestone boulders of lithological type VI, in association with *Asteroceras dommerguesi* Zaytsev, sp. nov. and *Paradasyceras* cf. *stella* (J. de C. Sowerby).

***Arnioceras* cf. *mendax* Fucini, 1902**

Plate VI, figs. 6a, 6b, 12a–12c

Shape. Shell is evolute, ophioconic, small- to medium-sized. Whorls are subrectangular or subquadrate. Lateral sides flattened to slightly convex. Ventral side is wide, slightly convex. Umbilical and ventrolateral margins are well expressed. Umbilicus is wide, bowl-shaped.

Sculpture. There is a low ventral keel on inner whorls, bordered by shallow but well-defined sulci. Ventral side of outer whorls three-keeled with a high, acute central keel and narrow, rather deep ventral sulci and low, but clearly distinguishable lateral keels. There are narrow high rectiradiate or several rursiradiate ribs on the lateral sides. The ribs on inner whorls reduced, ending abruptly on the ventral side near ventral sulci. The ribs on the outer whorl reach the lateral keel.

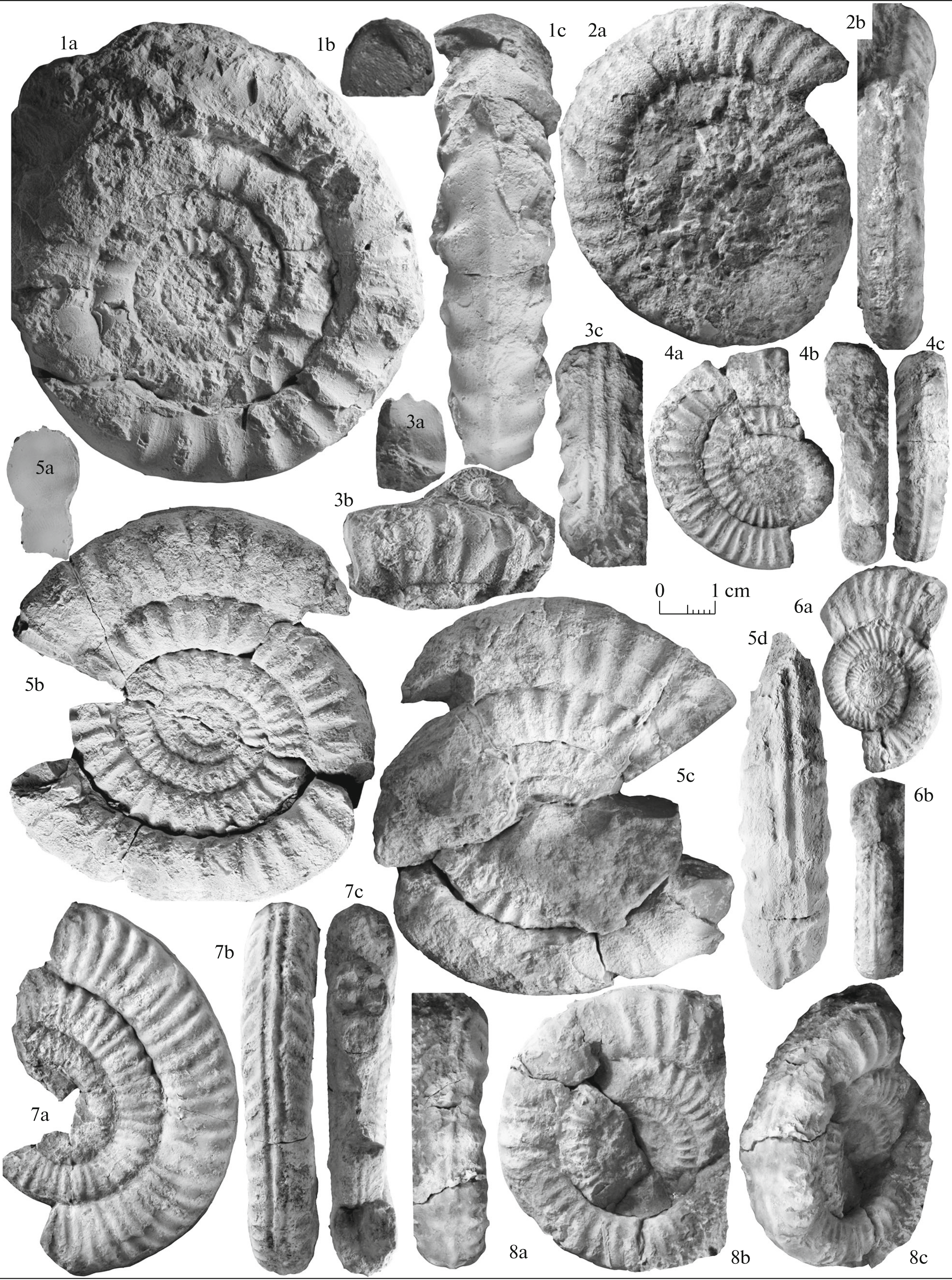
Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/32	–	9.0	29	10.0	–	–	–	90	17
150/33	32	5.0	17.5	7.0	15.6	21.9	54.7	71.4	15

Comparison and remarks. The described specimens differ from *Arnioceras rejectum* Fucini by less density of ribbing, and the absence of bending of the ribs forward in the venter, and in a slightly more convex three-keeled ventral side with rather deep ventral sulci on outer whorls. These characters allow to compare the described material with *A. mendax* Fucini. It differs from *A. ceratitoides* (Quenstedt) in a

Plate VII. Echioceratidae. Life-size images. (1) *Echioceras raricostatoides* (Vadasz), specimen no. 150/45: (1a) lateral view, (1b) transverse section (D = 64 mm), (1c) ventral view; (2) *Orthechioceras* aff. *edmundi* (Dumortier), specimen no. 150/42: (2a) lateral view, (2b) ventral view; (3, 7) *Paltechioceras oosteri* (Dumortier): (3) specimen no. 150/47: (3a) transverse section, (3b) lateral view, (3c) ventral view; (7) specimen no. 150/48: (7a) lateral view, (7b) ventral view, (7c) transverse section (D = 69 mm); (4, 6) *Plesechioceras* cf. *pierrei* (Spath): (4) specimen no. 150/41: (4a) lateral view, (4b) apertural view, (4c) ventral view; (6) specimen no. 150/40: (6a) lateral view, (6b) ventral view; (5) *Paltechioceras aureolum* (Simpson), specimen no. 150/46: (5a) transverse section (D = 75 mm); (5b, 5c) lateral view, (5d) ventral view; (8) *Arietites* sp., specimen no. 150/26: (8a) ventral view, (8b) lateral view, (8c) inclined.

Plate VII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wider (up to subquadrate) whorl section and a wider venter.

D i s t r i b u t i o n. Lower Sinemurian, Beds with Arietites sp. and Metophioceras sp. of Crimea. Species *A. mendax* is known from Mediterranean province. The stratigraphic interval of its distribution is poorly studied, since the species is often mentioned in the literature without a stratigraphic description. It comes from the Bucklandi Zone of Sicily (Vialli, 1959) and the lower Sinemurian Semicostatum Zone of Austria, Spain (Cordillera Betica), and Italy. In addition, it is known from the upper Sinemurian (Stellare Subzone of Obtusum Zone) in Switzerland (Dommergues and Meister, 1990a) and Hungary (Géczy, 1972). Similar forms were noted from Leslei Zone of British Columbia, Canada (Palfy, 1991). The stratigraphic position of this species in Crimea is still unclear. *Arnioceras mendax* var. *taurica* was described by Moiseev (1944) from the environs of Oreanda (Crimea) in the same locality with *Coroniceras* ex gr. *bucklandi* (J. Sowerby, 1816), which can indicate the lower Sinemurian Bucklandi Zone.

M a t e r i a l. Three specimens (two of them are fragmentarily preserved) from limestone boulders of lithological type VI.

Arnioceras sp.

Plate VI, figs. 3a–3c

S h a p e. Shell is evolute, small sized, flattened. Whorls increase moderately during their growth. Lateral sides are flattened, somewhat diverging toward the ventrolateral margin, where the maximum of whorls width is noted. Ventral side is wide, flattened. Ventrolateral and umbilical margins is well-pronounced, angular. Umbilicus is wide, stepped.

S c u l p t u r e. There are high narrow ridge-like ribs on lateral sides that reach a maximum height at the ventrolateral margin. Ribs are rursiradiate at all stages of ontogenesis. There is no more or less prolonged juvenile smooth stage: the lateral sides are covered with densely spaced ribs already at D = 5 mm. The ribs on inner whorls is quite sharply reduced at the ventrolateral margin and on the outer whorls. They are gently curved forward passing the ventral side. Already on juvenile whorls, there is a low keel in the middle of the venter. Ventral sulci are absent.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/34	34	9.5	18	9.5	27.9	27.9	52.9	100	15

C o m p a r i s o n a n d r e m a r k s. On the basis of the absence of a more or less prolonged smooth juvenile stage, the described specimen is similar to *Arnioceras oppeli* Guerin-Franiatte, from which it differs in it's wider section. It differs from *A. hartmanni* (Oppel), which also has rursiradiate ribs, in more densely ribbing on inner whorls; it differs from *A. semicostatum* (Young et Bird), *A. ceratitoides* (Quenstedt), and other similar species in the absence of a prolonged juvenile smooth stage and in rursiradiate ribs.

D i s t r i b u t i o n. Sinemurian of Crimea. The stratigraphic distribution interval of the genus includes the Sinemurian Semicostatum–Obtusum Zone (Stellare Subzone) of Europe, the Caucasus, North Africa (Atlas Mountains), Tunis, Northeastern Russia, China (Tibet, Guangdong), Japan, Indonesia (Timor Island, Roti Island), New Zealand, New Caledonia, Canada (British Columbia, Alberta, Yukon), United States (Alaska, Nevada, California), Mexico, Chili, Argentina, Peru, Equador, and Colombia.

In Crimea, there are findings of different species of the genus *Arnioceras* in limestone boulders in the Bodrak River valley (Repin, 2017), in mudstones of the Bodrak River valley (Zaitsev and Arkadiev, 2019), and in sandstones on the Southern Coast of Crimea near the settlement of Oreanda (Moiseev, 1944).

M a t e r i a l. Single specimen from the limestone boulder of lithological type VI.

SUBFAMILY ASTEROCERATINAE SPATH, 1946

Genus *Asteroceras* Hyatt, 1867

Asteroceras dommerguesi Zaitsev, sp. nov.

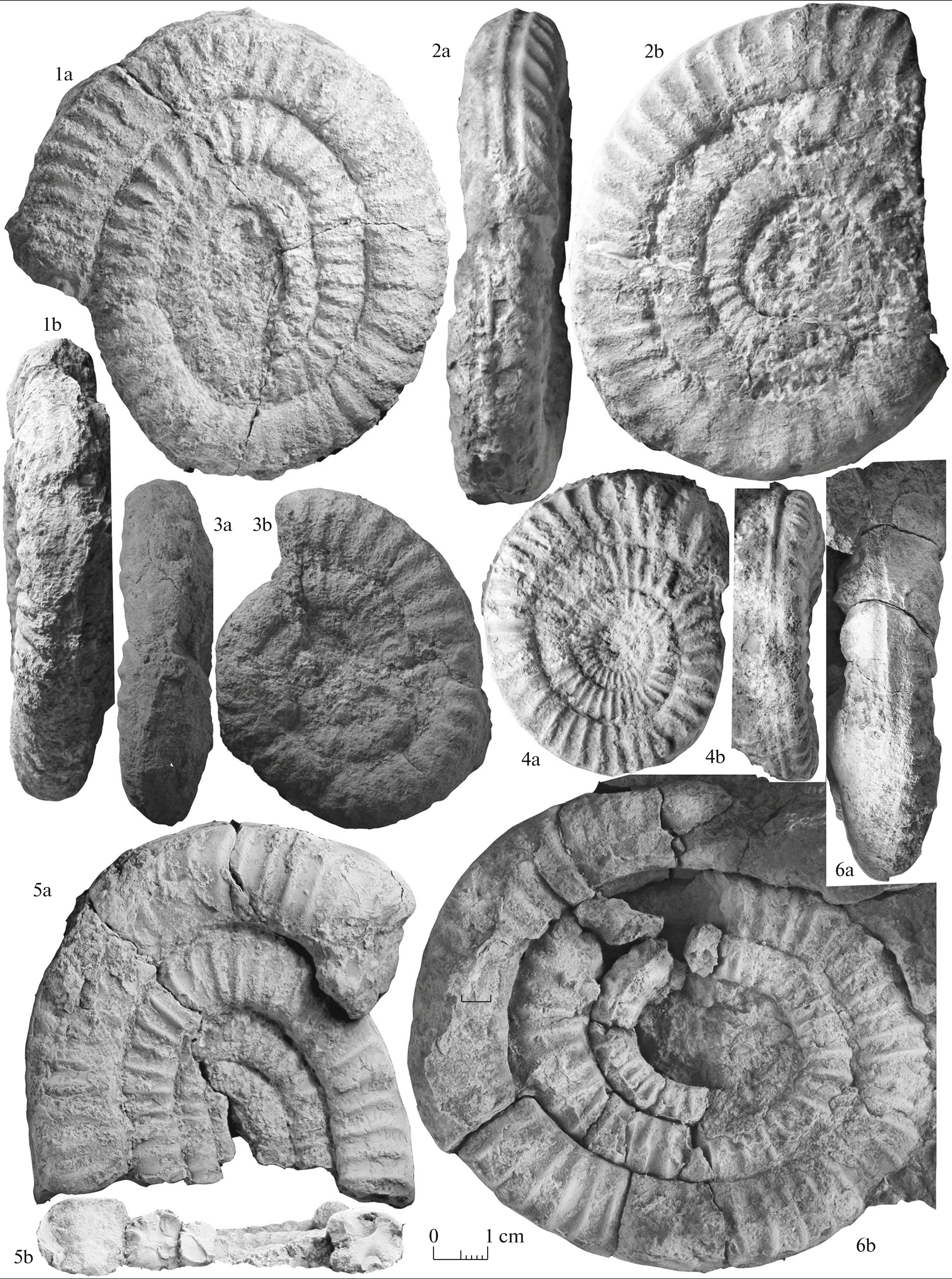
Plate VI, figs. 1a–1c; 2a, 2b

Asteroceras nov. sp.: Dommergues et al., 2008, p. 555, fig. 6G.
Asteroceras (?) sp. (B): Dommergues and Meister, 2017, p. 242, fig. 82.

E t y m o l o g y. In honor of paleontologist Jean-Louis Dommergues.

Plate VIII. Echioceratidae. Life-size images. (1, 4) *Paltechioceras recticostatum* (Trueman et Williams): (1) specimen no. 150/50: (1a) lateral view, (1b) ventral view; (4) specimen no. 150/49: (4a) lateral view, (4b) ventral view; (2, 3) *Paltechioceras romanicum* (Uhlig): (2) specimen no. 150/51: (2a) ventral view, (2b) lateral view; (3) specimen no. 150/52: (3a) ventral view, (3b) lateral view; (5, 6) (?) *Orthechioceras* sp.: (5) specimen no. 150/44: (5a) lateral view, (5b) transverse section; (6) specimen no. 150/43: (6a) ventral view, (6b) lateral view.

Plate VIII



H o l o t y p e. Specimen no. 150/35 from the limestone boulder in the Greek Quarry, the southern of Simferopol. Beds with Arnioceras rejectum and Asteroceras dommerguesi.

S h a p e. Shell is medium-sized, evolute. Whorls are moderately increase in height during the ontogenesis. At the same time, their sections is vary from wide, depressed, to subelliptical (on an outer whorl), with the maximum width in the near-umbilical quarter of the whorls. Lateral sides convex, on the outer whorl is converging toward the wide uniformly rounded ventral side. Ventrolateral margin is flat. Umbilicus is wide, bowl-shaped. Umbilical wall convex.

S c u l p t u r e. Rectiradiate or weakly rursiradiate ribs occur only the lateral sides. They gradually decrease in height as they approach the ventrolateral margin and wedge out without passing to the ventral side.

The ribs are gradually decrease in width and the width of the intercostal spaces increases during the ontogenesis. There are very insignificant strokes are crossing the ventral side on the outer whorl of the holotype, which are distinguishable in lateral illumination. A remarkable feature is the absence of any traces of keel and ventral sulci on the ventral side (at least on the last whorl).

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/35	81.2	29.5	31.2	25.5	36.3	31.4	38.4	116	15
150/36	96	35	38	25	36.5	26	39.6	140	17

C o m p a r i s o n and r e m a r k s. This described species is includes forms with a convex, uniformly rounded ventral side, even without the "rudiments" of the keel and ventral sulci (at least on the outer whorl).

A specimen from the Djebel Chibla locality (Algeria, Vilayat Bedjaya), identified as *Asteroceras* nov. sp. (Dommergues et al., 2008) and *Asteroceras* (?) sp. (B) (Dommergues and Meister, 2017) (see synonymy), has a similar ventral side. For this reason the Algerian specimen is considered here as the described species, however it differs from the holotype by it's narrower ribs at the early stages of ontogenesis, a slightly narrower whorl section, and a slightly denser ribbing.

The species is assigned to the genus *Asteroceras* on the basis of it's similarity in shell proportions, as well as in the density and configuration of the ribs on the lateral sides with the Tethyan species of this genus: *A. varians* Fucini and *A. margarita* (Parona). At the same time, the similarity of the ventral side of the species under consideration with that of boreal *Arctoasteroceras*, following J.-L. Dommergues, is considered as convergent (Dommergues et al., 2008, pp. 555).

The pattern of ribbing, in which the ribs tend to be reduced in the upper part of the lateral side, is common for many Tethyan *Asteroceras* (*A. varians* Fucini, *A. margarita* (Parona), *A. suevicum* (Quenstedt), *A. saltriensis* (Parona)). In addition, in *A.* gr. *varians* Fucini, there is a tendency to reduction of the keel and ventral sulci. Thus, only a rudimentary keel is preserved on the outer whorl in *A. varians* var. *interposita* Fucini. However, unlike *Asteroceras* gr. *varians*, Crimean specimens are characterized by a flat ventrolateral margin and regularly convex ventral side.

Crimean specimens differ from the similar species *A. meridionales* Dommergues et al., 1990 in a complete absence of even "rudiments" of the keel and ventral sulci.

The described species differs from another species of *Aegasteroceras* described and characterized at its initial diagnosis by Spath (1925) (*A. simile* (type species), *A. sagittarium*, *A. crissum*, and *Aeg. acuticostatum*), as well as from the North African species *A. peyssonneli* (Rakus et Guex, 2002) in a more involute shell (at similar ratios of Dn/D > 40%), the complete absence of even a rudimentary ventral keel, and a complete reduction of ribs on the ventral side (while in *Aegasteroceras*, even at large diameters, reduced ribs cross the ventral side).

D i s t r i b u t i o n. This species is known from the upper Sinemurian of Crimea (Beds with Arnioceras rejectum and Asteroceras dommerguesi), as well as from North Africa (Algeria) (presumably the Obtusum Zone; Dommergues et al., 2008, p. 555).

M a t e r i a l. Three specimens; in Two of them have preserved more than half of the outer whorl. Limestone boulders of lithological type VI, in association with *Arnioceras rejectum* Fucini and *Paradasyceras* cf. *stella* (J. de C. Sowerby).

FAMILY OXYNOTICERATIDAE HYATT, 1875

SUBFAMILY GLEVICERATINAE GUEX, RAKÚS, MORARD ET QUARTIER-LA-TENTE, 2008

Genus *Gleviceras* Buckman, 1918

Gleviceras iridescens (Tutcher et Trueman, 1925)

Plate V, figs. 2a–2e

Victoriceras iridescens: Tutcher and Trueman, 1925*, p. 643, Fig. 14.

Gleviceras cf. *iridescens* (Tutcher et Trueman): Schlatter, 1991, pl. 11, fig. 3.

Gleviceras iridescens (Tutcher et Trueman): Owens and Bassett, 1995, p. 139, Fig. 19.4 [=image of holotype].

Gleviceras juv. aff. *iridescens* (Tutcher et Trueman): Meister et al., 2003, pl. 2, figs. 21–22.

Gleviceras ex gr. *iridescens* (Tutcher et Trueman): Géczy and Meister, 2007, p. 181, pl. XXVI, fig. 6; pl. XXVII, figs. 4, 7.

Holotype. A "broken shell" from Westfield Quarry (about 1.6 km southwest of Radstock, Somerset County, United Kingdom) from A.E. Trueman's collection. Beds with Eteoderoceras armatum (upper Sinemurian Raricostatum terminal zone or lower Pliensbachian Jamesoni Zone). It is stored at the National Museum of Wales: specimen no. NMW 79.19G.2. It is depicted in (Owens and Bassett, 1995, Fig. 19.4).

Shape. Shell is large-sized, suboxicone, discoidal with a lanceolate whorl section (high, narrow, with a pointed ventral side). Then, whorls become wider and their sections become highly oval in ontogeny. Lateral sides are slightly convex, converge toward the venter, and merge on the venter at an acute angle. The maximum whorl width is in its near-umbilical third. Ventral side is lanceolate on the inner whorls and strongly convex on the outer whorls. Shell is characterized by a narrow funnel-shaped umbilicus with vertical umbilical walls. Umbilical margin is smoothly rounded.

Sculpture. Outer whorls is completely smooth. The weak prorsiradiate ribs are visible on inner whorls of the fragmentarily preserved shell in near-umbilical part of lateral sides. The ventral side bears a low but well-marked keel, which is reduced on the outer whorl.

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/38	107.5	60	11.6	30	55.8	27.9	10.8	200

Suture line is complexly dissected and characterized by a wide ventral lobe and a rather narrow, asymmetric V/L saddle, which is divided by a deep cut into two unequal parts. The lateral lobe exceeds the ventral one in depth (Fig. 6).

Comparison and remarks. The ontogenetic development of the shape of the cross section depicted in (Tutcher and Trueman, 1925) agrees very well with the Crimean specimens. The change in the cross section of the shell during ontogenesis and the absence of sculpture on outer whorls make it possible to distinguish the described species from similar species of *Gleviceras* (for example *G. lotharingius* (Reynes)). It differs from the same-aged species of the genus *Radstockiceras* in a wider umbilicus and a wider cross section of the outer whorls.

The described species differs from the ornamented *Oxynoticeras* Hyatt (subfamily Oxynoticeratinae), which also have an oxycone shell (*O. stenomphalum* Pia, *O. soemanni* (Dumortier), *O. orientale* Douvillé, and *O. simpsoni* (Simpson)), in a different pattern of the suture line with very deeply dissected saddles and lobes without noticeable simplification of the second lateral saddle. In addition, it differs from all representatives of the genus *Oxynoticeras*, which preserve the oxycone shell and the angled ventral side during the ontogenesis in the specific development of a cross section with a very wide outer whorl (highly oval, with a rounded ventral side).

Perhaps, *Gleviceras* sp. juv. (specimen no. 150/39, Plate V, figs. 5a, 5b) can be assigned to the described species. It is characterized by a well-developed low keel and wide, low, almost straight ribs that become wider in the near-siphonal part of the lateral sides and rather sharply tapering without passing to the ventral side. At the same time, the ribs on the last preserved whorl are almost completely reduced as in juvenile *G.* juv. (aff. *iridescens* (Tutcher et Trueman)) from Yorkshire (Meister et al., 2003, fig. 4).

Distribution. Terminal Sinemurian of Crimea. Terminal Sinemurian (Aplanatum Subzone) and basal Pliensbachian (the base of Jamesoni Zone) of Hungary; terminal Sinemurian–basal Pliensbachian (the base of Jamesoni Zone) of Yorkshire (Great Britain).

Material. A single well-preserved specimen with fragmentarily preserved shell from the limestone boulder of lithological type VI, in association with *Phricodoceras lamellosum* (specimen no. 150/22).

FAMILY ECHIOCERATIDAE BUCKMAN, 1913

Genus *Plesechioceras* Trueman et Williams, 1925

***Plesechioceras* cf. *pierrei* (Spath, 1956)**

Plate VII, figs. 4a–4c, 6a, 6b

Shape. Shell is small-sized, ophioconic. Inner whorls are subrounded. Outer whorl is elliptical, with slightly convex lateral sides. Ventrolateral margin is gently rounded. Umbilicus is wide, shallow, bowl-shaped. Umbilical wall convex.

Sculpture. There is a low, well-defined, rounded ventral keel, bordered by narrow shallow sulci. Lateral sides are ornamented by slightly concave, thin, rather densely spaced ribs (at D = 26 mm—47 ribs per whorl). The ribs are gently curved forward while passing the ventral side and almost reach the keel. The ribbing on the inner whorls is weakly rursiradiate; on the outer whorl it becomes prorsiradiate.

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/40	37	9.5	21	9	25.7	24.3	56.8	106
150/41	41	8.5	25	8.5	20.7	20.7	61	100

Comparison and remarks. It is noted that the systematics of early Echioceratidae is difficult because of their strong morphological variability (Rakus and Guex, 2002, p. 87). The species *P. pierrei* was previously considered as part of the genus *Palaeoechioceras* Spath (Getty, 1973). However, its similarity to the type species of the genus *Plesechioceras*—*P. delicatum* (Buckman)—gives a reason for considering it as

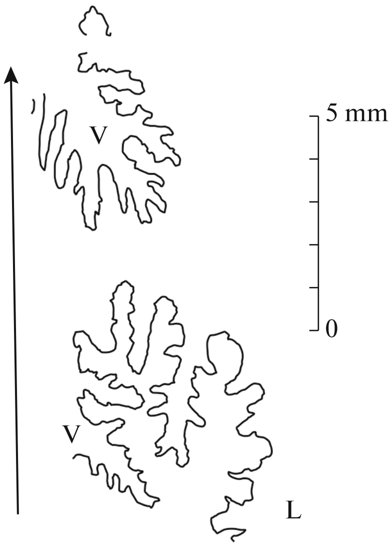


Fig. 6. Fragments of suture line of *G. iridescens*, specimen no. 150/38, D = 77 mm.

a part of the *Plesechioceras* genus, being different only in slightly less prorsiradiate ribs. Both genera are often considered as synonyms (Dommergues, 1993; etc.).

Closely related species *P. pierrei* (Spath), *P. delicatum* (Buckman), and *P. doricum* (Savi et Meneghini) are difficult to distinguish. The Crimean specimens are attributed to *P.* cf. *pierrei* (Späth) mainly because of their less prorsiradiate ribs on the outer whorl.

Crimean specimens differ from typical *Plesechioceras pierrei* in the rursiradiate ribbing on inner whorls. From the similar *Palaeoechioceras spirale* (Trueman et Williams), they differ in somewhat larger shells, as well as less coarse ribbing. The specimen from the Bodrak River valley (Crimea) identified by Yu.S. Repin as *Palaeoechioceras spirale* (Trueman et Williams) is apparently identical to the material from the Greek Quarry, since it also has a rursiradiate ribbing on the inner whorls (Repin, 2017, pl. I, figs. 4a, 4b).

D i s t r i b u t i o n. Upper Sinemurian, Beds with Plesechioceras cf. pierrei of Crimea. Species *P. pierrei* belongs to early Echioceratidae, which appear in the Oxynotum Zone. However, the exact stratigraphic distribution interval of this species is still uncertain. It is known both from the Euroboreal and from the Mediterranean province in the basal part of the Densinodulum Subzone (the base of the Raricostatum Zone). In North Africa, the species occurs below the first levels with Plesechioceras delicatum (Buckm.), and the stratigraphic distribution interval can correspond to the upper part of the Oxynotum Zone (Dommergues and Meister, 2017). In addition, this species is probably present in the northern part of the Pacific (North America).

M a t e r i a l. Two specimens from limestone boulders of lithological type VI.

Genus *Orthechioceras* Trueman et Williams, 1925 (sensu Getty, 1973)

Orthechioceras aff. *edmundi* (Dumortier, 1867)

Plate VII, figs. 2a, 2b

S h a p e. Shell is evolute, ophioconic, medium-sized. The whorls are slowly increase in height during ontogenesis. Whorls have a subquadrate section with slightly convex lateral sides. Umbilicus is wide and shallow, bowl-shaped. Umbilical wall is convex.

S c u l p t u r e. Ventral side is three-keeled: low rounded central keel, bordered by shallow, but well-defined sulci with slight peripheral keels laterally. Ribbing on lateral sides is rather dense. Slightly prorsiradiate ribs are gently curved forward in the ventrolateral part of a whorl. The width of the intercostal spaces is somewhat wider than the width of ribs.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/42	63	11	39	11	17.5	17.5	61.9	100	23

C o m p a r i s o n a n d r e m a r k s. The described specimen is characterized by a three-keeled ventral side and regular, relatively dense ribbing with weakly prorsiradiate, slightly concave densely spaced ribs. A similar pattern of ribbing is characteristic of primitive Echioceratidae, such as late *Plesechioceras* or *Orthechioceras* gr. *edmundi* (Dumortier). The presence of a three-keeled venter brings the species closer to *Paltechioceras* Buckman. This species is assigned to *Orthechioceras*, since representatives of this genus may have well-defined sulci on the ventral side, as, for example, in some Crimean specimens of *Orthechioceras* cf. *edmundi* (Zaitsev, 2021, pl. II, fig. 2d).

Apparently, the specimen of "*Plesechioceras* (?) sp. 2" from North Africa belongs to the same species (Dommergues and Meister, 2017, p. 263, Fig. 115). The specimen of "(?)*Vermiceras ophioides* (d'Orbigny)" from Italy is also similar in morphology (Fucini, 1903, p. 138, pl. XII [XV], figs. 10–11).

D i s t r i b u t i o n. Upper Sinemurian (probably, Beds with Plesechioceras cf. pierrei) of Crimea. Specimens with similar morphology from North Africa presumably belong to the Oxynotum Zone (Dommergues and Meister, 2017). However, the age of these forms remains insufficiently precisely defined.

M a t e r i a l. One specimen from a limestone boulder of lithological type VI.

(?) *Orthechioceras* sp.

Plate VIII, figs. 5a, 5b, 6a, 6b

S h a p e. Shell is evolute, ophioconic, flattened, relatively large. Whorls are slowly increasing in height during ontogenesis. Inner whorls are wide subquadrate with the width slightly larger than their height, which becomes higher, subrectangular on the outer whorls. Ventral side of inner whorls is wide and flattened and becomes remarkably convex on the outer whorl. Umbilicus is wide, shallow, bowl-shaped. Umbilical wall is convex.

S c u l p t u r e. Ventral side is distinctly three-keeled, with rather deep ventral sulci and low lateral keels, which is especially noticeable on the inner whorls. Ribs are high, radial, acute, relatively sparsely spaced. The ribbing becomes denser on the body chamber.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/43	99	18	67	17	18.2	17.2	67.7	106	24
150/44	–	17	–	16	–	–	–	106	22

C o m p a r i s o n a n d r e m a r k s. The studied specimens belong to *Orthechioceras* on the basis of the of coarse radial ribbing and three-keeled ventral side with deep ventral sulci. In terms of morphology, they are very close to specimens of *Orthechioceras* sp. from the Densinodulum Subzone of Scotland shown by Getty (1973, pl. 2, fig. 8).

D i s t r i b u t i o n. T.A. Getty indicates the distribution of the specimens with similar morphology in Scotland in the Densinodulum Subzone (the base of the upper Sinemurian Raricostatum Zone) of Scotland (Getty, 1973). However, M.J. Simms and M. Edmunds note that Getty probably miss attributed the British material to the Densinodulum Subzone, and rather it is come from the Aplanatum Subzone (terminal part of the Raricostatum Zone) (Simms and Edmunds, 2021, p. 10).

M a t e r i a l. Two specimens with a preserved body chamber and several fragments of outer whorls from the limestone boulder of lithological type VI.

Genus *Echioceras* Bayle, 1878

***Echioceras raricostatoides* (Vadasz, 1908)**

Plate VII, figs. 1a–1c

Ammonites raricostatus (pars): Dumortier, 1867, p. 173, pl. XXV, figs. 6, 7.

Arietites raricostatus: Parona, 1898, p. 8, pl. XII, fig. 2.

Echioceras rarecostatum: Bayle, 1878, pl. LXXVII, figs. 2–3; Gotsanyuk and Leshchukh, 2002, pl. II, fig. 2; pl. IV, figs. 3–8.

Echioceras raricostatum: Roman, 1938, p. 91, pl. IX, fig. 84; Krymgolts and Nutsubidze, 1958, p. 67, pl. XXVI, fig. 1.

Ammonites raricostatus costidomus: (pars) Quenstedt, 1885, p. 188, pl. 23, fig. 20.

Arietites raricostatoides: Vadász, 1908*, p. 373, text-fig. 26; Tomas and Pálfy, 2007, p. 247, figs. 5g, 5h, 5j–5k.

Echioceras sparsicostatum: Trueman and Williams, 1925, p. 713, pl. II, fig. 8.

Echioceras fulgidum: Trueman and Williams, 1925, p. 717, pl. I, fig. 12.

Echioceras raricostatum (pars): ? Kazakova, 1962, p. 45, pl. II, fig. 2.

Echioceras ex gr. *raricostatum* (pars): Dommergues and Meister, 1987, p. 319, pl. 3, figs. 1, 2, 4; Meister, 1991, p. 231, pl. 1, figs. 6, 7.

Echioceras raricostatoides: Getty, 1973, pl. 1, fig. 12; Schlatter, 1984, pl. 3, figs. 1, 3; Schlatter, 1991, p. 35, pl. 2, figs. 5–6; Schlegelmilch, 1992, p. 56, pl. 21, fig. 11; Dommergues, 1993, p. 134, pl. 7, figs. 2, 4; Guerin-Franiatte in Fischer, 1994, p. 55, pl. 20, figs. 7a, 7b, 8a, 8b (= *Ammonites raricostatus*: d'Orbigny, 1844, p. 213, pl. 54, fig. 14); Blau, 1998, p. 206, pl. IV, figs. 3–8; Howarth, 2002, p. 127, pl. 4, fig. 2; 2013, p. 29, figs. 21, 4d, 4e, 4f; Ţibuleac, 2005, pl. III, fig. 2; Wierzbowski et al., 2012, p. 37, pl. 1, figs. 2–5; Howarth, 2013, figs. 21, 4d–4f; Lukeneder and Lukeneder, 2018, p. 102, text-figs. 8a, 8b, pl. 5; Simms and Edmunds, 2021, fig. 7a; Zaitsev, 2021, p. 42, pl. III, figs. 1a–1c, 2a–2b, 10; Turin, 2021, p. 16, pl. 2, figs. 5–6.

N e o t y p e. Lectotype designated by S. Buckman (Bayle, 1878, pl. LXXVII, figs. 2, 3) is not preserved. Getty (1973, pl. 1, fig. 12) chose the neotype, which comes from the Raricostatum Zone in the vicinity of the commune of Seichamps near Nancy (Northeastern France).

S h a p e. Shell is medium-sized, ophioconic and consists of six or seven rounded whorls with the maximum width near the center of the whorl. Ventral margin is rounded. Umbilicus is wide, shallow. Umbilical wall is convex.

S c u l p t u r e. There is a low, well-defined, rounded ventral keel without lateral keels. Lateral sides bear a coarse rectiradiate ribs, slightly projecting upward above the surface of the whorl at the ventrolateral margin. Inner whorls are densely ribbed. The density of the ribs gradually decreases during ontogenesis. The ribs on the ventral side are gently curved forward and approach the ventral keel at an angle of about 60°. There are threadlike striae (six striae between two ridges of the ribs) on the lateral sides of the outer whorl.

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/45	73.8	15.3	44.5	16.8	20.7	22.8	60.3	91.1	14

C o m p a r i s o n. It differs from *E. quenstedti* (Schafhäutl) in a distinctly pronounced raricostatic ribbing (with coarser sparse ribs at the later stages of ontogenesis); it differs from *E. raricostatum* (Zieten) in a narrower rounded whorl section.

D i s t r i b u t i o n. E. raricostatoides biohorizon in southwestern Crimea (previously was considered as Beds with E. raricostatoides (Zaitsev, 2021)). Within the Tethyan Subrealm, the distribution of the species is limited to a narrow stratigraphic interval in the Raricostatum Subzone (E. raricostatoides biohorizon; see Blau, 1998). This species is known from the Central European and Euroboreal provinces: Romania (Vadász, 1908; Ţibuleac, 2005), Western Ukraine (Gotsanyuk and Leshchukh, 2002; Wierzbowski et al., 2012), Slovakia, Austria (Blau, 1998; Lukeneder and Lukeneder, 2018), Germany (Schlegelmilch, 1992), Switzerland (Meister, 1991), Lorraine (Getty, 1973; Guerin-Franiatte in Fischer, 1994), Great Britain (Buckman, 1923), and Northern Ireland (Simms and Edmunds, 2021). It is also known in the Mediterranean province in Italy (Parona, 1898).

M a t e r i a l. A single well-preserved specimen from the limestone boulder of type VI.

Genus *Paltechioceras* Buckman, 1924

Paltechioceras aureolum (Simpson, 1855)

Plate VII, figs. 5a–5d

Ammonites *aureolus*: Simpson, 1855*, p. 94; Simpson, 1884, p. 134.

Echioceras aureolus: Buckman, 1911 (in Buckman 1909–1930), pl. XXVIII, figs. 1–2; Buckman, 1914 (in Buckman 1909–1930), pl. XCVI, figs. 1–3.

Echioceras regustatum: Buckman, 1914, p. 96c.

Paltechioceras aureolum: Getty, 1973, Figs. 4M–4N, pl. 5, figs. 3–4; Topchishvili, 1990, p. 19, pl. V, figs. 2–4; Edmunds et al., 2003, p. 70, Fig. 4.4; Meister et al., 2012, p. 358, pl. VI, figs. 2a, 2b; pl. VII, fig. 2; Fauré, 2021, p. 80 (14), pl. 2, figs. 11–12.

? *Echioceras* (*Paltechioceras*) cf. *aureolum*: Mouterde and Rocha, 1981, p. 67, pl. III, fig. 2.

Paltechioceras ourelum: Topchishvili et al., 2006, pl. 6, figs. 3–5.

L e c t o t y p e is depicted by Buckman (1914, pl. XCVI). According to Buckman, the specimen " agrees in diameter, color, and characters with Simpson's description" (Buckman, 1914, p. 96b). It is kept at the Geological Survey Museum, London (specimen no. GSM 26402). It comes from the upper Sinemurian Raricostatum Zone in Robin Hood's Bay) (North Yorkshire, Great Britain).

According to Howarth (1962), this specimen is the holotype, since the second specimen (WM 872), shown in (Buckman, 1911, pl. XXVIII, figs. 1–2) and called the paratype (Buckman 1914, p. 96), was later attributed by Buckman to another species—*Echioceras regustatum* Buckman (Buckman, 1914, p. 96c) (Howarth 1962, p. 106). According to Getty (1973, p. 20) however, *Echioceras regustatum* Buckman represents the inner whorls of *Paltechioceras aureolum* (Simpson).

S h a p e. Shell is ophioconic, evolute, medium-sized. Umbilicus is wide, bowl-shaped. Whorl section is subrectangular. Lateral sides is slightly convex; ventral side is convex.

S c u l p t u r e. Lateral sides have rather wide and sparsely arranged radial ribs (ribs on inner whorls are sometimes slightly prorsiradiate). The ventral side on the outer whorls is tricarinate, with a high central keel bordered by wide sulci and rather low weakly pronounced lateral keels. Ventral sulci on the inner whorls are poorly developed, and lateral keels are absent.

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/46	75	15.0	39	14.0	20	19	52	107	17
Palt.au-02	≈50	11.0		10.5	22	21		105	15

C o m p a r i s o n a n d r e m a r k s. It differs from other species of *Paltechioceras* in more sparse ribbing with a slower increase in density during ontogenesis (Getty, 1973, p. 19) (Fig. 7), in coarse and wide (but not exceeding the width of the intercostal space) subradial ribs, and in a convex ventral side.

In addition, it differs from *P. romanicum* (Uhlig) in more convex ventral and lateral sides.

D i s t r i b u t i o n. Upper Sinemurian of Crimea (P. aureolum biohorizon). Upper Sinemurian, Raricostatum Zone, Aplanatum Subzone, P. aureolum biohorizon of Great Britain, France, Abkhazia, and, probably, Portugal.

M a t e r i a l. Two specimens from a boulder of limestone of lithological type VI.

Paltechioceras oosteri **(Dumortier, 1867)**

Plate VII, figs. 3a, 3b, 7a–7c

Ammonites sinemuriensis d'Orbigny: Ooster, 1860, p. 13, pl. 13, figs. 3–5.
Ammonites oosteri: Dumortier, 1867*, p. 164, pl. XXX, figs. 3–4; Reynés, 1879, pl. XLV, figs. 12–14.
Arietites bonnardii d'Orbigny: Bayle, 1878, pl. LXXVI, fig. 1.
Arietites bonnardii var oosteri: Hug, 1899, p. 13, pl. 12, figs. 2, 7.
? *Vermiceras oosteri*: Fucini, 1902, p.143, pl. XIII, fig. 3.
Euechioceras oosteri: Trueman and Williams, 1925, p. 726.
Euechioceras angustilobatum Trueman et Williams: Trueman and Williams, 1925, p. 726.
Paltechioceras ebriolum Trueman et Williams: Trueman and Williams, 1925, p. 729, pl. IV, fig. 5; Edmunds et al., 2003, fig. 6.4.
Paltechioceras cf. *ebriolum*: Otkun, 1942, pl. 3, fig. 3.
Kamptechioceras variabile Trueman et Williams: Trueman and Williams, 1925, p. 731, pl. II, fig. 1.
Stenechioceras angustilobatum: Buckman, 1927 (in Buckman 1909–1930), pl. DCXCVII, figs. 1, 2, 3, 3a (= holotype *Euechioceras angustilobatum*: Trueman, Williams, 1925).
Paltechioceras oosteri: ? Zeiss, 1965, p. 38; pl. 2, fig. 3; ? Smith, 1981, p. 192, pl. 5, figs. 2–3; Schlatter, 1991, p. 44, pl. 5, figs. 8–11; Blau, 1998, p. 213, pl. X, figs. 14, 17, 19; pl. XIV, fig. 2; Blau et al., 2000, p. 267, Figs. 11.4, 6–7; Hillebrandt, 2002, pl. 11, figs. 14–21; Meister et al., 2012, p. 357, pl. VI, fig. 3, pl. IX, figs. 1, 4, pl. X, figs. 1–2; Lukeneder and Lukeneder, 2018, p. 105, Figs. 8l, 8m; pl. 10.
Paltechioceras cf. *oosteri*: Donovan, 1958, p. 29, pl. 2, figs. 2a, 2b; Schlatter, 1991, p. 44, pl. 5, fig. 12; ? Seyed-Emami et al., 2008, p. 243, fig. 4F; Meister et al., 2012, p. 358, pl. VI, fig. 3 (juv), pl. X, fig. 5; Simms and Edmunds, 2021, p. 11, Fig. 7.l.
Paltechioceras sp.: Michard et al., 1979, pl. 1, fig. 1.

L e c t o t y p e is depicted in (Dumortier, 1867, pl. XXX, figs. 3–4). It comes from the Rhone River basin (France) and is kept at Museum d'Histoire Naturelle de Marseille.

Despite this specimen being called in some works a holotype by monotype (Blau, 1998), it cannot be considered as such, since Dumortier also assigned two specimens from the Swiss Alps depicted earlier by Ooster (1860, pl. 13, figs. 3–5) to the new species. Dumortier also indicated two localities in the list for the species. Thus, Dumortier had at least three specimens in the standard series.

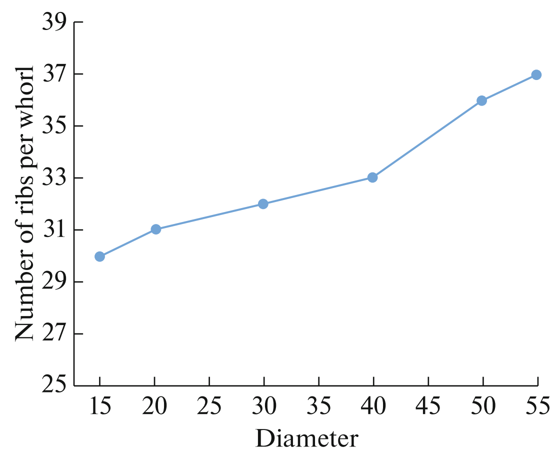


Fig. 7. The ribbing curve for *P. aureolum* (specimen no. 150/46).

S h a p e. Shell is ophioconic, medium-sized. Inner whorls subquadrate in section; outer whorls subrectangular (H > W) with the maximum width in the near-umbilical half. Umbilical and ventrolateral margins are well pronounced. Umbilicus very wide, shallow, bowl-shaped.

S c u l p t u r e. Ventral side three-keeled with a high well-developed central keel, bordered by deep ventral sulci. Shell is relatively densely ribbed. Ribs are coarse, rounded in section, radial or slightly prorsiradiate, gently curved forward when passing to the ventral side. Some ribs are curved, converge in pairs, or combine to form irregularly arranged asymmetric rib forks and loops.

M e a s u r e m e n t s in m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/47	–	16.2		14.5				112	–
150/48	69	14.5	43	12.5	21	18.1	62.3	116	29

C o m p a r i s o n a n d r e m a r k s. A characteristic diagnostic feature is the presence of irregularly arranged double and loop-shaped ribs on the lateral sides. There are four nominal species, that have the above trait (*P. variabile*, *P. angustilobatum*, *P. ebriolum*, and *P. oosteri*, see synonymy). They differ from each other in the frequency of rib loops, as well as in the shape of the whorl section and the width of inner whorls. However, the majority of authors are consider all of these species as synonyms. Thus, according to P.L. Smith, *P. ebriolum* is a synonym of *P. oosteri* (Dum.) (Smith, 1981). R. Schletter (1991) also considers these two species as very similar. Blau (1998, pl. X, fig. 17) attributes even small fragments with rib loops to *P. oosteri*. This concept was formulated by K. Meister, who noted that all of that four nominal species are part of the *P. oosteri* s.l. group, and *P. oosteri* s.s. species is characterized by an average degree of irregular ribbing (Meister et al., 2012, p. 358). This opinion is also accepted in the present paper.

The described species differs from *P. romanicum* (Uhlig) in a higher (subrectangular) whorl section of outer whorls, as well as a noticeably denser and irregular ribbing.

D i s t r i b u t i o n. Upper Sinemurian (P. oosteri biohorizon) of Crimea. Upper Sinemurian, Raricostatum Zone, Aplanatum Subzone, P. oosteri biohorizon of Europe. According to Blau (1998, p. 189), the species can be found in the vicinity of Lienz (Austrian Alps), as well within the P. romanicum biohorizon of the terminal Sinemurian. Meister et al. (2012, p. 347) emphasize the cosmopolitanism of this species, which is known from north of the Mediterranean–Caucasian region: in the Austrian Alps (Blau, 1998; Lukeneder and Lukeneder, 2018), Turkey (Otkun, 1942), and Iran (Seyed-Emami et al., 2008). A specimen of *P.* aff. *oosteri* (Dum.) with irregular ribbing from the southern part of the same area (Algeria) is depicted in (Dommergues et al., 2008, p. 558). However, the Crimean specimens differ from the latter in noticeably wider ventral sulci. In the Euroboreal province, this species is known from the Rhone River basin and the Kos Plateau in France (Ooster, 1860; Dumortier, 1867; Michard et al., 1979; Meister et al., 2012), Switzerland (Hug, 1899; Donovan, 1958; Schlatter, 1991), Germany (Zeiss, 1965; Blau et al., 2000), England (Trueman and Williams, 1925; Edmunds et al., 2003), and Northern Ireland (Simms and Edmunds, 2021). This species is also known from the north of South America (Hillebrandt, 2002) and the Northwestern United States (Oregon and Nevada) (Smith, 1981).

M a t e r i a l. One incomplete specimen and two small fragments from limestone boulders of lithological type VI.

***Paltechioceras recticostatum* (Trueman et Williams, 1925)**

Plate VIII, figs. 1a, 1b, 4a, 4b

Orthechioceras recticostatum: Trueman, Williams, 1925*, p. 723, pl. III, figs. 1a–1b; Schlatter, 1987, p. 1120, taf. 1, figs. 1a, 1b; Howarth, 2013, p. 29, figs. 22, 1a–1b.

Paltechioceras recticostatum: Bremer, 1965, p. 139, pl. 12, figs. 4a, 4b; Topchishvili, 1990, p. 18, pl. IV, figs. 5, 5a; pl. V, fig. 1, 1a; Edmunds et al., 2003, figs. 4.3, 4.5, 5.5; Topchishvili et al., 2006, pl. 6, figs. 1–2.

? *Orthechioceras radiatum* Trueman et Williams: Trueman and Williams, 1925, p. 724, pl. II, figs. 9a–9b.

H o l o t y p e is depicted in (Trueman and Williams, 1925, pl. 3, figs. 1a–1b). It comes from Eoderoceras armatum beds (upper Sinemurian Raricostatum Zone) of the Kilmersdon Colliery Quarry (Radstock), Somerset, England). It is stored at the British Natural History Museum, J.W. Tutcher's collection, specimen no. BM C41748. It is redepicted in (Howarth, 2013, figs. 22, 1a–1b).

S h a p e. Shell is ophioconic, medium-sized. Whorls are subquadrate, with a wide flattened ventral side and flattened lateral sides. Umbilicus is wide, bowl-shaped. Umbilical wall is convex.

S c u l p t u r e. Ventral side is tricarinate, with well-developed ventral sulci, high central and low lateral keels. Lateral sides have coarse straight relatively sparsely spaced ribs, which become gently rursiradiate on the outer whorl. The rib density gradually increases during ontogenesis (Fig. 8).

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/49	54	11.0	33	10.0	20.4	18.5	61.1	110	20
150/50	85	13.0	58	13.0	15.3	15.3	68.2	100	28

C o m p a r i s o n a n d r e m a r k s. It differs from *Paltechioceras aureolum* (Simpson) in less coarse and denser ribbing.

Despite the fact that the described species was chosen as the type species for the genus *Orthechioceras* (Trueman and Williams, 1925, p. 706), Getty (1973, p. 23) considered that this species differs from other *Orthechioceras* in its three-keeled ventral side and "it is closer morphologically to *Paltechioceras*."

In addition, it differs from the group of *Orthechioceras* species characteristic of the Densinodulum Subzone, for example, of *O. edmundi* (Dumortier) or *O. viticola* (Dumortier), in the stratigraphic distribution interval (Aplanatum Subzone). Owing to this, *P. recticostatum* (Trueman et Williams) is considered here in the composition of the genus *Paltechioceras* (sensu Getty, 1973). The morphological similarity and phylogenetic relationship of the studied species with late *Paltechioceras* have also been repeatedly emphasized in the literature (Dommergues, 1982a, p. 380; Simms and Edmunds, 2021, p. 10; etc.).

D i s t r i b u t i o n. Upper Sinemurian (Paltechioceras oosteri biohorizon) of Crimea. This species characterizes the P. tardecrescens/P. oosteri/P. recticostatum biohorizon in Western Europe (Blau et al., 2000); it occurs in southwestern Germany and Great Britain. In addition, this species is known from Turkey and Caucasus.

M a t e r i a l. Two well-preserved specimens from limestone boulders.

***Paltechioceras romanicum* (Uhlig, 1900)**

Plate VIII, figs. 2a, 2b, 3a, 3b

Arietites romanicus: Uhlig, 1900*, p. 25, text-fig. 2, pl. I, figs. 5a–5d.
Arietites wähneri: Uhlig, 1900, p. 27, pl. I, figs. 4a–4c.
Vermiceras wähneri: Fucini, 1902, p. 135, pl. XII [XV], figs. 8a–8b.

? *Ortechioceras romanicum totonacorum* Erben: Erben, 1956, p. 339, pl. 40, figs. 4–5.

Paltechioceras romanicum cf. *romanicum*: Bremer, 1965, p. 140, pl. 13, figs. 1a–1b.

Paltechioceras romanicum anatolicum Bremer: Bremer, 1965, p. 141, pl. 13, figs. 2a–2b.

Paltechioceras romanicum: Alkaya and Meister, 1995, p. 142, pl. IV, figs. 6, 8–20; Blau, 1998, p. 211, pl. X, figs. 10, 13, 16, 18; ? Venturi et al., 2006, Fig. 2 (t).

Paltechioceras cf. *romanicum*: Hillebrandt, 2002, pl. 11, fig. 22.

? *Paltechioceras* cf. *romanicum*: Palfy, 1991, p. 157, pl. 13, fig. 1; Guex et al., 2008, p. 91, text-fig. 3.72.

Paltechioceras aff. *romanicum* (Uhlig): Dommergues et al., 1994, pl. 3, fig. 17; Meister et al., 2003, pl. 1, figs. 7–9; ? Géczy and Meister, 2007, p. 188.

? *Paltechioceras* ex gr. *herbichi* (Uhlig)—*romanicum* (Uhlig): Dommergues and Meister, 2017, p. 265, fig. 118.

Holotype (by monotype) is depicted in (Uhlig, 1900, pl. 1, figs. 5a–5d). It comes from the Lower Jurassic olistoliths in the Cretaceous flysch of the Praşca Peak (Carpathians, Rarau Syncline, Bukovina, Romania).

Shape. Shell is ophioconic, medium-sized. Both inner and outer whorls are subquadrate (the whorl height on average is almost equal to its width). Lateral sides are slightly convex. The maximum width of the whorl is usually in its near-siphonal half. Ventral side slightly convex. Umbilicus is wide, shallow, bowl-shaped.

Sculpture. Ventral side bears well-defined three keels. The central keel is higher than the lateral ones and is bordered by the deep ventral sulci. Coarse, rather sparsely arranged ribs are on lateral sides. Ribs are most often rursiradiate. However, they can be radial or even prorsiradiate. When passing to the ventral side, they gently curve forward. However, such curvature in some specimens can be displayed before reaching the ventral margin on the lateral sides. On the ventral side, ribs reach the lateral keels with a slight weakening.

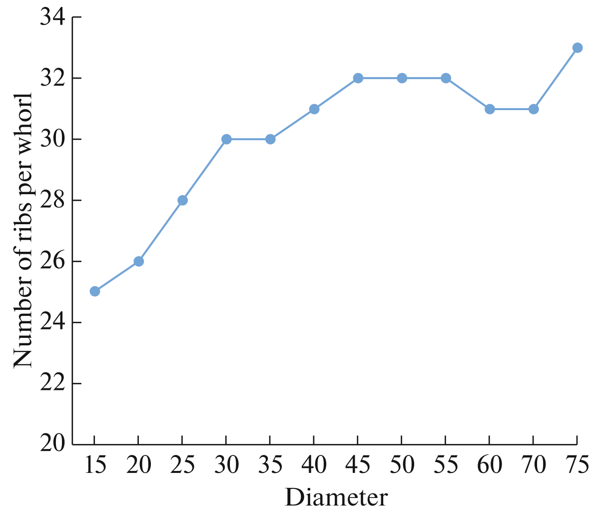


Fig. 8. The ribbing curve for *P. recticostatum* (specimen no. 150/49).

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/51	93.5	16	62	16	17.1	17.1	66.3	100	22
150/52	64	13.5	40	13	21.1	20.3	62.5	104	18

Comparison and remarks. Unlike *P. tardecrescens* (Hauer), the described species has rursiradiate, much more sparsely spaced ribs, as well as a wider subquadrate section of the whorls. It differs from *P. aureolum* in denser ribbing and a wider, subquadrate whorl section; it differs from *P. recticostatum* in coarser sparse rursiradiate ribbing and a wider, subquadrate whorl section.

Specimen of *Arietites* cf. *romanicus* from Western Ukraine (Gotsanyuk and Leshchukh, 2002, pl. III, figs. 1a–1b) is not included in synonymy, since it is similar to the genus *Echioceras* in terms of morphology.

Distribution. Upper Sinemurian of Crimea, P. romanicum biohorizon. Upper Sinemurian, Raricostatum Zone, Aplanatum Subzone, P. romanicum biohorizon of Europe. It is the most widespread in the Mediterranean (West Tethyan) and Austroalpine subprovinces of the Mediterranean–Caucasian paleobiogeographic realm: in Austria (Dolomites, Lienz, Upper Austrian Alps (Blau, 1998)); Hungary (Bakony Mountains (Géczy and Meister, 2007)); Romania (Eastern Carpathians, Prasca Hill (Uhlig, 1900)); Italy (Central Apennines (Dommergues et al., 1994)); North Africa (High Atlas (Morocco) (Guex et al., 2008)). This species also occurs in the Central and Eastern Pontic Mountains in Turkey (Bremer, 1965; Alkaya and Meister, 1995). Within the Euroboreal province, there are only dubious indications of findings from Great Britain (North Yorkshire, Robin Hood's Bay): Hesselbo et al. (2000, p. 605) only mentioned *P.* aff. *romanicum* without providing images of ammonites. In addition, Blau (1998, p. 212) noted that some of the juvenile forms from Robin Hood's Bay described by Dommergues and Meister (1992) as *P. tardecrescens* (Hauer) can be attributed to *P. romanicum*.

In addition, the species is known in the East Pacific paleobiogeographic region: Canada (British Columbia, Haida Gwaii Islands (Queen Charlotte Islands) (Palfy, 1991)); ? Mexico, from where G. Erben described an independent subspecies—*Ortechioceras romanicum totonacorum* Erben (Erben, 1956). However, Blau (1998, p. 212) does not assign it to *P. romanicum*.

M a t e r i a l. Several well-defined inner moulds and numerous fragments of outer whorls from limestone boulders (VI) with sandstone interbeds (V).

INCERTAE FAMILIAE

"*Cymbites* sp."

Plate V, figs. 1a, 1b

Gemmellaroceras abnorme (Hauer): Bremer, 1965, p. 180, pl. 16, fig. 3.

"*Cymbites*" sp.: *Dommergues* et al., 1990, p. 322, pl. 4, figs. 7–8; Alkaya and Meister, 1995, p. 163, pl. V, figs. 13–14.

S h a p e. Shell is small-sized, flattened. Inner whorls are subrounded; outer whorls are ellpitical, elongated in height, with the maximum width approximately in the middle. Ventral side is strongly convex. Lateral sides are convex. Umbilicus is wide, bowl-shaped. Umbilical margin is rounded. The degree of involution of whorls decreases during ontogenesis.

S c u l p t u r e. Ventral side is smooth. Lateral sides have a wide, rather rarely and irregularly arranged spindle-shaped ribs, which disappear before reaching the ventrolateral margin. Ribs are weakly sigmoid curved.

M e a s u r e m e n t s in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/53	28.5	10.5	10	7	36.8	24.6	35.1	150	9

C o m p a r i s o n and r e m a r k s. The only specimen in the collection is conditionally assigned here to the genus *Cymbites* Neumayr, as in the previous publications (Dommergues et al., 1990; Alkaya and Meister, 1995). It probably represents a new species, but there is insufficient factual material in both previous and present studies for its description.

The Crimean material is quite similar to the specimen depicted in (Alkaya and Meister, 1995, pl. V, fig. 14), being different only in a somewhat narrower whorl section.

D i s t r i b u t i o n. Upper Sinemurian of Crimea, P. romanicum biohorizon. This species is known from Turkey, from the Raricostatum Zone under the name of "*Cymbites*" sp. and, in particular, from the P. romanicum biohorizon (Alkaya and Meister, 1995, p. 163, pl. V, figs. 13–14), as well as from the Raricostatum Zone of the Piedmont Alps in French-speaking Switzerland (Dommergues et al., 1990, p. 322, pl. 4, figs. 7–8). The species was previously also described under the name *Gemmellaroceras abnorme* (Hauer) from the Raricostatum Zone in Turkey (Bremer, 1965, p. 180, pl. 16, fig. 3).

M a t e r i a l. One well preserved specimen. Limestone of lithological type VI. In association with juvenile Echioceratidae, *Paltechioceras romanicum* (Uhlig) (specimen no. 150/52) and *Zetoceras zetes* (specimen no. 150/5).

S U P E R F A M I L Y EODEROCERATOIDEA SPATH, 1929

FAMILY EODEROCERATIDAE SPATH, 1929

SUBFAMILY EODEROCERATINAE SPATH, 1929

Genus *Eoderoceras* Spath, 1925a

R e m a r k. In accordance with Edmunds (2009), the species described below, which are characterized by two rows of tubercles and developed secondary ribbing on the lateral and ventral sides, are belong to the genus *Eoderoceras* (and not, for example, *Paramicroderoceras* Dommergues, Ferretti et Meister, 1994, as was done in a number of previous studies; see synonymy).

***Eoderoceras praecursor* (Geyer, 1886)**

Plate IV, figs. 4a–4c, 5a–5c, 8a–8c

Ammonites brevispina J. de C. Sow: (pars) Hauer, 1856, p. 53, pl. 17, figs. 6–7.

Aegoeeras praecursor: Geyer, 1886*, p. 264 [52], pl. III, figs. 27–29; pl. IV, fig. 1.

Aegoceras (*Microderoceras*) *praecursor*: Andrusov, 1931, p. 148.

Coeloderoceras preaecursor galatieum: Bremer, 1965 (ssp. nov.), p. 168, Abb. 3s; pl. 14, fig. 4.

Coeloderoceras sp. aff. *praecursor*: Bremer, 1965, p. 169, pl. 15, fig. 7.

? *Epideroceras latinodosum* Bremer: Bremer, 1965, p. 160, Abb. 3l, pl. 15, fig. 2.

Epideroceras (*Epideroceras*) *latinodosum*: Cope, 1991, p. 310, pl. 3, fig. 4, pl. 4, fig. 10.

Coeloderoceras (*Villania*?) ex gr. *praecursor*: Dommergues, 1987, p. 101, pl. 2, figs. 1–2.

Epideroceras praecursor: Alkaya, Meister, 1995, p. 146, pl. V, figs. 6–8, 9.

Epideroceras aff. *praecursor*: Alkaya, Meister, 1995, p. 146, pl. V, fig. 11.

Paramicroderoceras praecursor: Blau, 1998, p. 231, pl. XIII, figs. 1–2; Géczy and Meister, 2007, p. 206, pl. XLIII, fig. 11.

? *Omoderoceras cantianense* Venturi et al.: Venturi et al., 2004, p. 368, text-figs. 4a–4b; pl. 1, figs. 1–3.

L e c t o t y p e is depicted in (Geyer, 1886, pl. 3, fig. 27), designated in (Wiedenmayer, 1980, p. 145), and redepicted in (Blau, 1998, pl. XIII, fig. 1). It comes from Hierlatz limestones (Austria). It is kept at the Museum of the Geological Survey of Austria (Vienna) (Geologische Bundesanstalt Wien), specimen no. 1886/02/51.

S h a p e. Shell is evolute, medium-sized. Whorls are semievolute, relatively slowly increasing in height during ontogenesis. Inner whorls are depressed. Whorl section of outer whorls rather wide, subquadrate to oval. Lateral sides is slightly convex. Ventral side is convex. Umbilical and ventral margins are flat. Umbilicus is wide, shallow, bowl-shaped. Umbilical wall is convex.

S c u l p t u r e. On the inner whorls, the lateral sides have a simple, slightly rursiradiate, rather high ribs with two rows of tubercles: larger tubercles at the ventrolateral margin and smaller ones near the umbilical margin, in the near-umbilical quarter of a whorl. The tubercles are reduced quite quickly during ontogenesis, first, the inner row disappears, and then the outer one. Ribs on the outer whorls have a tendency to reduce. Ventral side is smooth or is covered with numerous barely discernible threadlike ribs.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/54	52.5	15	26	19	28.6	36.5	49.5	79	14
150/55	81	25	37	22	30.9	27.2	45.7	114	–
150/56	50.5	16	24	15	31.7	29.7	47.5	107	–

V a r i a b i l i t y. Crimean specimens are quite similar to specimens from Turkey shown in (Bremer, 1965), where they are assigned to three independent species (see synonymy). In the present paper, these species are considered as morphotypes of the sole species, with a wide range of variability. Variability is expressed, first of all, in the more or less early reduction of ribs during the ontogenesis, as well as in variations in the rate of increase in whorls and the shape of the cross section, which can be more or less high at the same diameter.

C o m p a r i s o n a n d r e m a r k s. On the basis of the early reduction of the inner row of tubercles in the course of ontogenesis, some authors consider the described species in the composition of the genus *Epideroceras* Spath (Alkaya and Meister, 1995). Blau (1998) attributed this species to the genus *Paramicroderoceras* Dommergues, Ferretti et Meister as well as the others Mediterranean Eoderoceratidae. However, in more recent works, the genus *Paramicroderoceras* is considered as a junior synonym of *Eoderoceras* Spath (Edmunds, 2009; Howarth, 2013).

Unlike the similar species *Eoderoceras hungaricum* (Géczy), which is also characterized by early reduction of the inner row of tubercles during ontogenesis, the described species has a well-developed ornamentation on the inner whorls and narrower and higher ribs, which have the same height over their entire length.

D i s t r i b u t i o n. Upper Sinemurian of Crimea, Austria, Czech Republic, Hungary, and Italy; upper Sinemurian (Oxynotum and Raricostatum zones) of Turkey.

M a t e r i a l. Three large well-preserved specimens and several fragments from the limestone boulders of type VI with sandstone interbeds.

Eoderoceras bispinatum (Geyer, 1886)

Plate III, figs. 4a–4c; Plate V, figs. 6a, 6b, 7a, 7b

Ammoniles brevispina J. de C. Sow.: (pars) Hauer, 1856, p. 53, pl. 17, figs. 4–5.

Aegoceras bispinatum: Geyer, 1886*, p. 266 [54], pl. IV, figs. 4–13; Hug, 1899, p. 27, pl. VII, figs. 2–3.

Aegoceras (Microderoceras) bispinatum: Andrusov, 1931, p. 148, pl. 9, fig. 12.

Microderoceras bispinatum bispinatum (Geyer): Bremer, 1965, p. 152, Abb. 3h; pl. 15, figs. 3a, 3b.

Coeloderoceras bispinatum: Rakus, 1999, p. 360, text-fig. 35, pl. 4, fig. 4.

Paramicroderoceras aff. bispinatum: Venturi et al., 2004, p. 372, text-figs. 7a1–a3, pl. 2, figs. 6, 8a–8c.

? Eoderoceras ex gr. *bispinigerum* (Buckman): Repin, 2017, pl. 1, figs. 6, 12.

L e c t o t y p e is depicted in (Geyer, 1886, pl. 4, fig. 4) and designated in (Donovan, 1958, p. 35). It comes from the upper Sinemurian Hierlatz Limestone Formation (Austria).

S h a p e. Shell is evolute, subplatycone, medium-sized. Inner whorls are rounded-trapezoidal, with the maximum width at the ventrolateral margin. Outer whorls is subelliptic, compressed. Lateral sides slightly convex or flattened. Ventral side on the inner whorls wide is slightly convex; it becomes more convex during the ontogenesis. Umbilicus is wide, shallow, bowl-shaped. Umbilical margin is flat. Umbilical wall is convex.

S c u l p t u r e. Lateral sides have rather coarse radial ribs (13–16 per half whorl), which end in a large tubercle at the ventrolateral margin and do not pass to the ventral side. In the near-umbilical quarter, there is a second, less developed, row of tubercles on the ribs. On well-preserved specimens the threadlike inserted ribs are present, which strengthen toward the ventral side and cross it without interruption.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/57	47.7	17.9	20.2	17	37.5	35.6	42.3	105	13
150/58	72.5	21.2	31.5	20	29.2	27.6	43.5	106	15
150/59	68	21	27.5	18	30.9	26.5	40.4	117	16
150/60	47	16	20	15	34.0	31.9	42.6	107	15

C o m p a r i s o n a n d r e m a r k s. This species is differs from *E. fila* (Quenstedt) in less dense ribbing, as well as in a well-developed (not "rudimentary") near-umbilical row of tubercles; it differs from *E. praecursor* (Geyer) in the absence of reduction of ribs and tubercles on the outer whorls. Unlike *E. ancyrense* (Bremer), it has a more flattened (subplatycone) shell with a narrower whorl section.

Probably, the specimens from the Bakhchisaray region of Crimea identified by Repin (2017) as *E.* ex gr. *bispinigerum* (Buckman) belong to the described species. They are also characterized by a subplatycone shell and a well-developed inner row of tubercles in the absence of rib reduction. Perhaps, the specimens described in the present paper as *E.* sp. juv. (Plate IV, figs. 6a, 6b, 7a, 7b; Plate III, figs. 3a, 3b, 5) should be assigned to this species.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. Upper Sinemurian of the Czech Republic (Andrusov, 1931) and Switzerland (Hug, 1899), upper Sinemurian (?Raricostatum Zone) of Italy (Venturi et al., 2004) and Turkey (Bremer, 1965), upper Sinemurian of the Oxynotum Zone and (?)Raricostatum of Austria (Rakus, 1999).

M a t e r i a l. Four well-preserved specimens and numerous fragments from limestone boulders of lithological type VI with sandstone interlayers.

***Eoderoceras ancyrense* (Bremer, 1965)**

Plate V, figs. 3a, 3b, 4a–4d

Microderoceras bispinatum ancyrense: Bremer, 1965*, p. 154, Abb. 3j, 4i, pl. 14, fig. 5.

? *Gemmellaroceras aegoceroides* (Gemmellaro): Bremer, 1965, p. 181, pl. 16, figs. 6a, 6b.

Epideroceras bispinatum ancyrense: Alkaya, Meister, 1995, p. 146, pl. 5, figs. 2–4, 10.

H o l o t y p e. The specimen is depicted in (Bremer, 1965, pl. 14, fig. 5). It comes from the Kizik locality (Ankara Province, Turkey), the upper Sinemurian Raricostatum Zone or the lower Pliensbachian Jamesoni Zone. It is kept at the University of Tübingen (Germany), specimen no. Ce 1259/26.

S h a p e. Shell is small-sized, swollen (subcadiconic). Internal whorls are wide, depressed, with a wide, archlike ventral side. Outer whorls is a subquadrate (W ≈ H). Lateral sides are slightly convex. Ventral side is rather wide, convex (more convex on the outer whorls than on the inner ones). Umbilicus is wide, relatively deep, bowl-shaped. Umbilical wall is convex.

S c u l p t u r e. There are broad, low radial ribs on the lateral sides. The ribs on medium whorls have two rows of low tubercles: one row at the ventrolateral margin, the second is on the near-umbilical quarter of the whorl. There are numerous threadlike riblets are on the ventral side.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/65	47	16.2	16.2	16	34.5	34.0	34.5	101	14
150/66	35	15	10	15	42.9	42.9	28.6	100	11

C o m p a r i s o n. The described species differs from *E. bispinatum* (Geyer) in a swollen subcadicon shell with the whorls that increase in width faster during ontogenesis.

D i s t r i b u t i o n. Upper Sinemurian of Crimea. The Upper Sinemurian Raricostatum Zone and, possibly, the lower Pliensbachian Jamesoni Zone of Turkey (Bremer, 1965; Alkaya and Meister, 1995) and Italy (Venturi and Bilotta, 2001).

M a t e r i a l. Two specimens from the limestones of type VI.

FAMILY EPIDEROCERATIDAE DOMMERGUES ET MEISTER, 1999

Genus *Epideroceras* Spath, 1923

***Epideroceras lorioli* (Hug, 1899)**

Plate III, figs. 6a–6c, 7a–7d; Plate IV, figs 1, 2a–2c

Aegoceras (*Platypleuroceras*) sp. aff. Aegoc. *brevispina* Sowerby: Söhle, 1899, pl. 11, fig. 3.

Aegoceras lorioli: Hug, 1899, p. 28*, pl. VIII, fig. 1; pl. 9, fig. 3.

Epideroceras exhaeredatum: Buckman, 1923 (in Buckman 1909–1930) (sp. nov.), pl. 441.

Epideroceras tchedimicum Topchishvili: Topchishvili, 1990, p. 24, pl. VIII, figs. 3–5; pl. IX, fig. 1; Topchishvili et al., 2006, pl. 9, figs. 2–5.

Epideroceras ex gr. *lorioli*: Dommergues, Meister, 1987, p. 321, pl. 5, fig. 9; Meister and Böhm, 1993, p. 177, pl. 5, fig. 1; Meister and Friebe, 2003, p. 41, pl. 12, figs. 1, 3, 6.

Epideroceras aff. *lorioli*: Dommergues and Meister, 1990b, pl. 2, figs. 2, 6, 7.

Epideroceras lorioli: Dommergues and Meister, 1989, p. 466, pl. 4, figs. 2, 4; pl. 5, figs. 1, 2; pl. 6, figs. 1, 3; Topchishvili, 1990, p. 23, pl. VII, figs. 3–5; pl. VIII, figs. 1–2; Schlatter, 1991, p. 64, Abb. 74–75; pl. 14, figs. 4, 5; pl. 15, figs. 1, 2; Alkaya and Meister, 1995, p. 145, pl. 5, fig. 16; (pars) Blau, 1998, p. 227, pl. XI, figs. 5–8 (non figs. 9–11, =*Eoderoceras* sp.); pl. XII, fig. I-13; text-figs. 28, 30, 29, 31, 32 (? non pl. XIV, fig. 1, =*Epideroceras grande* Donovan); Edmunds et al., 2003, p. 90, Figs. 21.4, 14.1; Topchishvili et al., 2006, pl. 8, figs. 4–5; pl. 9, fig. 1; Dommergues and Meister, 2013, Figs. 11 B1, B2; Neige and Dommergues, 2021, p. 173, Figs. 131A–131B.

Epideroceras (*Epideroceras*) *lorioli*: Dommergues, 1993, p. 148, pl. 10, fig. 17; Cariou and Hantzpergue, 1997, pl. 5, figs. 1a–1b.

L e c t o t y p e is depicted in (Hug, 1899, pl. VIII, fig. 1) and designated by Donovan (1958, p. 41). Switzerland, upper Sinemurian Raricostatum Zone. It is kept at Naturhistorisches Museum Bern, Switzerland.

S h a p e. Shell is medium-sized, flattened. The whorls increase moderately in height. During the ontogenesis. Inner whorls have subcircular section, which becomes more or less elliptical during ontogenesis, reaching the maximum width in the near-umbilical third of the whorl. Outer whorls low-volume, compressed laterally. In this case, they are characterized by a significant variability in the degree of compression. Lateral sides at juvenile stages convex and slightly convex to flattened on outer whorls. Ventrolateral margin flat, weakly pronounced. Lateral sides smoothly turn into a rather narrow convex ventral side. Umbilicus is wide, shallow, bowl-shaped. Umbilical wall low, convex.

Sculpture. Lateral sides have low sparsely arranged radial ribs (the width of the intercostal spaces significantly exceeds the width of the ribs). The number of ribs varies from 10 to 20 per half whorl. Ventral side smooth: ribs gradually wedge out at the ventrolateral margin.

Ribs on inner whorls have two rows of pointed tubercles, somewhat elongated in the radial direction. The outer row of tubercles is located at the ventrolateral margin, while the inner row is near the umbilical margin. The inner row of tubercles is poorly developed and occurs only in inner whorls (D < 50 mm). At the late stages of ontogenesis, the outer row of tubercles is also completely reduced.

Measurements in mm and ratios (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W	Number of ribs per 1/2 whorl
150/67	84	25.8	39	24	30.7	28.6	46.4	108	20
E.1.02	>53.5	20.6	>32	17					>15
150/68	>82	>34	>43.5	17					>12
E.1. 04	81.5	31.8	33	19	39	23.3	40.5	167	10
E.1.05	70.2	25	28	18.8	35.6	26.8	39.9	133	18
E.1.06	80.8	28.7	36	20.5	35.5	25.4	44.6	140	17
E.1.07	53.8	18.2	20.5	15.9	33.8	29.6	38.1	115	–
150/69	46	16	20	12	34.8	26.1	43.5	133	15
E.1.09	81.9	27.8	32.8	21.2	33.9	25.9	40.1	131	–
E.1.10	48	17.5		≈17	36.5	≈35.4		≈103	≈15
E.1.11	>63	17.5							>12
150/70	88	29.0	39	20	33.0	22.7	43.3	145	16

Variability. Some morphological characters vary over a wide range. Among them are the outlines of the section (H/W ratio of outer whorls varies from 103 to 167%; as a result, the cross section of outer whorls looks more or less elongated in height) and the degree of involution of whorls—from touching to semievolume (13 to 31% of the penultimate whorl is covered). Different specimens show more or less late loss of tubercles during ontogenesis. However, the inner row of tubercles is always reduced before the outer one. Other characters vary in substantially smaller range.

Comparison and remarks. Owing to the significant variability of some morphological characters (the outlines of the section and a pattern of ribbing), the volume of this species is still debatable. Some authors is consider the variable signs as valuable for diagnostics and distinguish on their basis a series of independent species: *Epideroceras exhaeredatum* Buckman, *Ep. grande* Donovan, *Ep. hugi* Donovan, *Ep. tchedimicum* Topchichvili. Followers of this approach to understanding the volume of the species or species often use the definition *Ep. lorioli* in the open nomenclature applicable to most adult specimens in the samples. Other researchers, on the contrary, emphasize the blurring of morphological boundaries between all of the above nominal species, as well as their joint presence of the same sections in the Raricostatum Zone.

Followers of such an approach call into question the independence of the species mentioned above, considering that variations in the outlines of the cross section and the pattern of ribbing at adult stages of ontogenesis stay within intraspecific variability (Blau, 1998).

Dommergues (1987) divided the late Sinemurian representatives of the genus *Epideroceras* into two large groups, based primarily on the degree of involution of whorls: (1) *Ep*. gr. *lorioli-hugi*—evolute forms, often reaching large sizes (including all species listed in the synonymy in the present paper), and (2) *Ep*. gr. *steinmanni* (Hug)—more involute forms: *Ep. steinmanni* and *Ep. deflexum* (Buckman). At the same time, however, he stressed, “impossible de démontrer, par une méthode objective, la réalité de ces deux groupes” (Dommergues, 1987, p. 88). Later, Dommergue and Bonnot (2007) came to the conclusion that *Ep. steinmanni* is probably a variety of *Ep. lorioli*, while

Ep. hugi, on the contrary, is an independent species and has very limited stratigraphic distribution.

In the present paper, the species *Ep. exhaeredatum* and *Ep. tchedimicum* are considered as morphological variations of *Ep. lorioli*, while *Ep. hugi* and *Ep. Steinmanni* are considered as independent species. *Ep. grande* is considered as an independent species (possibly megaconch *Ep. lorioli*). In this case, its main diagnostic character is the size of an adult shell, the calculated diameter of which in some Crimean specimens of *Ep. grande* exceeds 450 mm (see below).

The Crimean ammonites differs from the similar species *Ep. hugi* in a higher growth rate of whorls and the absence of tubercles on the lateral sides of adult whorls; it differs from *Ep. steinmanni* in a relatively wider umbilicus (31% of the diameter in the lectotype *Ep. steinmanni*).

D i s t r i b u t i o n. Upper Sinemurian of Crimea (P. oosteri and P. romanicum biohorizons). The described species is the most common late Sinemurian representative of the genus *Epideroceras*.

It is especially widespread at the northern margin of the Mediterranean (West Tethyan) subprovince, as well as in adjacent areas. In the Central European province, this species is known from the Eastern Alps (the northernmost part of the Apulian block (=Adriatic plate)). In addition, it is known from Northern Italy and the Bavarian Alps (Southern Germany). In the Austroalpine subprovince, it is known from Austria (Vorarlberg, Linz, and Salzburg) and Hungary (Villan region). The species is known in Eastern Europe from the Romanian Carpathians, in Western Europe from Southwestern England (Radstock), in the Central Alps from Eastern France (Burgundy, Oisan massif) and Northern Switzerland (Klettgau), and in Asia from the Caucasus (Georgia) and from the Pontic Mountains (Northern Turkey).

The stratigraphic distribution of the described species in all localities does not spread beyond the upper Sinemurian Raricostatum Zone. Dommergues and Meister (1991a) consider that the stratigraphic distribution of the species is limited to the interval of the P. boehmi biohorizon of the Raricostatum Subzone–terminal Aplanatum Subzone of the upper Sinemurian Raricostatum Zone.

M a t e r i a l. Twelve specimens of a varying degree of preservation; perhaps, shells of fragmentary preservation should also be attributed to this species. Limestone boulders of type VI and sandstones of type V.

***Epideroceras grande* Donovan, 1958**

Plate II, figs. 5a–5d; Plate III, figs. 1a, 1b, 2a–2d

Epideroceras grande: Donovan, 1958*, p. 38, pl. 3, figs. la, 1b.

Epideroceras aff. *steinmaimi*: Donovan, 1958, pl. 7, figs. la, 1b

Epideroceras lorioli: Donovan, 1958, p. 41, pl. 5; (pars) Blau, 1998, p. 227, pl. XIV, fig. 1.

Epideroceras aff. *lorioli*: Donovan, 1958, p. 41, pl. 6.

H o l o t y p e. It is depicted in (Donovan, 1958, pl. 3, figs. 1a–1b). It comes from the Raricostatum Zone in the environs of the town of Thun (Canton of Bern, Switzerland) and is stored at Naturhistorisches Museum Bern (Switzerland).

S h a p e. Shell is evolute, very large. The internal whorls are rather wide (whorl height is about the same as width). The penultimate whorl in all specimens has a high-oval compressed section (H/W = 1.41–1.84), with a rather narrow ventral side. The maximum whorls width is in the near-umbilical third. Umbilicus is wide, shallow, bowl-shaped.

S c u l p t u r e. Lateral sides bear a low subradial ribs that do not extend to the ventral side. It seems that there are about 20–28 ribs per a half whorl. On the penultimate whorl, the ribbing becomes less distinct, up to a complete reduction as in the holotype and the specimen depicted in (Donovan, 1958, pl. 5). The ribbing on an adult body chamber is very coarse with very wide pointed ribs.

M e a s u r e m e n t s i n m m a n d r a t i o s (%).

Sample no.	D	H	Du	W	H/D	W/D	Du/D	H/W
150/71	229	75	108.8	53.1	32.8	23.2	47.5	141
150/72		78		54				144
150/73	–	131	–	80	–	–	–	164

C o m p a r i s o n a n d r e m a r k s. *Epideroceras grande* Donovan, 1958 differs from *Ep. hugi* Donovan in the larger size, the higher growth rate of whorls, and the absence of tubercles on the ribs of outer whorls. The very large forms (probably megaconchs) of the genus *Epideroceras*, which are similar to specimens from the Raricostatum Zone in Switzerland and Austria are assigned here to *Ep. grande* (Donovan, 1958; Blau, 1998). In terms of morphology, they are very similar to late Sinemurian *Ep. lorioli* (Hug) and *Ep. steinmanni* (Hug), being different mainly in the very large size of the adult shell. For example, the most complete Crimean specimen (no. 150/73) with a preserved body chamber has six or seven whorls with a supposed diameter of about 450 mm. The Crimean specimens of *Ep. lorioli* (see above) have the same number of whorls, the maximum diameter of which is as high as 100 mm. In this case, no intermediate gradations in size between *Ep. lorioli* and *Ep. grande* were found among the Crimean specimens. According to this, *Ep. grande* is considered here as an independent species.

As well as the specimens of *Ep. lorioli* known beyond Crimea, those of *Epideroceras grande* Donovan, 1958 rarely exceed 200 mm in diameter with the exception of specimens assigned here in synonymy to *Ep. grande*. The similar very large specimens of late Sinemurian *Epideroceras* (D = 270–350 mm) were described by Donovan (1958) under the names *Ep. lorioli*, *Ep.* aff. *lorioli*, *Ep.* aff. *steinmaimi*, and *Ep. grande*.

However, in subsequent works, all these forms were often included in the composition of the species *Ep. lorioli* (Blau, 1998; etc.).

D i s t r i b u t i o n. This species is known from the upper Sinemurian Raricostatum Zone of Switzerland and Austria. It was also described in Turkey without any images of specimens provided (Bremer, 1965).

M a t e r i a l. Four specimens of varying degrees of preservation. Limestone boulders of lithological type VI with sandstone interbeds.

FAMILY COELOCERATIDAE HAUG, 1910

Genus *Tetraspidoceras* Spath, 1926

? *Tetraspidoceras* sp.

Plate IV, figs. 3a–3c

S h a p e. Whorls is wide, trapezoid, with a wide strongly convex ventral side.

S c u l p t u r e. Coarse radial ribs on the lateral sides bears two rows of large well-defined tubercles. The thin threadlike secondary ribs, crossing the ventral side is begin rom the outer row of tubercles.

C o m p a r i s o n a n d r e m a r k s. Crimean specimens are assigned to the genus *Tetraspidoceras* with a certain degree of conditionality on the basis of their outlines of the section of a whorl characteristic of the genus (wide, trapezoidal, with two rows of large tubercles). However, representatives of the genus *Vicininodiceras* Trueman have similar morphological characters at some stages of ontogenesis. Unfortunately, it is impossible to accurately determine the generic affiliation of a single specimen owing to its fragmentary preservation.

D i s t r i b u t i o n. Representatives of the genus occur in the upper Sinemurian (Raricostatum Zone) and lower Pliensbachian (Jamesoni Zone) of Great Britain (Hebrides, Radstock), Central France, France and Alpine Front Range, the Central Apennines, the Bakony and Villani Mountains in Hungary, Morocco, Tunis, and, probably, Indonesia.

M a t e r i a l. A small fragment from a limestone boulder of lithological type VI.

PALEOBIOGEOGRAPHY, STRUCTURE OF AMMONITE ASSEMBLAGES, AND CORRELATION

On the basis of the analysis of biogeographic distribution of genera and groups of ammonoid species, Dommergues distinguished two provinces in the Early Jurassic of Europe (West Tethyan) and Northwestern European (Subboreal and Euroboreal) (Dommergues, 1982b; Dommergues et al., 2001, 2009).

According to Dommergues's ideas, the appearance of these provinces was associated with the so-called "Liassic faunal event" that occurred in the late Sinemurian–Pliensbachian. It is noted that this "event" was not catastrophic, but was a succession of numerous episodes of differentiation of faunas between biochorems (Dommergues and Meister, 1991b). The trend of isolation of the Euroboreal province began in the late Sinemurian. The provincialism in the early Sinemurian was still poorly recognizable and ammonoids prevailed everywhere with a wide habitat area (Dommergues, 1982b, p. 1048).

The Euroboreal province appears to be more or less faunistically homogeneous, although separate areas can be distinguished. Among them are Celtic (France and Germany), Aquitano-Iberian (Southern France and Northeastern Spain), and Anglo-Lusitanian (England and Portugal). At the same time, the Mediterranean province is usually divided into three unequal parts (subprovinces): Mediterranean sensu stricto, Central European (Austroalpine, including Austroalpine and Southern Alps), and Pontic (Meister, 1995; Dommergues and Meister, 1991b; Dommergues et al., 2009). The latter apparently includes the Pontic Ridge (Northern Turkey), the Caucasus, and Northern Iran (Dommergues et al., 2001, p. 202).

The ammonoids of the Pontic subprovince is characterized by some endemic evolutionary trends, as well as a noticeable similarity to the Southern Celtic faunas of Europe: South France and South Germany (Dommergues et al., 2001, p. 202). It should be noted, however, that the eastern part of the Mediterranean province is less studied than the Western European one and the preservation of ammonites is usually worse. Ammonite assemblages of the Pontic Mountains (Pontic subprovince) have been studied in the most detail (Bremer, 1965; Cope, 1991; Alkaya and Meister, 1995). Here, red oolitic marls (the red nodular calcareous marls), which resemble Ammonitico Rosso facies, are noted (Alkaya and Meister, 1995). In the Caucasus, to the east of the Pontic Mountains, there was a marine basin with terrigenous and, less frequently, volcanogenic and carbonate deposits (including the most easterly Ammonitico Rosso facies in the Tethys). Further to the east, carbonate facies with numerous bivalves and very rare ammonoids predominate (Khudoley, 1997, p. 13).

The correlation of the Sinemurian beds with fauna and biohorizons of Crimea with the stratigraphic scales of other regions is shown in Fig. 9. Note that the ammonite assemblages at the stratigraphic levels established in the boulders from the Greek Quarry and in the previously described Sinemurian limestone boulder from Tat'yanina Mountain in the Bodrak River basin (Zaitsev, 2021) are different. The only general proven level is the E. raricostatoides biohorizon. The boulder from Tat'yanina Mountain recorded a reasonably narrow age interval corresponding to the lower half of the Raricostatum Zone (Densinodulum and Raricostatum subzones), whereas boulders from the Greek Quarry show multiple separated stratigraphic levels covering the entire Sinemurian.

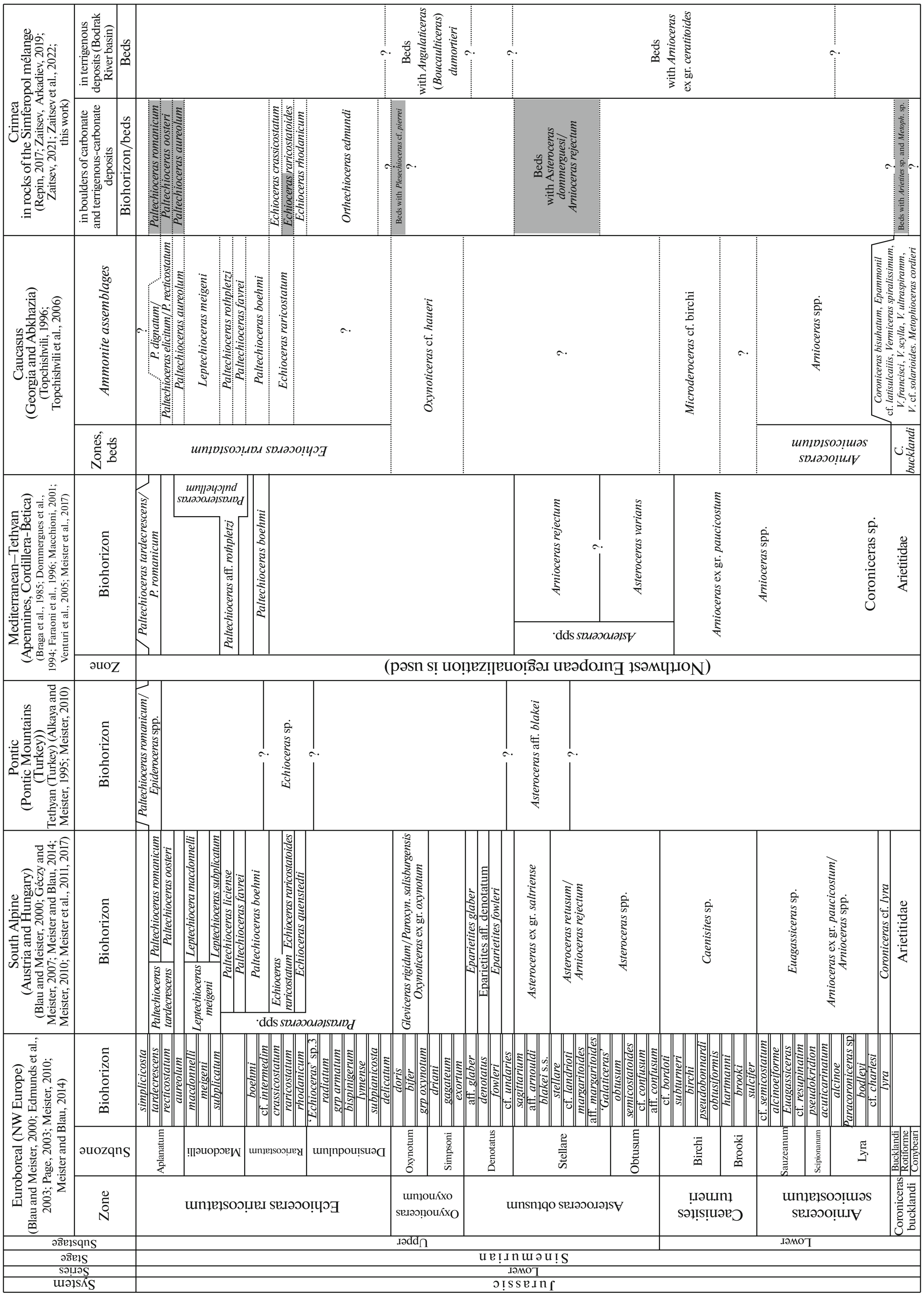


Fig. 9. Correlation of the Sinemurian stratigraphic intervals of Crimea with stratigraphic scales of other regions. The stratigraphic levels in the Greek Quarry are shown in gray; the levels previously established in Crimea are shown in white (Zaitsev, 2021).

In general, the ammonoid assemblage from the Greek Quarry is represented by 11 families. At the same time, the findings of limestone boulders with the fauna of the lower Sinemurian to the lower part of the upper Sinemurian (Obtusum Zone) are quite rare. The most numerous and diverse faunal assemblages (ten families) were recognized in the stratigraphic interval corresponding to the upper Sinemurian Upper Oxynotum Zone–Raricostatum Zone (Fig. 10). The boulders with ammonoids characteristic of the Aplanatum Subzone of the Raricostatum Zone, which is represented in the Greek Quarry in almost full stratigraphic volume, are especially numerous.

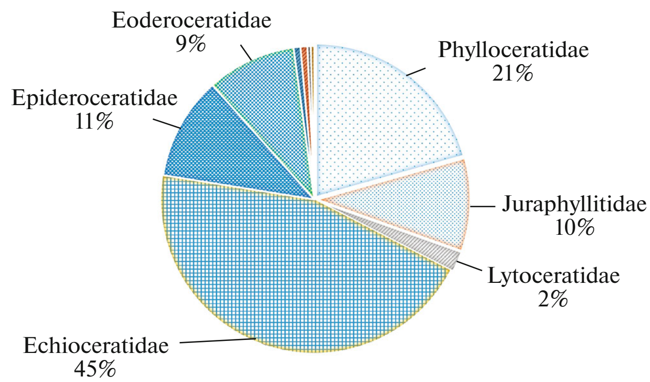
The early Sinemurian—beginning of late Sinemurian faunal assemblages are characterized by the predominance of ammonites of the Arietitidae family. The faunal assemblage of *Arnioceras rejectum*, *Asteroceras dommerguesi*, and *Paradasyceras* cf. *stella* (Beds with Arnioceras rejectum) is represented by Mediterranean species typical of the Central European (Austroalpine) and Mediterranean s.s. provinces.

The interval corresponding to the Upper Oxynotum Zone–Raricostatum Zone is characterized by the prevalence of Echioceratidae with predominance of the genus *Paltechioceras* in the Aplanatum Subzone. The latter is represented by species most characteristic of the Euroboreal province and the Pontic subprovince. Attention is drawn to the absence of representatives of *Paltechioceras* gr. *tardecrescens* (*P. tardecrescens* (Hauer), *P. insigne* (Trueman et Williams), *P. nobile* (Trueman et Williams), *P. aplanatum* (Hyatt)), characteristic of the Aplanatum Subzone of Euroboreal regions. At the same time, *Paltechioceras romanicum* is present, which is more typical of the Mediterranean province and the northern margin of the Tethys, including Northern Turkey (Alkaya and Meister, 1995).

The representatives of Phylloceratidae occupy a significant proportion (more than 20%) in the ammonite assemblages. Juraphyllitidae representatives are quite numerous, but are not dominant. At the same time, among the *Phylloceratida* are species that are not characteristic of Northwestern Europe (*Partschiceras striatocostatum*, *Juraphyllites libertus*) or are rare in this region (*Juraphyllites* ex gr. *limatus*). The latter is distributed mainly at the northern margin of the Tethys. *Lytoceratida* are quite rare and taxonomically less diverse.

The total number of oceanic (bathypelagic) *Phylloceratida* and *Lytoceratida* is less than one-third of the total number of specimens. If we exclude Juraphyllitidae from this list of specimens, some of which could have been inhabitants of the shallow shelf zone (Meister, 1993), then the proportion of oceanic forms will be less than 23%.

A significant proportion (more than 20%) are representatives of Epideroceratidae and Eoderoceratidae, represented exclusively by species typical of the northern margin of the Tethys (Central European and Pontic subprovinces). Representatives of the genus *Epideroceras* are quite numerous (more than 10% of the total number of specimens). It is noted that representatives of this genus have a center of biodiversity in the Alps (Dommergues and Géczy, 1989) and are most numerous on the northern coast of the Tethys, from the Western Alps to the Pontic Mountains (Dommergues, 1982b), although they are known further east, up to the Pamirs (Khudoley, 1997, p. 13). A large proportion of these ammonites in assemblages is considered an indicator of Mediterranean faunas (Donovan, 1958).



Taxon	Number of specimens	%
Phylloceratidae	57	20.65
Juraphyllitidae	27	9.78
Lytoceratidae	6	2.17
Phylloceratida + Lytoceratida	**90**	**32.61**
Echioceratidae	124	44.93
Epideroceratidae	30	10.87
Eoderoceratidae	26	9.42
Schlotheimiidae	2	0.72
Oxynoticeratidae	2	0.72
Coeloceratidae	1	0.36
Incertae Familiae	1	0.36
Total	276	100

Fig. 10. Structure of ammonoid assemblages (Oxynotum and Raricostatum zones).

The proportion of other ammonite families in the structure of assemblages is insignificant. They are represented by a species of Oxynoticeratidae, characteristic of Northwestern Europe and the Alps, as well as the only representative of the Schlotheimiidae (genus *Phricodoceras*), which had a wide distribution area. The occurrence of "*Cymbites*" sp. in Crimea, which was previously noted exclusively in the Pontic and Central European subprovinces, is of interest (Table 1).

The succession of late Sinemurian Echioceratidae assemblages (Raricostatum Zone) recently established in Southwestern Crimea (Zaitsev, 2021) is identical to

Table 1. List of ammonoid species found in the Greek Quarry and their distribution in the late Sinemurian of the Mediterranean province and adjacent areas

Species	NW European	Mediterranean sensu stricto	Mediterranean—Alpine (Central European)	Mediterranean—Pontic (including Caucasus)
Phylloceras ex gr. *frondosum*	+	+	+	+
Zetoceras zetes	+	+	+	+
Partschiceras striatocostatum	+ (southern margin)	+	+	+
Paradasyceras cf. *stella*	-	+	+	?
Juraphyllites libertus	-	+	+	+
Juraphyllites ex gr. *limatus*	+	+	+	+
Phricodoceras lamellosum	+	+	+	+
Arnioceras rejectum	-	+	+	-
Arnioceras cf. *mendax*	-	+	+	-
Asteroceras dommerguesi	-	+	-	-
Gleviceras iridescens	+	-	+	-
Plesechioceras cf. *pierrei*	+	+	+	-
Echioceras raricostatoides	+	+	+	-
Paltechioceras aureolum	+	-	-	+
Paltechioceras oosteri	+	?	+	+
Paltechioceras recticostatum	+	-	-	+
Paltechioceras romanicum	-	+	+	+
Eoderoceras praecursor	-	+	+	+
Eoderoceras bispinatum	-	+	+	+
Eoderoceras ancyrense	-	+	-	+
Epideroceras lorioli	+ (southern margin)	+	+	+
Epideroceras grande	-	-	+	+
"*Cymbites*" sp.	-	-	+	+

that at the southern margin of the Euroboreal province (Southern Celtic faunas of Burgundy).

On the basis of the foregoing, it may be concluded that the Sinemurian ammonite faunas of Crimea as a whole have Mediterranean features. The Sinemurian ammonoid assemblages from the Greek Quarry and other localities of Crimea are the most similar to those that are characteristic of the northern margin of the Tethys (the Pontic and, to a lesser extent, Central European subprovinces).

CONCLUSIONS

(1) The ideas about the taxonomic composition of the Sinemurian ammonoids of Crimea have been significantly expanded. The data on the presence of ammonoid species belonging to 21 genera and 11 families in the Greek Quarry are given. At present, this quarry is the richest known locality of Sinemurian ammonoids in Crimea.

(2) The first occurrence of the following ammonoids in Crimea has been established: "*Cymbites*" sp., *Paltechioceras recticostatum* (Trueman et Williams), *P. oosteri* (Dumortier), *P. aureolum* (Simpson), *Orthechioceras*(?) sp., *O.* aff. *edmundi* (Dumortier), *Plesechioceras* cf. *pierrei* (Spath), *Arnioceras* cf. *mendax* Fucini, *A.* sp., *A. rejectum* Fucini, *Arietites* sp., *Metophioceras* sp., *Coroniceras* (*Pararnioceras*) sp., *Epideroceras grande* Donovan, *Eoderoceras ancyrense* (Bremer), *Eo. praecursor* (Geyer), *Tetraspidoceras*(?) sp., *Gleviceras iridescens* (Tutcher, Trueman), *Phricodoceras lamellosum* (d'Orbigny), *Adnethiceras* sp., *Paradasyceras* cf. *stella* (J. de C. Sowerby), *Juraphyllites libertus* (Gemmellaro), *J.* ex gr. *limatus* (Rosenberg), *J.* sp., and *Phylloceras* ex gr. *frondosum* (Reynes). A new species *Asteroceras dommerguesi* Zaytsev sp. nov. has been described.

(3) The ammonite assemblages from limestone boulders of the Greek Quarry have been recognized and biostratigraphic units—layers with fauna and bio-

horizons—have been distinguished on their basis. Most of the studied ammonite species characterize the Aplanatum Subzone of the upper Sinemurian Raricostatum Zone. Index species of three biohorizons of the Aplanatum Subzone (*Paltechioceras aureolum*, *P. oosteri*, and *P. romanicum*) of the standard ammonite scale for Western Europe were found (Page, 2003). In addition, index species indicating the presence of lower biohorizons of the upper Sinemurian than was previously established have been found in the quarry (Zaitsev and Ippolitov, 2015). Among them are *Echioceras raricostatoides* (Vadasz) (E. raricostatoides biohorizon), *Plesechioceras* cf. *pierrei* (Spath) (the boundary interval between the Oxynotum and Raricostatum zones), and a faunal assemblage including *Asteroceras dommerguesi* sp. nov. and *Arnioceras rejectum* Fucini (the Obtusum Zone, probably the Stellare Subzone).

(4) On the basis of the occurrence of the assemblage of *Arietites* sp. and *Metophioceras* sp., which is correlated with the Bucklandi Zone (probably with the Rotiforme Subzone) of the standard ammonite scale for Western Europe (Page, 2003), the presence of boulders bearing the lower Sinemurian fauna in the Simferopol mélange was substantiated for the first time. This was previously considered fundamentally impossible owing to the regional stratigraphic disagreement in Crimea (Panov et al., 2004).

(5) The supposition about the occurrence of early Pliensbachian fossils in the limestone boulders of the Greek Quarry, based on the discovery of a belemnite rostrum fragment of *Gastrobelus* ?*teres* (Stahl) in the talus (Zaitsev and Ippolitov, 2015), has not yet been confirmed on the basis of the analysis of ammonite complexes.

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The main sections of the article were written by B.A. Zaitsev; A.P. Ippolitov made the main contribution to the preparation of the geological description of the locality and also collected part of the ammonoid collection.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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