

New Occurrences of Heteromorph Ammonites in the Berriasian–Valanginian of the Crimean Mountains

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Abstract—A new species, *Bochianites* (?) *ambiguus* sp. nov., is described from the Lower Berriasian of the Eastern Crimea. It is proposed that the name *B. laevis* Liu, 1988 be used instead of *B. levis* Arkadiev, 2008, as the former is a senior synonym and homonym. For the first time a species of the genus *Leptoceras* is described from the Upper Berriasian–Lower Valanginian of the former Soviet Union. Problems in the identification of heteromorph ammonites when they are partially preserved are discussed, and the geographical distribution and facial affinities of the heteromorph ammonite family Bochianitidae are considered.

Keywords: new species, heteromorphy ammonites, family Bochianitidae, Berriasian–Valanginian, Crimean Mountains.

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INTRODUCTION

Heteromorphs are uncommon in the ammonite assemblages of the Berriasian–Valanginian of the Crimean Mountains. There are virtually no publications on this fossil group from this region, although Retowski (1893, p. 237, pl. 14, Fig. 5) figured a fragment of *Protancyloceras gracile* (= *Bochianites* (?) cf. *ambiguus* sp. nov.) from the “Tithonian” (=Berriasian *jacobi* Zone) of the Eastern Crimea. Only recently Arkadiev (2008) described Berriasian species of the genus *Bochianites* from this region for the first time, and also found a specimen of a species of *Leptoceras*.

The genus *Bochianites* has an almost cosmopolitan distribution (Arkadiev, 2008; Rogov and Igolnikov, 2009), which includes Western and Eastern Europe, Africa, Madagascar, North and South America, Antarctica, Indonesia, New Guinea, the Crimean Mountains, Pakistan, Tibet, Eastern Greenland, Northern Siberia, Barents Sea shelf, and northern regions of European Russia. The stratigraphic range of the species includes mainly Berriasian–Lower Hauterivian, although some species are known from the Tithonian and the Lower Barremian. Occurrences of the earliest, Late Tithonian, *Bochianites* are confirmed from Indonesia and Nepal (Boehm, 1904; Enay, 2009). Early Berriasian *Bochianites* are distributed more widely, including Tunisia (Memmi and Salaj, 1975), Crimea (Arkadiev, 2008), Antarctica (Thomson, 1979), Cali-

fornia (Imlay and Jones, 1970), in northern Siberia (Rogov and Igolnikov, 2009). *Bochianites* is most widespread in the Valanginian. At the same time there is a difficulty in assigning straight fragments of the Tithonian–Valanginian well ornamented ammonites to the genera *Protancyloceras* or *Bochianites*. Many of these ammonites (*Protancyloceras passendorferi* Wierzbowski, *P. africanus* Tate, *Bochianites thieuloidis* Cantú-Chapa, *B. xizangensis* Liu, *B. zigzag* Etayo-Serna) are described based on fragments of the straight portion of the shell, while the morphology of the early stages of these species is unknown. Many specimens described in the literature are represented by small straight shell fragments, making it difficult to identify them to genus.

The stratigraphic range of the genus *Leptoceras* is mainly restricted by the Upper Berriasian–Lower Valanginian. *Leptoceras* is recorded from Europe, North Africa, and Central America.

All specimens of *Bochianites* described in this paper were collected by Perminov in the Eastern Crimea in the vicinity of Feodosiya (Fig. 1), on St. Elias Cape and are restricted to the Feodosiyan Marl Series Lower Berriasian *jacobi* Zone (*grandis* Subzone) (Arkadiev et al., 2008). The only specimen of *Leptoceras studeri* (Ooster) was found by Arkadiev in 2010 in the Eastern Crimea near the village of Sultanovka (Yuzhnoe) in a clay series, forming a core of the Sultanovka Syncline

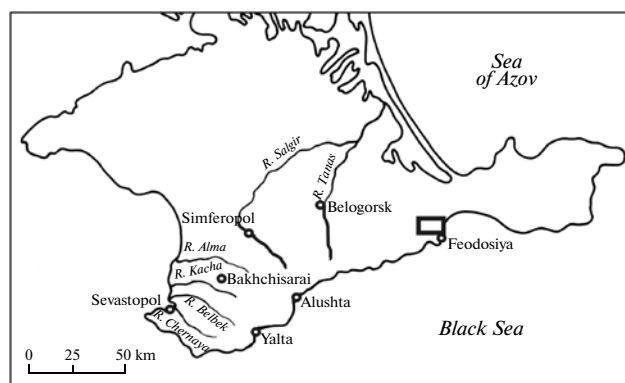


Fig. 1. Localities of heteromorph ammonites (in the outlined rectangular area near Feodosiya): Feodosiya, St. Elias Cape (45°01'27" N, 35°24'89" E); village of Sultanovka (45°00'10" N, 35°17'38" E), Nanikovo (45°00'03" N, 35°12'38" E).

and traditionally considered Lower Cretaceous based on belemnites and aptychi. The lower part of the section here contains beds of the Sultanovka Formation (Berriasian) and Nanikovo Series (Valanginian) (Astakhova et al., 1984; Arkadiev, 2007). The Valanginian age of the Nanikovo Series is based on the occurrences of the Lower Valanginian ammonites *Kilianella roubaudiana* (d'Orbigny), Upper Valanginian ammonites *Neocomites neocomiensis* (d'Orbigny) and aptychi *Didayilamellaptychus didayi* (Coquand). Until recently no identifiable ammonites have been found from the Sultanovka section. Apart from *Leptoceras studeri*, Arkadiev found *Spiticeras* sp. and *Fauriella* sp. stratigraphically lower in the same section. This assemblage suggests a Late Berriasian–Late Valanginian age.

There are various interpretations of the systematics of the genera *Bochianites*, *Leptoceras*, and *Protancyloceras*. In the latest edition of *Treatise... on Cretaceous ammonites* (Wright et al., 1996), *Leptoceras* and *Protancyloceras* are classified in the subfamily Protancyloceratinae Breistroffer, 1947, whereas *Bochianites* is classified in the subfamily Bochianitinae Spath, 1922. Vermeulen (2006) proposed a different interpretation, according to which the genus *Protancyloceras* is assigned to the family Protancyloceratidae Breistroffer, 1947, the genus *Leptoceras* is assigned to the family Leptoceratoididae Thieuloy, 1966, and Bochianitidae are considered as a separate family. We do not see sufficient evidence to include *Protancyloceras*, *Bochianites*, and *Leptoceras* in different families, and we follow Vašíček and Wiedmann (1994) who proposed to retain only Upper Hauterivian–Barremian ammonites in the family Leptoceratoididae, a proposal supported by Klein et al. (2007).

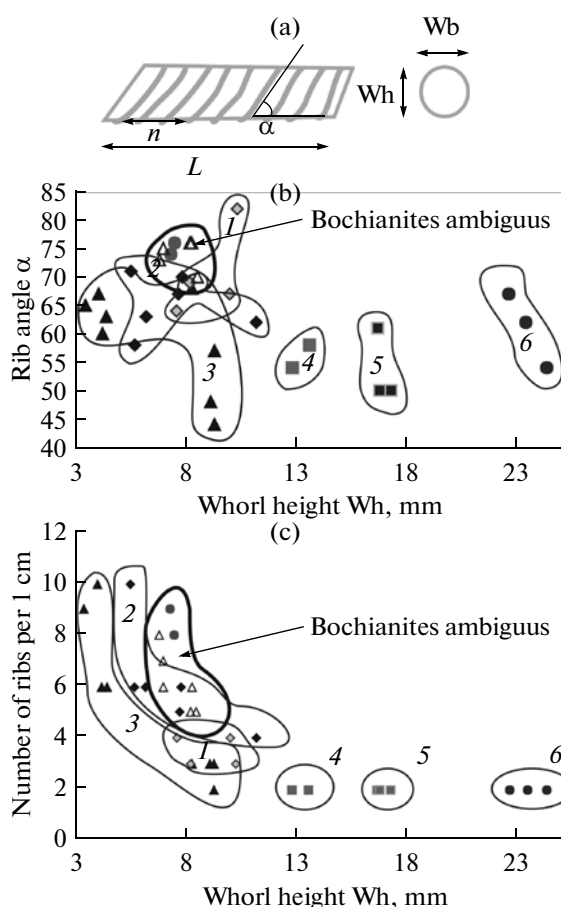


Fig. 2. Diagrams showing (a) measurements of heteromorph ammonites used in this paper and (b, c) comparison of *Bochianites (?) ambiguus* sp. nov. with other ornamented Tithonian–Valanginian bochianitids with straight shells. The figure indicate the species: (1) *Bochianites thieuloidis* Cantú-Chapa (Cantú-Chapa, 1976, pl. 3, fig. 4, 10; pl. 6, fig. 14); (2) *Protancyloceras passendorferi* Wierzbowski (Wierzbowski, 1990, pl. 2, figs. 4, 5, 7); (3) *Bochianites* cf. *neocomiensis* (d'Orbigny) (Rogov and Igonnikov, 2009, pl. 1, fig. 7; Alsen, 2006, pl. 39, fig. U; Fischer, 2006, pl. 9, fig. 4 (lectotype); Reboulet, 1995, pl. 26, fig. 9); (4) *Protancyloceras africanus* (Tate) (Tate, 1967, pl. 7, fig. 5); (5) *Bochianites xiangensis* Liu (Liu, 1988, pl. 12, fig. 1); (6) *Bochianites* sp. (Enay, 2009, pl. 51, fig. 7).

MATERIAL

All specimens described in this paper are housed in the TsNIGR Museum (St. Petersburg, coll. no. 13217).

MEASUREMENTS

Specimens of *Bochianites* in the collection studied are represented by fragments of straight portions of shells, for which there is no accepted system of measurements. We propose to measure their length (L), height (Wh), and width (Wb), as well as the ribbing density per 1 cm of the shell surface (n) and their angle α (Fig. 2a).

SYSTEMATIC PALEONTOLOGY

Family *Bochianitidae* Spath, 1922Genus *Bochianites* Lory, 1898

Type species. *Baculites neocomiensis* d'Orbigny, 1842; Valanginian, France.

Diagnosis. Shell straight, smooth or ribbed, rounded-oval in cross section, slightly elongated ventrodorsally. Simple ribs on flanks inclined forward, crossing ventral side arching forward, and becoming weaker, almost obsolete on dorsum. Sometimes intercalating ribs present. Some species with constrictions. Suture with three major weakly dissected lobes (V, L, D) and auxiliary lobes on the top of the saddles.

Species composition. *Bochianites* (?) *ambiguus* sp. nov., Berriasian, *jacobi* Zone, *grandis* Subzone of the Crimea; *B. ambikyensis* Collignon, 1962, Valanginian of Madagascar; *B. baculitoides* Arnould-Saget, 1953, Tithonian–Berriasian of Tunisia; *B. crymensis* Arkadiev, 2008, Berriasian, *jacobi* Zone, of the Crimea; *B. demissus* Bodylevsky, 1960, Valanginian of northern Siberia; *B. glaber* Kitchin, 1908, Valanginian, Hauterivian (?) of South Africa; *B. glennensis* Anderson, 1945, Tithonian (?) of California; Berriasian *kochi* Zone of northern Siberia, *B. gracilis* Thomson, 1974, Berriasian of Alexander Island (Antarctica); *B. goubenchensis* Mandov, 1971, Berriasian, *jacobi* Zone of the Crimea; Upper Valanginian of Bulgaria, England, and France; ?*B. kiliani* Lory in Turner, 1962, Hauterivian of France; *B. laevis* Liu, 1998 (= *B. levis* Arkadiev, 2008), Berriasian, *boissieri* Zone (Beds with *Euthymiceras* and *Neocosmoceras*) of the Crimea, Berriasian of Tunisia, Valanginian of the Czech Republic and Tibet; Upper Valanginian–Lower Hauterivian of Bulgaria, Austria, Switzerland, Mallorca; *B. neocomiensis* (d'Orbigny, 1842), Berriasian of the Crimea; Valanginian of the Czech Republic; Upper Valanginian of Poland, Bulgaria, Germany, England, Spain, France, Austria, Barents Sea Shelf, Eastern Greenland, Northern Siberia, Upper Valanginian–Lower Hauterivian of Switzerland, the Caucasus (?); *B. nodosocostatus* Mandov, 1971, Upper Valanginian of Bulgaria; *B. paskentaensis* Anderson, 1938, Berriasian (?), Valanginian of California; *B. renevieri* Ooster, 1860, Lower Barremian of Switzerland; *B. thieuloides* Cantú-Chapa, 1976, Upper Valanginian of Mexico; *B. versteeghi* Boehm, 1904, Berriasian (?) of the Sulu Islands (Indonesia), Alexander Island (Antarctica); *B. weteringi* Boehm, 1904, Upper Tithonian of the Sulu

Islands (Indonesia); *B. xizagensis* Liu, 1988, Valanginian of Tibet; *B. zigzag* Etayo-Serna, 1985, Valanginian of Columbia.

Comparison. This genus is distinguished from the genera *Kabylites*, *Janenschites*, and *Baculina*, which are similar in the shell morphology, by its sutural outline.

Remarks. Incompletely preserved specimens of *Bochianites* are difficult to identify and are easy to confuse with other Lower Cretaceous heteromorph ammonites (e.g., *Protancyloceras*), from which *Bochianites* is distinguished by a straight shell and the absence of the ventral band (area on the ventral side where the ribs are interrupted). Apparently, Klein et al. (2007), based on this character, included in *Bochianites* such species as *B. africanus* (Tate) and *B. gerardianus* (Stoliczka). The former species has a distinct ventral band, while the latter has a curved shell. In our opinion, both species should be assigned to the genus *Protancyloceras*. Some species of *Bochianites* show a significant intraspecific variability. For instance, specimens of *B. neocomiensis* from the Valanginian of France, in the opinion of Reboulet (1995, p. 179), show a gradual transition from prominently ornamented shells to those lacking ribbing. This complicates the identifications of isolated occurrences of *Bochianites* even more.

The name *B. levis* Arkadiev, 2008 is a junior homonym and apparently a junior synonym of *B. laevis* Liu, 1988, described from the Valanginian of Tibet. Both species have a smooth shell and, in contrast to the Valanginian–Hauterivian *B. oosteri* Sarasin et Schondelmayer, 1902, have a more strongly dissected suture. Therefore we suggest that the Crimean ammonites should be named *B. laevis* Liu.

Bochianites (?) *ambiguus* Arkadiev, Rogov et Perminov, sp. nov.

Plate 5, figs. 1–3

cf. *Ancyloceras gracile*: Retowski, 1893, p. 273, pl. 14, fig. 5.

Bochianites goubenchensis: Arkadiev, 2008, p. 22, pl. 3, fig. 6.

Etymology. From the Latin *ambiguus* (ambiguous).

Holotype. TsNIGRMuseum, no. 1/13217; Eastern Crimea, Feodosiya, St. Elias Cape; Berriasian, *jacobi* Zone, *grandis* Subzone.

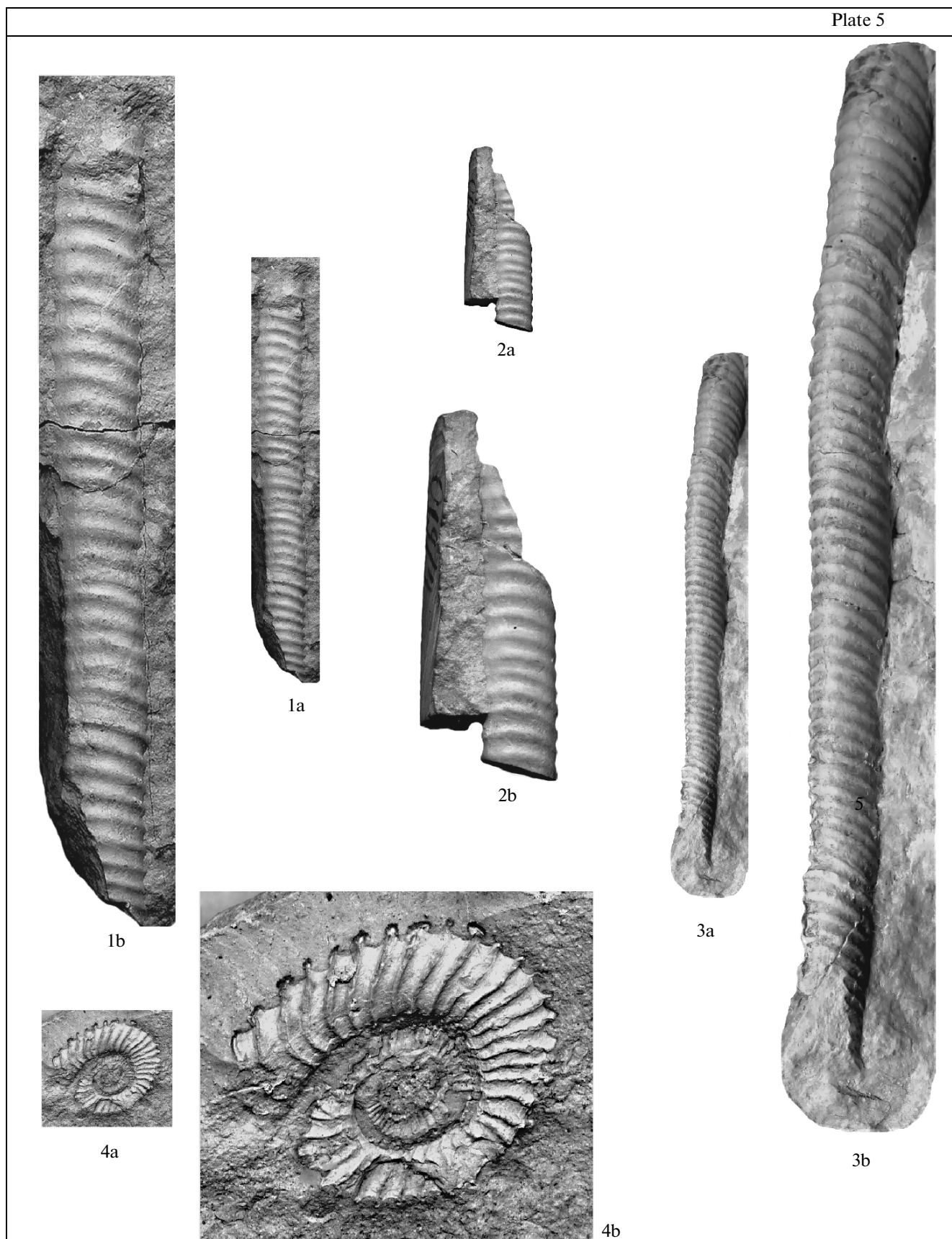
Shape. The preserved fragments of the shell are straight or weakly curved (specimen no. 1/13217), but the latter character probably results from a deformation. Specimen no. 2/13217 expands slightly towards

Explanation of Plate 5

Figs. 1–3. *Bochianites* (?) *ambiguus*, sp. nov.: (1) specimen no. 2/13217, lateral view, (1a) $\times 1$ and (1b) $\times 2$; (2) specimen no. 3/12217, lateral view, (2a) $\times 1$ and (2b) $\times 2$; (3) holotype, no. 1/13217 lateral view, (3a) $\times 1$ and (3b) $\times 2$; Eastern Crimea, vicinity of Feodosiya, St. Elias Cape, Dvuyakornaya Formation, Feodosiyan Marl Series; Berriasian, *jacobi* Zone, *grandis* Subzone; coll. by V.A. Perminov.

Fig. 4. *Leptoceras studeri* (Ooster), specimen no. 5/13217, lateral view, (4a) $\times 1$ and (4b) $\times 3$; Eastern Crimea, vicinity of Koktebel, Sultanovka River; Upper Berriasian–Lower Valanginian (?); coll. by V.V. Arkadiev.

Plate 5



the aperture. The section is elliptical and laterally compressed (perhaps also deformed).

Ornamentation. The flanks are covered with prominent, densely spaced single ribs, weakly inclined forward, and have constrictions. Specimen no. 1/13217 shows three constrictions, spaced at a distance of 25–30 mm, with 15–17 ribs between the constrictions. The ribs are interrupted on the ventral side by a barely visible band.

Dimensions in mm:

Specimen no.	Fragment L	Wh	Wb
Holotype 1/13217	89.0	6.3 (at the beginning) 9.1 (at the end)	—
2/13217	69.5	8.0	—
3/13217	28.0	7.4	5.0

Comparison. This species differs from the closely related species *B. goubenchensis* Mandov in the coarser and more evenly spread ribs, and by the more closely spaced constrictions. It is distinguished from other coarsely ornamented species of *Bochianites* (*B. neocomiensis* (d'Orb.), *B. thieuloidis* Cantú-Chapa, *B. xizangensis* Liu), by the somewhat more closely spaced ribs at a similar height and by the larger angle of the forward inclined ribs (Figs. 2b, 2c). Along with *B. (?) ambiguus* sp. nov. there are less strongly ornamented specimens as well as some with no ornamentation altogether (*B. neocomiensis* (d'Orb.), *B. crimensis* Arkadiev, *B. laevis* Liu), although they do not form a complete succession of variation. In addition, *B. (?) ambiguus* is distinguished from the above species by the presence of well developed constrictions. The new species differs from other species of *Bochianites* with constrictions (*B. demissus* Bodylevski, *B. versteeghi* Boehm, *B. weteringi* Boehm), in its much coarser ornamentation. It is very similar to *Bochianites* sp. from the Upper Tithonian of Nepal (Enay, 2009, pl. 51, fig. 7). According to Y. Klein (pers. comm.) "*Bochianites* cf. *gerardianus*" from the Berriasian of Pakistan (Fatmi, 1977, p. 262), has ribs running across the venter at an angle of 45°, which is clearly distinct from *B. (?) ambiguus*.

Remarks. The incompleteness of the type material and the absence of data on the early shell ontogeny do not allow positive assignment to *Bochianites*. Some Early–Middle Tithonian *Protancyloceras* (Figs. 2b, 2c), e.g., *P. passendorferi* Wierzbowski and *P. gracile* (Wierzbowski, 1990, pl. 1, fig. 10; pl. 2, figs. 1–15) are very similar to *B. (?) ambiguus* in ornamentation. This group of *Protancyloceras* species was ancestral to *Bochianites*, whereas the lack of data in the early shell ontogeny of the Late Tithonian and Early Berriasian coarsely ornamented *Bochianites* does not allow positive delineation between these genera.

Occurrence. Berriasian (*jacobi* Zone, *grandis* Subzone) Crimean Mountains.

Material. Eastern Crimea: 4 specimens from the vicinity of Feodosiya, St. Elias Cape, coll. by V.A. Perminov; 1 specimen from the section near the village of Nanikovo, coll. by T.N. Bogdanova.

Genus *Leptoceras* Uhlig, 1883

Type species. *Ancyloceras brunneri* Ooster, 1860; Berriasian of Switzerland.

Diagnosis. Shell small, with crioconic or cyrtoconic coiling. Body chamber uncoiled. Ribs simple, rectiradiate or rursiradiate towards aperture, crossing ventral side uninterrupted and of consistent strength. Nodes absent. Suture with broad saddles, with first lateral lobe distinctly tripartite in early whorls, later becoming asymmetrical (see Thieuloy, 1966, text-fig. 3).

Species composition. *L. brunneri* (Ooster, 1860), Upper Berriasian–Lower Valanginian of Switzerland, France, Spain, and Romania; *L. hubachi* (Royo, 1945), Berriasian of Colombia; *L. studeri* (Ooster, 1860) (= *Protoleptoceras jelevi* Nikolov), Upper Berriasian–Lower Valanginian of Switzerland, France, Spain, Romania, Morocco; Upper Berriasian of Bulgaria and Poland, Lower Valanginian of Austria, Mexico, and the Crimea.

Comparison. This genus is distinguished from the closely similar genus *Protancyloceras* by its shell being more strongly coiled at early stages and the absence of a ventral discontinuation of the ribbing. It differs from the genus *Bochianites* in the coiled shell and in the absence of constrictions.

Remarks. The genus is very similar to some Barremian ammonites of the family Leptoceratoididae, especially *Karsteniceras*, from which they are distinguished by their more strongly dissected suture and the absence of constrictions. Ammonites of these two genera were for a long time confused with one another, e.g., in the *Osnovy paleontologii* [Fundamentals of Paleontology] (Drushchits and Eristavi, 1958, p. 105; the only previously existing Russian-language description of the genus) the genus *Leptoceras* is considered as Barremian and its diagnosis corresponds to that of the Barremian Leptoceratoididae. The genera *Leptoceras* and *Protancyloceras* are phylogenetically connected. *Protancyloceras hondense* (Imlay), originally assigned to *Leptoceras* (Imlay, 1942) was apparently a transitional species between the two genera. Thieuloy (1966) proposed a phylogenetic lineage *Protancyloceras guembeli*–*P. hondense*–*Leptoceras studeri*. The two latter species are indeed very similar morphologically. The Lower Valanginian *?Leptoceras ubalaense* Haas from Colombia (Haas, 1960, p. 4, text-fig. 6) displays densely spaced ornamentation, and probably should be assigned to the genus *Protancyloceras*.

A specimen of *Leptoceras* (*L. studeri*, Pl. 5, figs. 4a, 4b) in our collection comes from the Upper Berriasian–Lower Valanginian of the Eastern Crimea. It is represented by a distorted evolute shell with loosely coiled whorls (criocon) and weakly convex flanks. The flanks

possess simple single ribs originating from the umbilical edge. The ribs are straight in the initial part of the shell and are weakly rursiradiate on the last whorl. At a shell diameter of about 20 mm the number of ribs per whorl reaches 32. This species is distinguished from the closely similar *L. brunneri* by the higher, more densely coiled whorls, more densely spaced ribs and the fact that the ribs are not rursiradiate on the outer whorls in *L. brunneri*.

DISCUSSION

Having appeared at the very beginning of the Tithonian in the epicontinental seas of Western Europe, the heteromorph ammonites of the family Bochianitidae became widespread by the end of the Tithonian in the Superrealm Tethys-Panthalassa, and at the beginning of the Berriasian also appeared in the Panboreal Superrealm. Their occurrences are mainly restricted to the relatively deep-water zones of the continental slope, usually containing numerous other oceanic ammonoids—phylloceratids and lycoceratids. The broad and rapid spread of the early bochianitids and their “mosaic” distribution suggest that *Protancyloceras* species were epiplanktonic, and their distribution was linked to the distribution of floating algae (Barthel and Geyssant, 1973; Wierzbowski, 1990).

The distribution of the Early Berriasian bochianitids mainly in the eastern region of the Neotethys (the Crimea, Tibet, and Indonesia) can be explained by the ranges of these semiplanktonic ammonites being primarily controlled by the character of the oceanic surface currents; these ammonites could not reach territories to the west of the Crimea, where the northern margin of the ocean turned northwards relatively abruptly.

The connection between the increase in abundance and diversity of heteromorph ammonites with rapid transgressions and increase in pelagic zones of the basin is well known (Mikhailova and Baraboshkin, 2009). It was not accidental that in the Valanginian, a period with several large-scale transgressions, the abundance and diversity of heteromorph ammonites increased considerably, whereas the range of bochianitids reached its maximum. In the Valanginian, many bochianitids reached the deep-water zones of epicontinental basins for the first time. At the same time, a few *Leptoceras* reached the most easterly part of their range (the Crimea). Their further transition toward the east could have been prevented by the same features of oceanic circulation that facilitated the colonization of those regions by *Bochianites*, which was spreading in the western direction.

The appearance of heteromorph ammonites in the Berriasian–Lower Valanginian of the Crimea agrees well with the interpretation of the origin of these sediments that suggests that they were formed at a depth of over 200 m on the continental slope (Arkadiev et al., 2006; Arkadiev, 2008).

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REFERENCES

- Alsen, P., The Early Cretaceous (Late Ryazanian–Early Hauterivian) Ammonite Fauna of North-East Greenland: Taxonomy, Biostratigraphy, and Biogeography, *Fossils & Strata*, 2006, vol. 53, pp. 1–229.
- Arkadiev, V.V., Fedorova, A.A., Savel'eva, Yu.N., and Tesakova, E.M., Biostratigraphy of Jurassic–Cretaceous Boundary Sediments in the Eastern Crimea, *Stratigr. Geol. Korrelyatsiya*, 2006, vol. 14, no. 3, pp. 84–112 [*Stratigr. Geol. Correlation* (Engl. Transl.), vol. 14, no. 3, pp. 302–330].
- Arkadiev, V.V., Raschlenenie na svity berriasskikh otlozhenii Gornogo Kryma, *Vestn. S.-Peterb. Univ., Ser. 7, Geol. Geogr.*, 2007, no. 2, pp. 27–43.
- Arkadiev, V.V., Representatives of the Family Bochianitidae (Ammonoidea) from the Lower Cretaceous of the Crimean Mountains, *Paleontol. Zh.*, 2008, no. 5, pp. 18–26 [*Paleontol. J.* (Engl. Transl.), vol. 42, no. 5, pp. 468–478].
- Arkadiev, V.V., Bogdanova, T.N., Lobacheva, S.V., Kalacheva, E.D., and Sey, I.I., Berriasian Stage of the Crimean Mountains: Zonal Subdivisions and Correlation, *Stratigr. Geol. Korrelyatsiya*, 2008, vol. 16, no. 4, pp. 57–80 [*Stratigr. Geol. Correlation* (Engl. Transl.), vol. 16, no. 4, pp. 400–422].
- Astakhova, T.V., Gorak, S.V., Kraeva, E.Ya., Kulichenko, V.G., Permyakov, V.V., Plotnikova, L.F., Semenenko, V.N., et al., *Geologiya shel'fa USSR. Stratigrafiya (shel'f i poberezh'e Chernogo morya)* (Geology of the Shelf of the Ukrainian SSR: Stratigraphy (Shelf and Coast of the Black Sea)), Kiev: Naukova Dumka, 1984.
- Barthel, K.W. and Geyssant, J.R., Additional Tethyian Ammonites from the Lower Neuburg Formation (Middle Tithonian, Bavaria), *N. Jb. Geol. Paläontol., Monatsh.*, 1973, no. 1, pp. 18–36.
- Boehm, G., Beiträge zur Geologie von Niederländisch-Indien. I Abt. Die Südküsten der Sula-Inseln Taliabu und Mangoli. I Abs. Grenzschichten zwischen Jura und Kreide, *Palaeontographica*, 1904, Suppl. 4, no. 1, pp. 1–46.
- Cantú-Chapa, A., El contacto Jurásico-Cretácico, la estratigraphía del Neocomiano, el Hiato Hauteriviano Superior–Eoceno Inferior y las Ammonites del Pozo Bejuco 6 (Centro-Este de México), *Bol. Soc. Geol. Mexicana*, 1976, vol. 37, pp. 60–83.
- Drushchits, V.V. and Eristavi, M.S., Superfamily Ancylocerataceae, in *Osnovy paleontologii. Mollyuski-golovonogie. II. Ammonoidei (tseratity i ammonity), vnutrirakovinnye*

- (Fundamentals of Paleontology: Mollusks, Cephalopods: 2. Ammonoids (Ceratites and Ammonites). Endocochlians), Luppov, N.P. and Drushchits V.V., Eds., Moscow: Gos. Nauch.-Tekhn. Izd. Lit. po Geol. i Okhr. Nedr, 1958, pp. 104–106.
- Enay, R., Les faunes d'ammonites de l'Oxfordien au Tithonien et la biostratigraphie des Spiti-Shales (Callovien supérieur–Thitonien) de Thakkhola, Népal Central, *Docum. Lab. Géol., Lyon*, 2009, no. 166, pp. 1–351.
- Fatmi, A.N., Neocomian Ammonites from Northern Areas of Pakistan, *Bull. Brit. Mus. (Nat. Hist.). Ser. Geol.*, 1977, vol. 28, no. 4, pp. 257–296.
- Fischer, J.-C., Gauthier, H., Busnardo, R., Combémoré, R., Delanoy, G., Guérin-Franiatte, S., Joly, B., Kennedy, W.J., Sornay, J., and Tintant, H., *Révision critique de la Paléontologie Française d'Alcide d'Orbigny, Volume IV Céphalopodes Crétacés*, Leiden: Backhuys Publishers, 2006.
- Haas, O., Lower Cretaceous Ammonites from Colombia, South America, *Am. Museum Novit.*, 1960, no. 2005, pp. 1–62.
- Imlay, R.W., Late Jurassic Fossils from Cuba and Their Economic Significance, *Bull. Geol. Soc. Am.*, 1942, vol. 53, no. 10, pp. 1417–1478.
- Imlay, R.W., and Jones D.L., Ammonites from the *Buchia* Zones in Northwestern California and Southwestern Oregon, *US Geol. Surv. Prof. Pap.*, 1970, no. 647-B, pp. 1–59.
- Klein, J., Busnardo, R., Company, M., Delanoy, G., Kaka-badze, M., Reboulet, S., Ropolo, P., Vašíček, Z., and Vermeulen J., *Fossilium Catalogus I: Animalia: Pars 144: Lower Cretaceous Ammonites III: Bochianitoidea, Protancyloceratoidea, Ancyloceratoidea, Ptychoceratoidea*, Leiden: Backhuys Publ., 2007, pp. 1–381.
- Liu, G., Upper Jurassic and Lower Cretaceous Ammonites from Yamzho Yumco Area Xizang (Tibet), in *Tectonic Evolution of the Lithosphere of the Himalayas*, Liu, G., Jin, Ch., Wang, F., et al., Eds., Beijing: Geol. Publ. House, 1988, pp. 66–122.
- Memmi, L. and Salaj J., Le Berriasien de Tunisie. Succession de faunes d'Ammonites, de Foraminifères et de Tintinnioïdiens, *Colloque sur la limite Jurassique–Crétacé. Lyon, Neuchâtel*, 1973, *Mém. B.R.G.M.*, 1975, no. 86, pp. 58–67.
- Mikhailova, I.A. and Baraboshkin, E.Yu., The Evolution of the Heteromorph and Monomorph Early Cretaceous Ammonites of the Suborder Ancyloceratina Wiedmann, *Paleontol. Zh.*, 2009, no. 5, pp. 51–60 [*Paleontol. J.* (Engl. Transl.), vol. 43, no. 5, pp. 527–536].
- Reboulet, S., L'évolution des Ammonites du Valanginien–Hauterivien inférieur du bassin vocontien et de la plate-forme provençale (Sud-Est de la France), *Docum. Lab. Géol. Lyon*, 1995, no. 137, pp. 1–371.
- Retowski, O., Die tithonischen Ablagerungen von Theodosia, Ein Beitrag zur Paläontologie der Krim, *Bull. Soc. Imp. Nat. Moscou, N. Sér.*, 1893, vol. 7, nos. 2–3, pp. 206–301.
- Rogov, M.A. and Igolnikov, A.E., Ammonites of the Genus *Bochianites* from the Lower Cretaceous of the Panboreal Superrealm and Their Significance for Paleobiogeographic Reconstructions, in *Sovremennye problemy izucheniya golovonogikh mollyuskov. Morfologiya, sistematika, evolyutsiya, ekologiya i biostratigrafiya* (Contributions to Current Cephalopod Research: Morphology, Systematics, Evolution, Ecology, and Biostratigraphy), Leonova, T.B., Barskov, I.S., and Mitta, V.V., Eds., Moscow: Palaeontol. Inst. Ross. Akad. Nauk, 2009, pp. 124–126.
- Tate, R., On Some Secondary Fossils from South Africa, *Quart. J. Geol. Soc.*, 1867, vol. 23, pp. 139–175.
- Thieuloy, J.-P., Leptoceras berriasiens du massif de la Grande-Chartreuse, *Trav. Lab. Géol. Grenoble*, 1966, vol. 42, pp. 281–295.
- Thomson, M.R.A., Upper Jurassic and Lower Cretaceous Ammonite Faunas of the Ablation Point Area, Alexander Island, *Br. Antarct. Surv. Sci. Rep.*, 1979, no. 97, pp. 1–37.
- Vašíček, Z. and Wiedmann, J., The Leptoceratoidinae: Small Heteromorph Ammonites from the Barremian, *Palaeontology*, 1994, vol. 37, part 1, pp. 203–239.
- Vermeulen, J., Nouvelle classification à fondement phylogénétique des ammonites hétéromorphes du Crétacé inférieur, *Ann. Mus. Hist. Nat. Nice*, 2006, no. 21, pp. 137–178.
- Wierzbowski, A., The Taxonomy and Phylogenetic Significance of Early Tithonian Ammonites of the Genus *Protancyloceras* Spath from the Pieniny Klippen Belt (Carpathians, Poland), *Atti II Conv. Int. "Fossili, Evoluzione ed Ambiente"*, Pergola, 25–30 ottobre 1987, Pergola: Com. Cent. Raffaele Piccinini, 1990, pp. 479–489.
- Wright, C.W., Callomon, J.H., and Howarth, M.K., *Treatise on Invertebrate Paleontology: Part L. Mollusca 4, Revised*, Vol. 4: *Cretaceous Ammonoidea* Boulder–Lawrence: Geol. Soc. Am. and Kansas Univ. Press, 1996.