

Ammonite *Fauriella boissieri* (Pictet), the Index Species of the Berriasian Upper Zone from the Crimean Mountains

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Abstract—Ammonite *Fauriella boissieri* (Pictet), the index species of the Berriasian upper zone, is described for the first time as taxon occurring in the Crimean Mountains. In the Berriasian sections of the central Crimea and Chatyr-Dag massif, species *F. boissieri* are encountered only in association with upper Berriasian ammonites. The Berriasian–Valanginian boundary has not been identified based on ammonites in the Crimean Mountains. Consequently, there is no reason to include the *otopeta* Zone into the *boissieri* Zone in the rank of its upper subzone.

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Key words: Crimean Mountains, Berriasian, ammonites, zonal biostratigraphy, correlation.

According to recent data, the standard *jacobi*, *occitanica* and *boissieri* ammonoid zones are distinguished in the Berriasian of the Crimean Mountains (Arkad'ev and Bogdanova, 2004). Zonal index species *Berriasella jacobi* (Mazenot) have been described from central (Sary-Su River) and eastern (Feodosiya area) Crimea (Arkad'ev and Bogdanova, 2004). Kvantaliani and Lysenko (1979) reported on *Pseudosubplanites grandis* (Mazenot), the index species of the upper subzone in the *jacobi* Zone, from the eastern Crimea, although this taxon was described for the first time by Glushkov (1997a) from the Feodosiya section. Later on, it was also discovered in the Tonas River basin (Arkad'ev et al., 2005). Species *Tirnovella occitanica* described originally by Retowski (1893) from the Feodosiya section has been revised afterward by Bogdanova et al. (1999), and the *occitanica* Zone is reliably established in this section.

Many researchers mentioned as well that *Fauriella boissieri* (Pictet), the index species of the Berriasian upper zone, occurs in the Crimean Mountains, although it has never been described as yet. An ammonite specimen from the Bel'bek River valley in the southwestern Crimea, which has been figured and named by Eristavi (1957) as *Berriasella* cf. *boissieri*, is not that species in my opinion and belongs most likely to the genus *Dalmasiceras*. In the same area, Drushchits and Yanin (1958) detected the *boissieri* species form the 15-m-thick member of alternating shales and calcareous sandstones. According to current understanding, this species is characteristic of stratigraphic interval spanning an upper part of the *occitanica* Zone and lower part of the *boissieri* Zone (Bogdanova and Arkad'ev, 1999; Arkad'ev et al., 2002). Drushchits and Yanin (1959) also identified *Thurmannia* ex gr. *boissieri* (Pic-

tet) in the Berriasian section of the Sary-Su River in the central Crimea. Kuznetsov and Shemyakin (1965) noted occurrence of *Thurmannia* (Subthurmannia) *boissieri* in the Sponge Horizon of the southwestern Crimea. Besides, two *boissieri* forms: *Subthurmanniceras* ex gr. *boissieri* from the central Crimea (Sary-Su River) and *Thurmanniceras boissieri* from the Baidarskaya Valley of the southwestern Crimea, are mentioned in the well-known edition *Geology of the USSR*, in volume 8 dedicated to the Crimea.

Sazonova and Sazonov (1974) who discriminated the *boissieri* Zone in the Feodosiya section published the following list of ammonite species characteristic of this unit: *Euthymiceras euthymi* (Pictet), *Neocosmoceras* sp., *Malbosciceras malbosi* (Pictet), *M. paramimounum* (Mazenot), *Mazeniticeras curelense* (Kilian), *Fauriella boissieri* (Pictet), *F. rarefurcata* (Pictet), *F. latecostata* (Kilian), *Tirnovella alpillensis* (Mazenot), and *Jabronella discrepans* (Retowski). Index species of the *boissieri* Zone have neither been described nor figured in their work, and subsequent works have not proved its occurrence in the Feodosiya area.

As it follows from data presented above, the *boissieri* Zone is most confidently established in sections of the southwestern and central Crimea, where ammonoid assemblages of the upper Berriasian are known very well. In relevant areas of the Crimean Mountains, the *boissieri* Zone has been distinguished long ago (Kvantaliani and Lysenko, 1979; Drushchits and Gorbachik, 1979), although in subsequent stratigraphic schemes this stratigraphic interval is determined either as Brachiopoda Beds (Bogdanova et al., 1981) or as the *Berriasella callisto* Zone (Glushkov, 1997b). Considered

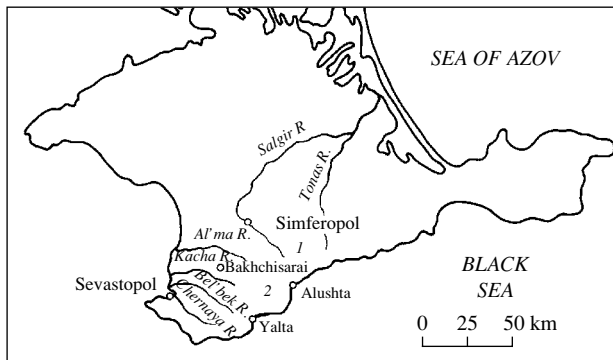


Fig. 1. Geographic localities of Berriasian sections studied in the Crimean Mountains: (1) Enisarai Ravine, Sary-Su River; (2) Chatyr-Dag massif.

in this work are four specimens of *Fauriella boissieri* (Pictet) collected by Drushchits, Lysenko, and Arkad'ev. One almost intact ammonite shell is from the Berriasian clays of the Sary-Su section in the central Crimea; three other specimens are from exposures in the Tas-Kor Ravine, the Chatyr-Dag massif (Fig. 1). Many researchers repeatedly studied section of the central Crimea (Sary-Su River and Enisarai Ravine), which is characterized in detail by Bogdanova and Kvantaliani (1983) in their work. Arkad'ev, Savel'eva and Fedorova described once more this section in 2004. The section shown in Fig. 2 is after Bogdanova with additions done by Arkad'ev who revised ammonites. Unfortunately, the exact occurrence level of *boissieri* species is unknown, although they are confined most likely to *Euthymiceras* and *Neocosmoceras* beds in the section upper part.

In the Chatyr-Dag massif, specimens of *Fauriella boissieri* have been found in the Tas-Kor Ravine at the massif northern flank near the village of Mramornoe above the synonymous quarry (Fig. 2). Arkad'ev and Lysenko studied this area in 2003 and 2005. Lysenko and Vakhrushev (1974) who studied that section earlier published only its general description without mentioning occurrence of *Fauriella boissieri*. In the area under consideration, Berriasian deposits are exposed in a separate fault-bounded tectonic block and overlie limestones of the same age (opinion of Lysenko). The Berriasian gray to yellowish gray shales and siltstones are up to 60 m thick. Near the contact with limestones, there is a condensed horizon with sagged pockets containing abundant belemnite rostra *Duvalia* sp., bivalves *Gervillia anceps* (Deshayes in Leymerie), and corals *Montlivaltia* sp. (Lysenko and Vakhrushev, 1974). I identified here *Fauriella boissieri* (Pictet), *Malbosiceras malbosi* (Pictet) and *M. chaperi* (Pictet). Approximately 5 m above the limestone top, there is second occurrence level of abundant fossils. Dominant at this level are large (up to 200 mm in diameter) shells of *Malbosiceras malbosi* (Pictet) found in association with *Berriasella callisto* (d'Orbigny), *Berriasella* sp.,

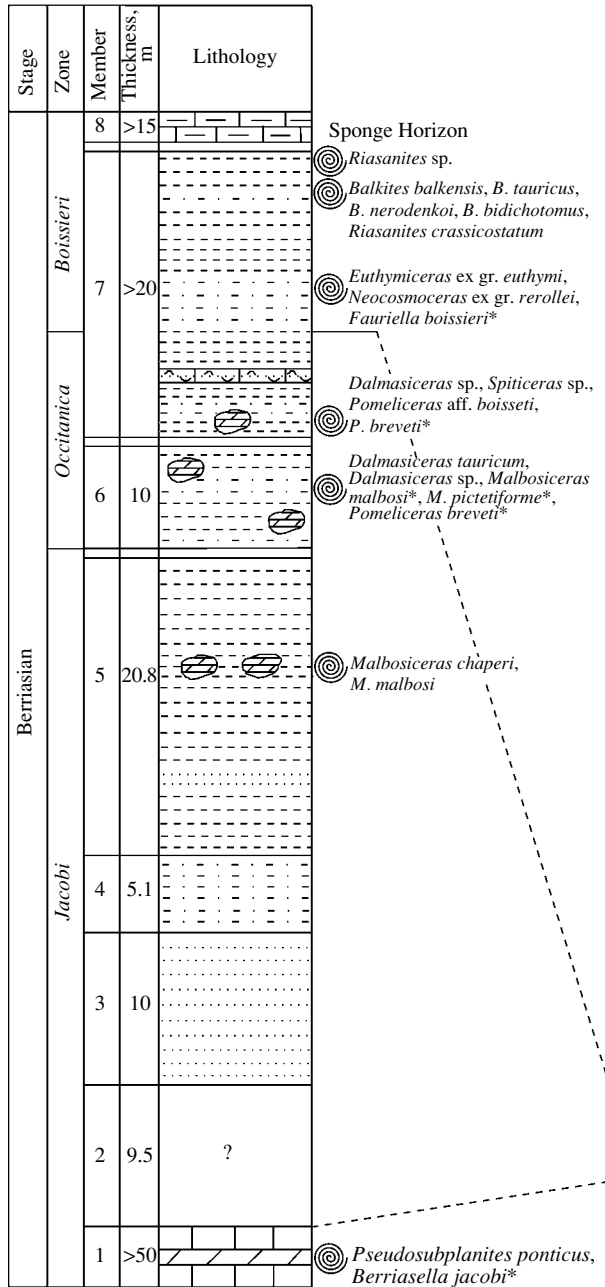
Jabronella cf. *paquieri* (Simionescu), *Fauriella* sp., *F. rarefurcata* (Pictet), *Tirnovella* sp., and *T. alpillensis* (Mazenot). Siltstones fine- to medium-grained are loose and can be easily broken by hands. At this level, all ammonites are compressed, deformed and replaced by siltstone material. In distinction from them, ammonites of the lower level near limestones retained better their morphology, although they are somewhat rounded and show other signs of redeposition. Besides ammonites, siltstones contain bivalves, brachiopods, aptychi, shark teeth, and plant detritus. Ammonites of the condensed horizon belong to different zones: *Fauriella boissieri* is typical of synonymous zone of the upper Berriasian, while *Malbosiceras chaperi* is a taxon of the *jacobi* zone only being redeposited therefore. The ammonite assemblage of the second level is characteristic of the upper Berriasian *boissieri* Zone. In the stratotype area, species *F. boissieri* and *F. rarefurcata* are known from the *paramimounum*, *picteti*, and *callisto* subzones, being of maximum abundance in the last two units (Le Hégarat, 1973). In southeastern France, species *Tirnovella alpillensis* and *Jabronella paquieri* are also typical of the *picteti* and *callisto* subzones, while *Malbosiceras malbosi* is widespread in the *paramimounum* and *picteti* subzones. According to my observations, the last species is present however in the *jacobi* and *occitanica* zones of the Crimean sections. Hence, the ammonite assemblage from the Tas-Kor Ravine corresponds in age most likely to middle and upper parts of the *boissieri* Zone.

Species *Fauriella boissieri* is widespread outside the Crimea being described in many publications (see references to its synonyms below). Until recent time, its stratigraphic range was thought to be restricted by the *boissieri* Zone of the upper Berriasian (Le Hégarat, 1973; Nikolov, 1982; Tavera, 1985).

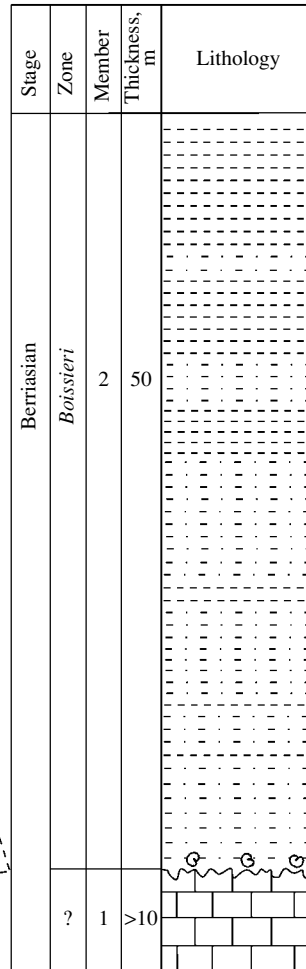
At present, stratigraphic ranges of some late Berriasian ammonite genera and species are defined not very precisely because of three reasons. First, complete Berriasian–Valanginian sections are absent in many regions, second, the same taxa are controversially identified, and third, they are inadequately studied. Accordingly, position of the Berriasian–Valanginian boundary in the Mediterranean is disputable. Hoedemaeker (1982) who studied complete Berriasian–Valanginian sections in Spain distinguished above the upper Berriasian *picteti* Subzone an interval, characteristic of which are representatives of genera *Tirnovella* (*T. alpillensis* included), *Kilianella*, *Sarasinella*, *Neocomites*, and *Olcostephanus*. This interval termed the *Tirnovella alpillensis* Subzone was included into the *Thurmanniceras* (*Kilianella*) *retrocostatum* Zone of the lower Valanginian and supplemented by remark that *alpillensis* forms with abundance maximum in synonymous subzone commenced their evolution in the *picteti* Subzone of the upper Berriasian.

Later on, Company (1987) established presence of *Tirnovella alpillensis* in the *otopeta* Zone and occur-

Central Crimea,
Enisarai Ravine, Sary-Su River



Chatyr-Dag,
Tas-Kor Ravine



Malboliceras malbosi,
Berriasella sp.,
B. callisto,
Jabronella cf. *paquieri*,
Fauriella sp.,
F. rarefurcata,
Tirnovella alpillensis

Fauriella boissieri,
Malboliceras malbosi,
M. chaperi

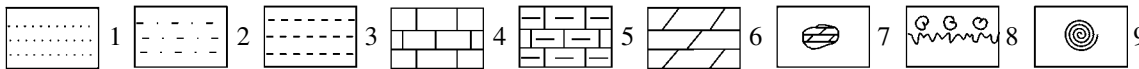


Fig. 2. Correlated Berriasian sections of the Crimean Mountains: (1) sandstone; (2) siltstone; (3) clay; (4) limestone; (5) clayey limestone; (6) marl; (7) marl nodules; (8) hard ground and condensed horizon; (9) occurrence levels of ammonites (species presumably occurring at the level are marked by asterisks).

rence of *Fauriella boissieri* in the lower part of the Val-ginian *pertransiens* Zone in Spain.

In preliminary ammonoid zonation suggested for the Mediterranean region (Hoedemaeker and Bulot, 1990), there was an interval of “unnamed association”

above the *picteti* Subzone, which was included into the *boissieri* Zone and corresponded to the *alpillensis* Subzone in the earlier ammonoid zonation suggested by Hoedemaeker (1982). Expecting a more complete investigation and description of fauna, experts on the

problem recommended including this interval into the Berriasian. Later on, it was decided to consider the interval as the upper *Tirnovella alpillensis* Subzone of the *boissieri* Zone (Hoedemaeker et al., 1993). Despite the opposition of Hoedemaeker, that decision was authorized in resolutions of the International Ammonite Working Group (Rawson et al., 1999; Hoedemaeker and Rawson, 2000).

New information about distribution of *Tirnovella alpillensis* and *Fauriella boissieri* in Mediterranean sections appeared in recent years. In Morocco, *alpillensis* forms have been detected in the *otopeta* Zone (Aguado et al., 2000), while *boissieri* specimen was described from the *otopeta* Subzone ranked accordingly as the upper *boissieri* Subzone (Wippich, 2003). In the mentioned region, *F. boissieri* is found in association with *Subthurmannia latecostata*, *Tirnovella alpillensis*, and *Thurmanniceras thurmanni*. At the Stramberk locality (Czechia), species *Subthurmannia* cf. *boissieri* is associated with Valanginian ammonites *Thurmanniceras pertransiens*, *T. thurmanni*, *Kilianella roubaudiana*, and *K. clavicostata*, which are characteristic of the *pertransiens* Zone (Houša and Vašiček, 2004). As is noted in the cited work, however, the species in question is confined in the Stramberk locality to the base of lower Valanginian deposits above deeply eroded Berriasian sediments (a greater part of the *boissieri* Zone is missing), and shells of this taxon are redeposited most likely.

Taking all this into consideration by positioning the Berriasian–Valanginian boundary in Mediterranean region, the “Kilian Group” decided to transfer the *otopeta* Zone into the Berriasian and ranked it as upper subzone of the *boissieri* Zone (Hoedemaeker et al., 2003). This decision is consistent with recommendation of the Brussels Symposium (Bulot, 1996) to define the Berriasian–Valanginian boundary at the first occurrence level of *Calpionellites darderi* at base of Zone E. Exactly this level corresponds to appearance datum of the typical Valanginian species *Tirnovella pertransiens*.

Valanginian ammonites are scarce in the Crimean Mountains, and it is difficult to establish here the relevant zonation (*Zones of the Cretaceous...*, 1989). None of the sections with the Berriasian–Valanginian transition proved by paleontological materials is known here. The Valanginian sediments transgressively overlap as a rule either the Berriasian and Upper Jurassic deposits, or the Tavrisheskaya Group.

In the Varnautskaya and Baidarskaya depressions of the southwestern Crimea, the deeply eroded Tithonian and Berriasian deposits are overlain by clays containing ammonites *Neocomites neocomiensis*, *Kilianella roubaudiana*, and *Thurmanniceras thurmanni* of the lower Valanginian (Eristavi, 1957; Lysenko, 1964). Similar situation is observable in the Chatyr-Dag area, where clays with Valanginian *Neocomites neocomiensis* fill in the erosion pockets in the Tithonian or Berriasian limestones (Lysenko and Vakhrushev, 1974).

The only place, where E.Yu. Baraboshkin established based on ammonites the lower Valanginian *pertransiens* Zone (*Atlas of the Cretaceous...*, 1997; Arkad'ev et al., 2002), is section of the Bel'bek Valley in the southwestern Crimea. Even here, nevertheless, the Berriasian–Valanginian boundary cannot be defined precisely, because the *Euthymiceras–Neocosmoceras* Beds correlated with the *boissieri* Zone and beds with ammonites of the *pertransiens* Zone are separated by carbonate and quartz conglomerate strata barren of ammonites and conventionally attributed to the Berriasian. In the central Crimea near the village of Mezgor'e, there are also known thick carbonate deposits with coral-algal bioherms, which are at the higher stratigraphic level than deposits containing ammonites of the upper Berriasian. Deposits with ammonites of the *otopeta* Zone are established in the Kacha and Bodrak river basins of the southwestern Crimea (Baraboshkin and Mikhailova, 2000), where they discordantly overlie the Tavrisheskaya Group, and concrete position of the Berriasian–Valanginian boundary is problematic here as well.

These data suggest certain structural and paleogeographic reorganization in the Crimean Mountains at the terminal Berriasian–initial Valanginian time. According to Baraboshkin (2005, p. 213), the early Valanginian was a time of “... essential reorganization in paleobasin of the Crimean Mountains. It triggered erosion of land that emerged in the Berriasian and quick subsidence of external zone in the Crimean Mountains (First Range area, Eastern Crimea), where pelagic clay facies accumulated in erosion incisions. The central Crimea of that time corresponded to a rise under eroding action...” In the Crimean Mountains, species *Tirnovella alpillensis* and *Fauriella boissieri* have not been found as yet in association with ammonites of the lower Valanginian *otopeta* or *pertransiens* zones (Baraboshkin and Mikhailova, 2000), and it would be motiveless therefore to support or disprove reasonably the resolutions of the “Kilian Group.”

Specimens of *Fauriella boissieri* (Pictet) described and figured in this work are stored at the TSNIGR Museum, St. Petersburg, collection no. 13146.

SYSTEMATIC DESCRIPTION

FAMILY NEOCOMITIDAE SALFELD, 1921

Genus *Fauriella* Nikolov, 1966

Type species *Berriasella gallica* Mazonot, 1939; Berriasian of southeastern France.

Fauriella boissieri (Pictet)

Plate, figs. 1–3

Ammonites boissieri: Pictet, 1867, p. 79, Plate 15, figs. 1–3; 1868, p. 248, Plate 39, fig. 3; non *Hoplites boissieri*: Toucas, 1890, p. 602, Plate 18, figs. 1A, 1B (= *Dalmasiceras*); non *Thurmannia boissieri*: Sayn,

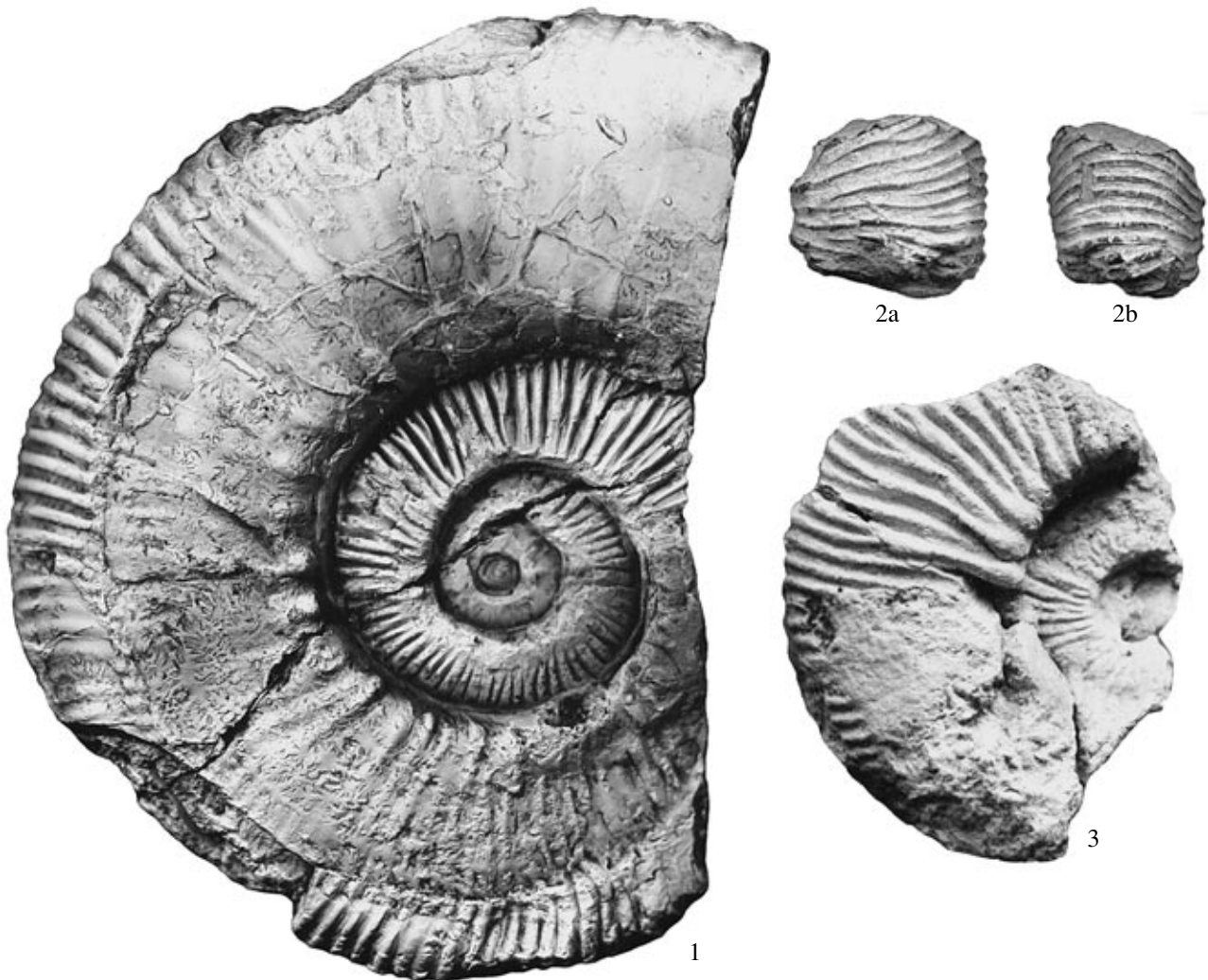


Plate. (1–3) *Fauriella boissieri* (Pictet): (1) specimen 1/13146, lateral view, $\times 1$, central Crimea, Sary-Su River, *boissieri* Zone, collection of V.V. Drushchits; (2) specimen no. 2/13146, lateral (a) and ventral (b) views, $\times 1$; (3) specimen no. 3/13146, $\times 1$, Chatyr-Dag massif, Tas-Kor Ravine, *boissieri* Zone, collection of N.I. Lysenko.

1907, p. 39, Plate 3, fig. 16 (= ?*Kilianella*); Stephanov, 1934, p. 212, Plate 5, fig. 4 (= *Kilianella*); *Hoplites* (*Thurmannia*) *boissieri*: Uhlig, 1910, p. 233, Plate 80, figs. 1a, 1b; *Hoplites* (*Thurmannia*) n. sp. indet, aff. *boissieri*: Uhlig, 1910, p. 234, Plate 81, figs. 1a, 1b; *Berriasella boissieri*: Mazenot, 1939, p. 106, Plate 15, fig. 2, Plate 16, figs. 1, 3, 4 (non fig. 2 = *Tirmovella alpillensis*); Sapunov, 1957, p. 156, Plate 2, fig. 6; Collignon, 1962, p. 9, Plate 178, figs. 780, 781; Hégarat et Remane, 1968, p. 26, Plate 1, fig. 8; *Berriasella rarefurcata*: Mazenot, 1939, p. 110, Plate 17, fig. 2; *Berriasella* sp. (gr. de *B. boissieri*): Arnould-Saget, 1953, p. 56, Plate 5, figs. 6, 9; non *Berriasella* cf. *boissieri*: Eristavi, 1957, p. 70, Plate 3, fig. 6, 7 (= *Dalmasiceras*); *Subthurmannia boissieri*: Nikolov, 1960, p. 171, Plate 12, fig. 1, Plate 13, figs. 1, 2, 3; *Thurmannia boissieri*: Fülöp, 1964, Plate 31, fig. 1; *Subthurmannia boissieri*: Dimitrova, 1967, p. 105, Plate 49, fig. 3; *Subthurmannia* sp. cf. *boissieri*: Marek, 1967, p. 186, Plate 1,

fig. 7; *Fauriella boissieri*: Hégarat, 1973, p. 149, Plate 21, figs. 1, 2, 3, Plate 48, fig. 1; Benest, Donze, Hégarat, 1977, p. 209, Plate 4, fig. 1, 2; Nikolov, 1982, p. 110, Plate 31, fig. 3, Plate 32, fig. 1, Plate 33, figs. 1, 2, Plate 34, figs. 1, 2; Sakharov, 1984, p. 40, Plate 7, fig. 4; Tavera, 1985, p. 291, Plate 44, figs. 2, 3, fig. 22G; Immel, 1987, p. 77, Plate 5, fig. 2; Company, 1987, p. 106, Plate 4, figs. 6, 7, Plate 18, fig. 6; Khimshiashvili, 1989, p. 11, Plate 1, fig. 6, Plate 3, fig. 2; Tchoumatchenco et al., 1995, Plate 1, fig. 5; Vašiček, Faupl, 2000, p. 597, Plate 1, fig. 6; Aguado, Company, Tavera, 2000, fig. 6a; *Fauriella rarefurcata*: Hégarat, 1973, p. 163, Plate 24, figs. 1, 2, 3, 5, 6, 7 (non fig. 4 = *Fauriella* sp.), Plate 46, figs. 6, 7; Nikolov, 1982, p. 120, Plate 41, figs. 1, 2, 4, Plate 42, fig. 1; *Fauriella* cf. *boissieri*: Khimshiashvili, 1976, p. 120, Plate 20, fig. 2; *Fauriella* aff. *boissieri*: Benest, Donze, Hégarat, 1977, p. 209, Plate 4, figs. 3, 4, 5; *Subthurmannia* (*Subthurmannia*) *rarefurcata*: Hoedemaeker, 1982, Plate 4, fig. 1; *Subthurmannia*

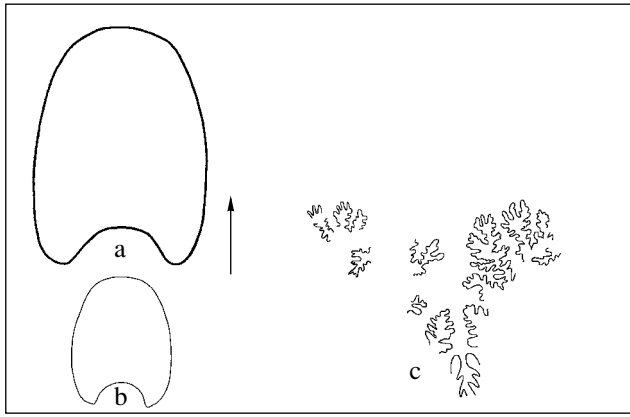


Fig. 3. Cross sections (a, b) and lobe line (c) of *Fauriella boissieri* (Pictet): (a, c) specimen no. 1/13146, magnification $\times 0.7$ and $\times 0.6$, respectively, central Crimea, Sary-Su River, *boissieri* Zone, collection of V.V. Drushchits; (b) specimen no. 2/13146, magnification $\times 0.6$, Chatyr-Dag, Tas-Kor Ravine, *boissieri* Zone, collection of N.I. Lysenko.

(*Subthurmannia boissieri*: Hoedemaeker, 1982, Plate 4, fig. 4; *Fauriella gallica*: Tavera, 1985, p. 287, Plate 43, figs. 6, 7, fig. 22/F; *Fauriella* gr. *simplicicostata*: Tavera, 1985, p. 289, Plate 43, fig. 8; *Subthurmannia* cf. *boissieri*: Houša, Vašiček, 2004, p. 14, Plate 2, fig. 9.

Shape: large discoid semi-evolute shell having wide sides: flattened lateral and slightly convex ventral ones. Intermediate and adult volutes are oval-rectangular in cross sections, elongated along height (figs. 3a, 3b). Wide umbilicus has steep walls.

Sculpture. Sculpturing is visible in intermediate and adult whorls. Lateral sides of intermediate whorls ($D = 60$ mm) are decorated with fine straight ribs taking origin at the umbilical wall. Ribs are of diverse morphology: solitary and double, branching away from umbilicus (one of the branches then bifurcates above the whorl's middle) or double bifurcating above the whorl's middle. Approximately 60 ribs are counted on the whorl 60 mm in diameter. Near termination of penultimate whorl ($H = 26$ – 28 mm), there appear tubercles at the umbilicus, the initial points of bifurcating ribs. Solitary ribs take origin at the umbilicus without tubercles. About 35 tubercles are counted near umbilicus on the adult whorl, $D = 135$ mm. Initial tubercles are small, hardly distinguishable on ribs, but at the last whorl end, they are 2–3 mm high, round and aculeiform. Sculpturing of whorls is uniform in general, but on the last whorl, there are the inset ribs taking origin between the main rib fascicles above the middle of the whorl. In addition, the ribs are slightly sinuous in configuration and somewhat smoothed in the middle of the whorl.

Being slightly inclined anteriorly, the ribs cross ventral side without breaks.

Specimen no.	D	H	W	D_u	H/D	W/D	D_u/D
1/13146	135	50	37	50	0.37	0.27	0.37

Lobe line is studied fragmentarily (Fig. 3c). It is highly dissected, with a deep lateral lobe.

Comparison. In distinction from close species *Fauriella rarefurcata* (Pictet), rib fascicles of the described shell are more frequent. As compared to *F. shipkovensis* (Nikolov et Mandov), ribs of the shell are closer spaced and finer.

Distribution: Berriasian (*boissieri* Zone) of the Crimea, Caucasus, Poland, Bulgaria, Czechia, France, the Alps, Algeria, Tunis, Madagascar, and Himalayas; Berriasian (*boissieri* Zone)–lower Valanginian (*pertransiens* Zone) of Spain; Berriasian (*boissieri* Zone)–lower Valanginian (*otopeta* Zone) of the Atlas Mountains (Morocco).

Material: 4 specimens (nos. 1/13146–4/13146) from the central Crimea (Sary-Su River, Chatyr-Dag massif) collected by V.V. Drushchits, N.I. Lysenko, and V.V. Arkad'ev.

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REFERENCES

1. R. Aguado, M. Company, and J. M. Tavera, "The Berriasian/Valanginian Boundary in the Mediterranean Region: New Data from the Caravaca and Cehegin Sections, SE Spain," *Cretaceous Res.* **21**, 1–21 (2000).
2. V. V. Arkad'ev and T. N. Bogdanova, "Genus *Berriassella* (Ammonoidea) and Ammonoid Zonation in the Berriasian of the Crimean Mountains," *Stratigr. Geol. Korrelyatsiya* **12** (4), 54–67 (2004) [*Stratigr. Geol. Correlation* **12** (4), 367–379 (2004)].
3. V. V. Arkad'ev, A. A. Atabekyan, E. Yu. Baraboshkin, et al., "Stratigraphy of Lower Cretaceous Deposits in the Mt. Bel'bek Area (Southwestern Crimea)," in *Geology of the Crimea* (NIIZK SPbGU, St. Petersburg, 2002), pp. 34–46 [in Russian].
4. V. V. Arkad'ev, T. N. Bogdanova, and S. V. Lobacheva, "New Data on Biostratigraphy of Berriasian Deposits in the Tonas River Basin (Crimean Mountains)," in *The Cretaceous System of Russia: Problems of Stratigraphy and Paleogeography*, Ed. by V. V. Arkad'ev and V. A. Prozorovskii (NIIZK SPbGU, St. Petersburg, 2005), pp. 111–135 [in Russian].
5. S. Arnould-Saget, "Les ammonites pyriteuses du Tithonique supérieur et du Berriasien de Tunisie centrale,"

- Ann. Min. Geol. Publ. Serv. Geol. Tunisie, No. 10, 1–132 (1953).
6. *Atlas of Cretaceous Fauna from Southwestern Crimea*, Ed. by V. V. Arkad'ev and T. N. Bogdanova (SPGGI, St. Petersburg, 1997) [in Russian].
 7. E. Yu. Baraboshkin, "Early Cretaceous Paleogeography of the East European Platform and Its Southern Flank," in *400 Million Years of geological History of the South-eastern Europe*, Ed. by A. M. Nikishin (Geos, Moscow, 2005), pp. 201–232 [in Russian].
 8. E. Y. Baraboshkin and I. A. Mikhailova, "New and Poorly Known Valanginian Ammonites from South-West Crimea," *Bull. Inst. Roy. Sci. Natur. Belgique. Sci. Terre* **70**, 89–120 (2000).
 9. M. Benest, P. Donze, and G. Le Hégarat, "Nouvelles données paléontologiques, paléocéologiques et sédimentologiques sur le Berriasien de la région de Lamoricière (Ouled Mimoun et El Rhoraf, Monts de Tlemcen, Algérie)," *Geobios*, No. 10, Fasc. 2, 195–249 (1977).
 10. T. N. Bogdanova and V. V. Arkad'ev, "the Genus *Dalmasiceras* (Ammonoidea) from the Berriasian of the Mountainous Crimean," *Paleontol. Zh.*, No. 4, 20–26 (1999) [*Paleontol. J.* **33** (4), 354–362 (1999)].
 11. T. N. Bogdanova and I. V. Kvantaliani, "New Berriasian Ammonites from the Crimea," *Byull. Mosk. O-va Ispyt. Prir., Otd. Geol.* **58** (3), 70–83 (1983).
 12. T. N. Bogdanova, E. D. Kalacheva, and I. I. Sei, "On the *Tirnovella occitanica* Zone (Lower Cretaceous, Berriasian) in the Feodosiya Section of Eastern Crimea," *Reg. Geol. Metallogeniya*, No. 9, 27–32 (1999).
 13. T. N. Bogdanova, S. V. Lobacheva, V. A. Prozorovskii, and T. A. Favorskaya, "Subdivisions of the Berriasian Stage in the Crimean Mountains," *Vestn. Leningr. Univ., Ser. Geol.-Geogr.*, No. 6, 5–14 (1981).
 14. L. Bulot, "The Valanginian Stage," *Bull. Inst. Roy. Sci. Natur. Belgique* **66** (Supplement), 11–18 (1996).
 15. M. Collignon, *Atlas des fossils caractéristiques de Madagascar. Fasc. 8. Berriasien, Valanginien, Hauterivien, Barrémien* (Serv. Geol. Madagascar, Tananarive, 1962).
 16. M. Company, *Los ammonites del valanginiense del sector oriental de las cordilleras Béticas (SE de España). Tesis Doctoral* (Univ. Granada, Granada, 1987).
 17. N. Dimitrova, *Lower Cretaceous Cephalopods (Nautioloidea and Ammonoidea), Fossils of Bulgaria, Vol. IV* (Bulgar. Akad. Nauk, Sofia, 1967) [in Bulgarian].
 18. V. V. Drushchits and T. N. Gorbachik, "Lower Cretaceous Ammonoid and Foraminiferal Zonations for the Southern USSR," *Izv. Akad. Nauk SSSR, Ser. Geol.*, No. 12, 95–105 (1979).
 19. V. V. Drushchits and B. T. Yanin, "A New Subdivision of Lower Cretaceous Deposits in the Bel'bek River basin," *Nauchn. Dokl. Vyssh. Shkoly, Ser. Geol.-Geogr.* **1**, 172–175 (1958).
 20. V. V. Drushchits and B. T. Yanin, "Lower Cretaceous Deposits of Central Crimea," *Vestn. Mosk. Univ., Ser. Biol.*, No. 1, 115–120 (1959).
 21. M. S. Eristavi, *Correlation of Lower Cretaceous Deposits in Georgia and the Crimea* (Akad. Nauk SSSR, Moscow, 1957) [in Russian].
 22. J. Fülöp, "A Bakonyhegység alsó-kréta (Berriazi-Apti) képződményei," *Geol. Hungarica, Ser. Geol.* **13**, 1–194 (1964).
 23. A. Yu. Glushkov, "Index Species of the Berriasian Lower Zone First Found in the Crimea," *Vestn. St. Petersburg. Univ., Ser. 7 Geol. Geogr.* **1** (7), 90–93 (1997a).
 24. A. Yu. Glushkov, "Berriasellids from the Crimean Mountains and Substantiation for the General Stratigraphic Scale of the Berriasian Stage in the Crimea," *Vestn. St. Petersburg. Univ., Ser. 7 Geol. Geogr.* **2** (14), 98–99 (1997b).
 25. P. J. Hoedemaeker, "Ammonite Biostratigraphy of the Uppermost Tithonian, Berriasian and Lower Valanginian Along the Rio Argos (Caravaca, SE Spain)," *Scripta Géol.* **65**, 1–81 (1982).
 26. P. J. Hoedemaeker and L. Bulot, "Preliminary Ammonite Zonation for the Lower Cretaceous of the Mediterranean Region," *Géol. Alpine* **66**, 123–127 (1990).
 27. P. J. Hoedemaeker and P. F. Rawson, "Report on the 5th International Workshop of the Lower Cretaceous Cephalopod Team (5 September, Vienna, 2000)," *Cretaceous Res.*, No. 21, 857–860 (2000).
 28. P. J. Hoedemaeker, M. Company, M. B. Aguirre-Urreta, et al., "Ammonite Zonation for the Lower Cretaceous of the Mediterranean Region; Basis for the Stratigraphic Correlations within IGCP-Project 262," *Rev. Espanola Paleontol.* **8** (1), 117–120 (1993).
 29. P. J. Hoedemaeker, S. Reboulet, M. B. Aguirre-Urreta, et al., *Report on the 1st International Workshop of the IUGS Lower Cretaceous Ammonite Working Group, the "Kilian Group" Lyon, 11 July, 2002*, *Cretaceous Res.* **24**, 89–94 (2003).
 30. V. Houša and Z. Vašiček, "Ammonoidea of the Lower Cretaceous Deposits (Late Berriasian, Valanginian, Early Hauterivian) from Štramberk, Czech Republic," *GeoLines* **18**, 7–57 (2004).
 31. H. Immel, "Die Kreideammoniten der Nördlichen Kalkalpen," *Zitteliana* **15**, 3–163 (1987).
 32. N. G. Khimshiashvili, *Tithonian and Berriasian Ammonoids of the Caucasus* (Metsniereba, Tbilisi, 1976) [in Russian].
 33. N. G. Khimshiashvili, *Berriasellids of the Caucasus* (Metsniereba, Tbilisi, 1989) [in Russian].
 34. S. S. Kuznetsov and P. N. Shemyakin, "Stratigraphic Position of Sponge Horizon in the Southwestern Crimea," *Vestn. Leningr. Univ. Ser. Geol., Geogr.*, No. 4, 56–60 (1965).
 35. I. V. Kvantaliani and N. I. Lysenko, "To the Problem of Berriasian Zonation in the Crimea," *Soobshch. Akad. Nauk Gruz. SSR* **94** (3), 629–632 (1979).
 36. G. Le Hégarat, "Le Berriasien du Sud-East de la France" *Doc. Lab. Géol. Fac. Sci. Lyon* **43/1**, 1–309 (1973).
 37. G. Le Hégarat and J. Remane, "Tithonique supérieur et Berriasien de l'Ardeche et l'Herault. Correlation des ammonites et des calpionelles," *Geobios*, No. 1, 7–69 (1968).
 38. G. A. Lychagin, "Cretaceous System. Lower Series," in *Geology of the USSR, Vol. 8: The Crimea, Pt. 1: Geo-*

- logical Description* (Nedra, Moscow, 1969), pp. 155–178 [in Russian].
39. N. I. Lysenko, "To Stratigraphy of Tithonian–Valanginian Deposits in the Baidarskaya Depression Southern Flank, the Crimea," *Dokl. Akad. Nauk SSSR* **159** (4), 806–807 (1964).
 40. N. I. Lysenko and B. A. Vakhrushev, "On Occurrence Mode of Lower Cretaceous Deposits at the Chatyrdag Northern Slope (the Crimea)," *Izv. Akad. Nauk SSSR, Ser. Geol.*, No. 4, 148–150 (1974).
 41. S. Marek, "Infrawalanzyn Kujaw," in *Z. Badan Stratygraficzno-Paleontologicznych w Polsce, Vol. 2*, *Biul. Inst. Geol.*, No. 200, 133–236 (1967).
 42. G. Mazenot, "Les Palaeohoplitidae Tithoniques et Berriasiens du Sud-Est de la France," *Mém. Soc. Géol. France, Paris, N. Sér.* **18** (1–4), 1–303 (1939).
 43. T. G. Nikolov, "Amonitna fauna ot valanzhina v Izotch-niya Predbalkan," *Tr. Geol. Bulgar., Ser., Ser. Paleontol.*, No. 2, 143–206 (1960).
 44. T. G. Nikolov, *Les ammonites de la famille Berriasel-lidae Spath, 1922. Tithonique Supérieur–Berriasien* (Sofia, 1982).
 45. F. J. Pictet, "Études paléontologiques sur la Faune à *Ter-ebratula diphyoides* de Berrias (Ardèche)," in *Melanges Paléontologiques Vol. 1* (2) (Bale-Géneve, 1867), pp. 44–130.
 46. F. J. Pictet, "Étude provisoire des fossils de la Porte-de-France, d'Aizy et de Lémenc," in *Melanges Paléon-tologiques Vol. 4* (Bale-Géneve, 1868), pp. 207–312.
 47. P. F. Rawson, P. J. Hoedemaeker, M. B. Aguirre-Urreta, et al., "Report on the 4th International Workshop of the Lower Cretaceous Cephalopod Team (IGCP-Project 362)," *Scripta Geol.* **3** (Spec. issue), 3–13 (1999).
 48. O. Retowski, "Die tithonischen Ablagerungen von The-odosia," *Bull. Soc. Natur. Mosc. N. Sér.* **7** (2–3), 206–301 (1893).
 49. A. S. Sakharov, "Jurassic–Cretaceous Boundary Depos-its in the Northwestern Caucasus," in *Boundary Stage of Jurassic and Cretaceous Systems* (Nauka, Moscow, 1984), pp. 36–42 [in Russian].
 50. I. Sapunov, "Stratigraphy and Tectonics of a Pre-Balkan Area between Dryanovskata and Veselina Rivers," *Izv. Geol. Inst. Bulgar. Akad. Nauk* **5**, 139–174 (1957).
 51. G. Sayn, "Ammonites valangiennes du Sud-Est de la France," *Mem. Soc. Geol. France, Paléont. mém.* **15** (23), 29–66 (1907).
 52. I. G. Sazonova and N. T. Sazonov, "Comparative Stratigraphy and Fauna of Jurassic–Cretaceous Bound-ary Beds in Eastern Europe," *Tr. VNIGNI*, No. 152, 194–314 (1974).
 53. A. Stefanov, "Geologie des Vorbalkan von Elena," *Mitt. Naturwiss. Inst. Sofia* **7**, 189–224 (1934).
 54. J. M. Tavera, *Los ammonites del tithonico superior-berriasiense de la zona Subbetica (Cordilleras Beticas). Tesis Doctoral* (Univ. Granada, Granada, 1985).
 55. P. Tchoumatchenco, T. Nikolov, D. Kozhoukharov, et al., "Le Crétacé inférieur dans le Massif de l'Ouarsen-is et les Monts de Tiaret (Algérie du Nord)," *Geol. Bal-canica* **25** (2), 27–59 (1995).
 56. A. Toucas, "Étude de la faune des couches tithoniques de l'Ardèche," *Bull. Soc. Géol. France. Ser. 3* **18**, 560–630 (1890).
 57. V. Uhlig, "The Fauna of the Spiti Shales," *Palaeontol. Indica. Ser. 15* **4** (2), 133–306 (1910).
 58. Z. Vašiček and P. Faupl, "Zur Biostratigraphie der Schrambachschichten in der Reichraminger Decke (Unterkreide, oberösterreichische Kalkalpen)," *Abh. Geol. Bundesanstalt.* **56** (2), 593–624 (2000).
 59. M. G. E. Wippich, "Valanginian (Early Cretaceous) Ammonite Faunas from the Western High Atlas, Morocco, and the Recognition of Western Mediterrane-an "Standard" Zones," *Cretaceous Res.* **24**, 357–374 (2003).
 60. *Zonation of the Cretaceous System in the USSR*, Ed. by V. A. Prozorovskii (Nauka, Leningrad, 1989) [in Rus-sian].