

FIRST FIND OF *PARABELEMNOPSIS*, THE ALIEN BELEMNITE FROM THE SOUTHERN HEMISPHERE, IN THE UPPER BERRIASIAN OF CENTRAL CRIMEA

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Abstract. *In the present paper we report about the find of belemnite of the Gondwanian origin, determined as *Parabelemnopsis* cf. *patagoniensis*, in the Late Berriasian of Central Crimea. This is the first find of such type over Northern Hemisphere known so far. Its appearance is correlated with probable ammonite invasions from South America to Europe and thus indicates an episode of invasion of Austral biota to the Northern Tethyan margin.*

Key words: *belemnites, Upper Berriasian, invasion, Gondwana, Crimea*

Introduction. After breakage of Gondwana and Laurasia during the Middle-Late Jurassic belemnite assemblages at southern margin of Tethys ocean (Northern Hemisphere: Southern Europe) and at epicontinental seas of Gondwana located south to the equator (Southern Africa, Madagascar, India, South America, Antarctica, Australia) evolved relatively independently [17, 18, 33]. Some common species for Europe and Gondwanian basins still were common around the Middle/Upper Jurassic boundary (e.g. see the review in [18]: 173), while the Lower Cretaceous has no well-established common species, except for those in some old publications which are in need of revision both systematically and stratigraphically (cf. [32]). No certain belemnite invasion and/or immigration events with precise stratigraphic position were discussed so far. However, such invasion episodes may indicate important paleoceanographic and paleoclimatic events, providing keys for the far-distance correlation levels, and thus need high attention.

Geological setting. The locality is situated 1.3 km south from the southern margin of the village Petrovo (coordinates: N 44°58'10.50"; E 34°18'39.29", altitude 480 m), in Fundukly ravine (**Fig. 1A,B**). The sequence of Upper Berriasian is represented by thick sandstones members with bands of sandy limestones and their ammonite assemblages were described by V.V.Arkadiev (in [4,5]) and is figured in more details herein (**Fig. 1C**). It is also known as the topotypic locality for a single ammonite species (*Pomeliceras* (?) *funduklense* Lysenko et Arkadiev, 2007 in Arkadiev, Bogdanova et Lysenko, 2007).

The part of the sequence containing described belemnite represents Bechku suite

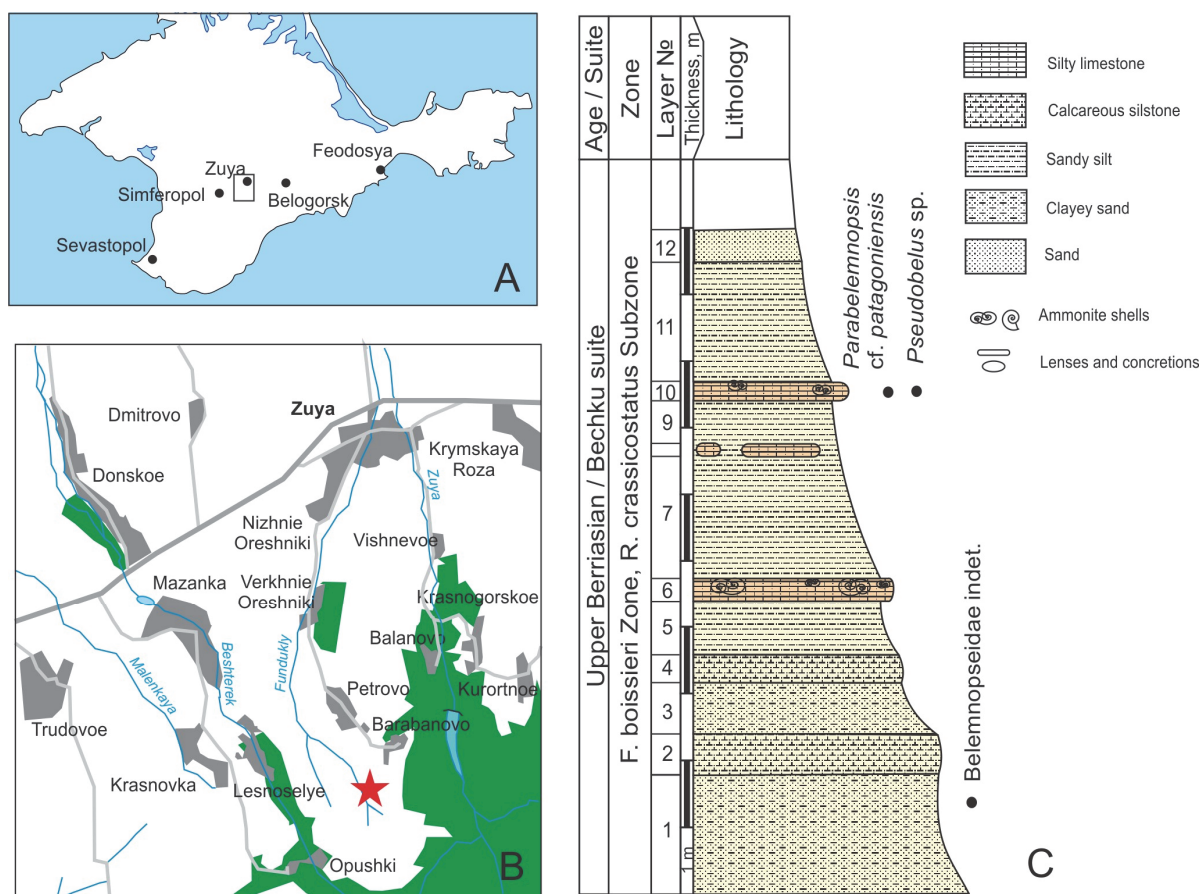


Fig. 1. Map showing the locality (A, B), which is marked with asterisk, and schematic drawing of the section (C).

and dated by the Late Berriassian *Fauriella boissieri* Zone, *Riasanites crassicosatus* Subzone [4]. *Parabelemnopsis* cf. *patagoniensis* originates from the bed 10, represented by the limestone, which is characterized by numerous ammonites *Riasanites*, solitary corals, abundant bivalve shells etc.; all the shelly fauna is overgrown by epibionts (serpulids and small oysters).

SYSTEMATIC PALEONTOLOGY

Family BELEMNOPSEIDAE Naef, 1922

The classic name *Belemnopsis* Bayle, 1878 in most publications during last 15 years was replaced by its junior synonym *Pachybelemnopsis* Riegraf, 1980 due to some formal taxonomical assumptions (see [30]). This also led to annihilation of associated family name BELEMNOPSEIDAE Naef, 1922 and replacement by its oldest junior synonym MESOHIBOLITIDAE Nerodenko, 1983. Recently Mitchell [24] has shown that taxonomical justifications for such replacement were not fully consistent and re-established the validity of both classic generic and family names. Herein we follow his suggestion.

Parabelemnopsis Howlett, 1989

1989 *Belemnopsis* (*Parabelemnopsis*) Howlett: p. 43.

Type species. *Belemnites madagascariensis* Besairie, 1930; Tithonian-Valanginian of Madagascar.

Species included. *P. madagascariensis* (Besairie, 1930); *P. patagoniensis* (Favre, 1908), *P. casterasi* (= ? "*Belemnopsis elongata*" Yin, 1975; "*Belemnopsis muricatus*" Chen, 1982), *P. regularis* (Yin, 1975), and one yet unnamed species from the Oxfordian of India and Indonesia.

Remarks. A cluster of large-sized elongated conical to subconical rostra with shallow ventral groove of common Madagascarian-South American origin was first recognized among *Belemnopsis* by Stevens ([34]: 160). Later this concept was used by Howlett [22], who established *Parabelemnopsis* as a new subgenus of *Belemnopsis*, however, this new taxon was not accepted by most belemnite taxonomists and synonymized with its parent taxon, *Belemnopsis* ([30] etc.). If one supports such "wide" concept of *Belemnopsis*, the genus will totally count ~100 species [30, 32] with huge morphological variety and spread all over the world in range from Middle Jurassic to Lower Cretaceous. From methodological point of view, splitting such "large genera" into smaller units is more productive ground for further research. Even if the demarcation between smaller genera is not completely distinct, applying different generic names tied to certain type species of different morphological types provide "growth points" for further elaboration of classification. For this reason, we support both subgeneric taxa, introduced by Howlett [22] – *Parabelemnopsis* and *Telobelemnopsis* --- as valid separate genera.

Howlett [22], who established *Belemnites madagascariensis* Besairie, 1930 as type species of his new subgenus *Belemnopsis* (*Parabelemnopsis*), included two more species into the subgenus – *P. casterasi* Besairie, 1936 from the Lower Kimmeridgian of Madagascar and and *P. patagoniensis* Favre, 1908 from the Hauterivian of Argentina.

Type specimen of *P. casterasi* differ markedly by elongation from *P. madagascariensis*, but further revision by Combémoré [15] postulated very wide intraspecific variety for both species and much extended stratigraphic ranges (Oxfordian/Kimmeridgian to Valanginian/Hauterivian for the former and Kimmeridgian–Upper Valanginian for the latter). *P. casterasi* was even expected to be a possible sexual dimorph of *P. madagascariensis* [15]. To our opinion, these two names may hide even a bush of closely related biological species waiting for their researcher.

One more poorly known species, *Belemnopsis muricatus* Chen, 1982 is definitely a member of *Parabelemnopsis* and probably a synonym of *P. casterasi* Besairie, 1936; but it is reported from Gyabula Formation in Tibet, which could mean Berriasian or younger age [23], while *P. casterasi* type material is Kimmeridgian, therefore, confirmation of synonymy needs new data on both species.

There is at least one find from the Oxfordian of Misool Island (Indonesia), described as "*Hibolithes longiscissus* Stolley, 1935" (see [11]: pl. 16, fig. 3,4, later re-figured in [12, 13], which belongs to the same group of species and should be described as a new species. It is also known from the Indian Oxfordian (Ippolitov & Desai, unpublished data).

All this extends the distribution of the genus *Parabelemnopsis* to the Indo-Pacific region and stratigraphic range to the Oxfordian.

Parabelemnopsis cf. *patagoniensis* (F. Favre, 1908)

Fig. 2a-d

cf. *1908 *Belemnopsis patagoniensis* sp. nov. Favre, s. 640, taf. XXXVII, fig. 6,7 [=lectotype, designated by Riccardi, 1977].

(?) cf. 1921 *Belemnites (Belemnopsis) patagonensis* [sic!] (Favre): Bonarelli & Nágera, p. 16-17, fig. 2.

non 1937 *Belemnites (Belemnopsis) patagoniensis* Favre: Feruglio, pp. 81-83, tav. X, fig. 1-4.

cf. 1977 *Belemnopsis patagoniensis* (Favre): Riccardi, p. 243-344, fig. 6a-i, g-i.

cf. 1977 *Belemnopsis* cf. *madagascariensis* (Besairie): Riccardi, p. 244-245, fig. 6d-f, j-l.

(?) cf. 1985 *Belemnopsis madagascariensis* (Besairie): Aguirre Urreta & Suarez, p. 1.9-1.12, pl. 1, figs. a-y.

cf. 1988 *Belemnopsis patagoniensis* Favre: Riccardi, pl. 9, figs. 5-6.

cf. 1988 *Belemnopsis madagascariensis* (Besairie): Riccardi, pl. 8, fig. 5.

cf. 1988 *Belemnopsis* cf. *madagascariensis* (Besairie): Crame & Howlett, Fig. 8e,f.

cf. 1989 *Belemnopsis* cf. *madagascariensis* (Besairie): Doyle & Howlett, text-fig. 1c [the same specimen as in Crame & Howlett, 1988].

cf. 1989 *Belemnopsis (Parabelemnopsis)* cf. *madagascariensis* (Besairie, 1930): Howlett, p. 43-44, pl. 9, fig. 3-4 [the same specimen as in Crame & Howlett, 1988].

Material. 1 fully preserved rostrum; № 01-ΦУН; Petrovo, Late Berriasian, bed 10.

Description. The only fully preserved rostrum is medium-sized and strongly elongated, with conical outline and profile in the posterior half, transforming to subconical in anterior part. Apical part is not clearly defined, apex is pointed. Cross-section is laterally compressed anteriorly, becoming rounded and even slightly depressed posteriorly. In alveolar region ventral side is wider, than dorsal and cross-section is egg-like. Ventral furrow is narrow. It runs adorally over a half of postalveolar part, then shallowing away posteriorly. No lateral lines can be observed. Apical line is ortholineate, as this can be judged from the central position of the protoconch.

Dimensions (mm), abbreviations after [19]. R=858; PA=61.6 (689%); DV=8.94 (100%); LL=8.47(95%); dv=5.70(100%); ll=5.75(101%).

Distribution. Tithonian (?), Berriasian-Barremian of Argentina and Antarctic peninsula.

Remarks. Among all known species of *Parabelemnopsis* the strongest affinity is observed to the South American Lower Cretaceous material. Unfortunately, the type series of *P. patagoniensis*, including the only figured specimen designated as lectotype by Riccardi ([27]: 243) is represented by fragments only. The type material is reported from the Lower Hauterivian of Argentina and associated with specimens determined as “*madagascariensis*” (see [28]), but having evidently more conical shape and more acute apex, than any topotypic specimens. However, in the same interval there are specimens which are much closer to Madagaskarian material and characterized by blunt apex. Riccardi [27] discussed the difference between two species – according to his opinion, *P. madagascariensis* is characterized by shorter rostrum with deeper and broader ventral groove. The second criteria is not fully reliable, as large ventrally grooved belemnites often show significant variety in this feature, but the first one looks true. Following this criteria, the only fully preserved rostrum of “*B. madagascariensis*” (figured in [28]) coming from type horizon should be re-determined as *P. patagoniensis*. To conclude, to the moment there are no evident specimens of typical *P. madagascariensis* known from Antarctica and Argentina so far. Some of

Fig. 2. *Parabelemnopsis* cf. *patagoniensis* (F. Favre, 1908): a—outline, ventral; b—left profile; c—cross-section in the apical part; d—cross-section in the alveolar part near protoconch. Black cross denotes the position of the protoconch.



described *P. madagascariensis* specimens belong not to *P. patagonensis*, but to other species and even genera.

All Feruglio's [21] specimens from the Tithonian, referred as *P. patagoniensis* do not belong to this species. The specimen on his fig.1 has too wide furrow, running over the whole rostrum and should be definitely reclassified. Specimens on fig. 2-4 have much shorter rostra and partly were reclassified into other species [22]. However, Bonarelli & Nagera's [10] fragment from the Tithonian and especially Riccardi's [27] fragments from the Berriasian may really belong to the species.

The only Crimean find is a rostrum of a young specimen, and is smaller than any known mature *Parabelemnopsis* species. This makes some restrictions for comparison and together with poorly

studied intraspecific variability of all the species, make us leave the determination in open nomenclature.

Discussion. Members of the genus *Parabelemnopsis* are probably not subtropical warm-water Tethyan elements, but true Austral species more or less analogous by biogeographic position to Boreal biota in Northern Hemisphere ([34]: 160). They are unknown along the northern margin of Tethys (Africa, Arabia), but are common at Madagascar, in South America and Antarctic peninsula; some few are known from Indo-Pacific region, along southern Tethyan margin (see above) and were never reported from Europe, including Crimea. The collection of the first author (A.I.), covering several hundreds of belemnites from the Berriasian, has no other finds of the genus, indicating that the find is more or less occasional. All this indicates that the find of *Parabelemnopsis* in Crimea is more likely a result of some short invasion episode rather than large total distribution over some time period.

Faunal exchange with Gondwanian biota for the Berriasian of Crimea is reflected not only in belemnites, but ammonites as well. First, there is a number of cross-Tethyan taxa known along both southern (Northern Africa, Arabia, Pakistan, Himalaya) and northern Tethyan margins, which are relatively common for Crimea (*Malbosiceras*, *Pomeliceras*, *Himalayites*, *Negrelliceras*, *Spiticeras*: see [5] for the full review), among them some species are not yet recorded from Southern Europe, but well-known from Indo-Himalayan region (like *Negrelliceras mirum*, *Spiticeras subspitiense*, *S. obliquelobatum*). Second, there are several records of ammonite *Substeueroceras* [3]

in Central Crimea, a genus widely spread in South and North Americas and only rarely met in Europe and along northern and Southern and Northern Tethyan margins. Despite stratigraphic position of *Substeueroceras* finds is not estimated, most probably they originate from the Tirnovella occitanica Zone, and therefore are a little bit more ancient than our *Parabelemnopsis* find.

To conclude, two main routes for Gondwana-Crimean faunal exchange were possible this time: one along Southern Tethyan margin from Indo-Himalaya region and another from South America via Caribbean region. At Late Jurassic – Earliest Cretaceous *Parabelemnopsis* existed both in South America (*P. patagoniensis*) and at Southern Tethyan margin (Tibet: “*Belemnopsis elongata*” Yin, 1975 and *P. regularis* (Yin, 1975)). The exchange between these two areas was easy because of existing trans-Gondwanian seaway this time [18]. However, belemnite complexes from Tibet (e.g. see [14]) definitely do not contain rostra similar in morphology to our find, therefore most probably *Parabelemnopsis* cf. *patagoniensis* came to Crimea by the second route. This assumption is supported by close morphological similarity with South American and Antarctic specimens rather than with Madagascarian-Tibetan ones (see above). However, relatively poor state of knowledge on belemnite biotas in all studied regions leaves some points for further discussion.

Conclusions. The belemnite invasion from Gondwana recorded from the Upper Berriasian of Crimea is the first record of such type all around Europe. The appearance of *Parabelemnopsis* cf. *patagoniensis* is roughly coeval with finds of ammonites of American origin (*Substeueroceras*) in the same geographic district, indicating that time cephalopod migrations from South America to European region were relatively common. Episode of appearance of biogeographically alien belemnite in Fauriella boissieri Zone still needs a comprehensive explanation from the point of paleoceanography and paleoclimatology. Potentially, further attention to the Berriasian belemnites provides opportunities for establishing interregional “datum planes”. Unfortunately, wide stratigraphic interval postulated for *P.* cf. *patagoniensis* in its home region (Tithonian? Berriassian-Barremian), the scarcity of its records and unstudied morphological variation in time do not allow to use Crimean find for any stratigraphical interpretations at the moment.

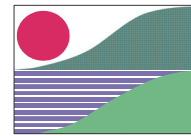
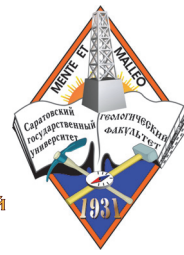
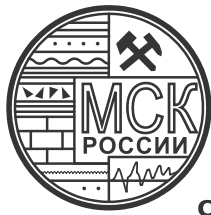
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