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On Some *Rarecostites* (Parkinsoniidae, Ammonoidea) from the Upper Bajocian *Parkinsoni* Zone of the Northern Caucasus

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Abstract—The ammonites of the genus *Rarecostites* (subfamily Parkinsoniinae) are studied from the lower part of the Upper Bajocian *Parkinsonia parkinsoni* Zone of the Kyafar River (Bolshoi Zelenchuk River Basin, Karachai-Cherkessia, Russia). The locality contains numerous microconch shells of *R. subarietis* (Wetzel). We follow de Grossouvre (1919) in considering the names *R. acris* (Wetzel) and *R. arietis* (Wetzel) to be subjective synonyms of *R. subarietis* and, thus, the standard *Acris* should be replaced by the *Subarietis* Subzone. The lower part of the section also contains numerous microconchs of *R. sherstyukovi* sp. nov. and, less commonly, macroconchs of *R. kyafarensis* sp. nov. The phylogeny of *Rarecostites* species is reconstructed; the above species are described and figured and the *sherstyukovi and subarietis* faunal horizons are established.

Keywords: Ammonoidea, Parkinsoniidae, *Rarecostites*, *Parkinsonia*, Middle Jurassic, Upper Bajocian, *Parkinsoni* Zone, Northern Caucasus

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INTRODUCTION

The ammonite family Parkinsoniidae is widespread across the entire northern Tethyan periphery and is one of the most important ammonite groups for biostratigraphic subdivision and correlation of the Upper Bajocian–Lower Bathonian of the Peri-Tethyan regions. Taxa of this family are well-studied in the northwestern Tethyan periphery, especially in Germany, England, and France. Nevertheless, thin and strongly condensed West European successions have some gaps that do not allow comprehensive reconstruction of the evolution of species and genera of this family. More complete sections containing these ammonites are known to the east, on the south of the Russian Platform, in the Caucasus and Transcaucasia, and also in Central Asia. However, the scarcity of these ammonite occurrences in these regions, their state of preservation, and insufficiently precisely established changes in associations prevented positive conclusions being drawn, especially on the phylogeny of early members of the family in the *Niortense–Acris* interval.

In 2014–2016, I undertook joint field excursion to the Northern Caucasus, Bolshoi Zelenchuk River Basin (tributary of the Kuban River, Zelenchukskii District of Karachai-Cherkessia). We focused on the Middle Jurassic beds, mainly the middle part of the Upper Bajocian, corresponding to the lower subzone of the *Parkinsoni* Zone of the standard scale, in several localities on the Kyafar River. We collected over 200 *Parkinsonia* (sensu lato) specimens from this interval. The collection was supplemented by material collected by amateur paleontologist M.P. Sherstyukov (Stavropol, Russia). Some results of this study are discussed below.

STRATIGRAPHY

The Late Bajocian–Early Bathonian deposits in the Kuban River Basin are assigned to the Upper Djangura Member (Besnosov, 1967) and represented by siliciclastic, mainly argillaceous deposits and crop out in several interrupted exposures on both banks of the Kyafar River from the village of Storozhevaya and, downstream, overlying the lithologically similar Lower Djangura Member (Lower Bajocian) (Fig. 1).

The upper part of the Djangura Formation in the Bolshoi Zelenchuk River Basin are eroded and are overlain by Quaternary deposits, less commonly, by Callovian and Upper Jurassic carbonates. The thickness of the Upper Djangura Member in some outcrops varies from 1 to 30 m. Beds dip NNE at 5°–7°, which helps to examine the sections exposed on steep slopes on river bends with rapid current.

The dark gray strongly arenaceous clays with layers of siltstone and scattered as ferruginous–carbonate concretions in the vicinity of the village of Storozhevaya are assigned to the *Niortense* Zone of the standard scale. Downstream, they are gradually replaced by gray argillite-like clay of the *Garantiana* Zone, with

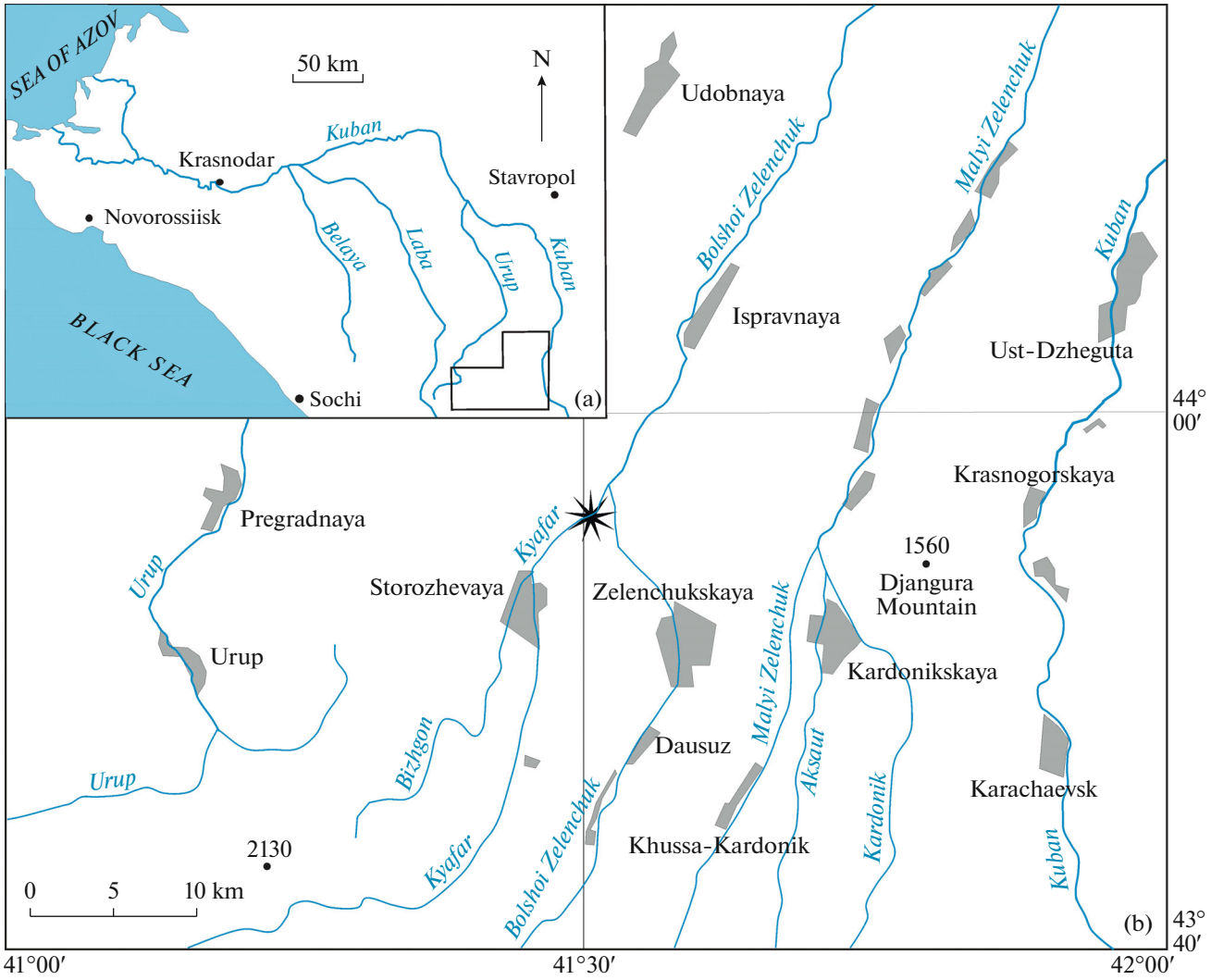


Fig. 1. Geographical position of localities nos. 1–4: (a) general map and (b) the square shows the contour of the detailed map.

layers and scattered siderite concretions, and, further, by dark gray argillite of the lower part of the *Parkinsoni* Zone (*Acris* [=*Subarietis*] Subzone), with layers of argillaceous limestone, and also numerous siderite concretions, both scattered in the beds and forming organized layers. The younger rocks of the *Parkinsoni* Zone, most likely belonging to the *Truellei* Subzone, are exposed much further downstream and represented by gray argillite-like clay with numerous concretions. Further exposures of the Djangura Formation are known downstream of the mouth of the Kyafar River, on the right bank of the Bolshoi Zelenchuk River and belong to the Lower Bathonian, lower part of the *Zigzag* Zone of the standard scale (Mitta and Sherstyukov, 2014; Mitta, 2015).

Researchers studying the Jurassic of the Northern Caucasus mainly use the West European zones for ammonites, although often in this region, the index species of units of the standard scale, and the zonal assemblages contain endemic taxa. At the same time, West European biostratigraphic subdivisions are relatively easily recognizable by the assemblage of species at the zonal and subzonal level. These biostrata include the *Subarietis* Subzone characterized on the Kyafar River by the oligotaxon assemblage of Parkinsoniinae, intermediate from the genus *Caumonisphinctes* to the genus *Parkinsonia* s. str. The entire interval of the subzone contains uncommon *Spirocera*s spp. (Mitta, 2017) and transit species of the suborders Phylloceratina (*Holcophylloceras*, *Calliphylloceras*, *Adabofoloceras*, *Pseudophylloceras*) and Lytoceratina (*Dinolytoceras*, and *Nannolytoceras*). In addition, Sherstyukov donated a few shells of *Lissoceras haugi* Sturani [M] (Mitta and Sherstyukov, 2014, pl. 3, fig. 3) and *Paragarantiana* ? ex gr. *platyrrimma* (Buckman) [m][1];

[1] The assignment of *Garantiana* shells from the *platyrrymma* group to macroconchs (Chandler et al., 2001), is apparently erroneous. These relatively small-sized ammonites have strongly evolute, not strongly inflated whorls, and are most likely microconchs.

the precise level of this ammonite occurrence ins unknown.

We studied the *Subarietis* Subzone in five successive exposures of various thicknesses on the right bank of the Kyafar River separated by intervals covered by landslides of Quaternary shingle beds, most likely obscuring tectonic faults (Fig. 2). Localities 1a and 1b and 2 and 3, respectively, can reliably be correlated by characteristic lithologies. Observational gaps between sections 1b and 2 and between sections 3 and 4 (without taking into account possible tectonic faults) can be up to 10 m. Taking into account the extension of the outcrops (around 650 m along a straight line) and the dip of the beds, the thickness of the *Subarietis* Subzone is at least 40 m. As mentioned above, this part of the Djangura Formation is represented by dark gray argillites with interbeds of argillaceous limestone (0.1–0.4 m thick), with interlayers and scattered ferruginous–carbonate concretions (5–10 cm across). The concretions often contain ammonites usually represented by casts, less commonly, with a partly preserved shell. Completely crushed argillaceous ammonite shells are also found in argillites outside the concretions. Belemnite rostra are far less common, whereas bivalve shells are extremely rare and usually preserved in the body chambers of ammonites (macroconchs).

MATERIAL

Ammonites in localities 1–4 are represented by both phragmocones and shells with partly or completely preserved body chambers. Most shells in the collections studied are microconchs, whereas macroconchs constitute less than 10% of the total number of shells. A considerable number of microconchs have features of adult shells—approximated last septa, a completely formed aperture with lateral lappets (Figs. 3a, 3b), and a partly uncoiled terminal whorl. Subadult specimens with short lappets and an initial stage of septal approximation are also common. In many specimens, a region of the shell toward the end of the phragmocone–beginning of the body chamber is absent or damaged. These "bitten" shells are probably results of deadly injuries inflicted by predators. There are also shells with healed injuries, especially common among macroconchs.

Two groups are clearly recognized among the microconchs. The first group includes shells reaching maturity at D = 50–60 mm, with a very short body chamber (ca. 0.5 whorls) and a ribbing coefficient of 1.3–1.6. Representatives of this group are mainly found in locality 4 and most commonly in the upper third of this outcrop.[2] They are much less common in locality 3, in the lower third. This species is described below as *Rarecostites sherstyukovi* [m], sp. nov. The second group is composed of shells reaching maturity at D = 70–100 mm, with a body chamber of about 0.6 of whorl, with a higher ribbing coefficient (1.65–1.85), often with nodes at the bifurcation point of the ribs on the phragmocone. The first, still uncommon members of this group appear at the top of outcrop 4 and occur further in all other localities gradually increasing in size and number. Wetzel (1911) comprehensively characterized the intraspecific variability for this group and proposed three new species names for its members: *Parkinsonia arietis*, *P. subarietis*, and *P. acris*. This species is redescribed below as *Rarecostites subarietis* (Wetzel) [m].

Macroconchs are mainly represented by immature specimens. Only a few specimens can be considered to be adult. Almost all macroconchs have lifetime injuries of various severities. Macroconchs are also often injured ("bitten") at the end of the phragmocone–beginning of the body chamber, which does not allow the presence of the terminal approximation of septa to be determined. The apertural region of the macroconchs is usually deformed–pushed in the ventrolateral area. Sometimes, concretions contain small fragments of body chambers with a preserved (simple) apertural margin (Fig. 3c). Although the finds of macroconchs are scanty, a new species can be established, which is described below as *R. kyafarensis* [M], sp. nov.

The collection also contains shells differing from the three above species. Additional collecting and study are needed for their positive identification

The material studied is housed in the Borissiak Paleontological Institute of the Russian Academy of Sciences (PIN, collection no. 5546) and British Geological Survey (GSM).

DISCUSSION

The family Parkinsoniidae Buckman, 1920 existing in the Late Bajocian–Early Bathonian includes two subfamilies, Parkinsoniinae Buckman, 1920 and Pseudocosmoceratinae Sazonov, 1960. The second family includes *Pseudocosmoceras* Murashkin, 1930 (the name *Medvediceras* Nikolaeva, 1967 is a junior subjective synonym of this generic name, see Mitta, 2009) and *Sokurella* Mitta, 2004. The relationships between these taxa and their relationships with other Parkinsoniidae are uncertain.

The nominal subfamily includes the macroconchs *Caumontisphinctes* Buckman, 1920 and microconchs *Infraparkinsonia* Westermann, 1956, forming a universally accepted dimorphic pair in the *Niortense* Chronozone (Dietl, 1980; etc.), and their descendants in the *Parkinsoni* and *Zigzag* zones – a dimorphic genus *Parkinsonia* Bayle, 1878. Until recently, *Durotrigensia* Buckman, 1928 for the Late Bajocian *Parkinsonia* and *Gonolkites* Buckman, 1925 for the Early Bathonian were considered as macroconchs of *Parkinsonia*. However, the absence of distinctions in the inner whorls allowed the synonymy of *Parkinsonia*

[2] Basal parts of the localities were covered with talus and needed considerable clearing and, hence, were only partially studied.

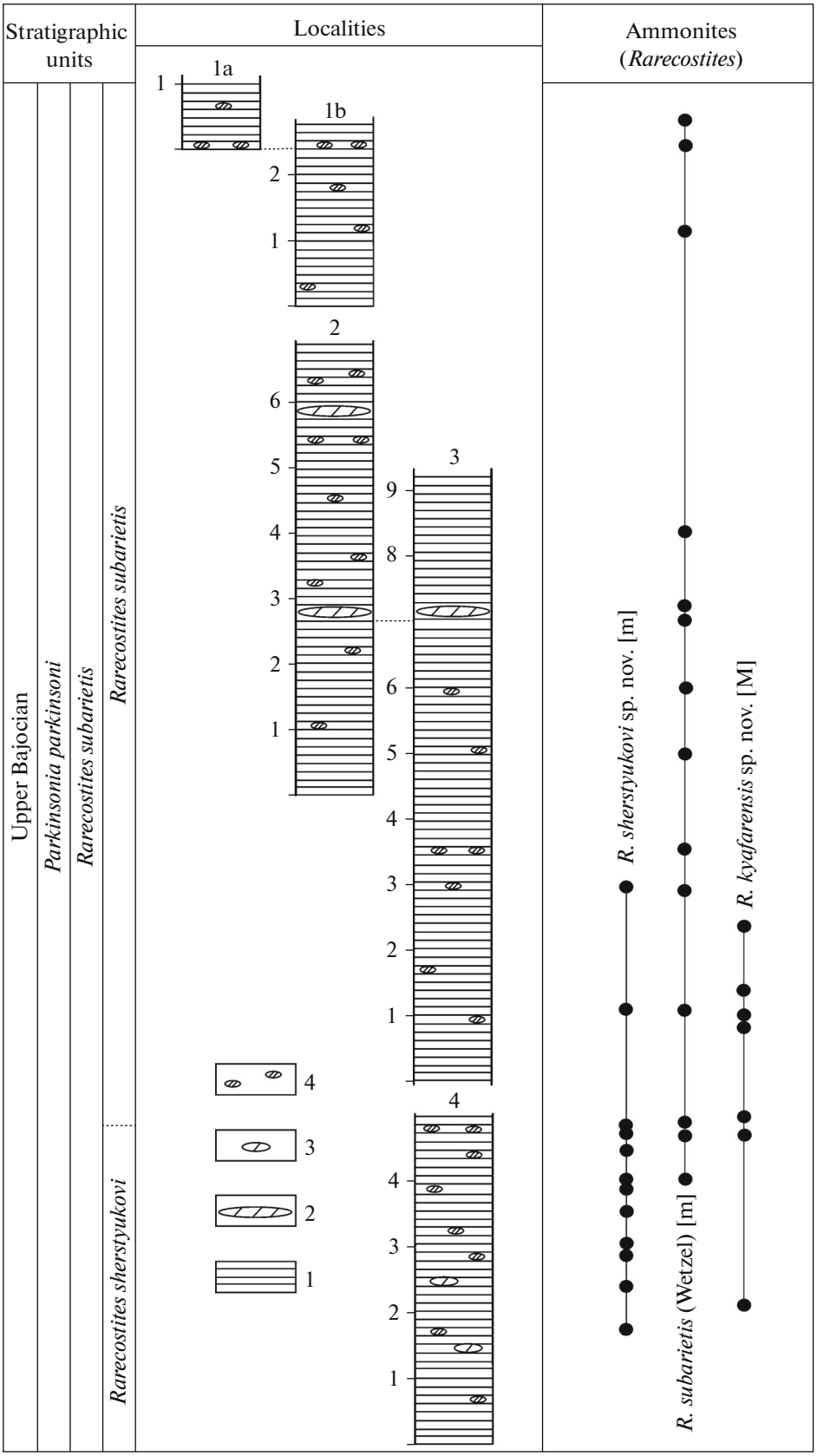


Fig. 2. Sections of the lower part of the *Parkinsonia parkinsoni* Zone on the Kyafar River; their correlation, and occurrences of ammonites of the genus *Rarecostites*. Explanations: (1) argillite, (2, 3) limestone beds and lenses, (4) concretions.

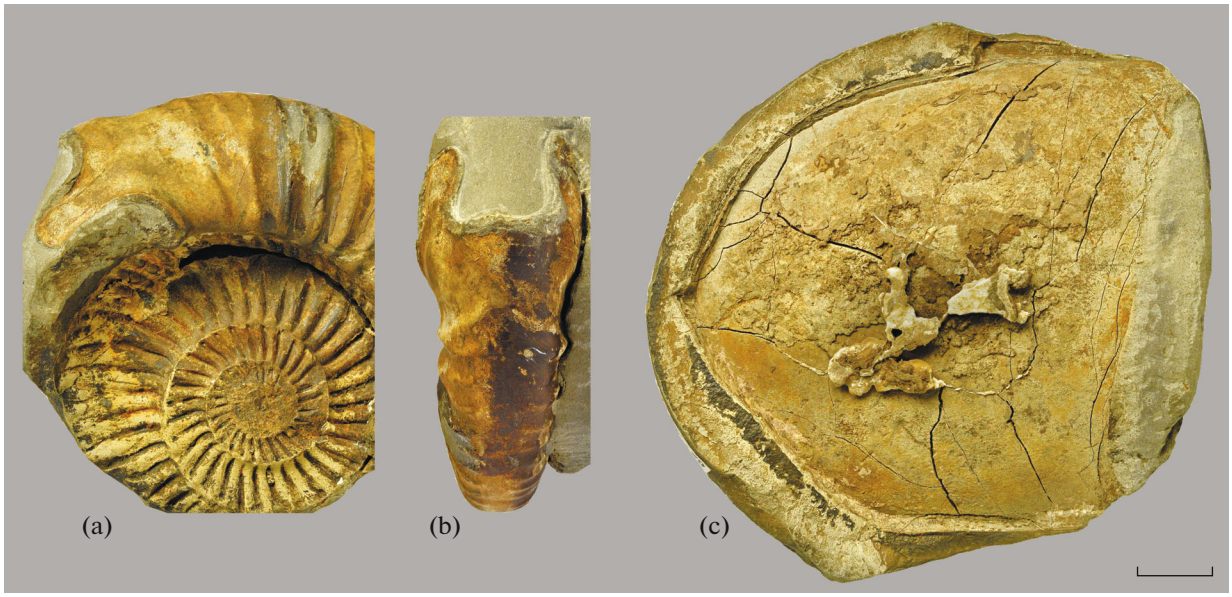


Fig. 3. Apertural parts of microconchs and macroconchs of the genus *Rarecostites*: (a, b) *R. subarietis* (Wetzel) [m], specimen PIN, no. 5546/61: (a) lateral and (b) ventral views; (c) *Rarecostites* sp. [M], specimen PIN, no. 5546/179, lateral view; locality 4, upper part of the section. Scale bar here and below, 10 mm.

over *Durotrigensia* (Besnosov and Kutuzova, 1982; Besnosov and Mitta, 1993) and, later over *Gonolkites* (Dietze and Dietl, 2006). Parkinsoniinae usually also include the genus *Oraniceras* Flamand, 1911, the origin and phylogeny of which among parkinsoniids is so far not established.

The dimorphic genus *Rarecostites*, with the type species *Cosmoceras parkinsoni* var. *rarecostatum* Buckman, 1881 [=*Parkinsonia orbignyana* Wetzel, 1911; =*Parkinsonia rarecostata* Buckman, 1922], was proposed by Besnosov and Kutuzova (1982) for the earliest parkinsoniines, except for the dimorphic pair *Caumontisphinctes* [M]/*Infraparkinsonia* [m]. This genus has not been widely accepted; authors simply noted it, but continued to assign species of this genus to *Parkinsonia* (Schlegelmilch, 1985, p. 93; Dietze, 2000, p. 14; Schweigert et al., 2002, p. 10).

According to Besnosov's later comments, the genus *Rarecostites* mainly includes species with a medium-sized shell, with a rounded, oval compressed, oval trapezoid, and oval rectangular cross section, embracing the preceding whorl for less than one-third of its height. The ventral groove developed on the phragmocone can be modified on the body chamber into a smooth band. The ribs on the phragmocones and body chambers of small-sized specimens are sharp, mainly bipartite, less commonly simple and intercalate; the rib branches approach the ventral groove at an acute angle, alternating on either side. The ribbing coefficient is less than 2. Angular nodes can be developed at the bifurcation points. This genus is distinguished from the ancestral genus *Caumontisphinctes* Buckman by the larger shell with more strongly embracing whorls, the less pronounced dimorphism, and the predominance of bipartite ribs. It differs from *Parkinsonia* Bayle, to which some of its species were previously assigned, by the less embracing whorls, clearly pronounced dimorphism, lower ribbing coefficient, and on average smaller size (Besnosov and Mitta, 1993, pp. 176–177).

When established, the genus included seven species: *R. rarecostatus* (Buckman), *R. praearietis* (Roché), *R. interruptus* (Bruguière), *R. arietis* (Wetzel), *R. donezianus* (Borissjak), *R. harmonulatus* (Khudjaev), and *R. subharmonulatus* (Khudjaev). Later, Besnosov (Besnosov and Mitta, 1993) also included *R. radiatus* (Renz), *R. acris* (Wetzel), *R. oglanlensis* (Amanniazov), *R. wetzeli* (Schmidtill et Krumbeck), *R. tenuicostatus* Besnosov, and *R.* (?) *mutabilis* (Nicolesco) in this genus. Some species, previously assigned to *Parkinsonia* (*P. orbignyana* Wetzel, *P. arietis* Wetzel, *P. subarietis* Wetzel, *P. kharmonulata* Khudjaev, *P. bigoti* Nicolesco, *P. praearietis* Roché, *P. kugitangensis* Amanniazov), were considered to be junior synonyms of other *Rarecostites* species.

The first description of the genus *Rarecostites* (and later taxonomic revision) has an obvious lack of clear understanding of its dimorphic nature, as all the above species, apart from the tentatively assigned *R. mutabilis* and its junior synonym *R. kugitangensis*, were based on microconchs. Despite the considerable geographic range of Besnosov's material of this species (Caucasus, Turkmenistan, Uzbekistan), it is based on a small number of specimens from different localities. Taking into account infrequency of finds of well-preserved adult specimens, it becomes clear why the *Rarecostites* macroconchs all belong to the same species.

Adult shells of parkinsoniid macroconchs, apart from the aperture shape and body chamber length, are different from microconchs in their size (several times larger) and smoothened ornamentation on the body chamber. The inner whorls of the phragmocones of macro- and microconchs of similar sizes are not very different. However, shells of the young immature macroconchs with preserved body chambers remained virtually unstudied and were occasionally erroneously identified as microconchs.

In the process of examination of the material from the Kyafar River, I came to the conclusion that early members of *Parkinsonia* s. l. are essentially different from *Parkinsonia* s. str. and the genus *Rarecostites* can be used as an intermediate link between *Caumontisphinctes* / *Infraparkinsonia* and the later *Parkinsonia* s. str. Below I list species that can be assigned to *Rarecostites*, with brief comments.

R. rarecostatus (Buckman, 1881) [m]. The complicated history of the type material of this species, with an erroneous designation of "holotypes," is generally correctly explained by Dietze (2000, p. 13). However, Rostovtsev (1985, p. 159), who proposed a lectotype from one of Buckman's syntypes, gave erroneous references (Buckman, 1922, pl. 370, figs. 1, 2). Hence, the lectotype (Buckman, 1922, pl. 352) was selected by Besnosov (Besnosov and Mitta, 1993, p. 180). The photographs of this specimen, kindly taken by Simon Harris (British Geological Survey, Keyworth, UK) are shown in Figs. 4e–4g.

R. interruptus (Bruguière, 1789) [m]. Besnosov correctly noted that Bruguière's figure reproduced by Buckman (1922, pl. 337) as a holotype, in fact shows an "unidentifiable whorl fragment" (Besnosov and Mitta, 1993, p. 183). However, the lectotype designation (Besnosov and Mitta, 1993, p. 182) of a specimen from Buckman's collection (Buckman, 1922, pl. 337A) which is not part of the type series, was incorrect and invalid. Hence, the name *interrupta* is a nomen dubium, while the "lectotype" (Figs. 4a–4d, photographs also by Simon Harris (BGS, Keyworth, UK), in the shell shape and ornamentation should be assigned to *R. rarecostatus* (Buckman), and is a topotype of this species.

R. radiatus (Renz, 1904) [m]. Dietze (2000, p. 6) showed that the species is based on a juvenile, which precludes exact determination, and, hence, this name is a nomen dubium.

R. donezianus (Borissjak, 1908) [m]. Besnosov's (Besnosov, 1990, p. 126; Besnosov and Mitta, 1993, p. 181) statement that Wetzel (1911) designated a lectotype for *Parkinsonia doneziana* is erroneous (this mistake was repeated in another paper: Mitta et al., 2004, p. 18). Wetzel only indicated that the species name under discussion is best applied to the specimen figured in Plate XIV[3], fig. 2. This action is not a valid lectotype designation. Hence, all specimens of *Parkinsonia doneziana* remain syntypes; they mostly belong to *Rarecostites* (Borissiak, 1908, pl. 4, figs. 3–6, microconchs, pl. 7, fig. 1, macroconchs). The juvenile specimen (Borissiak, 1908, pl. 4, fig. 1) is unidentifiable; a small shell with a preserved aperture and lappet (pl. 4, fig. 2) was correctly assigned by Besnosov to *Caumontisphinctes* (*Infraparkinsonia*). Thus, the name *Parkinsonia doneziana* Borissjak is also valid in relation to *Rarecostites*.

R. subarietis (Wetzel, 1911) [m]. Under this name I unite three species (*Parkinsonia arietis*, *P. subarietis*, and *P. acris*) described as new by Wetzel in the same paper from one locality and in this order. My material shows that all these forms are merely aberrations of the same species. My conclusion is indirectly supported by a recent paper of Dietze (2000) where the author finds it difficult to separate these species, and most relatively well-preserved ammonites are identified in open nomenclature. In addition, many authors previously united these three species under various names, e.g., Nicolesco (1928), who used the name *Parkinsonia subarietis* var. *acris*.

The name *R. arietis*, as first described, has priority over the others. However, Wetzel (1911, pl. 13, fig. 17) figured a single incomplete specimen in lateral view and did not designate a type specimen.

Schlegelmilch's (1985, p. 93) citation of the specimen figured by Quenstedt (1887, pl. 71, fig. 20) as the holotype of *Am. Parkinsoni planulatus* is likely to be a mistake (in contrast to the style usually followed in that paper, Schlegelmilch did not indicate it as the holotype in the explanation of plates, which he did for other holotypes).

The species *R. acris* is described better as *R. arietis;* hence, here we only figure the holotype (Wetzel, 1911, pl. 15, fig. 3, lateral view); and three paratypes, two of which agree with the diagnosis of the previously described *R. subarietis*, and the third is represented by a juvenile. The holotype is represented by an incomplete (and immature?) involute shell, regarded with some doubt as a microconch.

The species *R. subarietis* is described and figured more comprehensively compared to the above species. The holotype[4] is designated (Wetzel, 1911, pl. 13, figs. 18, 19), represented by a phragmocone, but with all diagnostic characters. Most paratypes (pl. 14, figs. 1–5; pl. 15, figs. 1, 2) are also easily identifiable. There are specimens with lappets and even with an aptychus in the body chamber. Only paratypes in pl. 14, fig. 6 (young specimen) and fig. 7 (body chamber) are macroconchs, probably representing a dimor-

[3] Wetzel's citation of the plate no. is incorrect; the correct number is IV.

[4] Wetzel's indication of "types" ("Typus") can be interpreted differently: as an indication of a typical specimen or a type designation. Considering that Wetzel never indicated more than one "type" for the same species, it is assumed that these were type designations (holotype designation). Wetzel definitely designated the type for *R. subarietis*.

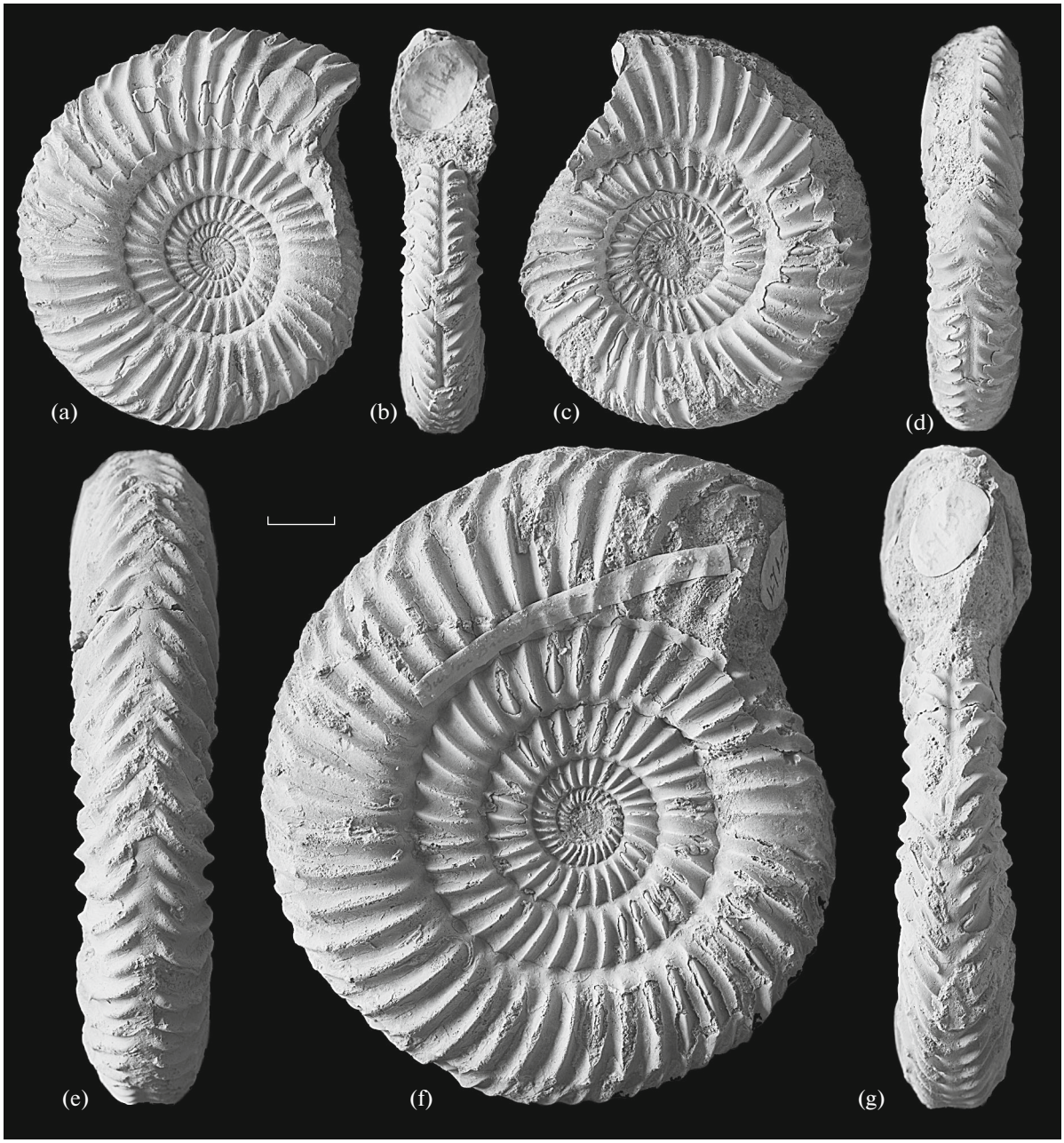


Fig. 4. *Rarecostites rarecostatus* (Buckman) [m], England, Dorset; *Astarte* Bed (upper part of the *Acris* [=*Subarietis*] Subzone, *rarecostatus* Horizon): (a–d) specimen GSM, no. 47142 [=*Parkinsonia interrupta* Bruguière *sensu* Buckman, 1923, pl. 337A], topotype, phragmocone: (a, c) lateral, (b) apertural, and (d) ventral views; (e–g) lectotype GSM, no. 47152 [=Buckman, 1922, pl. 352], phragmocone with a body chamber fragment: (e) ventral, (f) lateral, and (g) apertural views.

phic pair with the microconchs (based on a holotype) of *subarietis.*

Thus, it appears most reasonable to retain the name *subarietis* for this "group of species," as already suggested by de Grossouvre (1919) under the First Reviser Principle.

R. arietis (Wetzel, 1911) [m]. A subjective synonym of *R. subarietis* (Wetzel, 1911), see above.

R. acris (Wetzel, 1911) [m]. A subjective synonym of *R. subarietis* (Wetzel, 1911), see above.

R. orbignyanus (Wetzel, 1911) [m]. An objective synonym of *R. rarecostatus* (Buckman, 1881).

R. schlippei (Rollier, 1912) [m]. A junior subjective synonym of *R. subarietis* (Wetzel, 1911).

R. typus (Buckman, 1928) [m]. A junior subjective synonym of *R. subarietis* (Wetzel, 1911).

R. wetzeli (Schmidtill et Krumbeck, 1931) [m].

R. praearietis (Roché, 1939) [m]. See a description of *R. subarietis* below.

R. oglanlensis (Amanniazov, 1972) [m].

R. tschaloiensis (Amanniazov, 1972) [m].

R. tenuicostatus Besnosov, 1993 [m]. We agree with Schweigert et al.'s (2002, p. 10) opinion that the holotype of this species, based on its characters, belongs to the genus *Caumontisphinctes* and is a macroconch.

R. transitorius (Schweigert et al., 2002) [m].

R. sherstyukovi sp. nov. [m].

R. dorsetensis (Wright, 1856) [M].

R. mutabilis (Nicolesco, 1928) [M].

R. kugitangensis (Amanniazov, 1972) [M].

R. bradstockensis (Dietze, 2000) [M].

R. opiensis (Schweigert et al., 2002) [M].

R. kyafarensis sp. nov. [M].

The genus includes other taxa, apart from those listed above (and their synonyms). The genus very probably includes some other species: *R. radiatus* (sensu Renz 1913 non 1904), *R. subharmonulatus* (Khudjaev 1927), *R. gracilis* (Wetzel, 1937), etc., still poorly studied. Our microconch material from the Kyafar River clearly shows the succession *sherstyukovi* → *subarietis*; these taxa are first of all distinguished by an increase in size throughout phylogeny. Taking into account this trend and the stratigraphic distribution of the above mentioned taxa, we propose the following evolutionary succession of the main lineage of microconchs of *Rarecostites*: *sherstyukovi* sp. nov. → *subarietis* Wetzel, 1911 → *rarecostatus* Buckman, 1922 [morpha α] → *rarecostatus* sensu Chandler et al., 2001 (pl. 1, fig. 1 [morpha β]). The proposed phylogenetic lineage of macroconchs includes *kyafarensis* sp. nov. → bradstockensis Dietze, 2000 (pl. 9, 10 (only); paratype [morph α]) → *bradstockensis* Dietze, 2000 (holotype [morpha β]) → *dorsetensis* Wright, 1856.

Based on the distribution of characteristic ammonites, the following successive faunal horizons are recognized in the studied sections of the lower part of the *Parkinsoni* Zone on the Kyafar River: *scherstyukovi* (established herein) and *subarietis* (equivalent to the horizons of *subarietis* α and *subarietis* β of the Swabian Alb (Dietze, 2000). The faunal horizon of *rarecostatus* established in southern England (Callomon and Cope, 1995) is the terminal horizon for this subzone.

In the 20th century, various authors interchangeably used the names *Acris* and *Subarietis* for the lower subzone of the *Parkinsoni* Zone of the West European scale; but in the last decades, the former name became dominant (Dietze, 2000; Fernández-López et al., 2009; Pavia et al., 2015; etc.). Considering the above, I propose that the zone should be officially named the *Subarietis* Zone.

The systematic descriptions are below.

SYSTEMATIC PALEONTOLOGY

Superfamily Perisphinctoidea Steinmann, 1890

Family Parkinsoniidae Buckman, 1920

Subfamily Parkinsoniinae Buckman, 1920

Genus *Rarecostites* Besnosov et Kutuzova, 1982

***Rarecostites subarietis* (Wetzel, 1911) [m]**

Plate 2, figs. 1, 4–6

Parkinsonia parkinsoni: Schlippe, 1888, p. 208, pl. 4, fig. 5 (=*Parkinsonia schlippei* Rollier, 1911, p. 297).

Parkinsonia arietis: Wetzel, 1911, p. 185, pl. 13, fig. 17; Nicolesco, 1928, p. 21, pl. 1, fig. 11; Schmidtill and Krumbeck, 1931, p. 859, pl. 82, fig. 9; non Dorn, 1927, p. 228, pl. 4, fig. 3 (macroconch).

Parkinsonia subarietis: Wetzel, 1911, p. 187, pl. 13, figs. 18 and 19, pl. 14, figs. 1–5, 8 (non figs. 6, 7 = macroconchs), pl. 15, figs. 1 and 2; Nicolesco, 1928, p. 23, pl. 1, figs. 14–17, pl. 2, fig. 1; Schmidtill and Krumbeck, 1931, p. 860, pl. 82, fig. 7; Sibiryakova, 1961, p. 38, pl. 4, fig. 2.

Parkinsonia acris: Wetzel, 1911, p. 190, pl. 15, figs. 3–8; Mitta and Sherstyukov, 2014, pl. 3, fig. 2.

Parkinsonia schlippei: Rollier, 1911, p. 297.

Parkinsonia typus: Buckman, 1928, pl. 789.

Parkinsonia subarietis var. *acris*: Nicolesco, 1928, p. 25, pl. 2, figs. 2–5, pl. 3, fig. 1.

Parkinsonia acris var. angulicostata: Wetzel, 1937, p. 122, pl. 12, fig. 6.

? *Parkinsonia gracilis*: Wetzel, 1937, p. 122, pl. 12, fig. 4 (juv.).

Parkinsonia praearietis: Roché, 1939, p. 231 (part.).

Parkinsonia doneziana: Sibiryakova, 1961, p. 36, pl. 3, fig. 9.

Parkinsonia (Parkinsonia) rarecostata: Schlegelmilch, p. 93, 1985, pl. 33, fig. 3; Rioult et al., 1997, pl. 15, fig. 6; Dietze, 2000, pl. 6, fig. 1.

Rarecostites rarecostatus: Besnosov, Mitta, 1993, p. 180, pl. 35, fig. 2; Besnosov and Mitta, 1998, pl. 7, fig. 5.

Parkinsonia rarecostata: Gauthier et al., 1996, pl. 13, fig. 6.

Rarecostites acris: Besnosov, Mitta, 1998, p. 183, pl. 17, fig. 4.

Parkinsonia (Parkinsonia) arietis: Dietze, 2000, pl. 1, fig. 1, pl. 4, figs. 1 and 2.

Parkinsonia (Parkinsonia) cf. *arietis*: Dietze, 2000, pl. 4, fig. 3.

Parkinsonia (Parkinsonia) subarietis: Dietze, 2000, pl. 1, figs. 2 and 3, pl. 5, figs. 1, 2, pl. 6, fig. 2.

Parkinsonia (Parkinsonia) cf. *subarietis*: Dietze, 2000, pl. 5, fig. 3.

Parkinsonia (Parkinsonia) cf. *acris*: Dietze, 2000, pl. 7, fig. 2, pl. 8, figs. 2–4.

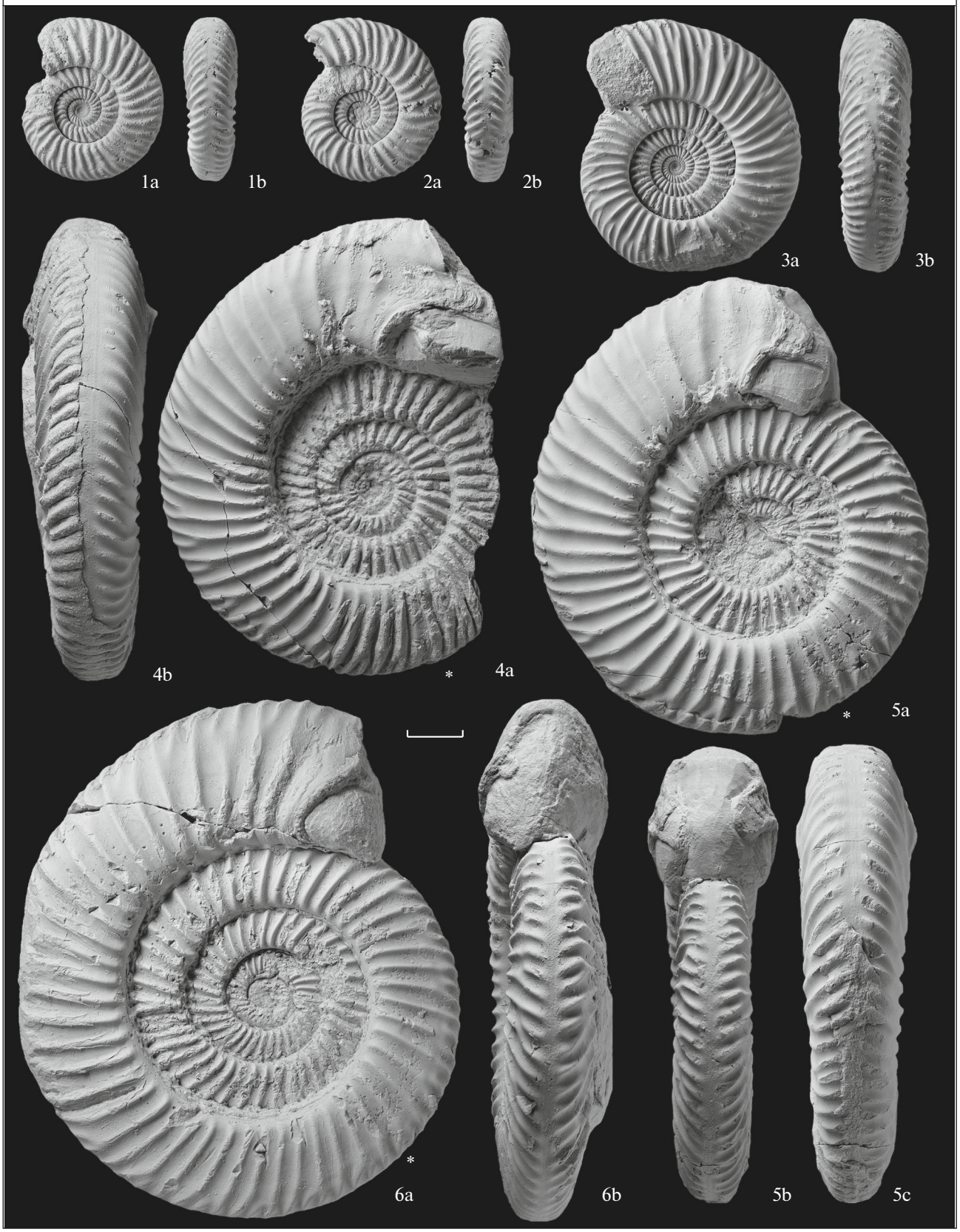
Parkinsonia (Rarecostites) subarietis: Cherkashin et al., 2015, pl. 14, figs. 6 and 8 (only).

non *Parkinsonia (Parkinsonia) acris*: Dietze, 2000, pl. 8, fig. 1 (young macroconch).

Holotype. Specimen illustrated by Wetzel (1911, p. 187, pl. 13, figs. 18, 19); Germany, Bielefeld; Upper Bajocian, "lower and upper *Parkinsonia* Beds".

Description. (Figs. 3a). Adult shells up to 70–100 mm in diameter. The cross section of the evolute whorls, embracing the preceding whorls for a third of their height, is subrectangular, with almost flat, weakly convex flanks and flattened venter. The ventral groove is present on the phragmocone and becomes a smooth band on the body chamber. The umbilicus is wide and very wide; the umbilical wall is steep; the umbilical shoulder is rounded. The body chamber of adult shells is 0.6 whorls; the lateral auricles are long.

Plate 2



The ribs are prominent, rectiradiate or prorsiradiate, bipartite and simple. The ribs disappear before reaching the midventer. Small nodes can be present in the bifurcation points. The nodes are weak on the molds and pronounced on the shell. The ribbing coefficient is 1.65–1.85.

Dimensions in mm and ratios:

Specimen PIN, no.	Dm	WH	WW	UW	WH/Dm	WW/Dm	UW/Dm
5546/17	93	27	21	48.1	0.29	0.23	0.52
	74.8	20	15.8	39.7	0.27	0.21	0.53
5546/36	83	22	18.4	44.4	0.27	0.22	0.53
5546/168	80	25	19.1	38.8	0.31	0.24	0.49
5546/166	78.4	22.8	16.6	38.4	0.29	0.21	0.49
5546/169	71	20.5	14.5	37.5	0.29	0.20	0.53
5546/39	60.5	18	13.5	28.8	0.30	0.22	0.44
5546/80	47.5	14.5	13.5	23.0	0.31	0.28	0.48
	23.0	7.25	6.55	10.6	0.32	0.28	0.46

Variability. The shell size may vary. Some specimens reached maturity relatively early, at Dm = 60 mm, or later, at Dm = ca. 100 mm. The degree of the whorl compression, ribbing coefficient, and the rib density may vary.

Comparison. This species is distinguished from the ancestral species *R. sherstyukovi* by the larger size, higher ribbing coefficient and appearance of nodes in the rib bifurcation points. It differs from its likely descendant species *R. rarecostatus* in the smaller size and lower ribbing coefficient and the less strongly developed nodes in the bifurcation points.

Remarks. Roché (1939, p. 231) established a new species, *Parkinsonia praearietis,* in the Upper Bajocian of France. Roché did not illustrate the new species and did not designate its type referring to two figures of *P. arietis* published by Dorn and Nicolesco. One of the syntypes of *P. praearietis* comes from the Franconian Alb (Bavaria) (Dorn, 1927, pl. 4, fig. 3). According to Dorn, ammonites he studied have a long body chamber, for nearly one complete whorl, and the specimen he figured is most likely a mature macroconch of *Caumontisphinctes* or a juvenile specimen of a macroconch of *Rarecostites*. The second syntype from Calvados (Nicolesco, 1928, pl. 1, fig. 11) is represented by an incomplete shell with a ventral groove prominent on the phragmocone and is likely to be a young specimen of *R. subarietis*.

Material. Over 70 specimens from the Kyafar River, localities 1–4.

***Rarecostites sherstyukovi* Mitta, sp. nov. [m]**

Plate 2, fig. 2

? *Parkinsonia orbignyana*: Sibiryakova, 1961, p. 39, pl. 4, fig. 5.
? *Parkinsonia complanata*: Sibiryakova, 1961, p. 41, pl. 4, fig. 8.
Parkinsonia (Rarecostites) subarietis: Cherkashin et al., 2015, pl. 14, fig. 7 (only).

Etymology. After the amateur paleontologist M.P. Sherstyukov (Stavropol), who provided the original information on the sections, made his collection available for study, and participated in fieldwork.

Holotype. PIN, no. 5546/174; Karachai-Cherkessia, Kyafar River, locality 4; upper member of the Djangura Formation, Upper Bajocian, *Parkinsoni* Zone, *Subarietis* Subzone; collected in 2015.

Description (Fig. 5). The shell on average reaches 50–60 mm in diameter and is laterally compressed. The cross section is high, subrectangular; the venter is rounded in the phragmocone, wide and flattened on the body chamber, and only in the apertural region of mature specimens becomes rounded again. The umbilicus is very wide, shallow; the narrow umbilical wall is steep. The body chamber of adult shells is 0.4–0.55 whorls; the aperture has well-developed lappets, an umbilical sinus, and a rounded ventral projection.

The ornamentation is represented by bipartite, simple, and intercalating ribs. The ribbing coefficient on the body chamber varies from 1.3 to 1.6; the bifurcation point is in the upper third of the flanks.

Dimensions in mm and ratios:

Specimen PIN, no.	Dm	WH	WW	UW	WH/Dm	WW/Dm	UW/Dm
5546/174	60.5	16	12.5	32	0.26	0.21	0.53
5546/67	60	17	12.5	30	0.28	0.21	0.50
	47.7	13.4	10.1	24.4	0.28	0.21	0.51
5546/175	59	15.7	12.5	32	0.27	0.21	0.54
	49	13.9 ~ 11		25.6	0.28	0.22	0.52
5546/77	53	14	11.6	27.3	0.26	0.22	0.52
	45	12.1	9.0	23.8	0.27	0.20	0.53
5546/20	52	13.3	10.7	28.1	0.26	0.21	0.54
5546/39	49	14	11.1	25	0.29	0.23	0.51
5546/186	36.8	10	9.5	19	0.27	0.26	0.52
	25.0	7.5	7.6	12.3	0.30	0.30	0.49

Explanation of Plate 2

Figs. 1, 4–6. *Rarecostites subarietis* (Wetzel) [m]: (1) specimen PIN, no. 5546/80, inner whorls of a phragmocone (body chamber and part of the phragmocone are separated): (1a) lateral and (1b) ventral views; locality 4, 1.0 m below the top of the section; (4) specimen PIN, no. 5546/168, adult shell: (4a) lateral and (4b) ventral views; locality 1a, base of the section; (5) specimen PIN, no. 5546/166, adult shell: (5a) lateral, (5b) apertural, and (5c) ventral views; locality 3, 6 m above the base of the section; (6) specimen PIN, no. 5546/17, almost adult shell with incipient lappets: (6a) lateral and (6b) apertural views; locality 2, 4 m above the base of the section.

Fig. 2. *Rarecostites sherstyukovi* sp. nov. [m], specimen PIN, no. 5546/186, phragmocone of an adult shell (body chamber and part of the phragmocone are separated): (2a) lateral and (2b) ventral views; locality 4, 1.2 m below the top of the section.

Fig. 3. *Rarecostites* cf. *kyafarensis* sp. nov. [M], specimen PIN, no. 5546/180, juvenile shell with a body chamber: (3a) lateral and (3b) ventral views; locality 4, 2.0 m below the top of the section.

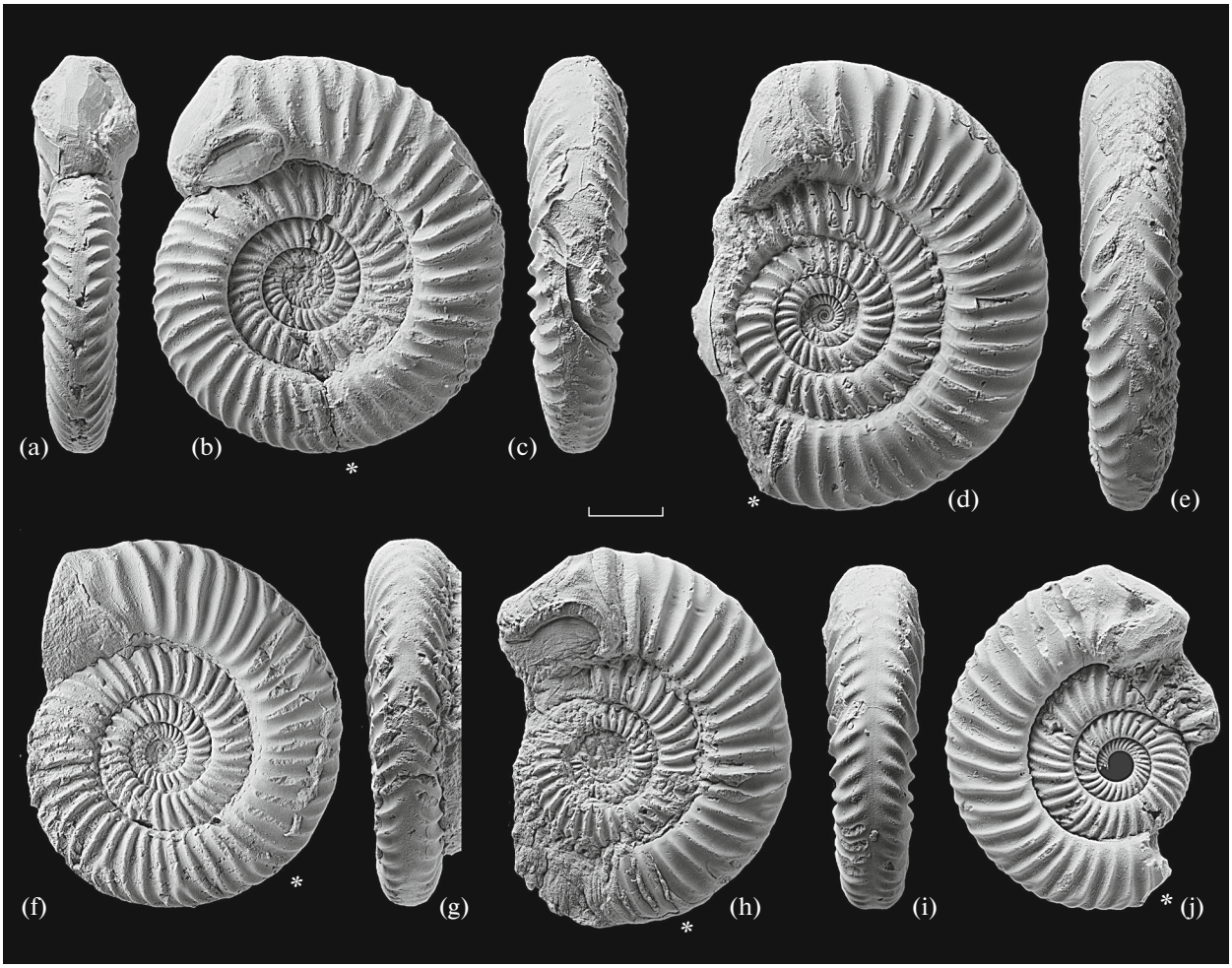


Fig. 5. *Rarecostites sherstyukovi* sp. nov. [m], all specimens are adult shells with lateral lappets : (a–c) specimen PIN, no. 5546/77, locality 4, 3.5 m above the base of the section: (a) apertural, (b) lateral, and (c) ventral views; (d, e) holotype PIN, no. 5546/174, the same locality and level (the lappet is preserved on the side that was not photographed): (d) lateral and (e) ventral views; (f, g) specimen PIN, no. 5546/39, the same locality and level: (f) lateral and (g) ventral views; (h) specimen PIN, no. 5546/173, lateral view, the same locality and level; (i, j) specimen PIN, no. 5546/81, locality 3, 3 m above the base of the section: (i) ventral and (j) lateral views. The asterisk [*] here and below indicates the beginning of the body chamber.

Variability. The shells reach maturity at different sizes, from 50 to 60 mm. In addition, the umbilical width and steepness of the umbilical wall, the density and number of ribs may vary.

Along with the typical specimens, there are rarely found shells with more rounded flanks (not figured). These shells do not show a flattened venter on the body chamber of adult specimens, whereas the phragmocone possesses nodes at the bifurcation point.

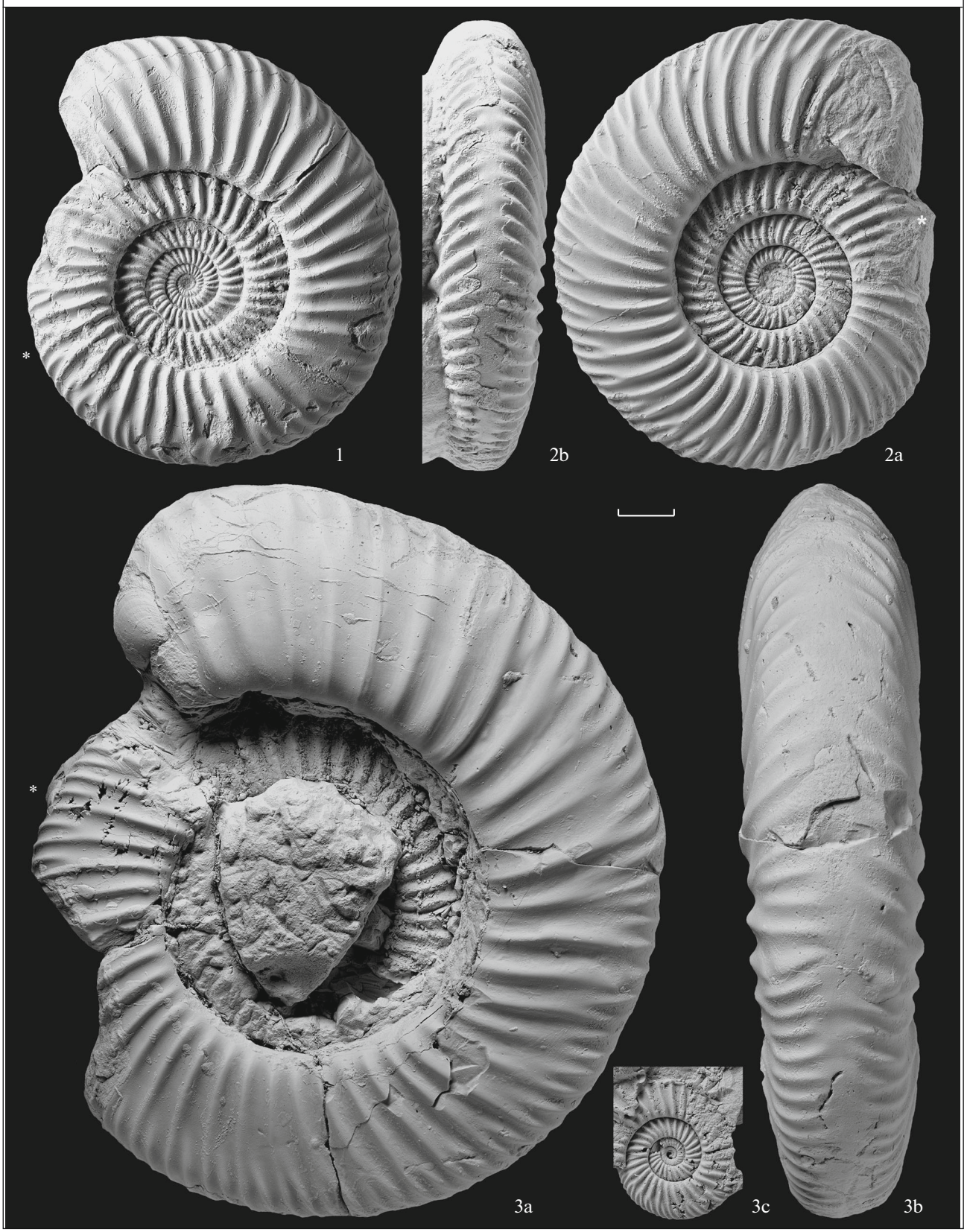
Comparison. The inner whorls of the phragmocone of this species (pl. 2, fig. 2) are very similar to those of *R. subarietis* (pl. 2, fig. 1) and differ only in the more strongly flattened whorls and shallow umbilicus and the more widely spaced ribs. It is also difficult to distinguish from the new species young specimens of *R. subarietis* with the body chamber (Nicolesco, 1928, pl. 1, fig. 11; Schmidtill and Krumbeck, 1931, pl. 82, fig. 7; Dietze, 2000, pl. 4, fig. 2); they are mainly dis-

Explanation of Plate 3

Fig. 1. *Rarecostites* aff. *kyafarensis* sp. nov. [M], specimen PIN, no. 5546/30, young specimen with a body chamber, lateral view; locality 4, 0.2 m below the top of the section.

Figs. 2 and 3. *Rarecostites kyafarensis* sp. nov. [M]: (2) specimen PIN, no. 5546/23, young specimen with a body chamber: (2a) lateral and (2b) ventral views; locality 4, 0.5 m below the top of the section; (3) specimen PIN, no. 5546/25: (3a) lateral, (3b) ventral, and (3c) inner whorls lateral views; locality and level are unknown (collected by M.P. Sherstyukov).

Plate 3



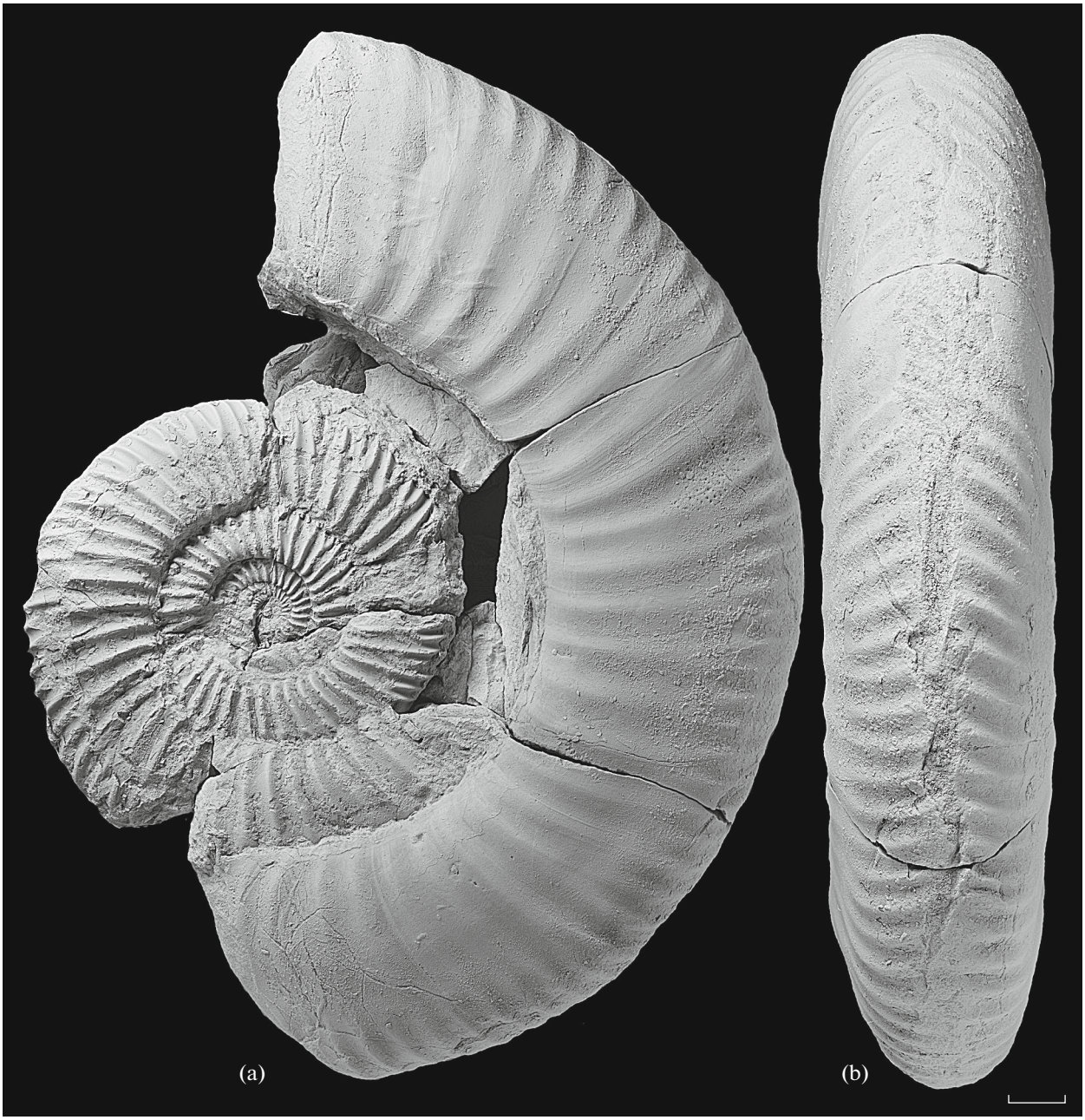


Fig. 6. *Rarecostites kyafarensis* sp. nov. [M], holotype PIN, no. 5546/24, phragmocone with a body chamber fragment, size reduced: (a) lateral and (b) ventral views; locality 3, 2.4 m above the base of the section.

tinguished by the absence of the ventral flattening characteristic of the adult shell. The new species differs from the adult shell of *R. subarietis* and *R. rarecostatus* in its much smaller size and lower ribbing coefficient. In addition, the new species typically does not have nodes in the bifurcation points. The last character and smaller size distinguish *Rarecostites sherstyukovi* from *R. transitorius* (Schweigert et al.). It differs from *R. oglanlensis* (Amanniyazov) in the larger shell and flattened venter on the body chamber.

R e m a r k s. Judging from the taxonomic characters and stratigraphic distribution, *Rarecostites sherstyukovi* was an immediate ancestor of *R. subarietis*. The possible ancestors of *Rarecostites sherstyukovi* include *R. transitorius* (Schweigert et al., 2002, pl. 1, fig. 1, holotype) from the *Garantiana* Zone; this is supported by rare occurrences with less strongly than usual flattened flanks and venter and the presence of nodes in the bifurcation points. More distant ancestors apparently include *R. oglanlensis* (Amanniazov,

1972, pl. 4, fig. 2, holotype) described from the vicinity of the Chaloi wells in western Turkmenistan (upper part of the *Niortense* Zone–?lower part of the *Garantiana* Zone; Besnosov and Mitta, 2000).

Material. About 60 specimens from the Kyafar River, localities 3 and 4.

***Rarecostites kyafarensis* Mitta, sp. nov. [M]**

Plate 2, fig. 3 (?); Plate 3, figs. 2 and 3

Parkinsonia pseudoplanulata: Mitta and Sherstyukov, 2014, pl. 3, fig. 1.

Etymology. From the Kyafar River.

Holotype. PIN, no. 5546/24; Karachai-Cherkessia, Kyafar River, locality 3; upper member of the Djangura Formation, Upper Bajocian, *Parkinsoni* Zone, *Subarietis* Subzone; collected in 2015.

Description (Fig. 6). The shell is up to 185 mm in diameter. The whorls are flattened high-trapezoidal, with the maximum width near the umbilicus. The cross section of the young whorls is subrectangular, with flattened flanks and a wide flattened venter; with age, the venter becomes more rounded and suboval at the end of the body chamber. The umbilicus is wide to very wide; the umbilical wall is steep in the phragmocone and becomes more gently sloping in the body chamber of adult specimens. The body chamber occupies about one whorl and the aperture is simple.

The ribs are bipartite, narrowly forked, simple and intercalating, weakly bent forward. The bifurcation point is in the upper third of the flanks, the subsequent whorls completely enclose the secondary ribs of the preceding whorls; branching on the body chamber of adult specimens is nearer the midflank. The ribbing coefficient varies from 1.75 to 2. The secondary ribs in the young whorls are interrupted before reaching the midflank. A smooth band running along the flank is almost indiscernible at the end of the body chamber of adult shells.

Dimensions in mm and ratios:

Specimen PIN, no.	Dm	WH	WW	UW	WH/Dm	WW/Dm	UW/Dm
5546/24	~180	52	38	93	0.29	0.21	0.52
	84	–	–	41	–	–	0.49
	72	22.5	~14	32	0.31	0.19	0.44
5546/25	127	37.5	30	60.4	0.29	0.24	0.48
	112	34.5	28.5	52	0.31	0.25	0.46
	22	7	6.5	12	0.32	0.29	0.55
5546/164	96	29.5	24	42.8	0.31	0.25	0.45
5546/23	80	25.4	19.6	36	0.32	0.25	0.45

Variability. Judging from available material, the variability is mainly observed in the degree of prominence of the ribs and their curvature.

Comparison. Macroconchs of *Rarecostites*, as previously mentioned, are extremely poorly studied and described based on a few specimens only. Therefore, it is very difficult to adequately compare *Rarecostites kyafarensis* with the previously established species. *R. kyafarensis* is most similar to the paratype of *Parkinsonia (Durotrigensia) bradstockensis* Dietze (2000, pl. 9, fig. 1; pl. 10, fig. 1) from southern Germany, which is distinguished from adult *R. kyafarensis* by the more strongly curved and more prominent ribs. In the holotype of *R. bradstockensis* (Dietze, 2000, text-figs. 3, 4) from Dorset, the ornamentation is smoothened at a considerably smaller diameter than in the above paratype; taking into account the stratigraphic interval of this occurrence, the holotype of *bradstockensis* is a macroconch of *R. rarecostatus*. Wetzel (1911, pl. 14, fig. 7) illustrated a complete body chamber of a macroconch with long and prominent primary ribs and preserved aperture. Another specimen (phragmocone) figured under the same name (*Parkinsonia subarietis* Wetzel, pl. 14, fig. 6), judging from the embracing whorls, is also a macroconch and differs from the shells of the new species of a similar size (pl. 3, fig. 2) in the more widely spaced primary ribs. A paratype of *bradstockensis* Dietze and macroconch paratypes of Wetzel and North Caucasian *R.* aff. *kyafarensis* (pl. 3, fig. 1) were probably macroconchs of *R. subarietis*; and the earliest valid name for this taxon is apparently *R. mutabilis* (Nicolesco) (holotype: *Parkinsonia planulata* Quenstedt var. *mutabilis*; Nicolesco, 1928, pl. 13, fig. 5). Shells of *R. kyafarensis*, including a juvenile specimen (pl. 2, fig. 3), were found in the interval of the predominant distribution of *R. sherstyukovi* and most likely are macroconchs of this species.

Material. Nine specimens; Kyafar River, localities 3 and 4.

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