

## ***Sloveniaxon*, a new genus of ahermatypic Rugosa (Anthozoa) from the basal Permian (Asselian) of Slovenia**

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**ABSTRACT.** The proposal of the new genus is based on *Sloveniaxon asseliensis* sp. nov. from the late Early Asselian of the Dovžanova Soteska section NNE of Tržišč (Karavanke Mts.), in a *Cyathaxonia* facies assemblage with *Cyathaxonia* and *Lophophyllidium*. Together with *Variaxon* Fedorowski, 2010, the taxon is classified as Variaxoninae Fedorowski, 2010 of Antiphyllidae Iljina, 1970 (suborder Zaphrentoidina Schouppé & Stacul, 1959), descending from *Rotiphyllum* Hudson, 1942. *Sloveniaxon* was widely distributed in Eurasia (Spain, Hungary, Russia, Ukraine, Iran, Timor, China) during Late Bashkirian, Moscovian, Asselian, Sakmarian?, Late Artinskian, Capitanian, Dzhulfian? times; there it had been mostly misidentified as really quite homoeomorphic *Cyathaxonia* Michelin, 1847 or *Cyathocarina* Soshkina, 1928 (suborder Cyathaxoniina Spasskiy, 1977). The diagnostic difference is a true aseptal columella (*Cyathaxoniinae* Milne-Edwards & Haime, 1850) against a massive septal pseudocolumella (*Variaxoninae*), best visible in cross sections of the calice. For unambiguous identification, often neglected studies of the calicular phase are demanded to see the axial boss in *statu nascendi* without later stereoplasmatic thickening and diagenetic recrystallisations.

Future modern revisions (including intensive serial sectioning) should verify the proposed transfer of the following previous species into *Sloveniaxon*: *Cyathaxonia* (*Cyathocarina*) *multituberculata* Soshkina, 1928, *Cyathaxonia angularis* Fomichev, 1953, *Cyathaxonia archangelskyi* Fomichev, 1953, *Cyathaxonia lomonosovi* Fomichev, 1953, *Cyathocarina crassata* Guo, 1980, *Cyathaxonia degrootae* Rodríguez, 1984, *Cyathaxonia pinguis* Rodríguez & Kullmann, 1999, *Cyathaxonia* sp.n.B, Rodríguez & Kullmann, 1999.

**KEYWORDS:** Variaxoninae, *Cyathaxonia*-homoeomorphs, Karavanke-Mts., Eurasia-distribution, Bashkirian-Capitanian.

### **1. Introduction**

Traditionally, aphotic coral communities of cold and deeper waters are named as the *Cyathaxonia* facies (according to Hill, 1938: *Cyathaxonia* fauna). This originally Lower Carboniferous term is in common use for all such Rugosa faunas (from Ordovician to Permian times). The name-giving genus *Cyathaxonia* Michelin, 1847 (lower Famennian-Early Permian) seems to be well defined, but a partially homoeomorphic, phylogenetically unrelated taxon which sometimes caused misidentifications was recognized recently.

The best material was jointly collected in 2010 in the Asselian of the Karavanke Mountains (Southern Alps, Slovenia), where Heritsch (1933, 1938) had already described some ahermatypic Rugosa. Additional records - mainly among so-called *Cyathaxonia* species - from Iran (Sakmarian?), Indonesia (Timor island, Capitanian), Hungary (Dzhulfian?), Russia (Late Artinskian), Ukraine (Late Bashkirian-Moscovian), Spain (Late Bashkirian-Late Moscovian), and China (Moscovian-Cisuralian) indicate a much wider stratigraphical and regional distribution in Eurasia.

An older record of the new genus is the misinterpreted “*Cyathaxonia cornu cornu* Michelin, 1847?” of Flügel (1972, 84, fig. 17, pl. 3/7) from the Early Permian (Sakmarian?) basal Jamal Formation of East Iran (Kuh-e-Bagh-e-Vang section south of Shirgest), here determined as *Sloveniaxon* sp. The determination was repeated correctly by Flügel (1995, 39), but incorrectly by Flügel & Hubmann (1993, 36, fig. 9A, omitting the indispensable “?”). The preliminary determination of that specimen was *Cyathaxonia khmeriana* Fontaine, 1961 (cited in Ruttner et al., 1968, 70).

Quite unexpectedly, also a part of *Cyathaxonia* (*Cyathocarina*) Soshkina, 1928 from the Late Artinskian of the Russian Ural Mountains is not a member of the family Cyathaxoniidae Milne-Edwards & Haime, 1850. The illustrations of *Cyathaxonia* (*Cyathocarina*) *multituberculata* Soshkina, 1928 demonstrate a septal pseudocolumella in the lectotype (Soshkina, 1928, fig. 18, Soshkina et al., 1941, 43, pl. 1/3), but not in some hypotypes (Soshkina, 1932, figs. 4, 5, 8, obviously with an aseptal columella characterizing real *Cyathaxonia*).

Some of the *Cyathaxonia* species described by Rodríguez (1984: pl.3/7, “*Cyathaxonia cornu cornu* Michelin, 1847” Upper Bashkirian) and Rodríguez & Kullmann (1999, *Cyathaxonia* sp. n. B, *Cyathaxonia degrootae* Rodríguez, 1984, *Cyathaxonia pinguis* Rodríguez & Kullmann, 1999) might also

belong to *Sloveniaxon* gen. nov. Their illustrations of specimens from the upper Picos de Europa Formation (Late Moscovian, Myachkovian) in the Cantabrian Mountains do not include calicular stages, where a septal or aseptal columellar structure is more easily visible. Probably, Falces & Rodríguez (1994) observed such differences in the columellar microstructure, suitable to differentiate “two species groups”, but unfortunately this idea (published only in an unillustrated abstract) was not applied later in Rodríguez & Kullmann (1999).

Ukrainian Late Carboniferous *Cyathaxonia* species of the Donez Basin (Fomichev, 1953) demonstrate the same (and in Moscovian-Cisuralian times usual) co-occurrence of both true *Cyathaxonia* and *Sloveniaxon* gen. nov. in one assemblage. Our reinterpretation concerns *Sloveniaxon angularis* (Fomichev, 1953) (Moscovian), *Sloveniaxon? archangelskyi* (Fomichev, 1953), and *Sloveniaxon? lomonosovi* (Fomichev, 1953) (both late Bashkirian-early Moscovian). Finally, we dispose of two further isolated specimens of *Sloveniaxon*, an undescribed one from the Hungarian Bükk Mountains (Dzhulfian?), the other one from Indonesia (Timor island, Capitanian), already mentioned by Schouppé & Stacul (1959, 348, pl.13/73-75) as “*Pterocorallia incertae sedis* Form II”.

In addition, *Sloveniaxon* gen. nov. occurs certainly throughout China (hitherto misidentified as *Cyathocarina*). Correct determinations require intensive revisions of all these insufficiently sectioned, shortly described, and not well illustrated materials; therefore we select only some few citations, which should be excluded from the Cyathaxoniidae: Liao et al. (1987, pl. 5/6 - *Cyathocarina tuberculata* Soshkina, 1928, Moscovian), Guo (1980, 114, pl. 63/10 - *Cyathocarina crassata* Guo, 1980, Cisuralian), Wu (1975, 97, pl. 2/11-12 - *Cyathocarina tuberculata* Soshkina, 1928, Cisuralian), Yu et al. (1981, 20, pl. 1/7 - *Cyathocarina multituberculata* Soshkina, 1928, Cisuralian).

It is strange, that such a remarkable case of homoeomorphy between two totally unrelated, either columellate or pseudocolumellate taxa of different suborders (*Cyathaxoniina* Spasskiy, 1977, *Zaphrentoidina* Schouppé & Stacul, 1959) could survive up to present days. Steps to overcome these misidentifications started with Falces & Rodríguez (1994: observation of different microstructures in the “columella” of “*Cyathaxonia*”), Weyer (2001: interpretation of the aseptal columella in *Cyathaxonia* as an everted “aulos” = circulotheca, in the simple phylogenetic line *Laccophyllum* Simpson, 1900 → *Cyathaxonia* Michelin, 1847), Fedorowski & Vasilyuk (2011, affirmation of the unique aseptal columellar structure in



**Figure 1.** Locality map of the Dovžanova Soteska section, Karavanke Mts., Slovenia.

*Cyathaxonia* by complete ontogenetic studies), and Berkowski & Weyer (2012, this volume: redefinition of the terms columella and pseudocolumella for *Rugosa* in the original, already morphogenetic sense of their authors Milne-Edwards & Haime 1848).

## 2. Locality and stratigraphy in Slovenia

The *Sloveniaxon* material comes from Dovžanova Soteska (Dovžan's Gorge), written as Dolžanova in older publications and known as Teufelsschlucht (Devil's Gorge) in German-language literature. Dovžanova Soteska, 3.5 km NNE of the town of Tržič (Neumarkt in German-language literature) is known since Schellwien (1898, 1900) as a classical locality of fossiliferous Upper Carboniferous to Lower Permian sections (Fig. 1). Outcrops with corals are exposed along the forest path crossing the steep eastern slope of the gorge (NW slope of mount Vratni vrh) high above the Dolžanov bridge on the river Tržiška Bistrica. The section is indicated in Forke (2002, pl. 35/2, profile DSE).

The outcrops are exposed in three adjoining horizons (no. 130, 131 and 133 of Novak, 2007a) within a distance of ca. 5 m, Fig. 2) in the upper part of the Dovžanova Soteska Formation (a new lithostratigraphic term proposed by Forke, 2002, 210). Here, the sedimentological description of Novak (2007b) indicates a deepening phase of the reef mound expressed by an 80 cm thick horizon of thin-bedded brownish-grey calcareous siltstones, marlstones, and marly limestones (locality 130). Besides corals, rare brachiopods, sponge spicules and trilobite fragments occur. This short-term drowning sequence is followed by the re-establishment of the reef growth. Approximately 4 metres of dark-red thin-bedded grainstones to microbreccia composed predominantly of reworked bioclasts indicate deposition in the upper slope facies belt. Almost every limestone bed is capped by a thin violet-red stained silty crust (horizons 131 and 133). The diverse biotic association is predominantly composed of crinoidal columns, phylloid algae and bryozoan debris, accompanied by some small, often corroded corals, brachiopods, gastropods and fusulinid foraminifera. *Sloveniaxon* is found together with other small solitary *Rugosa* of the *Cyathaxonia* facies (*Cyathaxonia*, *Lophophyllidium*), and with the *Tabulata Sutherlandia* (attached to crinoid stems).

Based on lithological similarity and the distinctive red colour, this limestone was traditionally (since Schellwien, 1900) regarded as an equivalent of the Trogkofel Limestone of Artinskian age in the Carnic Alps. However, later studies of conodonts and fusulinids, which occur in several levels (Buser & Forke, 1996; Forke, 2002; Novak, 2007a, 2007b), indicated the late Early Asselian age (Kholodnolozhian of the Southern Ural Mountains). The difference in microfacies types

to the predominant *Shamovella-Archaeolithoporella*-cement boundstone type of the Trogkofel Limestone in addition to the age difference led Buser and Forke (1996) to introduce a new name - Dovžanova Soteska Limestone Member - to the upper part of the Dovžanova Soteska Formation (named by Forke, 2002), an approx. 140 m thick succession overlying Upper Carboniferous beds.

Index fossils among conodonts and fusulinids in the uppermost part are *Streptognathodus bellus* Chernykh & Ritter, 1997, *S. aff. nodulinearis* Chernykh & Reshetkova, 1987, *S. aff. isolatus* Chernykh, Ritter & Wardlaw, 1997, *Hindeodus minutus* (Ellison, 1941), and *Diplognathodus* sp., *Dutkevitchia complicata* (Schellwien, 1898), *Pseudoschwagerina aff. uddeni* (Beede & Kniker, 1924), *Sphaeroschwagerina carniolica* (Kahler & Kahler, 1937), and *S. citrififormis* (Kahler & Kahler, 1941).

Corals described by Heritsch (1933, 1938, ahermatypic taxa of the genera *Amplexocarina*, *Tachylasma*, *Sinophyllum*, *Lopholasma*) bear no precise locality data, but came clearly also from the late Early Asselian Dovžanova Soteska Formation.

## 3. Systematic Palaeontology

Abbreviations: CS cross section, LS longitudinal section, TS thin section, P peel, R remaining part of corallum, n number of major septa, N number of all septa, D diameter.

The studied coral materials are deposited in the Museum of Natural History at Humboldt University, Berlin (department of palaeontology, coral numbers MB.K....), and in the Chernyshev Museum of the All-Russian Geological Survey Institute (VSEGEI), St.Petersburg (E. D. Soshkina collection).

Suborder Zaphrentoidina Schouppé & Stacul, 1959

Synonyms: *Metriophyllina* Spasskiy, 1965, *Stereolasmatina* Hill, 1981, *Hapsiphyllina* Nudds in Nudds & Löser, 2001.

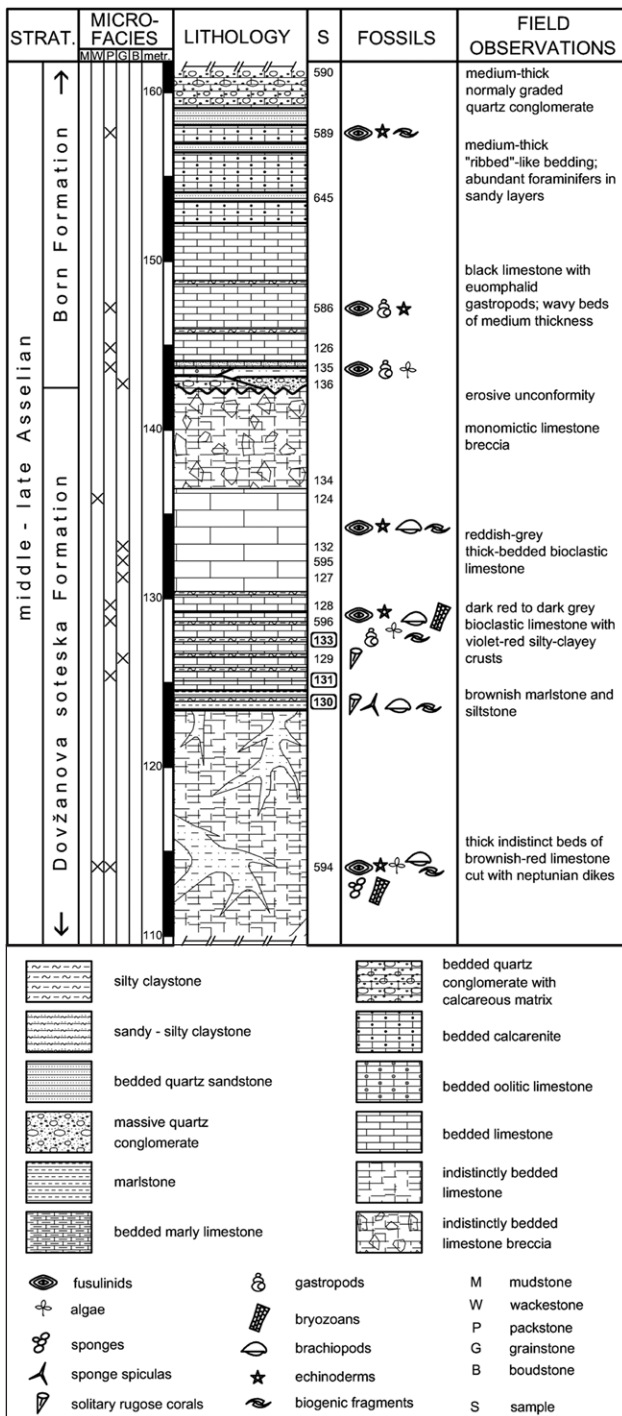
Family Antiphyllidae Iljina, 1970

Subfamily Variaxoninae Fedorowski, 2010

*Genera included.* *Variaxon* Fedorowski, 2010; *Sloveniaxon* gen. nov.

*Diagnosis.* Descendants of *Rotiphyllum* acquiring an axial boss (pseudocolumella), at first with short free catasepta, finally with long contrasting catasepta and a biform tabularium.

*Remarks.* Now, the subfamily is not longer a monophyletic taxon, and a phylogenetic line *Rotiphyllum* → *Variaxon* → *Sloveniaxon* seems acceptable. Fedorowski (2010) did not



**Figure 2.** Lithostratigraphic section of the Sloveniaxon occurrences in the upper Dovžanova Soteska Formation (sample beds 130, 131, 133, late Early Asselian).

propose a family assignment, but was thinking about a “distant” ancestor *Rotiphyllum* Hudson, 1942. A first revision (Weyer, 1977) of the type species of *Variaxon*, *Fasciculophyllum repressum* Schindewolf, 1952, had shown the presence of an axial boss; the resulting transfer to *Lophophyllidium*? was proposed only with reservation, already speculating about a future separate new genus descending directly from *Rotiphyllum*.

Fedorowski (2010, 181) preferred to classify *Antiphyllum* Schindewolf, 1952 (plesiomorph: short and free catasepta, normal tabulae) and *Claviphyllum* Hudson, 1942 (apomorph: longer contratingent catasepta, tabulae biform) perhaps in different families. We consider these features as a general trend (*sensu* Lang, 1923) appearing within many Rugosa families, frequently and independently repeated through Ordovician-Permian times, and high enough valued as a generic or even only subgeneric criterion as in the case of *Lophophyllidium* (*Lophbillidium*) Fedorowski, 1986.

*Distribution.* Late Serpukhovian-Capitanian (Dzhulfian?).

### Genus *Sloveniaxon* gen. nov.

*Derivation of name.* From the type area of the genus, Slovenia.

*Type species.* *Sloveniaxon asseliensis* sp. nov.

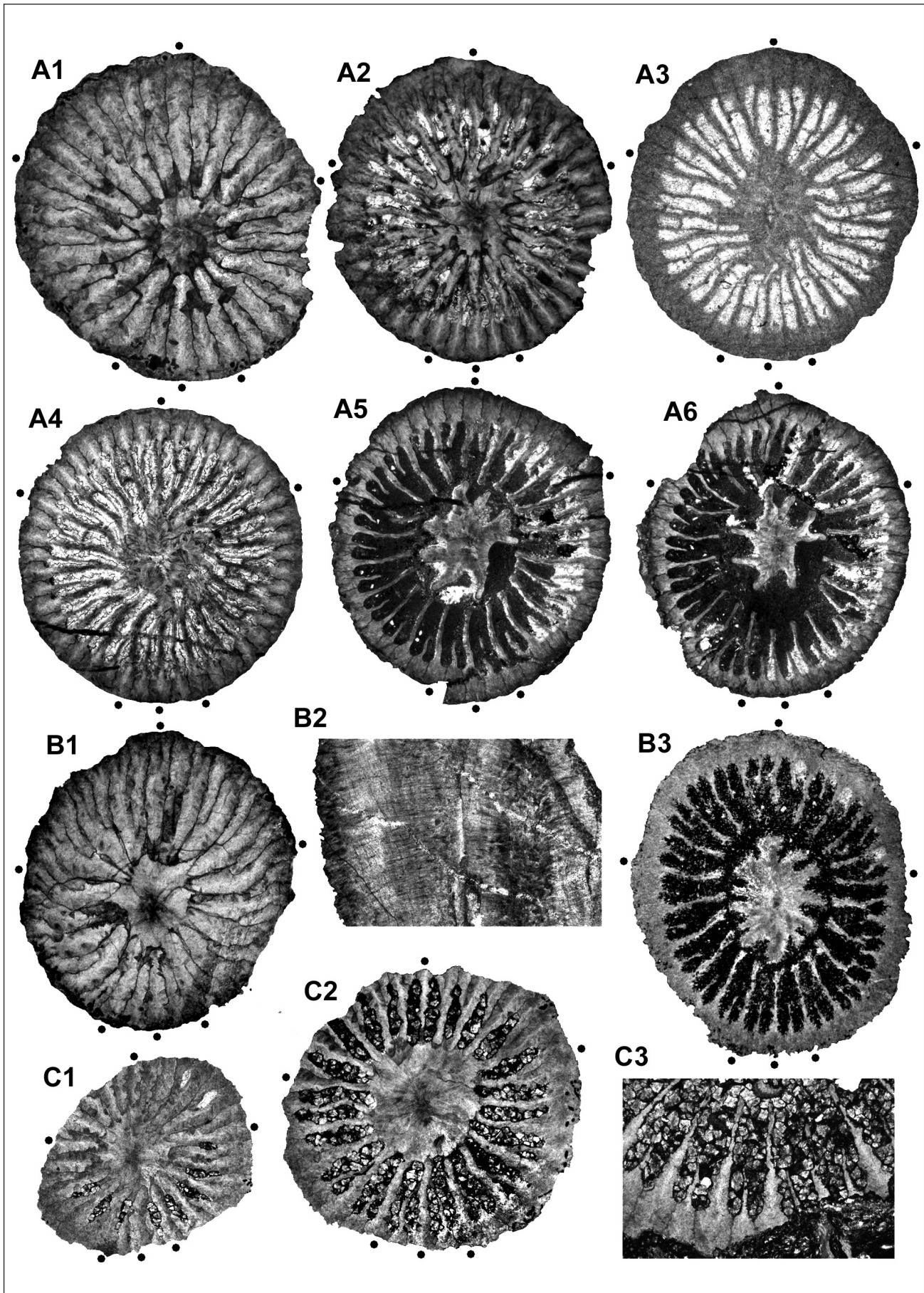
*Diagnosis.* Small long-conical, archaeothecate, diaphragmatophorous, with deep calice bearing a prominent massive pseudocolumella of few, slightly twisted septal lamellae (nearly without tabulae, no dominance of any antiseptal prolongation). Major septa radially arranged, reaching the axial boss in lower calice; cardinal septum slightly shorter than metasepta. Length of contracline or mostly contratingent minor septa amounts to 40-70% of that of major septa. Antiseptal triad equal to other catasepta, or a little more prominent. All septa with smooth, non-trabecular internal margin; their flanks are smooth or bear a weak to strong spiny ornament which disappears towards the calicular base after continuous stereoplasmatic thickening of the complete septal apparatus. Subtabular stages without (especially in the youth) or with only tiny open interseptal spaces. Simple tabulae strongly biform; horizontal or slightly axially inclined in position I, domed in position II.

*Species included.* *Cyathaxonia* (*Cyathocarinia*) *multituberculata* Soshkina, 1928, *Cyathaxonia angularis* Fomichev, 1953. ?*Cyathaxonia archangelskyi* Fomichev, 1953, ?*Cyathaxonia lomonosovi* Fomichev, 1953, ?*Cyathaxonia degrootae* Rodríguez, 1984, ?*Cyathaxonia pinguis* Rodríguez & Kullmann, 1999, ?*Cyathaxonia* sp. n. B, Rodríguez & Kullmann, 1999, ?*Cyathocarinia crassata* Guo, 1980, *Sloveniaxon* sp. A (“*Cyathaxonia cornu cornu* Michelin, 1847 ?” of Flügel 1972, 84, fig. 17, pl. 3/7), *Sloveniaxon* sp. B (1 unpublished specimen from the Dzhulfian? of the Bükk Mountains, Hungary), *Sloveniaxon* sp. C (“*Pterocorallia incertae sedis* Form II” of Schouppé & Stacul, 1959, 348, pl. 13/73-75).

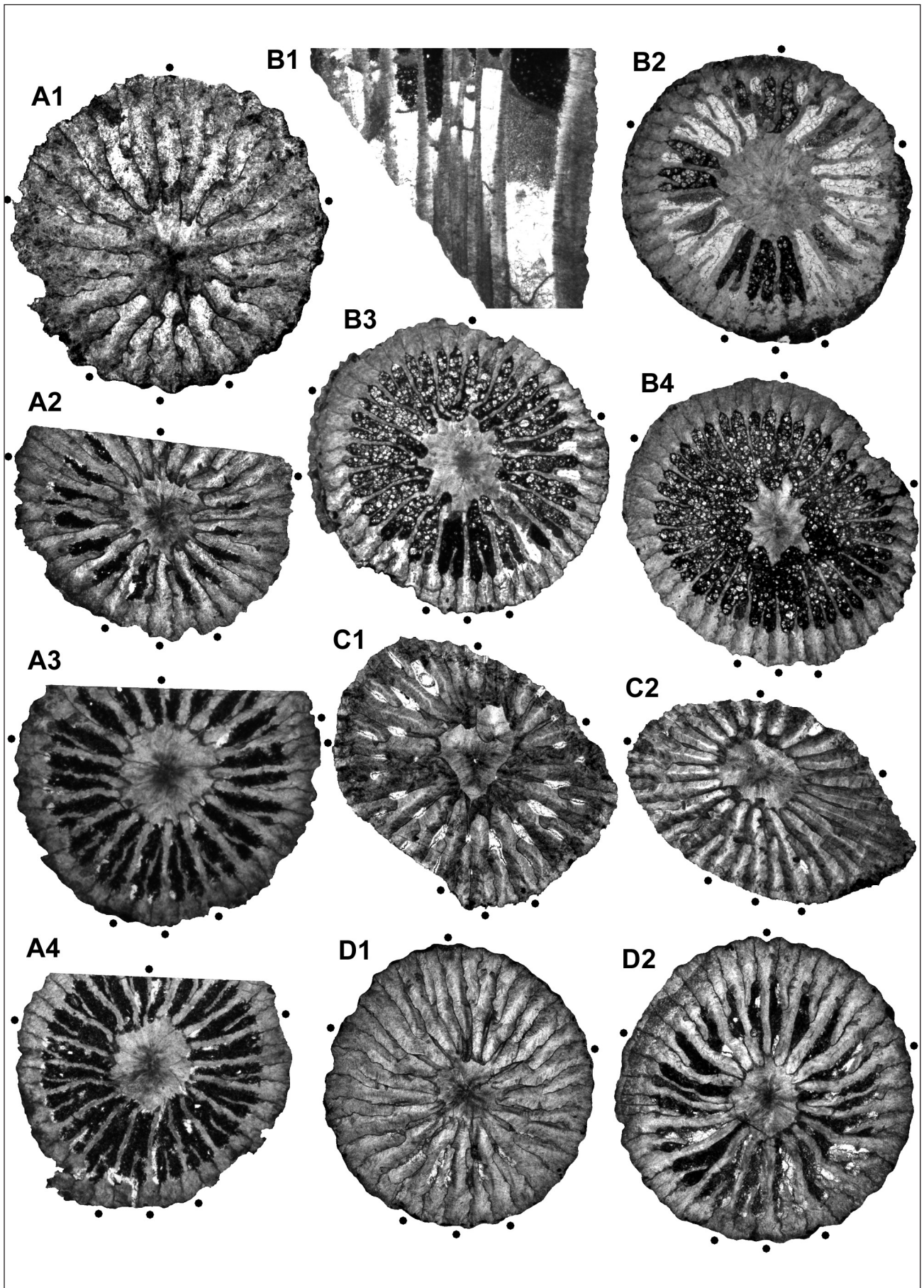
*Discussion.* *Sloveniaxon* differs from its assumed ancestor *Variaxon* in one apomorphic feature: the longer catasepta have changed towards a contratingent structure which is – as usual – connected with a marked biform tabularium. Further distinct characteristics (*Cyathaxonia*-like juvenile subtabular regions with strongly thickened septa leaving nearly no interseptal spaces, less shortened cardinal septum) might be only specific criteria. Both genera share the sometimes present, strong or weak spiny ornament of the septal flanks, appearing strange within the Antiphyllidae.

This reminds the partly homoeomorphic subgenus *Cyathaxonia* (*Cyathocarinia*) Soshkina, 1928, representing another suborder of Rugosa (*Cyathaxoniina* Spasskiy, 1977). Several times (Soshkina, 1928, 1932, Fomichev, 1953, Flügel, 1972, Rodríguez, 1984, Rodríguez & Kullmann, 1999), both taxa had been mixed. For sure identifications, often neglected studies of the calice are demanded to see the columella/pseudocolumella in *statu nascendi* without later stereoplasmatic thickening and diagenetic recrystallisations – then the differences between the circular aseptal columella of *Cyathaxonia* (genetically derived from tabulae after an everted growth of a former aulos (circulotheca) in the phyletic line *Laccophyllum* → *Cyathaxonia* in the Early Famennian; Weyer, 2001) and the septal pseudocolumella of *Sloveniaxon* are striking.

Temporarily, it seemed possible that *Cyathocarinia* is the valid name for the new genus *Sloveniaxon*. This was based on an incorrect designation of the type species in Ivanovskiy (1976, 50 - *C. multituberculata* Soshkina, 1928, said to be a questionable synonym of *C. rushiana* Vaughan, 1906), following Soshkina et al. (1941, 43 - genotype *C. rushiana* Vaughan, 1906, including as a subspecies *C. multituberculata* Soshkina, 1928 with synonym *C. tuberculata* Soshkina, 1928). The real type species is *Cyathaxonia* (*Cyathocarinia*) *tuberculata* Soshkina, 1928, designated by Lang et al. (1940, 43), surely an unfortunate (but valid) choice because this species was known by only one rather juvenile specimen; its original illustrations (Soshkina, 1928, 376, figs. 17) look like a



**Figure 3.** *Sloveniaxon asseliensis* sp. nov., paratypes; Dovžanova Soteska NNE Tržič, Karavanke Mts., Slovenia; upper Dovžanova Soteska Formation, locality/bed/sample 131 (A, C) and 130 (B), late Early Asselian. A1-6. no. MB.K.7930; series of subtabular (1-4, open interseptal spaces disappeared in the youth, later at maturity well visible, with regular contratingent septal pairs) and calicular CS (5, 6, local sparitic calcite indicates geopetal structure), x16(1), x10 (2, 3), x8,5 (4, 5), and x8 (6). B: Specimen no. MB.K.7935. B1: Juvenile CS, x16. B2: Median LS (left half metaseptum with fibro-normal = lamellar microstructure, without trabeculae; right half pseudocolumella with domed growth lines), x16. B3: Lower calicular CS (pseudocolumella with ca. 16 septal lamellae), x10. C: Specimen no. MB.K.7928. C1: basal calicular CS, x12. C2: lower calicular CS, x15. C3: septa with spinous flank ornamentation in a middle calicular CS, x20.



**Figure 4.** *Sloveniaxon asseliensis* sp. nov., holotype (B) and paratypes (A, C, D); Dovžanova Soteska NNE Tržič, Karavanke Mts., Slovenia; upper Dovžanova Soteska Formation, locality/bed/sample 130 (A,D) and 131 (B,C), late Early Asselian. A: Specimen no. MB.K.7934. A1: juvenile subtabular CS without open lumina, x25. A2-4: lower calicular CS, x14 (2, 3) and x12 (4). B: Specimen no. MB.K.7924. B1: eccentric LS, x12. B2-4: CS in the basal, lower and middle calice, x10 (appearance of biform tabulae in B3). C: Specimen no. MB.K.7929. C1: Juvenile subtabular CS showing unusual unclosed lumina, x15. C2: Subtabular later CS of a middle growth phase where lumina almost disappeared, x10. D1-2: Specimen no. MB.K.7936.; subtabular and lower calicular CS with well visible septal lamellae inside the pseudocolumella, x14.

normal *Cyathaxonia*. We can not provide a more comprehensive revision based on additional collections, as nobody has topotypes from the Northern Urals (river Ilytch).

*Epiphanophyllum* Iljina, 1970 (Middle Permian, Murgabian, Pamirs, Tajikistan) with its dominant antiseptal pseudocolumella (comparable to *Lophophyllidium* Grabau, 1928) is not related to *Sloveniaxon*. The original orientation of Iljina (1970) was reversed in Weyer (1979, 13, axial boss not of cardinal, but of antiseptal origin, as common in Rugosa).

*Cyathaxonella* Stuckenberg, 1895 remained unrevised, at present still a nomen dubium. The probably upper Viséan monotypic type species *C. gracilis* Stuckenberg, 1895 has short, obviously not contratingent catasepta. A lectotype designation (Ivanovskiy, 1976, 50) was done without any re-description; he simply declared the genus to be a synonym of *Cyathaxonia* Michelin, 1847, clearly an unjustified opinion against the better diagnosis of Stuckenberg (1895, "columella" with septal lamellae). In vain, we tried to restudy this specimen; it seems to be lost in the collections of the Chernychev Museum (VSEGEI, St.-Petersburg). Topotypes in calcareous preservation would be necessary for a modern analysis; perhaps *Cyathaxonella* is a senior synonym of *Variaxon*? But interesting are the determinations given as a faunal list in Schellwien (1898a, 1898b, *Cyathaxonella* nov. sp.) from the Dovžanova Soteska Formation (his "Troglkofel Limestone") - very probably this was the here described *Sloveniaxon asseliensis* sp. nov. and then an extraordinary precise determination for those times.

**Distribution.** Late Carboniferous (late Bashkirian-upper Moscovian), Ukraine (Donez Basin), Spain (Cantabrian Mountains), China, Early Permian (Asselian - Slovenia, Sakmarian? - Iran, Late Artinskian - Russia, Ural Mountains, Cisuralian - China), Middle Permian (Capitanian) - Indonesia (Timor), Late Permian (Dzhulfian)? - Hungary (Bükk Mountains).

***Sloveniaxon asseliensis* sp. nov.**

(Figs 3-6)

? 1898a *Cyathaxonella* nov. sp. -Schellwien: 697.

? 1898b *Cyathaxonella* nov. sp. -Schellwien: 361.

**Derivation of name.** After the Asselian age of the new species.

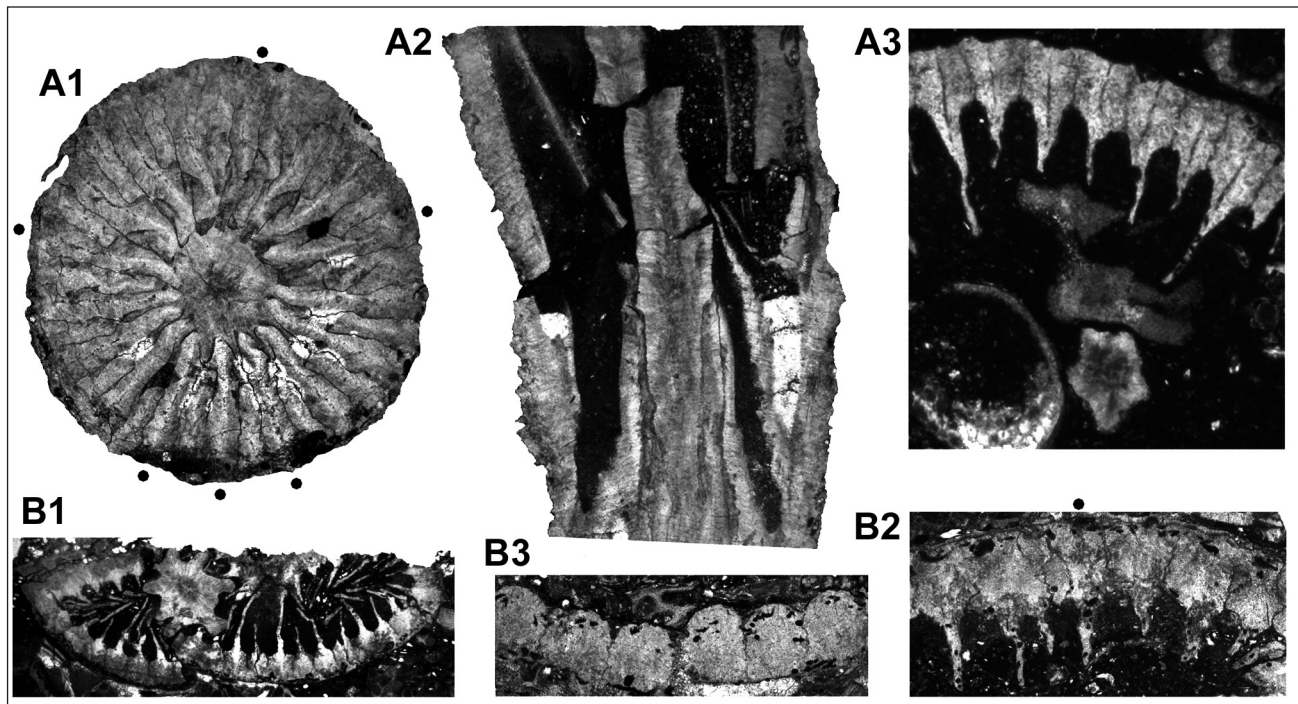
**Holotype.** Specimen no. MB.K.7924. [9CS (5P, 4TS), 2LS (TS), 2R] - Fig. 4/B1-4, 6/A1-6.

**Paratypes.** 14 specimens - 7 from the type locality/sample 131 (no. MB.K.7925.-7931., coll. Kossovaya, Novak & Weyer 2010), 2 from the locality/sample 133 (no. MB.K.7932.-7933., coll. Novak 2005), 5 from the locality/sample 130 (no. MB.K.7934.-7938., coll. Kossovaya, Novak & Weyer 2010). Altogether, 79 CS and 8 LS were prepared from 11 specimens (Figs 5-6).

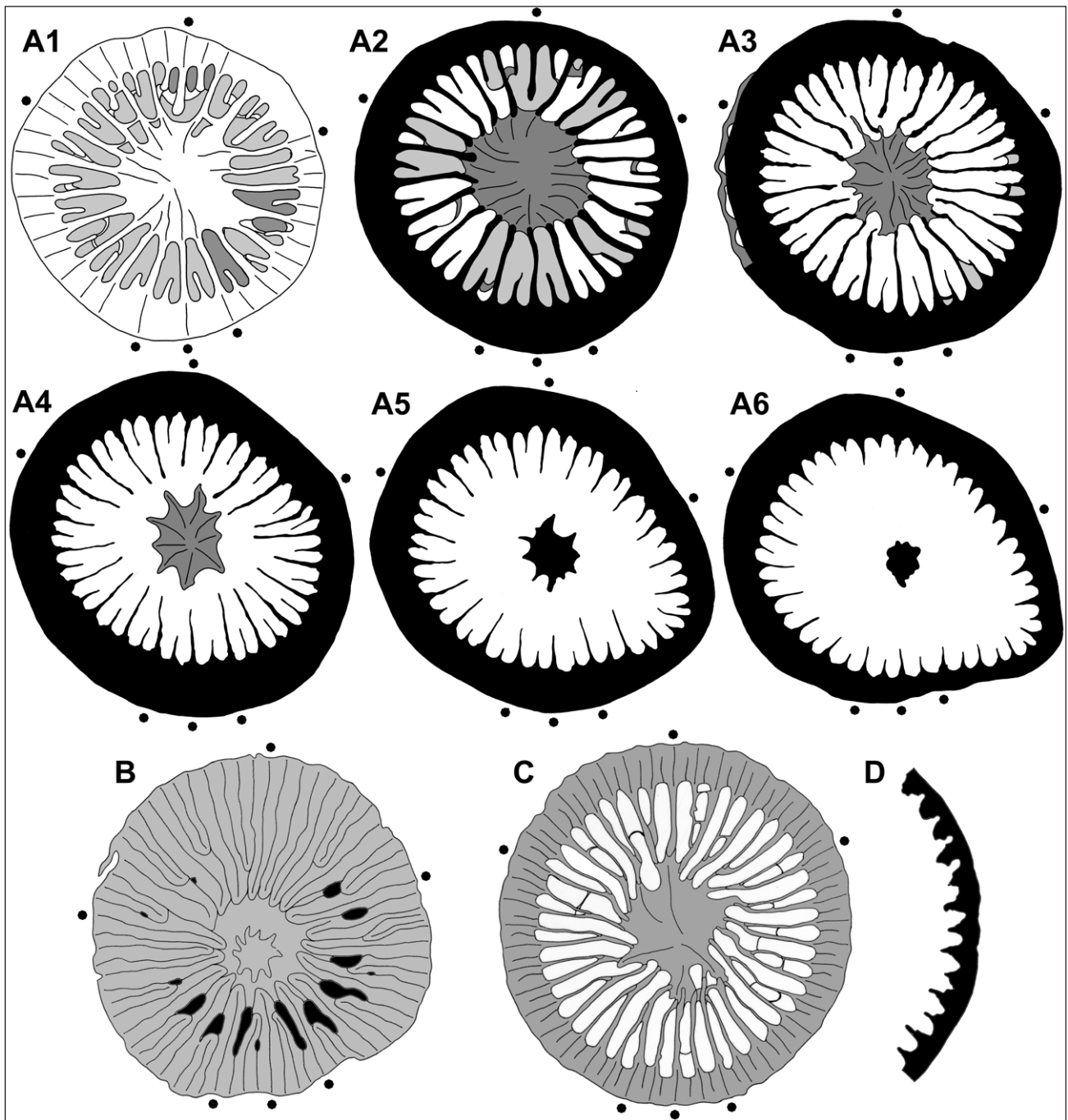
**Type locality and horizon.** Dovžanova Soteska section NNE Tržič (locality 131, Novak, 2007a - forest path at the steep eastern slope of the gorge high above the Dolžanov bridge on the river Tržiška Bistrica). Upper Dovžanova Soteska Formation (level about 125 m above its base - see Fig. 2), late Early Asselian.

**Diagnosis.** Small corallum (up to 29 mm length and 8 mm calice diameter) with 44 septa and a high massive pseudocolumella consisting of 9-17 well developed septal lamellae (occupying 24-34 % of the diameter). Septal flanks weakly spinose in the upper calice; deeper (and subtabular) smooth after strong stereoplasmatic thickening leaving no free interseptal spaces in the youth. Long catasepta contratingent.

**Description.** The small solitary, straight to very slightly cornute corallum reaches 15-20 mm length and 6-8 mm calicular diameter. A basal talon was never observed (even at the minimal preserved diameter of 1,6 mm). Mostly, there occurs corrosion before the final sedimentation (proximal and distal ends broken away, upper calice compressed, archaeotheca damaged, only sometimes showing the well developed regular interseptal longitudinal ribbing without hyposeptal furrows - Figs 4D, 5A3). Weak rejuvenescence is very rare (Fig. 6A3). All the material could not be freed from the sediment and was mainly collected by splitting the stones at right angle to the bedding plane (then looking for cross sections).



**Figure 5.** *Sloveniaxon asseliensis* sp. nov., paratypes; Dovžanova Soteska NNE Tržič, Karavanke Mts., Slovenia; upper Dovžanova Soteska Formation, locality/bed/sample 131, late Early Asselian. A: Specimen no. MB.K.7925. A1: Subtabular CS, with most septa strongly thickened by stereoplasma, x15. A2: median calicular LS, with tabulae only in contratingent lumina (position I), x10. A3: part of middle calicular CS, with still free metasepta and catasepta, and with top of pseudocolumella bearing 5 septal lamellae, x20. B: Specimen no. MB.K.7926. B1: Crushed middle calicular CS with pseudocolumella bearing 10 septal lamellae, x8. B2: cardinal septum, metasepta, and catasepta in a middle calicular CS showing weak ornamentation of septal flanks, x20. B3: undifferentiated, broadly rounded septa near the upper calicular margin, x20.



**Figure 6.** *Sloveniaxon asseliensis* sp. nov., holotype (A) and paratypes (B-D); Dovžanova Soteska NNE Tržič, Karavanke Mts., Slovenia; upper Dovžanova Soteska Formation, locality/bed/sample 131 (A-C) and 130 (D), late Early Asselian. A1-6: Specimen no. MB.K.7924. series of calicular CS, well demonstrating the change of free to contraclined and finally (at the calicular base) to contratingent catasepta, x10 (subtabular regions light grey in 1, white in 2). B: Specimen no. MB.K.7925.; subtabular CS, x15. C: Specimen no. MB.K.7930.; mature subtabular CS, x9. D: Specimen no. MB.K.7935.; septa with irregular flank ornamentation in the upper calice, x10.

The deep calice contains a high and massive pseudocolumella built of axially fused septal lamellae. Their peripheral free ends are well visible in middle calicular cross sections, but nearly disappear slowly against the calicular base after strong stereoplastic thickening. The microstructure may show their former presence (Figs 4A3, 6A2, 6B), even in most subtabular cross sections, where regular concentric growth lines as in *Cyathaxonia* are never seen. There is no dominant antiseptal participation and no prominent cardinal/counter lamella. A small lumen within the pseudocolumella (caused by an isolated tabula) occurs only once.

The adult septal apparatus (D 5-7 mm) has 44 radially arranged septa: 26 major septa (21 of equal length, cardinal septum only slightly shortened, 4 last metasepta of the four quadrants mostly appearing like minor septa), and 18 catasepta (of variable length amounting 30-80%, but mostly about 50% of

the length of major septa). Septal formulae of the smallest and of the larger cross section:

$\frac{3|3}{4|4}$  n 17                       $\frac{5|5}{6|6}$  n 26                       $\frac{4|4}{7|7}$  n 26

$\frac{4|4}{D 2.3 \text{ mm}}$                        $\frac{6|6}{D 5.2 \text{ mm}}$                        $\frac{7|7}{D 5.0-6.3 \text{ mm}}$

Fig. 4A1

Fig. 3B3

Fig. 3A4-6, 6A

Catasepta are free in the upper and middle calice; later (in the lower calice, when major septa join the pseudocolumella) they become contraclined and finally contratingent. The antiseptal triad has no longer minor septa. Septal flanks may bear weak and irregular tiny spines (Figs 3C3, 6D) which disappear in the deeper calice after continuous stereoplastic thickening of the complete septal apparatus. Subtabular regions of juvenile and middle growth stages have completely lost their interseptal lumina (thus much resembling the homoeomorphic genus *Cyathaxonia*) which

are left still widely open at maturity (Figs 6A1-2, 6C). Interseptal spaces of position I are closed first (Fig. 4A3, 4D2).

The septal microstructure (Fig. 3B2) is lamellar (Schindewolf, 1942, with synonymous term fibronormal of Kato, 1963); there are no trabeculae or tiny spines at the upper septal margins which have a special broadly rounded appearance (without a multitrabecular zone) near the upper rim of the calice (Fig. 5B3).

A strongly developed biform tabularium is visible in longitudinal sections (Fig. 5A2), in a series of calicular cross sections (Fig. 6A2-3), and in subtabular cross sections with interseptal lumina (Fig. 6C) demonstrating the contrary inclination of tabular intersections in position I (adaxially inclined) and position II (inclined towards the archaeotheca). A very weak cardinal fossula is indicated in Figs 6A1-2.

**Discussion.** The majority of definitely/probably included species (especially those from Bashkirian-Moscovian) is imperfectly studied and can be compared only after intensive revisions (including the hitherto neglected calicular morphology). No further record of Asselian times is known. Well differentiated are the Late Artinskian *Sloveniaxon multituberculatus* (Soshkina, 1928) by its much stronger spine ornament at the septal flanks, and the Capitanian *Sloveniaxon* sp. C (*Pterocorallia incertae sedis* Form II, Schouppé & Stacul, 1959) with smooth septal flanks. Obviously, there exist only very minor specific differences which are rather difficult to discriminate, as in *Cyathaxonia*. There, some authors (starting with Soshkina, 1932 and Schindewolf, 1951) proclaimed only few, extremely long-living species - an biologically improbable hypothesis not followed here.

**Distribution.** For the moment, only at the type locality/bed and two immediately neighbouring outcrops.

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