Observations on *Dissocladella annulata* (Elliott, 1993) nov. comb. (Calcareous algae, Dasycladales) from the Cenomanian of west Serbia

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**Abstract.** Based on material from the type area at Tetrebovo in the Zlatibor massif of W Serbia, the Cenomanian dasycladalean alga originally described as *Harlanjohnsonella annulata* by Elliott (1968, typified 1993 in: Granier & Deloffre), is emended and revisited as *Dissocladella annulata* (Elliott) nov. comb. The evidence of tufts of short secondaries arising at the top of the drop-like primaries allows its transfer to the genus *Dissocladella* Pia, 1936. This species displays a different degree of skeleton calcification which is described in detail. The monospecific genus *Harlanjohnsonella* Elliott becomes invalid, as being a junior synonym of *Dissocladella*.

**Key words.** Dasycladales, *Dissocladella annulata* (Elliott) nov. comb., systematic taxonomy, Cenomanian, Serbia.

**Introduction**

In 1968 Elliott described a new dasycladalean genus and species as *Harlanjohnsonella annulata* from transgressive, basal Upper Cretaceous, possibly Cenomanian of “Tetrebovo, Dlaglica SE of Zlatibor massif, SW Serbia” with the following diagnosis of the genus “Weakly calcified thin-walled tubular and annular dasyclad, with successive verticils showing numerous swollen primaries, the presumed secondaries not being calcified”. The species is typified 1993 in Granier & Deloffre Discussing the relationships, Elliott concluded “that the form now described was, in fact, a dasyclad of very similar plant morphology to *D. (Dissocladella) savitriae*, but more weakly calcified” and because “there is no direct fossil evidence of secondary branch-structure the species cannot correctly be referred to *Dissocladella*.”

Based on material sampled at the type locality (Radoičić 1995), from which new thin sections have been prepared, it is documented that the genus *Harlanjohnsonella* Elliott represents a younger synonym of *Dissocladella* Pia confirming Elliott’s presumption. The scope of the present paper is a taxonomic revision and detailed illustration of *Dissocladella annulata* (Elliott, 1968) nov. comb. допуњена је уз детаљне илустрације о структури скелета.

**Gеоlogiсаl sеttinɡ**

The Cretaceous deposits of the southern (Tetrebovo, Vis, Fig. 1) and of the central Zlatibor Mountains are rare remnants of a Cretaceous (Albian–?Lower Senonian) cover resting upon ultramaphic rocks. First data on the Cretaceous strata of southern Zlatibor were given by Elliott (1968, “possibly Cenoma-
The Tetrebovo succession (Figs. 1, 2), overlies peridotites. According to RAMPNOUX (1970, p. 275, fig. 145; 1974, p. 63), it starts with a Lower Cretaceous weathering crust. In detail the succession consists of:

- basal conglomerates,
- sandy limestones with gastropods, at places limestones with “Harlanjohnsonella annulata” ELLIOTT, and,
- limestones with Chondrodonta joannae CHOFAT, Radiolites lusitanicus PARONA and R. peroni DOUVILLE.

This succession was ascribed to the Turonian by RAMPNOUX in 1970, afterwards in 1974 to the Cenomanian–Turonian as being equal to that one at Ravni (East Zlatibor). In the meantime, the rudist limestones in the Ravni area, dated as Turonian by PEJOVIĆ & PASIĆ (1958) were revised as being Cenomanian in age (RADOIĆIĆ 1995). It should be mentioned, that this does not correspond to the same Ravni succession dated as Turonian by RADOIĆIĆ. Afterwards, these sparsely outcropping Tetrebovo Cretaceous deposits were sampled only at places (RADOIĆIĆ 1995). One of the oldest observed beds is represented by a marly limestone containing gastropods and large specimens of Dissocladella annulata (ELLIOTT) nov. comb., which are well visible without lens. Upward in the section, the limestone contains rare benthic foraminifera, the dasycladalean algae Heteroporella lepina PRATURLON, Terquemella sp. and a few fragments of Dissocladella annulata. They are followed by limestones with frequent foraminifera, respectively Marssonella turris (D’ORBIGNY), Rotalia mesogeensis TRONCHETTI, Pseudorhipidio- nia casertana (DE CASTRO), Pseudocyclammina rugosa (D’ORBIGNY) and Praevalveolina cf. iberica REICHEL. Between these beds and youngest observed skeletal calcarenites (middle-upper Cenomanian), the limestone with relatively frequent Pseudorhapydionina dubia DE CASTRO is sampled.

The limestone with Dissocladella annulata contains numerous large skeleton fragments, small and minute debris, different gastropods, molluscan shells
and rare crustacean fragments, also mentioned by Elliott (1968). In the 25 thin sections studied, only one specimen of Pseudorhipidionina casertana and a few small foraminifera were observed. Clearly, Dissocladella annulata obviously populated shallow-water environments, probably of low salinity. At the type locality, the limestone with Dissocladella annulata can be ascribed to the lowermost Cenomanian.

Systematic taxonomy

Division Chlorophyta
Order Dasycladales Pascher
Family Triploporellaceae (PIA, 1920)
Tribus Dissocladellae Elliott, 1977
Genus Dissocladella PIA, 1936 in: RAMA Rao and PIA, 1936
(Synonym Harlanjohnsonella Elliott, 1968)

Dissocladella annulata (Elliott, 1968), nov. comb., revisited
Pls. 1–5, Pl. 6, Figs. 1–16

1968 Harlanjohnsonella annulata nov. gen., nov. sp. – Elliott, p. 494, pl. 93, figs. 1-2, pl. 94, figs. 1-2.
1978 Harlanjohnsonella annulata Elliott – Bassoullet et al., p. 120, pl. 12, figs. 8-9.
1995 Harlanjohnsonella annulata Elliott – Radiočić, pl. 1, fig. 1.

Material. Twenty-five thin sections from the sample 022070, R. Radiočić collection RR4579 – 4584/9 deposited at the Geological Institute, Beograd.

Diagnosis. Elongated cylindrical thallus exhibiting a large central stem with moderately spaced horizontal whors. The whors consist of numerous laterals: drop-like primaries which, at the top, bear tufts of 5–6 thin phloiophorous secondaries. Primary calcification generally weak, stronger or only somewhat thicker around the proximal area of the primaries, becoming thinner outwards, especially at tip and around the secondaries. Possible presence of fertile and sterile individuals.

Description. Being rather variable in size, the skeleton of this species is rather thin with smooth inner surface. The primary calcification is diagenetically overgrown in variable degrees. Different degrees of recrystallization can be observed even within the same whorl. The weakly calcified distal part of the whors, if not early diagenetically recrystallized, is more or less dissolved or abraded. Therefore, secondary laterals are preserved only in very rare cases, while poorly preserved secondaries are discernable as pores or open pores on the surface of many recrystallized skeletons (Pl. 1, Figs. 2, 4; Pl. 2, Figs. 3, 4; Pl. 3, Fig. 7; Pl. 4, Fig. 9; Pl. 5, Figs. 1–6). Only in some specimens, the membrane of the central stem can be recognized as a dark thin micritic line (Pl. 2, Figs. 1, 2, 5; Pl. 3, Fig. 7). The thin calcareous encrustation of the membrane is rarely preserved; it can be recognized only between two primaries of successive whors, visible in some sections (Pl. 1, Fig. 4, arrows; Pl. 3, Fig. 4, left; Pl. 6, Figs. 4, 5). A thin-walled calcareous tube encloses the pores of primaries (Pl. 2, Fig. 1), (Pl. 3, Fig. 6; Pl. 4, Fig. 1) or more frequently, the thin wall on the surface bears open pores of primaries (Pl. 1, Fig. 1; Pl. 2, Fig. 5; Pl. 3, Figs. 2–5). In rare specimens, the skeleton is dissolved so that it consists of a thin calcareous layer with irregular external surface, on which some parts of the basal calcification of the primaries can be recognized (Pl. 1, Fig. 3; Pl. 2, Figs. 6, 7).

The laterals are arranged in a plane; they are rarely slightly overlapping as shown in the specimen illustrated in Pl. 5, Fig. 8. In successive whors, laterals do not alternate regularly, but occasionally alternation can be observed in a few successive whors. In the proximal part the primaries display a regular funnel-like form; they communicate with the central stem by means of minute pores. In deep tangential sections, small basal pores can be seen gradually increasing from the center to the periphery (Pl. 4, Figs. 1). Transversal sections of primaries are circular in shape (Pl. 4, Figs. 1, 2; Pl. 5, Fig. 7, 8). In both, transversal and longitudinal sections of the skeleton, the pores are often secondarily enlarged or diminished and/or more or less deformed.

Besides more or less large specimens, the analyzed limestones of Tetrebovo contain numerous small and especially minute fragments of disintegrated skeletons. These have particular value for the recognition of the structure of this species and the processes of the skeleton alteration. Minute and small fragments as those shown in Pl. 1, Fig. 4 (arrows), Pl. 3, Fig. 3 (arrows), and Pl. 6, Figs. 1–7 indicate that some skeletons are characterized by a somewhat stronger primary calcification only of the shorter proximal part of the whors, along with an especially thin calcification of the main axis membrane. Therefore, such a kind of calcification facilitated skeleton disintegration, more probably early post-mortem and becoming preserved as small or minute fragments. A further abiotic stage of calcification resulted in the overgrowth of the primary calcification leading to irregular thallus coatings to variable degrees that is completely or partly coverage even within the same whorl.

Calcification and mode of preservation (Figs. 3 and 4) Dissocladella annulata is characterized by two types of primary calcification, shown in the drawings on Fig. 3/1 and 3/3; Figure 3/4 illustrates the relationship between these two types, on Fig. 4. are given different calcification types of the laterals and of the preservation of skeleton.
First type, skeletons of group A (A skeleton): relatively strong proximal calcification usually covering 1/3 of their length, and then distally gradually becoming thinner. Distally, delicate parts of the skeleton, including the secondaries (Fig. 4/1A), were not preserved in the studied material. The characteristic feature of the group A skeleton is that the specimens display a smaller size of the primary laterals (Fig. 3/1, Fig. 4/1A-B, and 2A), resulting in a primarily non-calcified space between the calcified whorls and an annulation of the skeleton (referring to the species name *annulata*). The best examples are illustrated in Pl. 4, Figs. 3, 5 also in Pl. 6, Figs. 1–7, 10 and 11, and also in Fig. 3/1, 4/1A and 2A.

Second type, skeletons of group B (B skeleton): this type is characterized by a) larger primary laterals which are, also in both transversal and longitudinal sections, in slight contact in the largest middle part of the lateral’s length and b) by the stronger proximal calcification which, between successive whorls is compact - cf. collective calcified skeleton sensu DE CASTRO (1997, "guaine calcificata collettiva"). Secondly altered, this skeleton part is formed by calcite mosaic trimmed by smaller grains. In the studied material the B skeleton is often preserved as non-annulated relatively thin calcareous tubes (proximal area) with open pores of primaries (Pl. 3, Figs. 2–5). It has to be mentioned that in some recrystallized skeletons including secondaries, the “annulations” are reflected on the surface only as shallow feeble canals between the whorls (Pl. 4, Fig. 3 left wall, 4). Hence, this skeleton type is generally preserved as calcareous tubes mainly with open pores of the primaries at the surface.

**Dimensions.** The dimensions given by ELLIOTT (1968) are indicated between brackets. Longest observed specimen (L): 12 mm
External diameter (excluding small form in Pl. 2, Fig. 5) (D): 1.18–3.10 mm (up to 2.25 mm)
Central stem diameter (d): 0.940–2.590 mm
d/D: 71% – 89.5% (about 74 %)
Thickness of the calcareous wall (e): 0.098–0.247 mm, maximum up to 0.330 mm (recrystallized – skeletons into secondaries) (0.26 mm)
Distance between successive whorls (h): 0.198–0.210 mm (0.19–0.25 mm)
Diameter of primary pores (p): 0.098–0.123 mm (0.13–0.14 mm)

Thickness of central stem membrane 0.015– 0.024 mm
Number of laterals in a whorl (w): 35–70 (48–50)
The distance between the whorls represents a fairly constant value, while the most variable biometric parameter is the main stem diameter.

Relationships
As a consequence of the species emendation and new combination, Dissocladella annulata (Elliot, 1977) is placed in the Tribus Dissocladelleae Elliot, 1977. The genus Harlanjohnsonella Elliot, 1968 (so far monospecific) becomes invalid as representing a synonym of Dissocladella Pia, 1936. Mention should be made, that the possible existence of secondary laterals was already assumed by Elliott (1968) and integrated in the genus diagnosis. Elliot anticipatorily remarked the similarity of “Harlanjohnsonella annulata” with Dissocladella savitriae Pia, 1936 (type-species of the genus) from the Ma astrichtian–Danian of India showing some similar dimensional parameters (d, d/D, p) and both displaying typical thallus annulation. Dissocladella annulata (Elliot) may show more variable and relatively larger external diameters and higher number of laterals per whorl (w about 40 in D. savitriae). Apart from this, the special type of calcification and different degree of preservation (due not only to diagenesis) seems to be a species-specific feature of D. annulata, not reported from D. savitriae with fully calcified ring-like elements enclosing both primaries and secondaries. Curiously, Bassoulet et al. (1978, p. 92) mention an internal thallus undulation, though not mentioned in the original description. In any case, D. annulata lacks any internal undulation.

Remarks. In the generic discussion, Elliot included the Carboniferous Coelosporrella, the Permian Epimastopora and Pseudoepimastopora. From annular forms such as the Cretaceous Neomeris cretacea Delmas & Deloffre non Steinmann (Delmas & Deloffre, 1962), Dissocladella annulata “differs in the apparently simple branch-structure”. Furthermore Elliot concluded that “a closer comparison can be made with Dissocladella, especially the Paleocene Dissocladella savitriae (Pia, 1936).”

Bassoulet et al. (1978, p. 120) essentially refer to affinities with Pseudoepimastopora: “Le genre Pseudoepimastopora paraît très voisin du genre Harlanjohnsonella et les différences n’apparaissent pas évidentes” and...... “cette espèce pourrait appartenir au genre Pseudoepimastora”. Bassoulet et al. (1978) furthermore express doubts on the existence of “annuli or rings” in Harlanjohnsonella (Elliot 1968, p. 494). Also Jaffrezo et al. (1980) describing Pseudoepimastopora pedunculata were discussing affinities/differences to the genus Harlanjohnsonella. Pseudoepimastopora, however, cannot be considered in the discussion as it represents a nomen nudum (e.g. Granier & Deloffre 1993; Granier & Grgasovic 2000). In the “New taxonomy of Dasycladale Algae” presented by Deloffre (1988), Harlanjohnsonella Elliot, 1968 is treated as a synonym of Paraepimastopora Roux, 1979 although Harlanjohnsonella was established more than ten years earlier. Paraepimastopora is included by Deloffre (1988) in the Mastoporea Pia with aspodyle thalli, whereas in the original description Elliot placed it in the tribus Thysoporellae. Dragastan (1975) reported Harlanjohnsonella sp. from the Lower Cretaceous of Romania, a form later included tentatively in the synonymy of Anisoporella? cretacea (Dragastan 1967) by Bucur (1995). From the Valanginian of Greece, Dragastan & Richter (2003) described Harlanjohnsonella fuccthaueri as a new species characterized by a head-and-peduncle thallus morphology: the peduncle bearing “only primary vesiculiferous ramifications with two shapes: a proximal tubular and the distal part globulous, like vesicle. The cylindrical peduncle is continued by a “head” made up of euspondylic verticils with vesiculiferous ramification”. As shown in the present paper, Harlanjohnsonella represents a junior synonym of Dissocladella; therefore the generic position of the dasycladalean alga described by Dragastan & Richter (2003) remains open. The authors also allege that Dissocladella annulata (Elliot) should exhibit a head-and-peduncle type thallus, a view that must be rejected due to the studied abundant material. Concerning the section designated as holotype, in Pl. 4, Fig. 3, it has to be mentioned that the presence of a “head” is not sure (it may be the section of another specimen in a densely packed algal limestone).

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References


Резиме

Опсервације о врсти Dissocladella annulata (ELLIOTT, 1993) nov. comb. (Dasycladales) из ценомана западне Србије

Кредне наслаге јужног (Тетребово, Вис, сл. 1) и централног Златибора остаци су кредног покрова (алб–?доњи сенон) на ултрамафитима. Први податак о креди на јужном Златибору дао је ELLIOTT (1968), а на основу подataka и материјала RAMPNOUX-a. Присуство туронских седимената документовано је знатно доцније на ултрамафитима. Присуство туронских седимената документовано је знатно доцније на ултрамафитима. Присуство туронских седимената документовано је знатно доцније на ултрамафитима. Присуство туронских седимената документовано је знатно доцније на ултрамафитима. Присуство туронских седимената документовано је знатно доцније на ултрамафитима. Присуство туронских седимената документовано је знатно доцније на ултрамафитима.

Систематика

Ред Dasycladales PACHER

Фамилија Triploporellaceae (PIA, 1920)

Трибис Dissocladelleae ELLIOTT, 1977

Род Dissocladella PIA, 1936, in RAMA Rao and PIA, 1936

(Синоним Harlanjohnsonella ELLIOTT, 1968)
некалцифициран простор што је узрок анулације скелета али и склоности ка десинтеграцији. Скелет типа Б има нешто крупније примарне огранке, јаче калцифициран проксимални дио, те компакну калцификацију међу пршљеновима (тип “колективне калцификације скелета” у смислу De Castro-a, 1997). Очуваност скелета овог типа је другачија – то су кречњачке цјевчице са порама примарних огранака или са отвореним порама уколико зид није потпуније очуван. У скелету рано прекристалисалих јединки изгубљени су елементи унутарње грађе, али са отисцима секундарних огранака на површини скелета. 

Dissocladella annulata била је настањена у плитководном ареалу, највјероватније у условима смањеног салинитета. Кречњаци са Dissocladella annulata у типском локалитету приписани су најнижем ценоману.
PLATE 1

Dissocladella annulata (Elliott, 1993) nov. comb., emended, aspects of different skeleton preservation.

Fig. 1. Relatively well preserved oblique section of type B skeleton with calcification reaching from the main stem to p.p. distal parts of the primary laterals; note, that in the topmost whorl, the primary laterals are in slight contact. Thin section RR4584/7.

Fig. 2. Oblique section of type B skeleton altered by endolithic activity; in parts of the wall secondaries are discernible. Thin section RR4583.

Fig. 3. Oblique section of a dissolved skeleton with only a very thin remnant of the proximal part being preserved. Note some primary pores in the upper part of the figure. Thin section RR4583/5.

Fig. 4. Slightly oblique transverse section of a completely recrystallized type B skeleton with denticulated outer (moulds of secondaries) and smooth inner surface. Arrows: minute fragments of primaries (type A skeleton), in two of which parts of the encrusted stem membrane are preserved. Thin section RR4583/2.

Scale bar for all figures = 0.50 mm
Dissocladella annulata (ELLIOTT, 1993) nov. comb. (Calcareous algae, Dasycladales) from the Cenomanian of west Serbia
PLATE 2

*Dissocladella annulata* (Elliott, 1993) nov. comb., emended.

Fig. 1. Relatively well preserved, slightly oblique transverse section with main stem preserved as a thin micritic line; arrow: somewhat thicker part of the skeleton wall with a few poorly preserved open pores of secondaries. Thin section RR4584/8.

Figs. 2, 3. Transverse sections of poorly preserved, recrystallized and more or less dissolved skeletons with, in the upper part, slightly visible micritic main stem membrane. Thin sections RR4583/1 and 4583/7.

Fig. 3. Slightly oblique transverse section of a recrystallized type B skeleton, partly dissolved, with denticulate outer and smooth inner surface. Thin section RR4583/7.

Fig. 4. Oblique section of a large fragment, partly recrystallized, altered by endolithic activity and showing some relatively well visible open pores of secondary laterals. Thin section RR4583.

Fig. 5. Slightly oblique transverse section with only the proximal part of the skeleton and the main stem membrane as a thin micritic line being preserved. Thin section RR4583.

Figs. 6, 7. Transverse and longitudinal section of skeletons in nearly last stadium of dissolution; in both the inner surface is smooth. In Fig. 6, left, note the fragment of longitudinal wall section with three drop-like pores of primary laterals; Thin sections RR4584/8 and 4583/5.

Scale bar for all figures = 0.50 mm.
Dissociadella annulata (Elliott, 1993) nov. comb. (Calcareous algae, Dasycladales) from the Cenomanian of west Serbia
Fig. 1. Longitudinal section of a prevailing recrystallized calcareous tube (9 mm in length) in which some subsequently recrystallized pores of primaries are discernible. Thin section RR4584.

Figs. 2, 3. Longitudinal-oblique sections of thin type B skeleton’s wall showing open pores of primaries on the surface. Arrows in Fig. 3: small fragments; note on the left: calcification of group A, versus those of group B skeletons; detail shown in Fig. 4. Thin sections RR4584/5 and 4584/1.

Fig. 4. Detail of the section in Fig. 3, A versus B type skeletons; note the white lines: the relationship of the distance between the whorls (c-c): in group A (left) and B (right). Thin section RR4584/1.

Fig. 5. Transverse section. Thin section RR4583/4.

Fig. 6. Oblique section of the smallest skeleton observed. Thin section RR4584/2.

Fig. 7. Recrystallized skeleton, note (arrow), two pores of primaries arising from the micrite main stem (micrite line) (lower arrow). In the upper part a few pores of secondaries are slightly discernible (upper arrow). Thin section RR4583/5.

Scale bar for all figures = 0.50 mm.
Dissocladella annulata (ELLIOTT, 1993) nov. comb. (Calcareous algae, Dasycladales) from the Cenomanian of west Serbia
Figs. 1, 4. Longitudinal-oblique sections of annulated, selectively altered skeletons. Only the space between the whorls in the proximal area is recrystallized, while the primary calcification is preserved in their distal parts (left in both figures). Thin sections RR4584/8 and 4584/5.

Fig. 2. Longitudinal-oblique section of type B skeleton. Thin section RR4584/1.

Fig. 3. Longitudinal-oblique section of an annulated skeleton in which, in contrast to that one in Fig. 2, the whorls with the primaries are completely recrystallized (Fig. 4/2A), while the space between the whorl is not filled; arrows: thin encrusted stem membrane (right) and (left) recrystallized basal part of the space between the whorls. Thin section RR4582.

Fig. 5. Tangential section corresponding to the skeleton shown in Fig. 2. Thin section RR4584/5.

Fig. 6. Slightly deformed longitudinal-oblique section of type A skeleton similar to that one shown in Fig. 3, poorly preserved and slightly deformed. Thin section RR4584/2.

Fig. 7. Fragment of a longitudinal-oblique section of a type A skeleton; note the encrusted main stem membrane on the right. Thin section RR4584.

Fig. 8. Oblique section of type A skeleton with encrusted stem membrane between the whorls. Thin section RR4584/6.

Fig. 9. Oblique section of a recrystallized skeleton altered by endolithic activity; secondaries discernible in the upper part (arrow). Thin section RR4583/3.

Scale bar for all figures = 0.50 mm.
PLATE 5

Dissocladella annulata (Elliott, 1993) nov. comb.

Fig. 1. Fragment of a tangential section with pores of secondaries in the upper part. Thin section RR4583/1.

Figs. 2–6. Poorly preserved recrystallized oblique sections and fragments with pores of secondaries on the surface. Thin sections RR4584/2, 4584/2, 4584/4, 4584/3 and 4584/9.

Figs. 7, 8. Tangential-oblique and shallow tangential section; “pores” between whorls in Fig. 7 are in fact pseudopores. Thin sections RR4584/2 and 4584/4.

Fig. 9. Oblique deep tangential section. Thin section RR4584/7.

Fig. 10. Tangential section with pseudopores (= not uniformly calcified space between whorls). Thin section RR4583/5.

Scale bar for all figures = 0.50 mm.
Dissocladella annulata (ELLIOTT, 1993) nov. comb. (Calcareaous algae, Dasycladales) from the Cenomanian of west Serbia
PLATE 6

*Dissocladella annulata* (Elliott, 1993) nov. comb., emended (Figs. 1–16), and associated organisms (Figs. 17–21).

Figs. 1–8, 10. Longitudinal and longitudinal-slightly oblique sections of different minute and small fragments of type A skeletons. Thin sections RR4584, 4583/2, 4584/5, 4584/2, 4581, 4584/8, 4584/7, 4584/1, 4583/2 and 4584.

Fig. 9. Longitudinal section, fragment of type B skeleton. Thin section RR4583/4.

Fig. 11. Tangential section of a type A skeleton, corresponding to longitudinal section of skeleton in Fig. 10. Thin section RR4583/2.

Fig. 12. Fragment, longitudinal section of a recrystallized type B skeleton with few open pores of secondaries. Thin section RR 4583/4.

Fig. 13. Fragment of a slightly oblique transverse section with three pores of secondaries. Thin section RR4583/5.

Fig. 14. Fragment of recrystallized transverse section with denticulate surface. Thin section RR4584/4.

Fig. 15. Oblique section, note pores of secondaries. Thin section RR4586/5.

Figs. 16. Oblique section of a recrystallized skeleton affected by endolithic activity within the primaries. Thin section RR 4583.


Figs. 19–21. Sections of crustaceans – *Carpathocancer Schlagintweit & Gawlick* (former *Carpathiella Misik, Sotak & Ziegler*). Thin sections RR4583/2, 4584/6 and 45 84/3.

Figures 1–15: scale bar = 0.25 mm; figures 16–21: scale bar = 0.50 mm.