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Dasycladalean green algae and some problematic algae from the Upper Triassic of the Nayband Formation (northeast Iran)

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Abstract: This paper describes the dasycladales green algae from two sections of the Rhaetian Howz-e Khan Member of the Nayband Formation, northwest of the Dig-e Rostam motorway service area (south of the type locality of the Formation near the town Naybandan). Both sections are composed of bedded fine-grained limestones containing partly abundant dasycladales algae associated with foraminifers, which are mainly aulotortid types. Additionally scattered samples were collected from several beds of the Howz-e Khan Member in this area. The following dasycladalean taxa are described: *Chinianella carpatica* (Bystrický), *Griphoporella curvata* (Gümbel), *Griphoporella lutensis* nov. sp., some undetermined dasycladacean taxa, problematic algae like *Lithocodium aggregatum* Elliott, *Bacinella irregularis* Radoicic, and *Thaumatoporella parvovesiculifera* (Raineri). While *Chinianella carpatica* is not numerous and the other described algae are rare, *Griphoporella curvata* is extremely abundant in the investigated material. This paper describes *Ch. carpatica* for the first time from the Triassic of Iran and also includes a discussion of the strong variability of *G. curvata*. Additionally we include an informal description of a problematic fossil (animal: shell fragment?; plant: alga?).

Key words: Triassic, Iran, Nayband Formation, Green Algae, Dasycladales, *Chinianella*, *Griphoporella*, *Gyroporella*, *Lithocodium*, *Bacinella*.

Introduction

Dasycladalean green algae are an abundant fossil group in shallow-water carbonates, particularly in bedded limestones of Upper Paleozoic and Lower Mesozoic deposits. They are known from numerous localities around the world, especially from the Tethyan Realm. General works about the environmental distribution and diversity of Permian, Triassic, and Jurassic dasycladales are given by Flügel (1975, 1979, 1985), and the stratigraphical range of Triassic dasycladales were carried out by Ott (1972), Flügel (1991), and Bucur (1999). A general work with synonymy-lists of all species of Permian and Triassic dasycladaleans is published by Granier & Grgasovic (2000).

Red algae (solenoporaceans) occur in the bio-constructions of the Nayband Formation and are not described in this paper. Triassic dasycladales are scarcely known from Iran, but they are relatively abundant in the bedded limestones of some Nayband Formation localities. Senowbari-Daryan & Hamedani (2000) described the species of *Diplopora*, *Gyroporella*, and *Acicullela* from the Norian part of the Nayband Formation (central Iran). The genus *Acicullela* is also reported from the Triassic of the Zagros Mountains in southwest Iran (Golestaneh 1979). Foraminifers, dasycladales, including *Poikiloporella duplicata*, *Clypeina besici*, and *Teutloporella herculea* and some problematic fossils were described by Senowbari-Daryan (2003) from the Carnian of the Nayband Mount, not far from the localities of dasycladales described in this paper. The problematic fossil *Probolocuspis espahkensis*, described by Brönniman et al. (1974) was identified in a section near the town of Espahk (south of Tabas) and interpreted as dasycladales by Senowbari-Daryan & Majidifard (2003). Furthermore, *P. espahkensis* and another species of the genus — *P. aculeate* Nittel — are known from the Wetterstein limestones (Ladinian–Carnian) of the Northern Calcareous Alps, Austria (Nittel 2006).

Localities

The dasycladales, described in this paper are from two bedded limestone sections of the Rhaetian Howz-e Khan Member of the Nayband Formation. Both localities are situated in southwest area of the town of Naybandan, a small town east of the type locality of the Nayband Formation south of the Mount Nayband. Additionally scattered samples were collected from locality 3 in Fig. 1. The field work was done by the last two authors.

The first sampled section is located about 7 km southwest of the town of Naybandan (Fig. 1). The locality can only be reached on foot or by motorcycle. Approximately 160 rock-pieces were sampled from the ~246 m thick section of grey, bedded limestones. The lower part of the section, indicated as locality 1 in Fig. 1 (N 32°18′817″; E 57°27′213″) is composed mainly of thick-bedded limestones without reef building organisms. In the upper part of the section some sponges and corals occur. Thin sections, numbered "H" in plate explanations are derived from this locality. The second section is located about 15 km southwest of the town of Naybandan, about 8 km southwest of the first section (Fig. 1) (N 32°15′917″; E 57°24′942″). The lowermost part of the section is sandstone beds, continuing into carbonate beds of

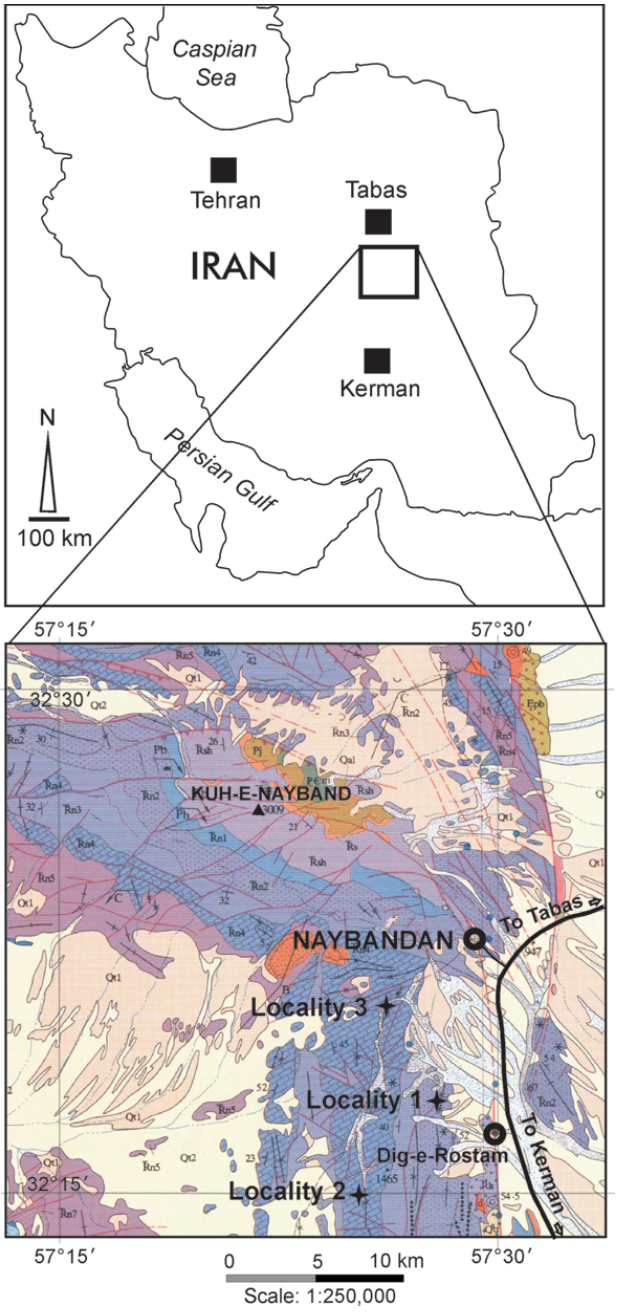

Fig. 1. Geographical position of localities southwest of the small town of Naybandan, from which the algae of the Howz-e Khan Member (Rhaetian) of the Nayband Formation are described. (Part of geological map of Naybandan, Kluyver et al. 1983.)

the Rhaetian Howz-e Khan Member. 76 rock-pieces were collected from this locality and are numbered "khk" in plate explanations. All other thin sections are taken from the different beds of the valley, lying north of the section 1 locality, indicated with a thick line numbered "3" in Fig. 1. Thin sections, marked "n" and "J" were collected from different area of the Howz-e Khan Member in valley between the localities 2 and 3 in Fig. 1. The investigated thin sections are deposited in the "Staatssammlung für Paläontologie und historische Geologie in München, Inventar-Nr: BSPG 2010 XIII 1-48".

Systematic paleontology

Family: **Triploporellaceae** Pia, 1920; emend. LoDuca, 1977

Definition: "Thallus with euspondyle ramifications; productive bodies endosporate or cladosporate" (LoDuca 1977: p. 943).

Tribe: **Triploporelleae** (Pia, 1920), Bassoullet et al., 1979
Genus: *Chinianella* Ott (not 1967), ex Granier & Deloffre, 1993: not 1994 as given in Granier & Grgasovic, 2000

Remarks: There is some confusion about the name of the genera *Chinianella* and *Heteroporella* Praturlon (1967). Ott (1967: p. 215; date of the journal 15th December 1967) introduced the genus name *Chinianella* with type species *Cylindroporella ellenbergeri* Lebouché & Lemoine (1963) and added the two further species, *Ch. crosi* Ott and *Ch. zankli* Ott to this genus. Ott (1968: date of the journal 15th December 1968) emended the genus *Heteroporella* Praturlon and attributed the species *Ch. crosi* and *Ch. zankli* to this genus. Granier & Deloffre (1993: p. 26; see also Granier et al. 1994 and Granier & Grgasocic 2000) re-introduced the genus name *Chinianella* Ott with type species *Ch. ellenbergeri* and also included the species *Heteroporella carpatica* Bystrický (date of the publication and reprint is 1967, but erronneous reference as cited by Granier & Deloffre 1993 is 1968; Granier et al. 1994; Granier & Grgasovic 2000) to this genus. Because *Chinianella zankli* was attributed to a non valid genus at that time by Ott (1967), therefore this species was also not valid. Consequently Granier & Deloffre (1993), Granier et al. (1994), and Granier & Grgasovic (2000) correctly synonymized *Chinianella zankli* Ott with *Ch. carpatica* (Bystrický). The complete synonymy-list of *Chinianella carpatica* (Bystrický) is given by Granier & Grgasovic (2000).

Chinianella carpatica (Bystrický), 1967
(date not given 1967 on reprint)
(Fig. 2A–I, Fig. 3)

*1967 *Heteroporella carpatica* sp. nov. — Bystrický, p. 302, pl. 15, fig. 1–5, pl. 16, fig. 4
*1967 *Chinianella zankli* n. sp. — Ott, p. 219, pl. 13, Fig. 2–3, text fig. 5/1–14
1968 *Heteroporella zankli* (Ott) — Ott, p. 258 (without illustrations)
2000 *Chinianella carpatica* (Bystrický) — Granier & Grgasovic, p. 20 (without illustration, complete synonymy-list)

Material: Several specimens (for thin section numbers of illustrated material see explanations of plates).

Description: Cylindrical specimens of this alga with regularly arranged sterile and fertile whorls. The outer diameter (D) of the thallus varies between 1.44 mm and 2.12 mm, inner diameter (d) between 0.32 mm and 0.52 mm. Diameter of all Iranian specimens corresponds the diameter of *Ch. carpatica* (Bystrický 1967) from the Carpathians, but is moderately smaller than those data given by Ott (1967) for specimens from the Alps.

Groups of five–six sterile laterals end on the thallus surface (Fig. 2H). Their number is given as possibly 4 by Ott (1967).

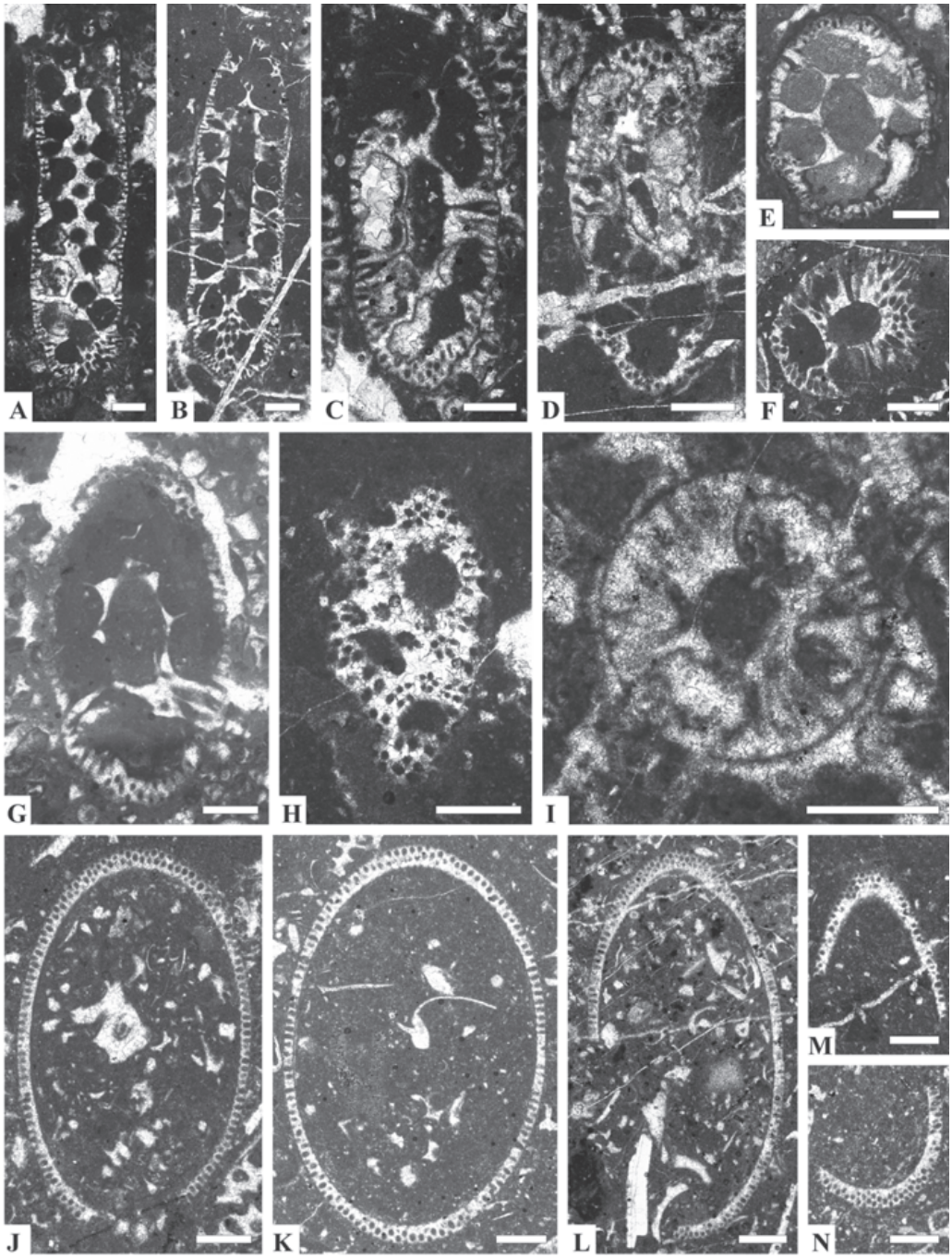

Fig. 2. *Chinianella carpatica* (Bystrický) and *Griphoporella lutensis* nov. sp. from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in all Figs. = 0.5 mm. ***A–I*** — *Chinianella carpatica* (Bystrický). **A** — Marginal axial section showing several sterile and fertile laterals with numerous peripheral laterals (secondary laterals) ending on the surface of the alga. Thin section BSPG 2010-XIII-9. **B** — Axial section through a specimen showing the main stem and numerous fertile and sterile laterals similar to Fig. A. Thin section BSPG 2010-XIII-9. **C** — Oblique section showing the two kinds of laterals as in Fig. A–B. The sterile branches exhibit several secondary laterals. Thin section BSPG 2010-XIII-24. **D** — Oblique section similar as Fig. C. Thin section BSPG 2010-XIII-31. **E** — Oblique cross section showing the fertile and sterile laterals. Thin section BSPG 2010-XIII-16. **F** — Similar as Fig. E. thin section BSPG 2010-XIII-11. **G** — Oblique section of a poorly preserved specimen. Thin section BSPG 2010-XIII-16. **H** — Oblique marginal section showing three fertile and several sterile laterals. Five sterile laterals are grouped. Thin section BSPG 2010-XIII-24. **I** — Cross section showing some fertile and sterile laterals as well as numerous peripheral laterals (secondary laterals). Thin section BSPG 2010-XIII-31. ***J–N*** — *Griphoporella lutensis* nov. sp. **J** — Oblique section similar to Fig. K. Thin section BSPG 2010-XIII-32. **K** — Holotype. Oblique section through the thallus showing the wide central stem and the thin thallus wall pierced by numerous equally distributed laterals. Thin section BSPG 2010-XIII-3. **L** — Oblique section through a broken specimen showing the same algal characteristics as other specimens. Thin section BSPG 2010-XIII-33. **M** — Section through a broken and poorly preserved specimen. Thin section BSPG 2010-XIII-19. **N** — Similar to Fig. M. Thin section BSPG 2010-XIII-25.

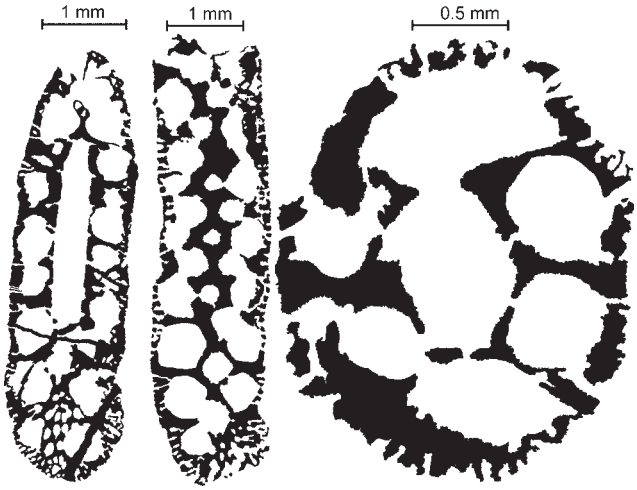

Fig. 3. *Chinianella carpatica* (Bystrický). Two longitudinal sections and a cross section exhibiting the fertile and sterile laterals, as well as the fine, distal laterals (drawn from specimens illustrated in Fig. 2A–B and E).

The number of laterals of sterile whorls is given 5–7 by Bystrický (1967) in sections, but maybe up to 20 laterals extending to the surface. The diameter of fertile laterals varies between 0.32 mm 0.60 mm. Both, the diameter of sterile and fertile laterals on the thallus surface are with 0.040–0.080 mm almost the same. In our material, there are 6 sporangia in each whorl, but Ott (1967) gives their number as 7–8. The biometrical data of Iranian specimens of *Ch. carpatica* (Bystrický) is given in Table 1.

Occurrence: The geographical distribution and the stratigraphical range of *Ch. carpatica* are given by Granier & Grgasovic (2000). The alga is described here for the first time from the Upper Triassic (Rhaetian) of Iran.

Genus: *Griphoporella* Pia, 1915

Type species: *Gyroporella curvata* Gümbel, 1872.

Remarks: The attribution of *Griphoporella* within the dasycladales is controversial. Pia (1915, 1920) did not place *Griphoporella* in any family. Following Deloffre (1988), Berger & Kaever (1992) attributed *Griphoporella* to the family Seletonellaceae (tribe: *Mastoporeae* Pia, 1920). Barattolo et al. (1993) discussed the differences between *Griphoporella* and other similar looking dasycladales attributing *Griphoporella* to the family Dasycladaceae, tribe Salpingoporelleae. The family Triploporellaceae was emended by LoDuca (1977) and this systematic is followed here.

Griphoporella curvata (Gümbel, 1872), Pia, 1915
(Fig. 4A–G, Fig. 5A–L, Fig. 6A–G, Fig. 7A–K, Fig. 8, Fig. 12)

*1872 *Gyroporella curvata* n. sp. — Gümbel pl. D.IV, fig. 2a–d
1915 *Griphoporella curvata* (Gümbel) — Pia, pl. 1, fig. 11
1988 *Griphoporella curvata* (Gümbel) — Sartorio & Venturini, p. 56/2
1988 *Macroporella retica* Zanin-Buri — Sartorio & Venturini, p. 56/3
1993 *Griphoporella curvata* (Gümbel) — Barattolo, De Castro & Parente, p. 26, pl. 1–7
1997 *Griphoporella curvata* (Gümbel 1872) — Grgasovic, pl. 2, fig. 8, 13 (selected syn.).
2000 *Griphoporella curvata* (Gümbel) — Granier & Grgasovic, p. 67–70 (com. syn.)
2000 *Griphoporella curvata* (Gümbel, 1872) Pia, 1915. — Senowbari-Daryan & Hamedani, p. 102, pl. 1, fig. 1, 2A, 4, 6, 7, pl. 2, fig. 1B, 2 B, 3B, pl. 3, fig. 2B, 4, pl. 4, fig. 9

Material: Numerous specimens. We have illustrated numerous specimens cut in different directions of the thallus to show the strong variability of this alga.

Description: The simple calcareous thallus of this alga is straight or moderately curved and slightly club shaped, reaching outer diameters between 2.6 mm and 4.0 mm, the inner diameter between 1.8 mm and 3.2 mm. Two specimens with diameters of 7.5 (Fig. 6A: type 2) and 10 mm (Fig. 12F/A) are extremely large.

The very wide axial stem is surrounded by a thin wall compared with the diameter of the alga. The thallus wall contains wide laterals arranged in alternating verticils (whorls), recognizable in sections oblique to the wall. The laterals are proximally narrow, becoming distally wider (phloiophore). They are always closed by a thin and convex wall. In the convex wall of some specimens very small pores are perceptible, but unverifiable. The partial lack of the convex wall in some specimens is interpreted as a possibly result of post-mortem weathering. The wall between the individual laterals is proximally relatively thick, becoming thinner in the middle part of the walls. Because of the relatively thin wall of the large thalli, most specimens are broken and the thallus fragments are extremely abundant in investigated thin sections.

We distinguished two types (based on variability?) of the thalli with moderately different biometrical data. Type 1 with

Table 1: Biometrical data of *Chinianella carpatica* (Bystrický) from the Rhaetian Howz-e Khan Member of the Nayband Formation, northeast Iran. **D** — outer diameter of the thallus, **d** — diameter of the central stem, **T** — thickness of the wall around central stem, **DS** — diameter of the sterile laterals at the base, **DF** — diameter of sporangia, **DSF** — diameter of sterile and fertile laterals ending on the surface of thallus, **d/D** — ratio of central stem/outer diameter of the thallus, **PS** — position of section. All measurements are in mm (d/D in %).

Section	D	d	T	DS	DF	DSF	d/D	PS
KHK3	1.6	0.4	0.04–0.06	0.04	0.32	0.04–0.05	0.25	cross
KHK19	1.6	0.32	0.12	0.04	0.48	0.04	0.2	cross
KHK19	1.68	0.44	0.08–0.1	0.04	0.6	0.04–0.05	0.26	cross
KHK19	2.12	0.48	0.08	0.04	0.48–0.5	0.06–0.08	0.22	oblique
KHK19	1.8	0.52	0.08	0.04–0.06	0.6	0.06–0.08	0.28	cross
KHK19-2	1.44	0.44	0.04–0.06	0.06	0.44–0.6	0.04–0.06	0.3	oblique
KHK19-3	–	–	–	–	0.4	0.08	–	tangential

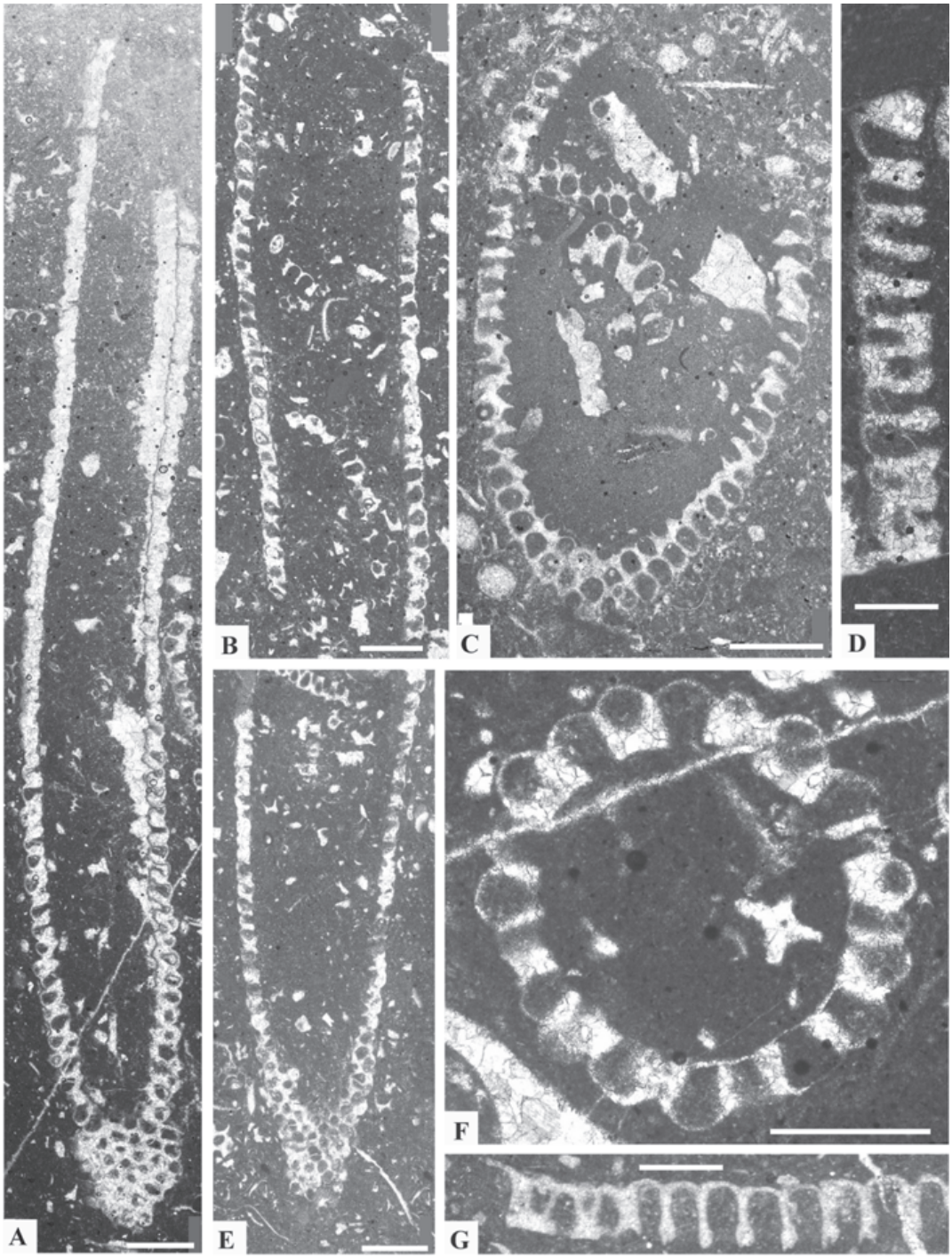

Fig. 4. ***A–G*** **—** *Griphoporella curvata* (Gümbel) type1 from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in A–C and E = 1 mm; in F = 0.5 mm; in D and G = 0.3 mm. **A** — Longitudinal section. The specimen shows the wide central stem and the thin wall of the thallus. In the well preserved lower part of the thallus the phloiophore laterals are narrow at the base (proximal) becoming wider to the periphery (distal). Outside the laterals are closed by a faulted thin wall. Thin section BSPG 2010-XIII-22. **B** — Longitudinal section through a broken specimen showing similar thallus wall characteristics as Fig. A. Some broken fragments of the same alga are embedded within the sediments of the central stem showing clearly the faulted thin wall covered the laterals on the outside. Thin section BSPG 2010-XIII-29. **C** — Oblique section showing the wide central stem and laterals with the same characteristics as in Fig. B. Some broken fragments are embedded within the central stem. Thin section BSGP 2010-XIII-4. **D** — Section through the thallus wall of a broken specimen exhibiting branches, which are distally closed by a thin and convex wall. Thin section BSGP 2010-XIII-16. **E** — Longitudinal section exhibiting similar characteristics to the thallus as in Fig. A. BSGP 2010 XIII-1. **F** — Cross section showing the wide central stem and the thin thallus wall with numerous laterals. The phloiophore laterals are proximally wide becoming distally wider. All laterals are closed by the faulted thin wall. The walls between the individual laterals are thinner than the diameter of the laterals. Thin section BSPG 2010-XIII-26. **G** — Section with similar thallus wall characteristics as Fig. D. Thin section BSPG 2010-XIII-41.

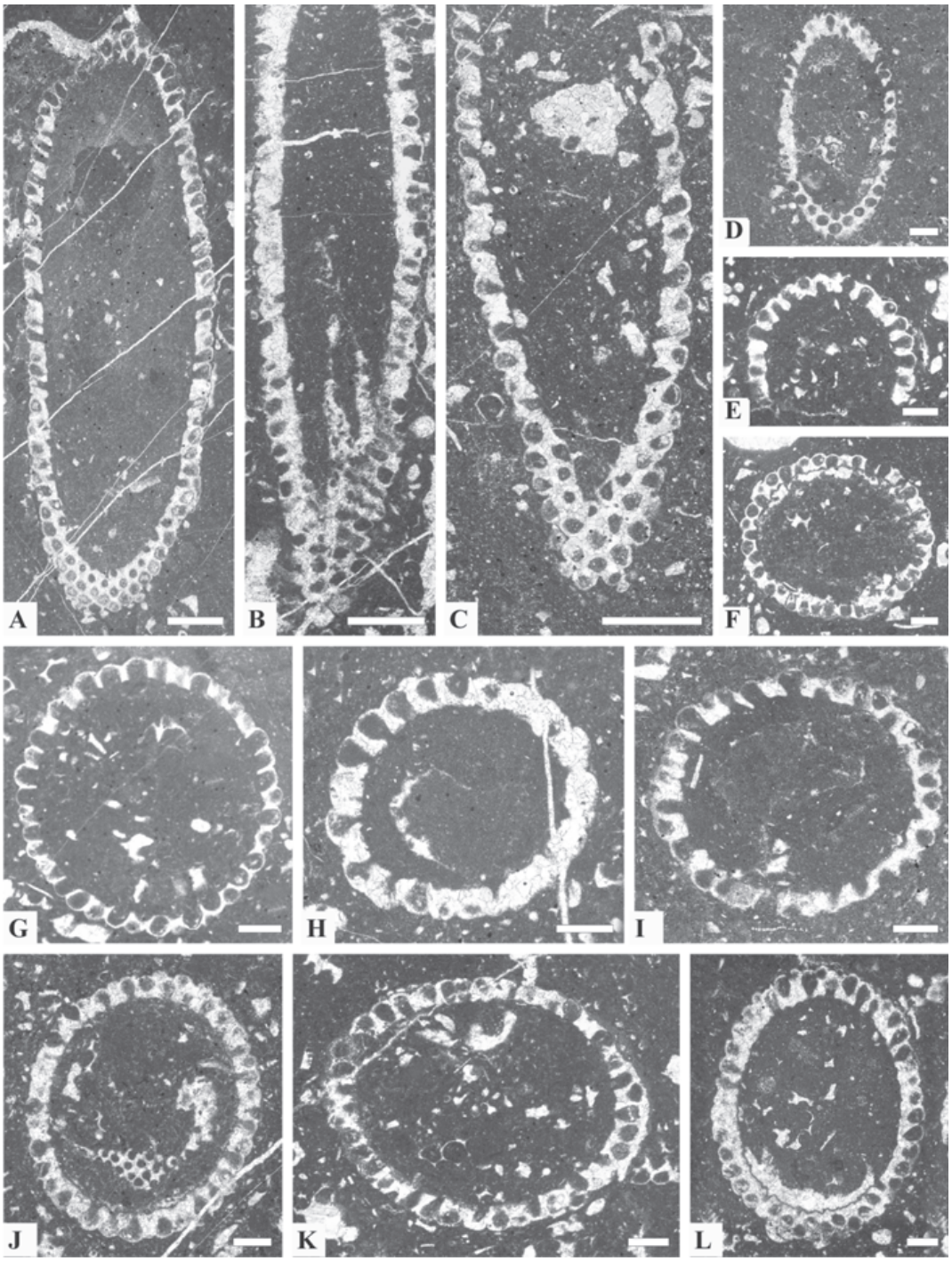

Fig. 5. ***A–L*** — *Griphoporella curvata* (Gümbel) type 1 from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in Figs. A–C = 1 mm, in D–L = 0.5 mm. **A** — Oblique section clearly showing the shape of closed laterals of the thin thallus wall. The alternating arrangement of the laterals is clearly recognizable in the oblique section through the wall in the lower part. Thin section BSPG 2010-XIII-15. **B** — Similar section as Fig. A. Thin section BSPG 2010-XIII-17. **C** — Longitudinal section showing the closed laterals of the thallus wall. Laterals are proximally narrow, becoming wider at the distal end (phloiophore). Laterals are arranged in alternating verticiles, recognizable in the oblique section through the wall in the lower part. Thin section BSPG 2010-XIII-13. **D** — Oblique section. Some laterals are open to the outside; this is interpreted possibly as a result of post-mortem weathering. Thin section 2010-XVIII-8. **E** — Cross section through a broken specimen displaying the shape of distally closed laterals. Thin section BSPG 2010-XIII-28. **F** — Cross section showing similar characteristics of the thallus as Fig. E. Thin section BSPG 2010-XIII-18. **G** — Cross section. The specimens exhibit the thin faulted wall covering the laterals. Thin section BSPG 2010-XIII-26. **H** — Cross section of a thallus showing similar characteristics as Fig. G. Thin section BSPG 2010-XIII-4. **I** — Similar to Fig. H. Thin section BSPG 2010-XIII-25. **J** — Similar to Fig. H. Thin section BSPG 2010-XIII-12. **K** — Similar to Fig. H. Thin section BSPG 2010-XIII-14. **L** — Oblique cross section demonstrating the shape of the laterals. Laterals are proximally narrow, become distally wider (phloiophore). Thin section BSPG 2010-XIII-34.

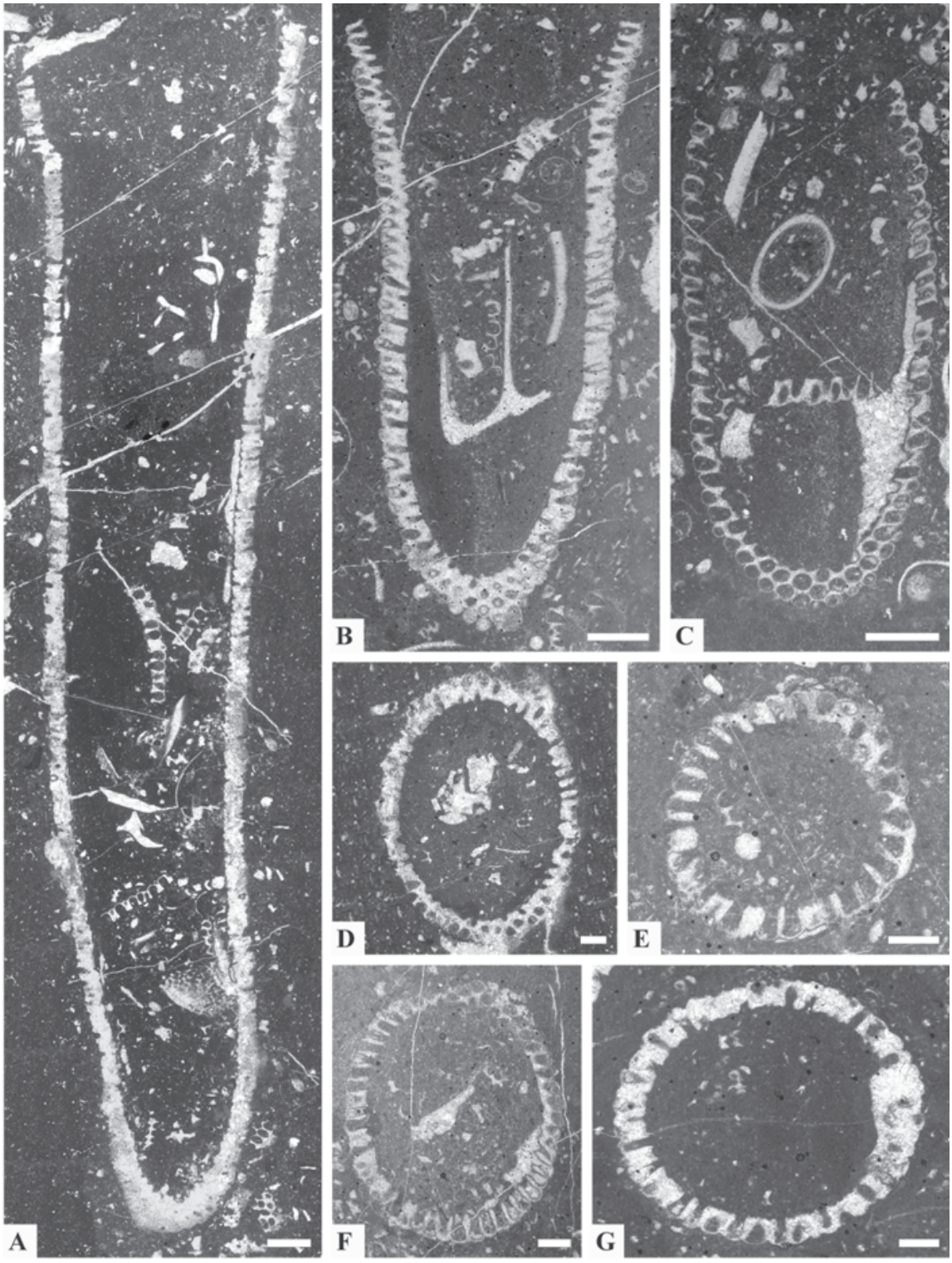

Fig. 6. ***A–G*** **—** *Griphoporella curvata* (Gümbel) type 2 (A–B, D, F–G) and type 1 (C, E) from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in Figs. A–C = 1 mm, in D–G = 0.5 mm. **A** — Longitudinal section showing the thin thallus wall with slender phloiophore laterals. Several broken thallus wall fragments are embedded within the central stem showing the shape of laterals. Thin section BSPG 2010-XIII-21. **B** — Longitudinal section showing numerous slender phloiophore laterals arranged in alternating verticiles (recognizable in lower part of the thallus). Thin section BSPG 2010-XIII-30. **C** — Longitudinal section showing the phloiophore and distally closed laterals. Thin section BSPG 2010-XIII-8. **D** — Oblique cross section. The slender phloiophore laterals are in part distally closed. Thin section BSPG 2010-XIII-6. **E** — Oblique cross section showing similar characteristic of the thallus as Fig. D. Thin section BSPG 2010-XIII-18. **F** — Similar section as Fig. D. Thin sections BSPG 2010-XIII-27. **G** — Similar section as Fig. E. Thin section BSPG 2010-XIII-15.

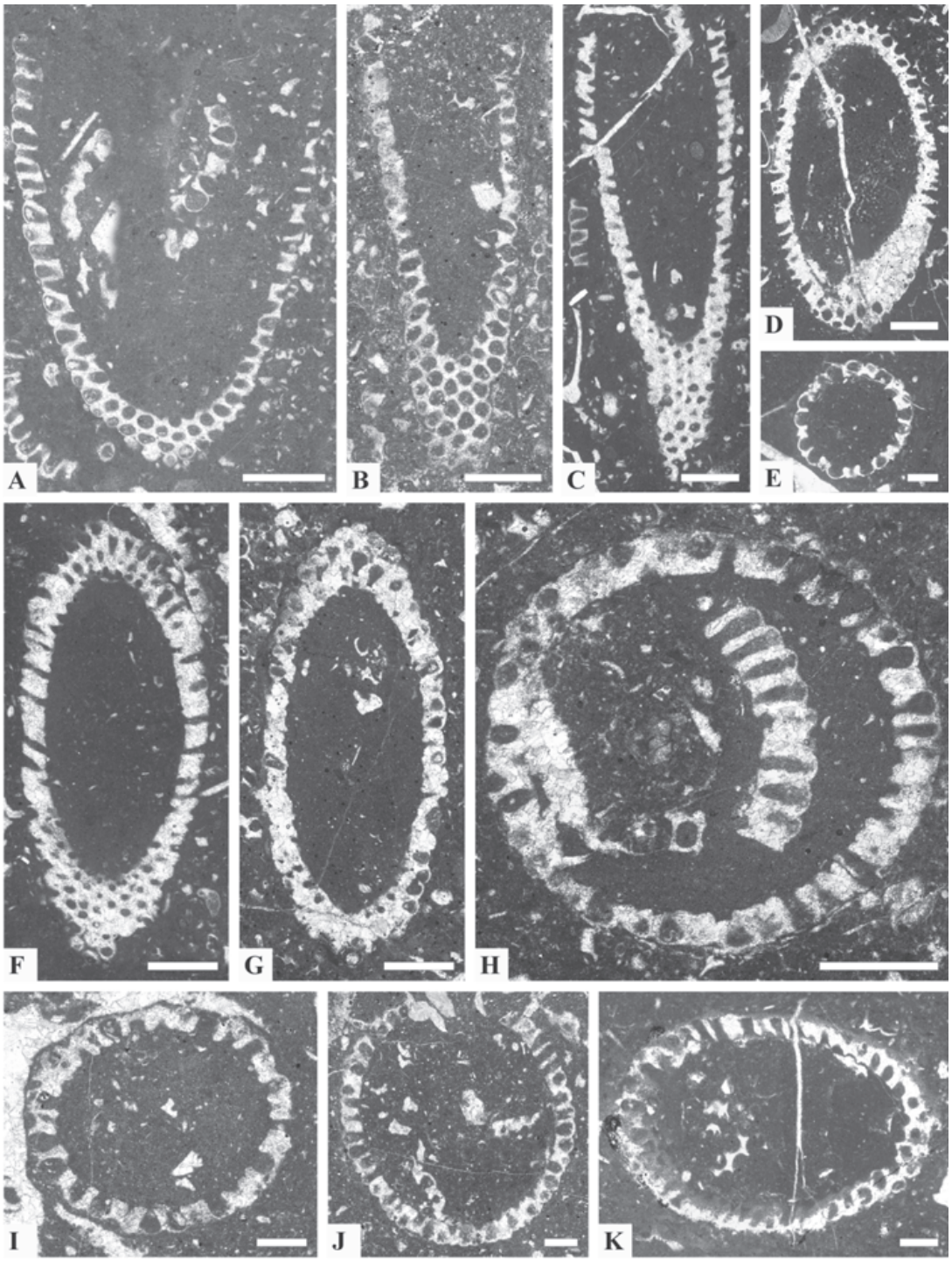

Fig. 7. ***A–K*** — *Griphoporella curvata* (Gümbel) type 2 (C–D, F, K) and type 1 (A–B, E, G–J) from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in Figs. A–D and F–H = 1 mm, in E, I–K = 0.5 mm. **A** — Longitudinal section of a specimen showing parts of the closed phloiophore laterals. Thin section BSPG 2010-XIII-17. **B** — Longitudinal section showing the distally closed phloiophore laterals. Note the alternating verticiles. The walls between the laterals are thinner than the diameter of laterals. Thin section BSPG 2010-XIII-40. **C** — Longitudinal section through a specimen showing the slender phloiophore laterals open at the distal end. The thickness of the walls between the branches is about the diameter of laterals or even thicker. Thin section BSPG 2010-XIII-20. **D** — Oblique cross section. Thin section BSPG 2010-XIII-19. **E** — Cross section. The laterals are distally closed by a thin wall. Thin section BSPG 2010-XIII-2. **F** — Section similar as Fig. C displaying slender laterals. Thin section BSPG 2010-XIII-18. **G** — Oblique longitudinal section showing distally closed laterals. Thin section BSPG-XIII-18. **H** — Cross section through a specimen showing the distally closed phloiophore laterals. The fragment within the axial stem also shows some distally closed laterals. Thin section BSPG 2010-XIII-37. **I** — Cross section showing the distally closed phloiophore laterals. Thin section BSPG-XIII-38. **J** — Similar as Fig. I. Thin section BSPG 2010-XIII-2. **K** — Section similar as Fig. G. BSPG 2010-XIII-3.

pear-shaped laterals (Fig. 4A–G, Fig. 5A–L, Fig. 6C,E, Fig. 7A–B,E,G–J, Fig. 12F/A); type 2 with slender laterals (Fig. 6A–B,D,F–G, Fig. 7C–D,F,K, Fig. 12F/B). Biometric data of the thallus of both types are separately summarized in Table 2. Illustrations in Fig. 8 exhibit the variability of the alga in the investigated material. Fig. 9 shows the ratio of the central stem the thallus diameter (d/D) of type 1 (triangle) and type 2 (rectangle) and Fig. 10 the ratio of the thallus wall to the outer diameter (t/D) of type 1 (triangle) and type 2 (rectangle) of *Griphoporella curvata*.

Discussion: On the basis of numerous specimens from the type locality Barattolo et al. (1993) re-described *Griphoporella curvata* (Gümbel 1872) designating the neotype and emending the species and genus diagnosis. A complete synonymy-list of the species is given by these authors and by Granier & Grgasovic (2000). Barattolo et al. (1993) synonymized *Macroporella retica* described by Zanin Buri (1965) from the Rhaetian of "Prealpi Lombardi", north Italia. Confirming the opinion of Barattolo et al. (1993) Pugliese (1995) re-described *Macroporella retica* from the Upper Triassic of the type locality near the town of Aviatic (Lombardy, Italy). Also those specimens, illustrated as *Macroporella retica* by Ciarapica et al. (1987) were synonymized with *Griphoporella curvata* (Gümbel) by Barattolo et al. (1993). The holotype of *Macroporella retica*, illustrated in pl. 44/a by Zanin Buri (1965) is different from several specimens of *Griphoporella*

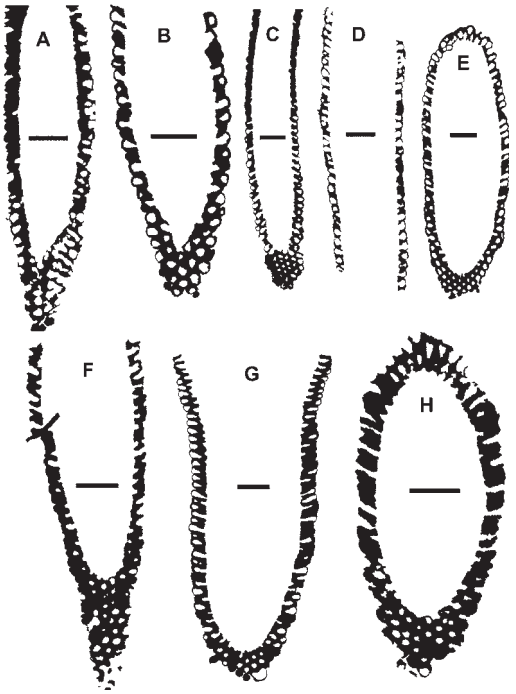

Fig. 8. *Griphoporella curvata* (Gümbel). Fig. A–E (type 1) and F–H (type 2). Drawn from specimens illustrated in Fig. 4A–B, Fig. 5A–C, Fig. 6B and Fig. 7C and F. Scale in all Figs. is 1 mm.

Table 2: Biometrical data of *Griphoporella curvata* (Gümbel). The data of both distinguished types are listed separately. **D** — outer diameter of the thallus, **d** — inner diameter of the thallus, **T** — thickness of the wall, **PP** — proximal diameter of laterals, **PD** — distal diameter of laterals, **TB** — thickness of the wall between the laterals, **TF** — thickness of the wall covered distally the laterals. All measurements are in mm.

Type 1

Section No:	D	d	T	PP	PD	TB	TF	Position
J-39	2.64	1.93	0.4	0.2	0.2	0.04	0.03	Cross
J-39	4.00	2.96	0.48	0.12	0.2	0.04	0.12–0.18	Longitud.
J-30	1.60	1.00	0.2–0.21	0.05–0.12	0.12–0.16	0.04	0.12	–
J-1-3	2.44	2.04	0.32	0.16	0.2	0.04	0.08	Cross
J-1-3	4.00	3.20	0.4	0.12–.16	0.2	0.04–0.06	0.06–.08	Cross
J-2-4	2.96	2.40	0.24–.28	0.08	0.16	0.04	0.04	Oblique
J-2-4	2.96	2.48	0.2–0.24	0.12	0.16	0.04	0.04–0.09	Oblique
J-14-2	2.80	2.16	0.32–0.36	0.16	0.24	0.06	0.06	Cross–oblique
J-14-2	3.20	2.48	0.28–0.32	0.16	0.28	0.04	0.08–0.12	Cross
J-18-2	3.40	2.64	0.4	0.12	0.12	0.04–0.08	0.16	Oblique
J-2-7	3.08	2.20	0.24	0.08	0.16–0.32	0.16–0.64	0.04	Cross–oblique
J-2-7	2.60	2.00	0.2	0.08–0.12	0.16–0.2	0.16–0.4	0.06–0.08	Oblique
J-2-7	2.60	1.8	0.32–0.4	0.08	0.36	0.16–0.2	0.04	Cross
J-15-1	2.08	1.64	0.24–0.4	0.16	0.2	0.08–0.4	0.04	Oblique
J-9-1	3.56	2.84	0.36	0.08–0.12	0.24	0.16	0.04	Cross
J-2-7	2.60	1.8	0.32–0.4	0.08	0.36	0.16–0.2	0.04	Cross
J-15-1	2.08	1.64	0.24–0.4	0.16	0.2	0.08–0.4	0.04	Oblique
J-9-1	3.56	2.84	0.36	0.08–0.12	0.24	0.16	0.04	Cross

Type 2

Section No:	D	d	T	PP	PD	TB	TF	Position
J-39	4.64	3.92	0.36	0.16	0.16	0.08	0.08	Cross
J-39	10.00	9.2	0.4–0.42	0.16	0.16	0.08	0.04	Cross
J-34	3.84	3.12	0.41	0.12	0.2	0.06	0.04	Oblique
J-34	2.64	2.08	0.4	0.1	0.1	0.06	0.08	Cross
J-2-4	4.00	3.36	0.32–0.36	0.16	0.2–0.24	0.04	0.04	Oblique
J-18	4.72	3.92	0.32–0.4	0.16	0.16–0.2	0.04–0.06	0.08–0.12	Oblique
J-18	3.00	2.20	0.32	0.16	0.16–0.18	0.04–0.12	0.12	Oblique
J-15-1	3.76	3.00	0.4	0.08–0.16	0.2–0.24	0.4–0.6	0.04	Longitudinal
J-10-1	3.20	2.48	0.4–0.48	0.12	0.12–0.16	0.08–0.12	0.04	Cross
J-10-1	1.64	1.16	0.24–0.28	0.16	0.16	0.04	0.04	Cross
J-3-2	3.6	3.00	0.28–0.32	0.08–0.12	0.2	0.12–0.16	0.04	Oblique

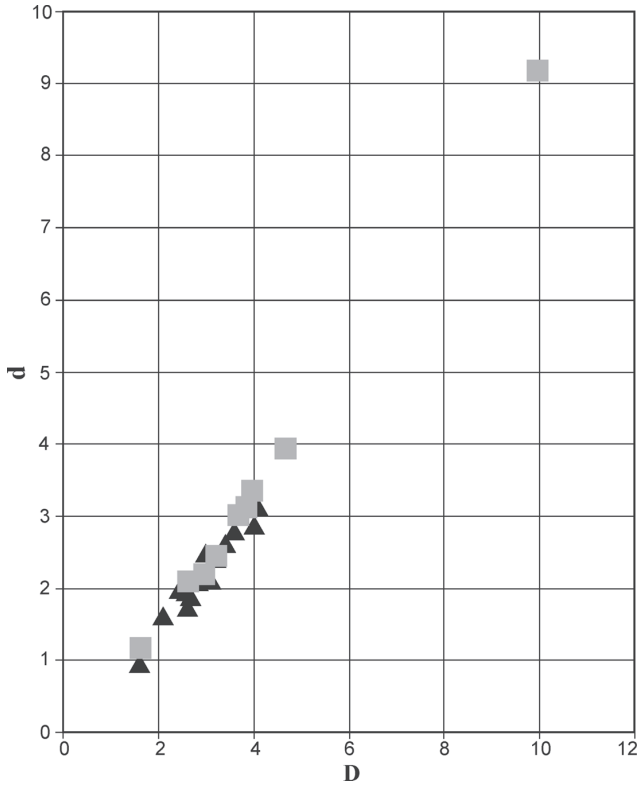

Fig. 9. Ratio of the central stem to the thallus diameter (d/D) of type 1 (triangle) and type 2 (rectangle) of *Griphoporella curvata* (Gümbel). There are no serious differences between types 1 and 2 discussed in the text. One specimen was observed (see Fig. 12F/A) with an outer diameter of 10 mm, much larger than all other specimens. Units for all data are in mm.

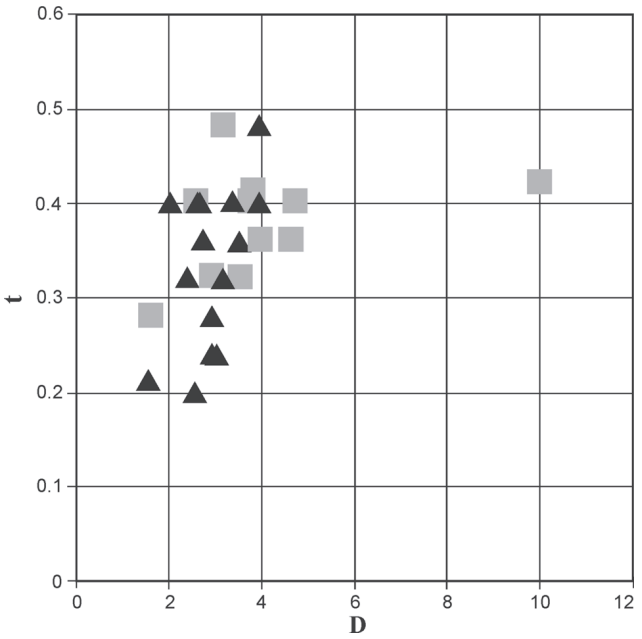

Fig. 10. Ratio of the thickness of thallus wall to the thallus diameter (t/D) of type 1 (triangle) and type 2 (rectangle) of *Griphoporella curvata* (Gümbel). Units for all data are in mm.

curvata (Gümbel) illustrated by the same author in pl. 63. The type species of *Macroporella retica*, illustrated by Zanin Buri (1965) in pl. 44/a, shows the distally closed laterals in part like in most specimen (type 1) from Iran, a characteristic, which is not visible in specimens illustrated by Barattolo et al. (1993). The closed laterals are also not visible in specimens of *Griphoporella curvata* (Gümbel) illustrated by other authors (e.g. Flügel 1981: fig. 10/E; Pugliese 1995: pl. 1, fig. 6; Grgasovic 1997: pl. 2, fig. 8, 13). The laterals of specimens from central Iran, described as *Griphoporella curvata* Senowbari-Daryan & Hamedani (2000) are also distally open and the shape of the laterals is different. The differences between our specimens are shown in Table 2 (type 1 and type 2).

In summary, based on the shape of laterals two types of *Griphoporella* can be distinguished in the investigated material. As shown in Table 2, the differences of other specific data are diffuse and do not allow us to describe them as separate species. Because both types are united in *Griphoporella curvata* (Gümbel) by previous authors, particularly in the synonymy-list of Barattolo et al. (1993) and Granier & Grgasovic (2000) we do not separate them and describe both types as *Griphoporella curvata* (Gümbel).

Occurrence: *Griphoporella curvata* (Gümbel) is known from the Norian–Rhaetian of numerous localities on the world (see Grgasovic 1997; Granier & Grgasovic 2000). It was described from the Norian of central Iran by Senowbari-Daryan & Hamedani (2000) and occurs extremely abundantly in the Rhaetian Howz-e Khan Member of the Nayband Formation in northeast Iran (this paper).

Griphoporella? sp.
(Fig. 11C,J)

Material: Six specimens, from which only two are illustrated.

Description: The two illustrated specimens are united in one species, but may be different taxa. The outer diameter of the specimens illustrated in Fig. 11C is 4.6 mm; inner diameter is 2.9 mm. It is surrounded by white incrustation (possibly spongiomorphids?). The polygonal laterals are about 0.3 mm in diameter and arranged in two rows.

The specimen, illustrated in Fig. 11J is cut in longitudinal section reaching an outer diameter of 3.0 mm; inner diameter 2.4 mm. Compared to the first specimen the laterals are circular or oval.

Griphoporella lutensis nov. sp.
(Fig. 2J–N, Fig. 12G–H, Fig. 13)

2005 Chains of spores of diploporid dasycladales — Fürsich et al., pl. 10, fig. 8

Derivatio nominis: Named from the Lut desert in east Iran.

Holotype: Specimen illustrated in Fig. 2K (compare Fig. 13).

Paratypes: All specimens in Fig. 2J,L–N, Fig. 12G–H.

Locus typicus: See locality 2 in Fig. 1 (it was also found in other two localities in Fig. 1).

Stratum typicum: Howz-e Khan Member (Rhaetian) of the Nayband Formation.

Diagnosis: Cylindrical, possibly club-shaped alga with extremely wide central stem and thin thallus wall with modest extension of laterals. Single laterals are distributed equally through the thallus wall. Euspondyl arrangement of the laterals.

Material: At least four, more or less well preserved and some broken specimens.

Depository: See chapter localities above.

Description: Compared to the outer or inner diameter of the thallus, the thallus wall is very thin reaching a thickness of 0.1–0.18 mm. The outer diameter of the thallus varies between 2.02–2.85 mm, the inner diameter between 1.77 mm and 2.62 mm. The wall contains numerous single laterals distributed equally within the wall and oriented vertically to the wall. The diameter of laterals is about 0.036–0.075 mm. Some of laterals are proximally or distally closed (due to the section), other are on both ends open being significant of all laterals. The wall between the laterals is about 0.01–0.03 mm. In oblique sections through the thallus wall the arrangement of the laterals seems to be of euspondyl type (Fig. 2J–L). The biometrical data of the thallus and thallus elements of *G. lutensis* nov. sp. are given in Table 3.

Discussion: Senowbari-Daryan & Hamedani (2000) described the species *Diplopora iranica* from the Norian part of the Nayband Formation, central Iran. Numerous coherent gametangia, arranged like hoses within the central stem were found within *D. iranica*. Fragments of such sporangia-hose were mentioned first as "Mikroproblematikum 1" by Flügel & Flügel-Kahler (1963) and later were described in detail by Flügel (1964) as "Problematikum 4". Such "cell-aggregates" were also illustrated from the Norian-Rhaetian carbonates of the Northern Calcareous Alps by Sadati (1981) as "Problematikum 4" or by Wurm (1982) as "*Griphoprella curvata*" or "micritic tubes" in page 274 by the same author. The dimensions of the "cells" in "Problematikum 4" Flügel and other specimens from the Alps correspond to the dimensions of the sporangia in *D. iranica* and are identical to our specimens described in this paper.

"Problematikum 4" Flügel (1964) and other specimens from the Alps and the sporangia-hoses in *D. iranica* appear dark micritic in transmitted light. As shown by Senowbari-Daryan & Hamedani (2000) the crystal sizes of the wall are micro-grains of about 5 μm and the mineralogy of Mg-calcite. The alga, described above as *Griphoporella lutensis* nov. sp. was never found within the central stem of other algae and *D. iranica* was not found in investigated material. *G. lutensis* appears light-coloured in transmitted light, indicating the calcite mineralogy of the alga, different from those described by Flügel (1964) and Senowbari-Daryan & Hamedani (2000). Further differences are the thickness of the wall between the individual laterals in *Griphoporella lutensis*. The wall between the gametangia in *D. iranica* is much thinner than in *Griphoporella lutensis*. Also the laterals in the new alga are proximally and distally open, the gametangia in *D. iranica* are closed at both ends. These differences are against the equality of this alga and the sporangia-hoses of *D. iranica*.

Diplopora cf. *D. interiecta* Fenninger, 1969
(Fig. 11F–G)

1969 *Diplopora interiecta* n. sp. — Fenninger, p. 24–25, pl. 1, fig. 1–9

Material: Two specimens.

Description: Two specimens of this alga are cut in longitudinal and oblique sections showing the character and the branching pattern of the laterals (metaspondyle) at the base of the thallus wall. The outer diameter of the alga is 1.5–2.9 mm; the inner diameter 1.1–2.0 mm; diameter of laterals 0.07–0.2 mm.

Remarks: *Diplopora* is an abundant algal genus in Triassic carbonates. Numerous specimens are known from Permian and Triassic strata (Granier & Grgasovic 2000). Three species of *Diplopora* are known from the Upper Triassic of Iran: *Diplopora interiecta* Fenninger (1969), *D. iranica* Senowbari-Daryan & Hamedani (2000), and *D. phanerospora* Pia (in: Fürsich et al. 2005). The dimensions and other characteristics of our species are similar to that species, described as *D. interiecta* by Fenninger (1969) from the Upper Triassic (Norian–Rhaetian) of the Golpaygan area (northwest Iran). Similar algae to *D. interiecta* were also reported from the Norian–Rhaetian of Austria and Sicily (see synonymy-list of *D. interiecta* in Granier & Grgasovic 2000).

Clypeina? sp.
(Fig. 11K)

Table 3: Biometrical data of *Griphoporella lutensis* nov. sp. (for abbreviations see Table 2). **P** — Diameter of laterals. All measurements are in mm.

Section No:	D	d	T	P	TB	Position of section
J-2-6	2.85	2.62	0.11	0.056–0.075	0.037	Oblique
KHK-14	2.05	1.80	0.1–0.11	0.04	0.01–0.02	Oblique
H-9	2.02	1.77	0.10–0.11	0.049	0.034	Oblique-cross
J-29	2.13	1.92	0.09–0.117	0.04–0.045	0.27	Oblique
J-2-6	–	–	0.11	0.05	0.037	Broken
J-2	–	–	0.15	0.056	0.0375	Longitudinal-broken
J-14-2	–	–	0.18	0.04	0.027	Longitudinal-broken
J-2-6	–	–	0.109	0.036–0.042	–	Oblique-broken
J-9-2	–	–	0.075–0.011	0.03	0.02–0.03	Oblique-broken
J-8-2	–	–	0.09–0.1	0.03–0.04	0.028	Longitudinal-broken
J-2	–	–	0.15	0.03–0.05	0.3	Longitudinal-broken
H-1	–	–		0.02–0.05	0.033–0.05	Tangential
J-20	–	–	0.11	0.054–0.059	0.01–0.03	Oblique-broken

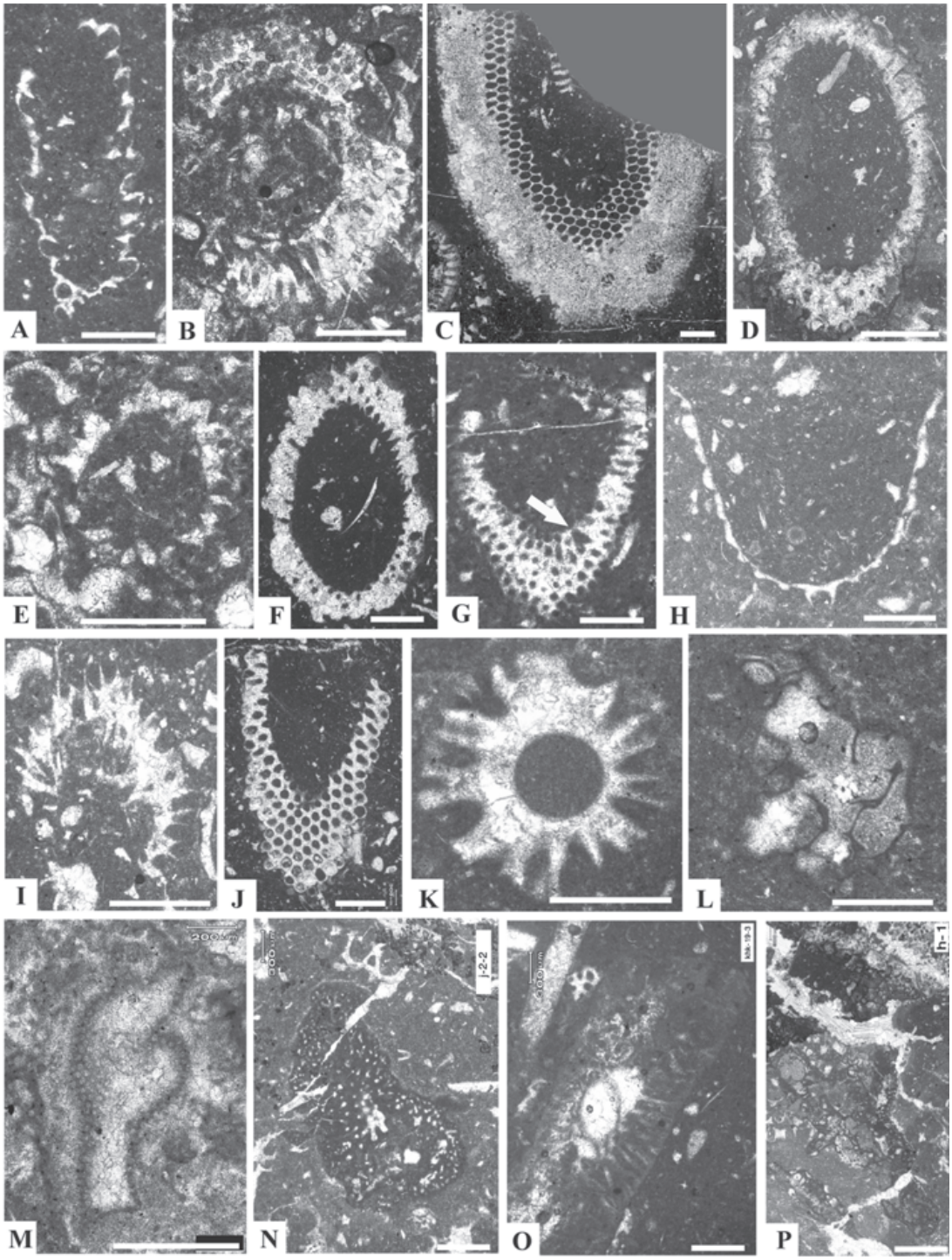

Fig. 11. Dasycladales and problematic algae from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in Figs. A–B, E, G–I, K–O = 0.5 mm, in Figs. C–D, F, J and P = 1 mm. **A** — Dasycladacean alga. Longitudinal section showing the thin thallus wall and laterals, which are closed to the outside. BSPG 2010-XIII-2. **B** — Dasycladacean alga gen. et sp. indet. 2. Thin section BSPG 2010-XIII-36. **C** — *Griphoporella*? sp. Oblique section through a broken specimen showing polygonal laterals arranged in two rows. Thin section BSPG 2010-XIII-6. **D** — Dasycladacean alga. Oblique section. The individual laterals become wider in the distal part of the thallus. Thin section BSPG 2010-XIII-16. **E** — Dasycladacean alga. Thin section BSPG 2010-XIII-12. **F–G** — *Diplopora* cf. *D. interiecta.* F — Thin section BSPG 2010-XIII-5. G — Thin section BSPG 2010-XIII-19. **H** — Dasycladacean alga gen. et sp. indet 1. Thin section BSPG 2010-XIII-23. **I** — Dasycladacean alga gen. et sp. indet 2. Thin section BSPG 2010-XIII-17. **J** — *Griphoporella*? sp. BSPG 2010-XIII-29. **K** — *Clypeina*? sp. Cross section through a re-crystallized specimen. Thin section BSPG 2010-XIII-7. **L** — *Bacinella irregularis* Radoicic. Thin section BSPG 2010-XIII-13. **M** — *Thaumatoporella parvovisiculifera* (Raineri). BSPG 2010-XIII-17. **N** — *Lithocodium aggregatum* Elliott. Thin section BSPG 2010-XIII-28. **O** — *Lithocodium aggregatum* Elliott. Thin section BSPG 2010-XIII-24. **P** — *Bacinella irregularis* Radoicic. Thin section BSPG 2010-XIII-16.

Material: One specimen only.

The only cross section of this species is strongly re-crystallized and the detail of the alga is not ascertainable. The outer diameter of the alga is 1.0 mm; the inner diameter 0.36 mm.

Remarks: *Clypeina* is an abundant algal genus in Cretaceous deposits. From Triassic only the species *Clypeina besici* is described by Pantic (1965) from the Carnian of the Dinarids (Montenegro). Questionable *Clypeina* from Upper Triassic (Norian–Rhaetian) is reported by Flügel (1979: pl. 2, fig. 9) and by Senowbari-Daryan (1980: pl. 14, fig. 6).

Similar algae to *Clypeina*? sp., described above are illustrated by Bodrogi et al. (1993) as *Clypeina* sp. from the Lower Cretaceous of Hungary. Nittel (2006) also illustrated from the Middle Triassic of the Northern Calcareous Alps, Austria a similar section identified as bryozoans. Most probably the Iranian species is a new algal taxon.

Dasycladales gen. et sp. indet 1
(Fig. 11H)

Material: One specimen only.

Description: The only one specimen is cut in longitudinal section. The U-shaped thallus exhibits a thin wall. The diameter of the thallus is about 1.6 mm. The outer surface appears to be annulated, caused by the narrow and short laterals in relatively wide distances.

Dasycladales gen. et sp. indet 2
(Fig. 11B, I)

Material: Two specimens only.

Description: From this alga only two incomplete specimens in cross section are available. The description is based mainly on specimen illustrated in Fig. 11B.

The thick-walled thallus exhibits a thin wall at the base of laterals. Laterals become continuously thinner to the thallus periphery, resembling representatives of the genus *Physoporella*. The outer diameter of alga is 1.65 mm; inner diameter 0.90 mm; wall thickness 0.82 mm.

Remarks: *Physoporella* is an abundant algal genus in the Permian and in Middle Triassic, particularly in the Anisian. Only two species of *Physoporella* are known from the Norian–Rhaetian: *Physoporella jomdaensis* Flügel & Mu (1982) from eastern Tibet and *Ph. zamparelliae* Parente & Climaco (1999) from south Italy. Most probably the Iranian species is a new algal taxon.

Dasycladalean algae
(Fig. 11A,D–E)

In addition to the described taxa other dasycladales occur very rare, illustrated in Fig. 11A,D–E. Specimen in A is a very small alga exhibiting the laterals corresponding to the genus *Griphoporella*. The specimen in D seems to be a representative of the genus *Macroporella*. The specimen in Fig. 11E is an indet one.

Division: **Chlorophyta** Kützing, 1843
Family: Incertae sedis
Genus: *Lithocodium* Elliott, 1956

Emended diagnosis: See Schlagintweit et al. (2010).

Type species: *Lithocodium aggregatum* Elliott, 1956.

Discussion: Elliott (1956) assigned *Lithocodium aggregatum* to codiacean algae. *Lithocodium aggregatum* was attributed to luftusiid foraminifer by Schmid & Leinfelder (1996). Banner et al. (1990) synonymized *Bacinella irregularis* Radoicic (1959) and *Pseudolithocodium carpaticum* Mišík (1979) with *Lithocodium*, attributing these to the new subfamily Lithocodioidea within the family Codiaceae (Siphonales, Clorophyceae). For *Bacinella*? *sterni* Radoicic (1972) the new genus *Radoicicinellopis* was established by Banner et al. (1990). Cherchi & Schroeder (2006) favour, that *Lithocodium* is a calcified cyanobacterium rather than a foraminifer. Recently Schlagintweit et al. (2010) discussed the systematic position of *Lithocodium* attributing it to "filamentous-septate heterotrichale ulvophycean alga". Assigning to "endolithic ulvophycean alga" these authors separate *Bacinella* from *Lithocodium*, which was synonymized by Banner et al. (1990). With separation of *Lithocodium* and *Bacinella* the systematic classification proposed by Schlagintweit et al. (2010) is followed here to describe the two following organisms.

?*Lithocodium aggregatum* Elliott, 1956
(Fig. 11N–O)

Remarks: According to Schlagintweit et al. (2010) the Triassic organisms, known as "*Lithocodium aggregatum"* Elliott is excluded from *Lithocodium aggregatum* Elliott (1956) by these authors. Here only the synonymy of Triassic "*Lithocodium aggregatum*" is listed below. For the synonymy of Jurassic–Cretaceous *Lithocodium* see Schlagintweit et al. (2010).

Selected synonymy

*1959 Problematicum A — Ohlen, p.73, pl.10, fig.1, pl.17, fig. 3
1979 *Lithocodium* — Senowbari-Daryan & Schäfer, pl. 1, fig. 8
1981 *Lithocodium aggregatum* Elliott — Sadati, p. 206, pl. 59, fig. 8
1984 *Lithocodium aggregatum* Elliott — Senowbari-Daryan, p. 33–34, pl. 10, fig. 8 (cum. syn.)

Description: Etching the substrate (bio- or lithoclast) *Lithocodium* grows as encrustation or as aggregates between other organisms. It is characterized by hollow cavities covered by a layer with thin-walled alveoli. A detailed description of *Lithocodium* and discussion about its systematic position are given by Banner et al. (1990), Schmid & Leinfelder (1995, 1996), Cherchi & Schroeder (2006), and by Schlagintweit et al. (2010).

Remarks: In Triassic deposits, as in Jurassic and Cretaceous, *Lithocodium aggregatum* is usually associated with *Bacinella irregularis*. In the investigated material we did not find them in association. *Lithocodium* with association of *Bacinella irregularis* is, however, reported by Fürsich et al. (2005) from the Nayband Formation of the same area.

Order: **Ulotrichales**
Family: Incertae sedis
Genus: *Bacinella* Radoicic, 1959

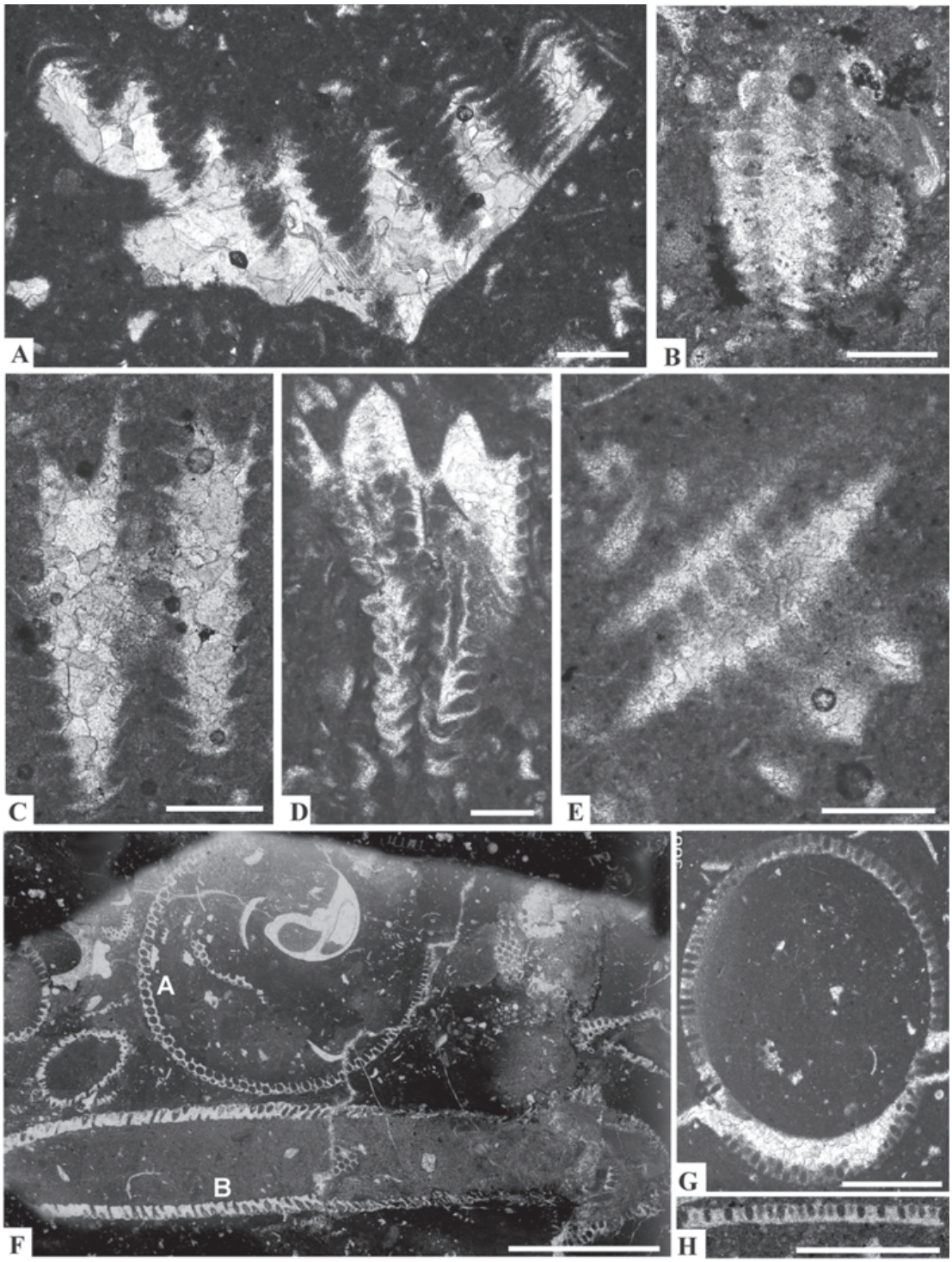

Fig. 12. Problematicum 1, *Griphoporella curvata* (Gümbel) and *Griphoporella lutensis* nov. sp. from the Howz-e Khan (Rhaetian) Member of the Nayband Formation south of the type locality, near the motorway service area Dig-e Rostam. Scale in A–E = 0.2 mm, in F = 5 mm, in G–H = 0.5 mm. **A** — Section through seven cohered "columns" with lateral elements. The lateral elements of individual "columns" are connected to each other. Thin section BSPG 2010-XIII-28. **B** — Section through three "columns" with laterally connected elements. Thin section BSPG 2010-XIII-28. **C** — Section through two "columns" with lateral elements. The lateral elements are curved upwards. Thin section BSPG 2010-XIII-38. **D** — Section through two "columns" with lateral elements curved upward building circular to oval cavities. A walled tube runs internally through each "column". Thin section BSPG 2010-XIII-16. **E** — Section through two "columns" with laterally connected elements. Thin section BSPG 2010-XIII-35. **F** — *Griphoporella curvata* (Gümbel). A — An extremely large (about 10 mm in diameter) specimen of type 1 with short laterals; B — A species of type 2 with long, slender laterals. Thin section BSPG 2010-XIII-10. **G** — *Griphoporella lutensis* nov. sp. Oblique section showing the thin wall with numerous laterals of the thallus. Thin section BSPG 2010-XIII-39. **H** — *Griphoporella lutensis* nov. sp. Section through a fragment showing the shape of the laterals in the thallus wall. Thin section BSPG 2010-XIII-40.

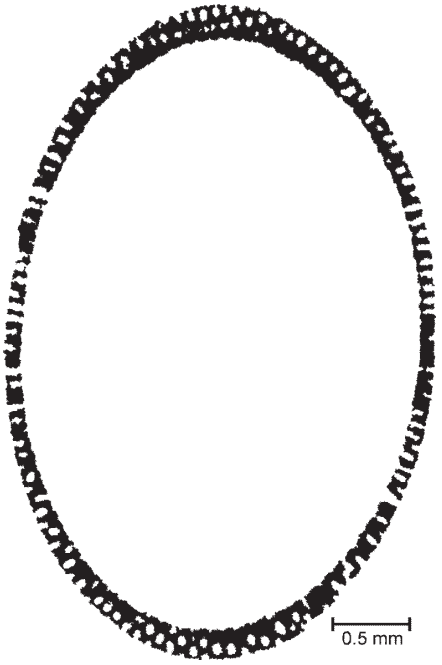

Fig. 13. *Griphoporella lutensis* nov. sp. (Holotype). The specimen shows extremely thin wall, compared with the thick axial stem (drawn from Fig. 2K).

Type species: *Bacinella irregularis* Radoicic, 1959.

Bacinella irregularis Radoicic, 1959
(Fig. 11L,P)

Selected synonymy

*1959 *Bacinella irregularis* n. sp. — Radoicic, p. 89, pl. 3, fig. 1–2
1984 *Bacinella irregularis* Radoicic — Senowbari-Daryan, p. 38, pl. 9, fig. 2 (with synonymy)
2005 *Bacinella irregularis* Radoicic — Fürsich et al., pl. 11, fig. 3

Description: The aggregates of *Bacinella* occur in micrite sediments forming bubble-like cavities with thin and micrite walls. The outer walls and the tabulae-like elements within the cavities are, like *Thaumatoporella* partly perforated (Fig. 11L). *Bacinella* do not occur together with *Lithocodium* in the investigated material.

Remarks: Occurring in association, the separation of *Lithocodium aggregatum* and *Bacinella irregularis* is in most cases not possible. They were also described as a single organism by some authors or as separate genus/species by others (for more information see Banner et al. 1990; Schlagintweit et al. 2010). *Bacinella* and *Lithocodium* were not found in association in the investigated material. Both organisms were also reported by Fürsich et al. (2005) from the Nayband Formation.

Incertae sedis
Genus: *Thaumatoporella* Pia, 1927

Type species: *Gyroporella parvovesiculifera* Raineri, 1922.

Thaumatoporella parvovesiculifera (Raineri), 1922
(Fig. 11M)

Selected synonymy

*1922 *Gyroporella parvovesiculifera* n. sp. — Raineri, p. 83, pl. 13, fig. 17–18
1927 *Thaumatoporella parvovesiculifera* (Raineri) — Pia, p. 69
1984 *Thaumatoporella parvovesiculifera* (Raineri) — Senowbari-Daryan, p. 35–36, pl. 7, fig. 1 (cum. syn.)
2002 *Thaumatoporella parvovesiculifera* (Raineri) — De Castro, text-fig. 2, pl. 1, fig. 1–11

Description: *Thaumatoporella parvovesiculifera* occurs, like the preceding species in micritic sediments or between the reef organisms. The fossil is characterized by well perforated sheets of aggregates. It is a rare fossil in the investigated material.

Remarks: The systematic position of *Thaumatoporella parvovesiculifera* is disputed. It was attributed to dasycladales by (Raineri 1922), solenoporacean (Elliott 1957), codiaceans (Johnson 1966), possibly sponges (Flügel 1983). De Castro (1990) compared *Thaumatoporella* with some volvocacean (planktonic green algae) and with rivulariacean cyanophyta. He attributed *Thaumatoporella* to the new family Thaumatoporellaceae and the new order Thaumatoporellales (see also De Castro 2002).

Problematicum 1 (shell fragment?, alga?)
(Fig. 12A–E)

Material: Several fragments.

Description: The specimen illustrated in Fig. 12A shows 7 cohered elements ("columns") in calcite (primary aragonite?) preservation. Other specimens illustrated in Fig. 12 show only fragments. Each element exhibits numerous spine-like to ¾ circular peripheral elements with regularly arrangement. Some of these peripheral elements are almost closed, building circular cavities of about 0.085 mm in diameter (Fig. 12D). The specimen illustrated in Fig. 12D also shows that these peripheral elements originate from a thin wall (0.04 mm thick) around an axial tube with a diameter of 0.085 mm. Other specimens show that these elements are connected laterally with others. The thickness of the individual "columns" is about 1.85 mm; their distance varies between 0.11 mm and 0.3 mm. The distance between peripheral elements around the "columns" varies between 0.7 mm and 0.8 mm.

Discussion: The specimen with an axial stem and cyst-like elements around it, illustrated in Fig. 12D shows that this fossil resembles dasycladales. The lack of the pores or laterals of the wall around the axial cavity does not confirm its interpretation as dasycladales. Other specimens, particularly the specimen illustrated in Fig. 12A also fail to support this interpretation.

The cohered columns with laterally connected elements support the interpretation of this fossil as sections through the ripped shell of juvenile bivalves, brachiopods or ostracods. The sections could be oriented parallel to fragments of shell. The axial cavity in Fig. 12C, however, does not support the interpretation of this fossil as shell fragments. Another interpretation could be the aptychus of cephalopods. We describe it here as "Problematicum 1", because ambiguous characteristics make the exact interpretation of this fossil impossible.

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