

About *Trinocladus* Raineri, 1922: when some *Permocalculus* (Gymnocodiacean algae) reveal to be Triploporellacean algae (Revision of the Jesse Harlan Johnson Collection. Part 5)

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Abstract The Upper Cretaceous-Paleogene genus *Trinocladus* that is based on *T. tripolitanus* Raineri, 1922, originally described from Libyan material, is morphologically well constrained. Its species are commonly distinguished on the basis of their biometrics. However, the narrow Gaussian distribution reported for some measurements may result from post-mortem dynamic sorting as suggested by a review of the surrounding microfacies. An examination of Brazilian material of the type-species suggests a slightly club-shaped thallus morphology. Two “false *Permocalculus*” species originally described by Johnson and the type-material of which has been reexamined are formally reascribed to the genus *Trinocladus*. *T. budaensis*, the smallest one, has slightly club-shaped thallus, too. *T. elliotti* is poorly mineralized and insufficiently documented. In addition to *T.*

tripolitanus, Raineri described a tiny species which was later revised by Pia, i.e., *Dissocladella undulata*. *D. bonardii*, a name recently introduced by Radoičić et al. and which is based on Raineri’s original material, is considered here as an objective junior synonym of *D. undulata*.

Keywords Cretaceous · Dasycladales · *Trinocladus* · *Dissocladella* · Biometric limitation

Introduction

When studying some fossil “calcareous” algae, the impact of various factors, among which a weak mineralization in the form of metastable aragonite, a centripetal micritization, the mechanical sorting of the bioclusters derived from them and their mechanical abrasion, may significantly affect the three-dimensional reconstructions of their thalli. In the case studied, we must bear in mind that the outer cortical layer of some Dasycladales, e.g., *Trinocladus* Raineri, 1922, vaguely resembles that of some Halimedaceae or Gymnocodiaceae (both Bryopsidales), e.g., *Permocalculus* Elliott, 1955. In addition, weak mineralizations on the main axis and on the proximal part of the laterals for the Dasycladales or on the medullar filaments for the Bryopsidales may result in a poor preservation of the inner parts of the original aragonitic coatings and can explain the common misinterpretation of the original algal architectures.

For instance, as for the “Inventory of the fossil Dasycladalean algae” (Deloffre and Granier 1992; Granier and Deloffre 1993), the genus *Trinocladus* Raineri, 1922, was supposedly known from the Late Jurassic to the Oligocene (with a hiatus in the earliest Cretaceous). With the exclusion of some Jurassic specimens that were erroneously ascribed to *T. perplexus* Elliott 1955, and later redescribed

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as *Thyrsoporella pseudoperplexa* Granier et Braik 2002, the stratigraphic range of the genus is currently restricted to the “mid-“ Cretaceous—Oligocene interval. Although some forms were erroneously interpreted as representatives of the genus *Trinocladus*, the opposite is also true. The present paper, which is the fifth contribution to the “Revision of the Jesse Harlan Johnson Collection” (Granier et al. 2013, 2017; Granier and Dias-Brito 2016; Basso and Granier 2017), also re-examines the case of two *Trinocladus* species that Johnson (Johnson and Kaska 1965; Johnson 1968) erroneously ascribed to the genus *Permocalculus*.

Material

The material studied comes from four collections hosted in three countries

1. The J. Pfender Collection is hosted at Sorbonne University—Pierre et Marie Curie University, Paris (France). We re-examined three thin sections from Turonian strata in Provence, SE France:

No. 90 “Barres Le Revest, *Trinocladus tripolitanus*, Boueinia”,

No. 90 bis “W de Costebelle, *Trinocladus undulatus*”, No. 90 ter “W Costebelle, *Trinocladus*”. This material was previously revised by Massieux (in Pfender and Massieux 1966).

2. The J.H. Johnson Collection is hosted at the Smithsonian National Museum of Natural History, Washington, D.C. (U.S.A.). It comprises one thin section U.S.N.M. No. 42547 from the “mid-” Cretaceous (Albian-Cenomanian) of Guatemala and a set of eleven thin sections U.S.N.M. Nos. 42607–42617 from the Buda Fm (Cenomanian) of Texas, U.S.A. Each set is associated to a species described by Johnson (1968; Johnson and Kaska 1965).
3. The P. Tibana Collection was temporarily hosted with the UNESPetro’s collections at the UNESP-Universidade Estadual Paulista, Rio Claro, S.P. (Brazil). Tibana’s material is from the Bonfim Fm (Cenomanian) of the Barreirinhas basin; thin sections Nos. 281–282 have a well-sorted grain-supported fabric whereas thin section No. 68–53 has a mud-supported fabric. The remaining set of fifteen thin sections found at the UNESPetro (Nos. 87B, 88A&B, 89B, 91B, 92A&B, 93A&B, 94A&B, 95A&B, and 96A&B) are from the Jandaira Fm (Turonian—lower Campanian) of the Potiguar basin; their fabric is mud-supported and their texture is that of bio-

clastic wackestones. Part of this material was illustrated by Granier (2015).

The genus *Trinocladus* and its type-species

The type-species is *T. tripolitanus* Raineri, 1922. It was originally documented by two figures (Raineri 1922, Pl. III, figs. 15–16). The first figure (Raineri 1922, Pl. III, fig. 15), that Pia selected as the “type” (lectotype), is a transverse section that displays the typical arrangement with three orders of pores, left behind in lieu of the laterals. According to Pia (1936) who first revised Raineri’s material, the primary pores are “approximatively club-shaped”; “the secondary pores repeat on a smaller scale the shape of the primary pores, narrow at their bases, expanding outward”; in turn, “the tertiary pores are short and slender”, possibly widening outward to form an external cortex. The second figure (Raineri 1922, Pl. III, fig. 16) is a long oblique section, that provides a glimpse of what tangential and axial sections look like. However, in this figure, only two orders of pores are visible. This pattern is not typical of *Trinocladus*, but it is characteristic of *Dissocladella* (Pia in L.R. Rao et Pia, 1936).

The Libyan *Dissocladella* controversy

According to Pia (1936) *Trinocladus* is an intermediary genus between *Dissocladella* and *Thyrsoporella*. (see Bas-soullet et al. 1978). Besides *Trinocladus tripolitanus*, Raineri (1922, p. 75–76, Pl. III, figs. 7–11) introduced a “*Neomeris cretacea* Stein. var. *ondulata*”. Pia (1936), who re-examined Raineri’s material, treated this variety as a genuine species, but he reascribed it to the genus *Dissocladella*. Incidentally he slightly modified the spelling of the specific epithet from *ondulata* to *undulata*.

According to the I.C.B.N. (2012, Art. 8 and 40), there was no need for the authors to select a “type (holotype, lectotype, or neotype) of a name of a species” before 1 January 1958. The five original figures were considered as syntypes and there was a need to select one of them as the lectotype. Although one of the five original Raineri’s specimens (1922, Pl. III, fig. 7) was the most poorly preserved, Radoicic et al. (2005, Pl. I, fig. 1) unfortunately selected it as the lectotype. Regarding this specimen, Pia (1936) even stated that it “is possibly some other fossil, not an alga”. In addition, Radoićić et al. (2005) reascribed it with doubt to the genus *Trinocladus* Raineri 1922, and, as they said, it “is expected to remain ill-defined”. Regarding the four remaining specimens (Raineri 1922, Pl. III, figs. 8–11), this group of authors (Radoićić et al. 2005) assigned them to a species that they

newly introduced, *i.e.*, *Dissocladella bonardii* Radoičić et al. 2005.

Due to the above mentioned issues and to the untenable conflict with Pia's (1936) protologue (*i.e.*, the species was described as a *Dissocladella*, with two orders of laterals, not as a *Trinocladus*, with three orders of laterals) and the strong opinion of Radoičić et al. (2005) about the specimen they selected as lectotype, a new lectotype designation is then requested. This new lectotype designation should supersede Radoičić et al.' designation. Accordingly we select here another Raineri's specimen (1922, Pl. III, fig. 8) as the new lectotype of the species *Dissocladella undulata* (Raineri, 1922), Pia 1936. Consequently, *D. bonardii* Radoičić et al. 2005, should be treated as an objective junior synonym of the Raineri's taxon.

Both species *D. undulata* (Raineri, 1922) and *Trinocladus tripolitanus* Raineri, 1922, were originally described in the same publication, from the close localities, from the Cenomanian of Libya. While describing one of her two specimens of *T. tripolitanus*, Raineri (1922, Pl. III, fig. 16) pointed out that “Due soli rami secondarii sono visibili per ciascun ramo primario ma non completi, mancano i rami di terzo ordine forse per la fragilità della loro costituzione” (Primary branches are partially preserved; each has only two visible secondary branches; there are no tertiary branches as a result of their fragile structure). Similarly Pia (1936) reported some specimens of *T. tripolitanus* having locally only primary pores, which correspond to the first order laterals, preserved (Pia 1936, Pl. 2, figs. 2, 4–5). Both of these authors conclude that it might be related to mechanical abrasion. Inward micritization may also have contributed in masking some outer features. In addition, according to Pia (1936), “we have to keep in mind that some whorls never had secondary and tertiary twigs. Probably this was not a peculiarity of certain plants, but of certain parts, presumably the lower ones, of each plant”. In conclusion, there is one last option left regarding *Dissocladella undulata* and *Trinocladus tripolitanus*: both species could be synonymous, which implies that sections ascribed to *Dissocladella undulata* would then represents the smallest, poorly or incompletely preserved sections of *Trinocladus tripolitanus* or another *T. sp.*, the tertiary pores of which are hardly visible or a matter of interpretation.

From the J. Pfender Collection, Massieux (in Pfender and Massieux 1966) illustrates a “*Trinocladus tripolitanus*” (*op. cit.*, Pl. 2, fig. 1; here Fig. 1b) with “extrêmement petites” dimensions—tertiary pores are hardly visible, if any—, a first “*Dissocladella undulata*” (*op. cit.*, Pl. 2, fig. 2; here Fig. 1c) and a second “*Dissocladella undulata*” (*op. cit.*, Pl. 2, fig. 3; here Fig. 1d). The first two sections (*op. cit.*, Pl. 2, figs. 1–2; here Fig. 1b, c) match with the morphology and the measurements of *D. undulata*; the third section (*op. cit.*, Pl. 2, fig. 3; here Fig. 1d) is probably a representative of the

Bryopsidales (with both larger medullar filaments and cortical filaments). These forms are associated to other algae, *e.g.*, *Boueinia* sp. and *Marinella lugeoni* Pfender, 1939, in well-sorted grain-supported fabrics.

New biometric observations on Brazilian *Trinocladus tripolitanus* specimens

We could not examine Raineri's material, which was previously revised by Pia (1936), but the species is quite common in the Upper Cretaceous strata of Brazil. Our specimens come from two localities: one in the Barreirinhas basin (Bonfim Fm, Cenomanian: Figs. 2a–c, 3b, c) and one in the Potiguar basin (Jandaira Fm, Turonian—lower Campanian: Figs. 2d, 3a, d). Our material, particularly the Cenomanian material from the Barreirinhas basin, is very similar to the one illustrated by Pia (1936).

The key measurements (D outer diameter; d inner diameter; d/D : ratio in %) of the three specimens measured by Pia (1936):

- Specimen 1, $D = 470 \mu\text{m}$, $d = 160 \mu\text{m}$, $d/D = 34\%$ (possibly abraded),
- Specimen 2, $D = 610 \mu\text{m}$, $d = 140 \mu\text{m}$, $d/D = 23\%$,
- Specimen 3, $D = 680 \mu\text{m}$, $d = 190 \mu\text{m}$, $d/D = 28\%$ (Table 1),

fit well with those of our Bonfim specimens (Figs. 2a–c, 3b, c):

- $D = 685 \pm 105 \mu\text{m}$ (13 measurements), $D \text{ min} = 525 \mu\text{m}$, $D \text{ max} = 890 \mu\text{m}$,
- $d = 150 \pm 25 \mu\text{m}$ (10 measurements), $d \text{ min} = 120 \mu\text{m}$, $d \text{ max} = 175 \mu\text{m}$,
- $d/D = 22 \pm 5\%$ (10 measurements), $d/D \text{ min} = 16\%$, $d/D \text{ max} = 30\%$ (Table 1).

The Jandaira specimens (Figs. 2d, 3a, d) show more variability, notably with occurrences of larger specimens (smaller specimens are similar to the ones of the Bonfim Fm). The grain-supported facies of the Bonfim Fm are dominantly bioclastic. In addition to the algae, *i.e.*, *Boueinia* sp., *Neomeris* sp. and *Trinocladus tripolitanus*, the bioclasts comprise some *Pieninia oblonga* Borza et Misik, 1976, which are Alcyonarian spicules (Granier 1986). In contrast the facies of the Jandaira Fm are mud-supported. In addition to the algae, *i.e.*, *Permocalculus* sp., *Terquemella* sp., *Neomeris* sp. and *Trinocladus tripolitanus*, the bioclasts comprise some foraminifera, *e.g.*, *Rhapydyonina liburnica* (Stache, 1889) and *Quinqueloculina* ssp. It is suggested here that the narrower distribution of sizes observed in Bonfim compared to the wider distribution observed in Jandaira probably results

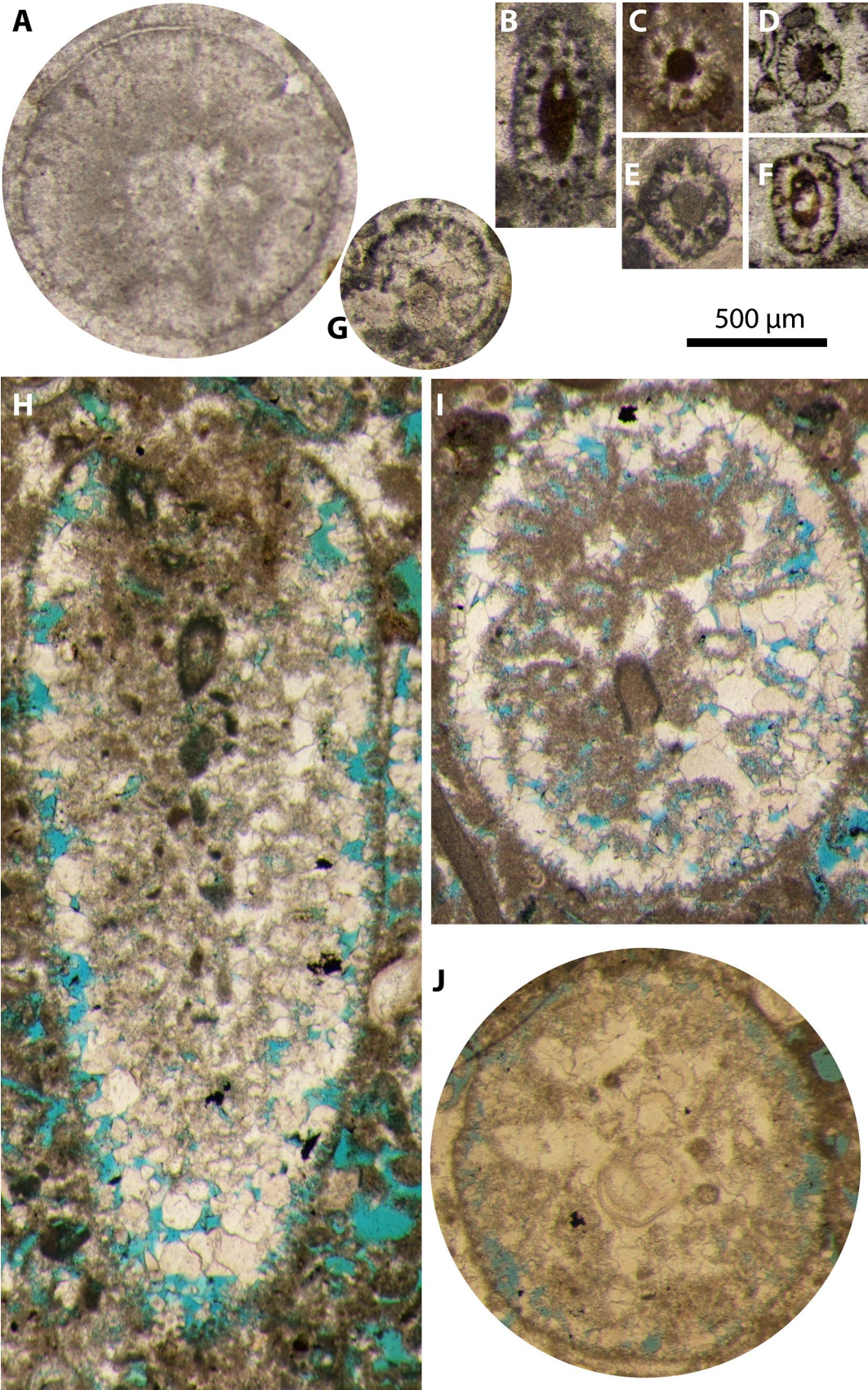


Fig. 1 **a** *Trinocladus elliotti* (Johnson et Kaska ex Deloffre 1992, non 1965) Radoičić 2006: transverse section, Johnson Collection, USNM no. 42547, Albian or Cenomanian, Guatemala. **b–g** Pfender Collection, Cenomanian, Provence France: **b**, **c** and **e**, **f** *Dissocladella undulata*; **b** oblique section, “*Trinocladus tripolitanus* Raineri, 1922” according to Massieux (Pfender and Massieux 1966, pl. 2, fig. 1), Pfender no. 90; **c** transverse section, “*Dissocladella undulata* Raineri, 1922” according to Massieux (Pfender and Massieux, 1966, pl. 2, fig. 2), Pfender no. 90ter; **e**) oblique section, Pfender no. 90; **f** oblique section, Pfender no. 90bis; **d** random section of a representative of the Bryopsidales, “*Trinocladus tripolitanus* Raineri, 1922” according to Massieux (Pfender and Massieux, 1966, pl. 2, fig. 3), Pfender no. 90bis; **g** indeterminate alga, Pfender no. 90. **h**, **i** *Sarosiella ferremollis* Segonzac, 1976, non 1972, Granier Collection, Paleocene, Libya: **h** longitudinal oblique section, no. A30(32); **i** oblique section, no. A29(65); **j** transverse section, no. A30(29)

from a mechanical sorting in higher energy environments, *i.e.*, Bonfim Barreirinhas barrier versus Jandaira Potiguar lagoon.

In conclusion, the key measurements combining both the Bonfim and Jandaira values provide a better, representative image of the species variability:

- $D = 775 \pm 205 \mu\text{m}$ (21 measurements), $D \text{ min} = 525 \mu\text{m}$, $D \text{ max} = 1325 \mu\text{m}$,
- $d = 190 \pm 70 \mu\text{m}$ (16 measurements), $d \text{ min} = 120 \mu\text{m}$, $d \text{ max} = 305 \mu\text{m}$,
- $d/D = 26 \pm 8\%$ (16 measurements), $d/D \text{ min} = 16\%$, $d/D \text{ max} = 42\%$ (Table 1).

Ideally new species should be defined from samples that did not undergo any sorting to prevent a misinterpretation of the alga sizes and morphology. In the case studied, although Pia (1936) was “under the impression that” the thallus “was of a rather slender, cylindrical shape”, the association of sections ranging in diameter from 525 to 1325 μm suggests the thallus had a slightly club-shaped morphology instead as originally reported by Raineri (1922: “cilindro-clavata”).

Additional measurements include h (spacing of two successive verticils) ranging from 90 to 155 μm , l_1 (maximum length the primary pores) up to 300 μm , p_1 (diameter of the primary pores at their larger part) from 60 to 145 μm , l_2 (maximum length the secondary pores) from 100 to 150 μm , p_2 (diameter of the secondary pores at their larger part) from 30 to 55 μm , l_3 (maximum length the tertiary pores) up to 30 μm . Although we have found some very large specimens, *i.e.*, with an outer diameter more than twice the diameters given by Pia (1936), we did not find small specimens with D ranging from 240 to 320 μm that he identified as “*Dissocladella undulata*”. Therefore, the hypothesis that *D. undulata* and *Trinocladus tripolitanus* could be synonymous is not supported by our finds. In Libya, both species occur in the same stratigraphic interval, but probably come from discrete localities (as a matter of fact, the thin section numbers of

Raineri’s collection given by Pia overlap but never coincide: 5, 16–18 and 21 for *Dissocladella undulata*; 7, 9, and 12 for *Trinocladus tripolitanus*).

The false *Permocalculus* species

Two authors (*i.e.*, Bucur 1994, and Radoičić 2006), without reexamining the type-material, and followers (Granier et al. 2017) pointed out that two *Permocalculus* (Gymnocodiaceae, Bryopsidales) species described by Johnson could be reassigned to the genus *Trinocladus* (Triploporellaceae, Dasycladales). Both species were nomina nuda because they were lacking the identification of an holotype. In both cases, there was a need to define a lectotype before introducing the new combination. Finally, a prerequisite would have been to re-examine the type-material.

The first author of the present paper (B.G.) got the opportunity to study Johnson’s material stored in the premises of the Smithsonian National Museum of Natural History, Washington, D.C. “*Permocalculus budaensis*” is present in thin sections U.S.N.M. Nos. 42607–42610, 42612–42613, and 42617; “*P. elliotti*” is found in one single thin section U.S.N.M. No. 42547.

Family Triploporellaceae (Pia, 1920)

Tribe Triploporelleae (Pia, 1920)

Genus *Trinocladus* Raineri, 1922

Type: *T. tripolitanus* Raineri, 1922, p. 79–83, Pl. III, figs. 15 (lectotype selected by Pia 1936)—16.

Synonym: *Sarosiella* Segonzac, 1976, non 1972, based on *S. ferremollis* Segonzac, 1976, non 1972, p. 394–396, Pl. XIX, figs. 1 (lectotype selected by Segonzac 1976), 2–6. *S. ferremollis* Segonzac, 1976, non 1972, is a *Trinocladus* with long primaries and relatively short secondaries.

Note: Unfortunately, the type-material and most of Segonzac’s Collection are definitely lost, thrown away by Charles-François Boudouresque, Aix-Marseille University. We illustrate here some specimens from the Paleocene of Libya (Fig. 1h–j) have a $D = 1375 \pm 165 \mu\text{m}$ with $D \text{ min} = 1030 \mu\text{m}$ and $D \text{ max} = 1590 \mu\text{m}$.

Trinocladus budaensis Johnson ex Granier et al., this work, non 1968

(Figure 4a–k)

nom. nud. 1968 *Permocalculus budaensis* n.sp. Johnson, p. 8, Pl. 1, figs. 2, 3 (USNM no. 42607) and 4–5 (USNM no. 42608).

nom. nud. 1968 *Permocalculus budaensis* var. *pygmaea* n.var. Johnson, p. 9, Pl. 2, fig. 2 (USNM no. 42613).

nom. nud. 1969 *Permocalculus budaensis* Johnson, 1968. Johnson, p. 27, not illustrated.

nom. nud. 1969 *Permocalculus budaensis* var. *pygmaea* Johnson, 1968. Johnson, p. 27, not illustrated.

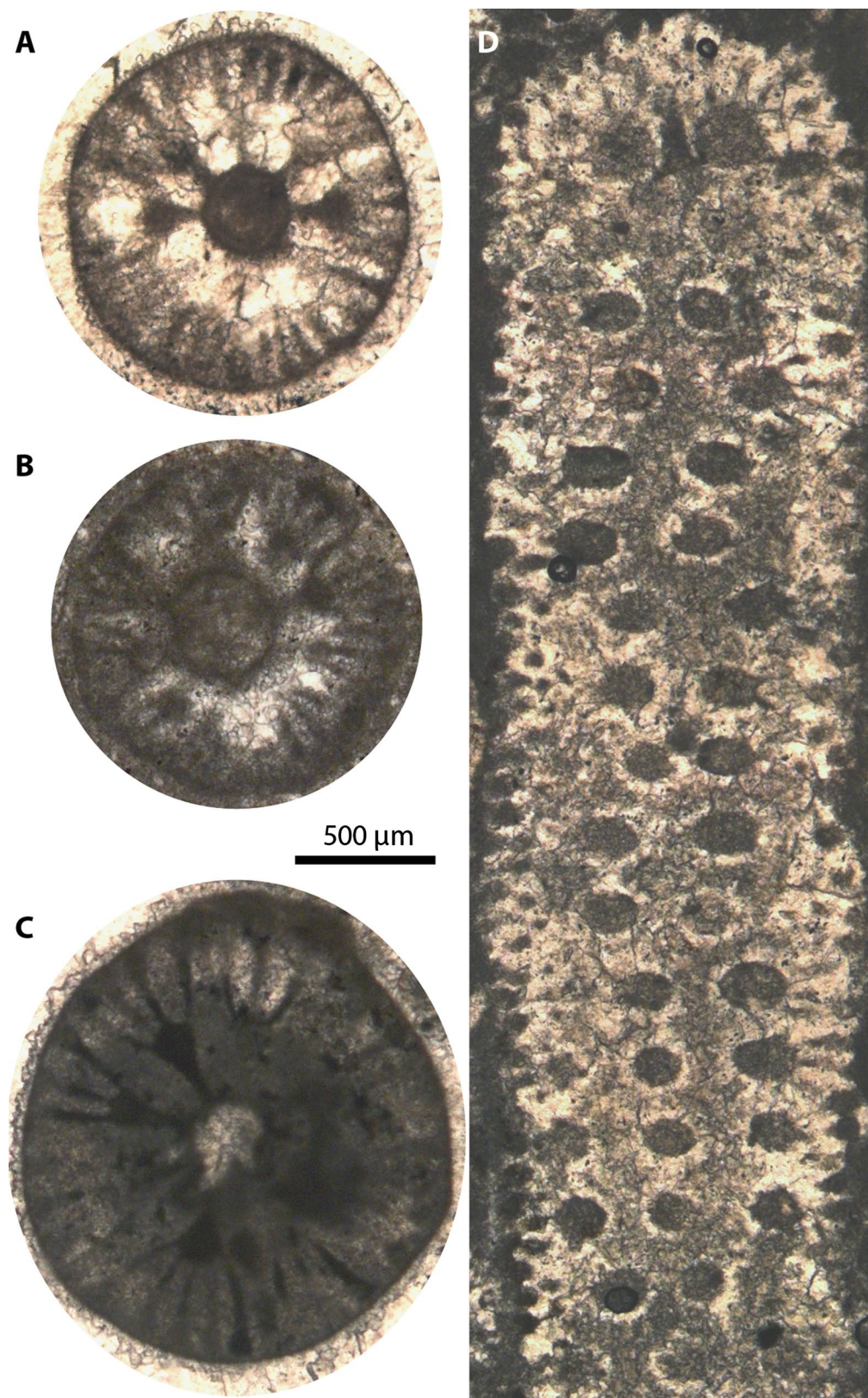


Fig. 2 *Trinocladus tripolitanus* Raineri, 1922: **a–c** Barreirinhas, Tibana Collection, Cenomanian, Brazil: **a** transverse section, no. 282; **b** no. 68-53; **c** no. 282; **d** Rio do Carmo, no. J087B, Dias-Brito Collection, Turonian—lower Campanian, Brazil

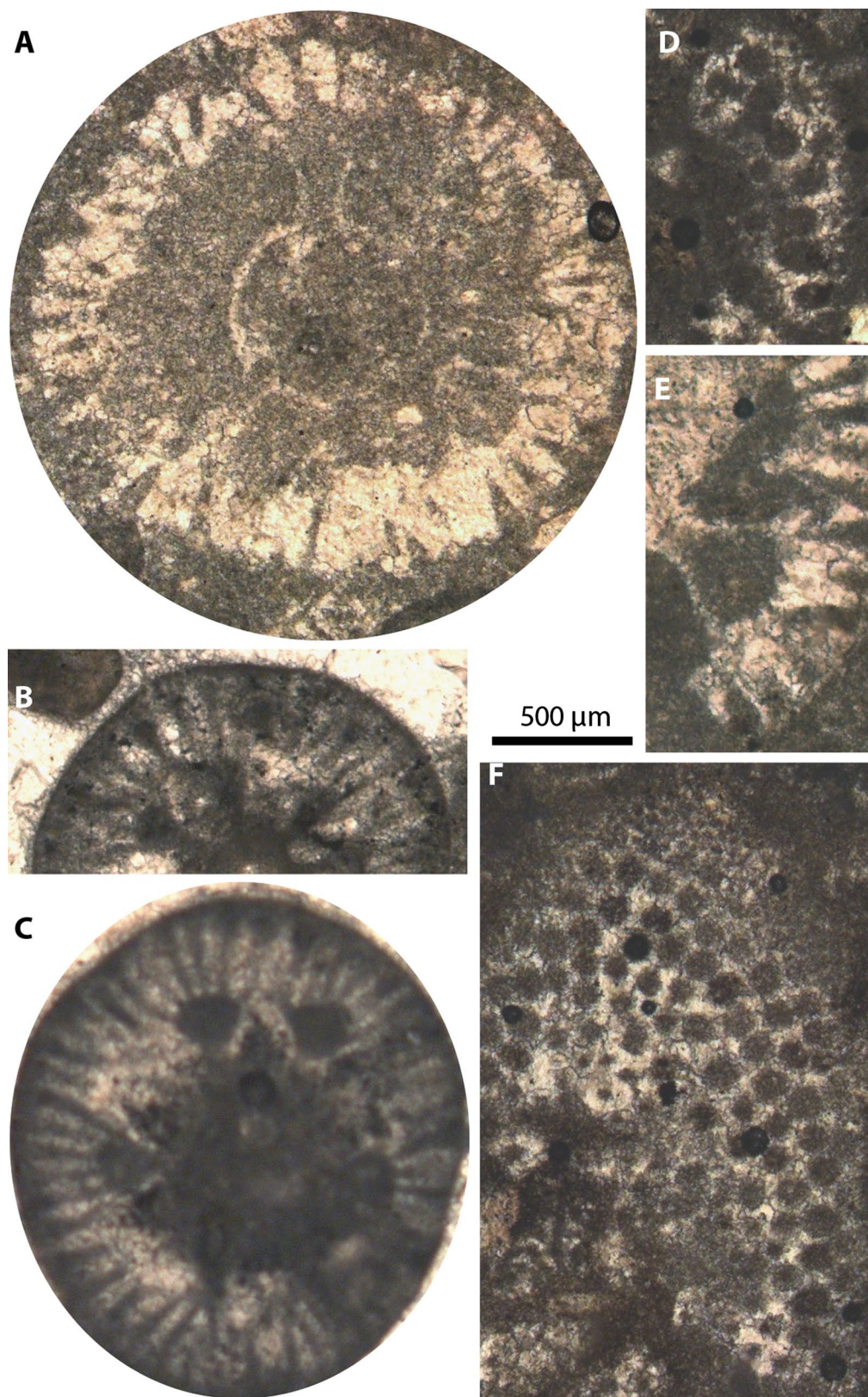


Fig. 3 *Trinocladus tripolitanus* Raineri, 1922: **a, d–f** Rio do Carmo, Dias-Brito Collection, Turonian—lower Campanian, Brazil: **a** no. J088B; **d, e** no. J094B; **f** no. J093A; **b, c** Barreirinhas, Tibana Collection, no. 282, Tibana Collection, Cenomanian, Brazil

nom. nud. **1992** *Permocalculus budaensis* Johnson, 1968. Deloffre, p. 25, Pl. 1, fig. 5 (excerpt from Johnson 1968, Pl. 1, fig. 5).

non nom. nud. **1994** *Permocalculus budaensis* Johnson, 1968. Bucur, p. 19–20, Pl. 7, Fig. 9.

Type: According to Johnson (1968), the “type slide” is “U.S.N.M. 42607, which contains several specimens”, actually two illustrated by the author (*op. cit.*, Pl. 1, figs. 2–3; here Figs. 4e, 3j). There was no identification of an holotype and we select here as the lectotype (*op. cit.*, Pl. 1, fig. 3; here Fig. 4j) amongst the specimens illustrated by Johnson.

Measurements

- $D = 440$ to $675\ \mu\text{m}$ according to Johnson (1968),
- $D = 585 \pm 125\ \mu\text{m}$ (23 measurements), $D_{\min} = 310\ \mu\text{m}$, $D_{\max} = 845\ \mu\text{m}$,
- $d = 125 \pm 30\ \mu\text{m}$ (16 measurements), $d_{\min} = 80\ \mu\text{m}$, $d_{\max} = 290\ \mu\text{m}$,
- $d/D = 23 \pm 5\%$ (16 measurements), $d/D_{\min} = 16\%$, $d/D_{\max} = 33\%$.

Additional measurements include h ranging from 100 to $165\ \mu\text{m}$, l_1 up to $155\ \mu\text{m}$, p_1 from 45 to $65\ \mu\text{m}$, l_2 from 70 to $130\ \mu\text{m}$, p_2 up to $40\ \mu\text{m}$, l_3 up to $50\ \mu\text{m}$, p_3 up to $20\ \mu\text{m}$.

Although the facies are grain-supported (grainstone texture), the mechanical sorting cannot be demonstrated due to a limited number of thin sections, each of which possibly represents discrete grain size sortings in relation to different levels of energy. The set of specimens with diameters ranging from 310 to $845\ \mu\text{m}$ suggests the thallus has a slightly club-shaped morphology.

Association and stratigraphy: This species is associated to algae [*Heteroporella lepina* (Praturlon, 1967), *Cymopolia* sp., *Neomeris* sp., *Cylindroporella*? sp., *Terquemella* sp., *Permocalculus* sp., *Ethelia alba* (Pfender, 1936), and *Marinella lugeoni* Pfender, 1939], foraminifera (Lituolidae,

Fig. 4 *Trinocladus budaensis* Johnson ex Granier et al., this work, non 1968, Johnson Collection, upper Albian-Cenomanian, Texas, USA: **a**, **c–f**, **h** and **j** USNM no. 42607; **b**, **g**, **i** and **l** USNM no. 42608; **k** USNM no. 42613. **a** slim subtransverse section (? lower part of a thallus) on the lower left corner and large oblique section (? upper part of a thallus) on the upper right corner; **b** longitudinal oblique section, “long section” according to Johnson (1968, pl. 1, fig. 5); **c** deep tangential section; **d** subaxial section; **e** longitudinal oblique section, “oblique long section” according to Johnson (1968, pl. 1, Fig. 2); **f** longitudinal oblique section; **g** tangential oblique section; **h** subtransverse section at the bottom with a *Neomeris* remain at the top; **i** transverse section; **j** oblique section, “oblique cross section” according to Johnson (1968, pl. 1, fig. 3); **k** two transverse sections, “*Permocalculus budaensis pygmaea*” according to Johnson (1968, pl. 2, fig. 2; **l** subtransverse section, “cross section” according to Johnson (1968, pl. 1, fig. 4) “*Permocalculus budaensis pygmaea*” (*Trinocladus budaensis* Johnson ex Granier et al., this work, non 1968)

Coscinoconus sp., *Nummuloculina* sp., *Cuneolina* sp., *Favusella* sp.), and *Pieninia oblonga* Borza et Mišik, 1976. This assemblage is characteristic of the uppermost Albian—Cenomanian.

***Trinocladus ellioti* (Johnson et Kaska ex Deloffre, 1992, non 1965) Radoičić, 2006**

nom. nud. **1965** *Permocalculus ellioti* n.sp. Johnson and Kaska, p. 65–66, Pl. 5, figs. 1–5 (USNM no. 42547).

nom. nud. **1969** *Permocalculus ellioti* Johnson et Kaska, 1965. Johnson, p. 26, Pl. 16, figs. 1–5 (excerpt from Johnson and Kaska 1965, Pl. 5, figs. 1–5).

1992 *Permocalculus ellioti* Johnson et Kaska, 1965. Deloffre, p. 26, Pl. 1, fig. 2 (excerpt from Johnson and Kaska 1965, Pl. 5, fig. 4)

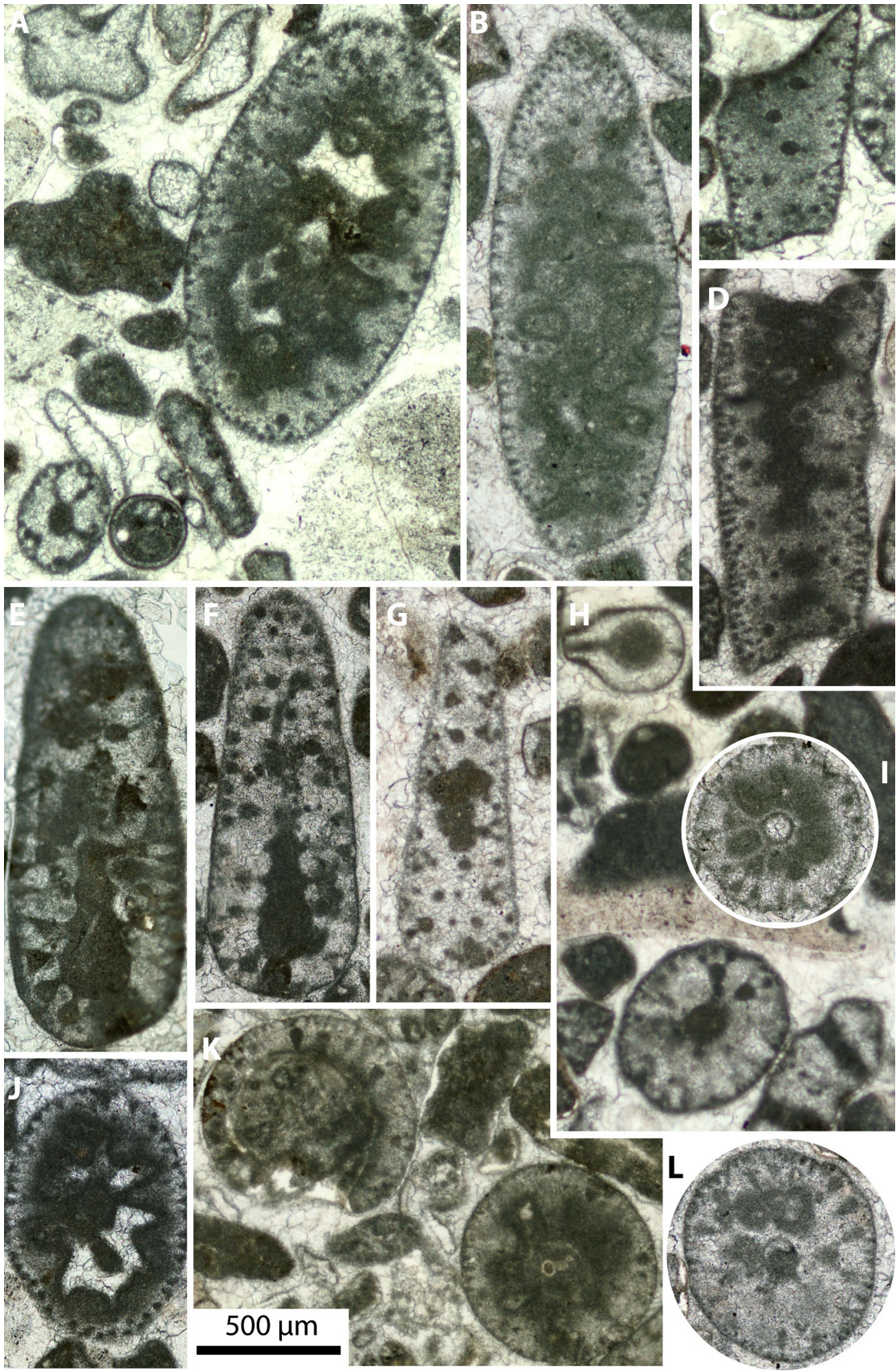
2006 *Trinocladus ellioti* (Johnson in Johnson et Kaska, 1965), n. comb. Radoičić, p. 70, not illustrated

Type: According to Johnson and Kaska (1965), the type is “Slide 18587 which contains six segments and numerous fragments. 18587 = U.S.N.M. No. 42547”. There was no identification of an holotype and Deloffre (1992: Pl. 1, fig. 2; here Fig. 5i) selected a lectotype amongst the specimens

Table 1 Inner and outer diameters of the main axis of some specimens or species cited in the text

<i>Trinocladus</i>	D_{\min} (μm)	D_{\max} (μm)	D	nD	d_{\min}	d_{\max} (μm)	d (μm)	nd	d/D_{\min}	d/D_{\max}	d/D	nd/D
<i>T. tripolitanus</i>												
Pia 1936, no. 1			470				160				34	
Pia 1936, no. 2			610				140				23	
Pia 1936, no. 3			680				190				28	
Bonfim	525	890	605 ± 105	13	120	175	150 ± 25	10	16%	30%	$22 \pm 5\%$	10
Jandaira	525	1325	775 ± 205	21	120	305	190 ± 70	16	16%	42%	$26 \pm 8\%$	16
<i>T. ferremollis</i>	1030	1590	1375 ± 165	10								
<i>T. budaensis</i>	310	845	585 ± 125	23	80	290	125 ± 30	16	16%	33%	$23 \pm 5\%$	16
<i>T. ellioti</i>	935	1235										
<i>T. divnae</i>	710	1947			126	177						

D outer diameter, d : inner diameter, $_{\min}$ minimum, $_{\max}$ maximum, n number of specimens measured



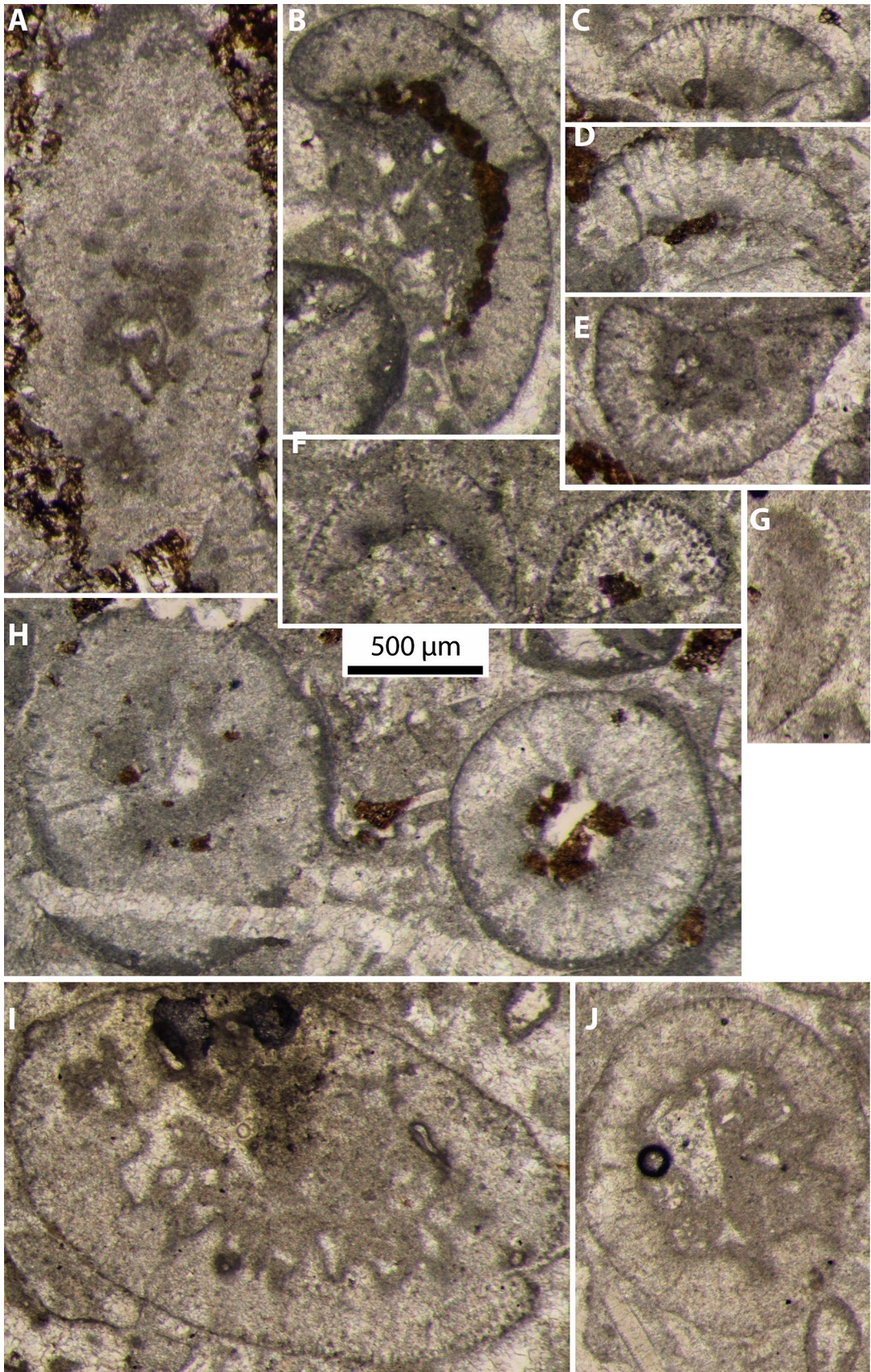


Fig. 5 *Trinocladus elliotti* (Johnson et Kaska ex Deloffre, 1992, non 1965) Radoičić, 2006, Johnson Collection, USNM no. 42547, Albian or Cenomanian, Guatemala: **a** longitudinal oblique section, “long section” according to Johnson and Kaska (1965, pl. 5, fig. 2); **b** broken oblique section; **c** small broken piece showing division of the laterals (primaries to tertiaries), “detail of a fragment showing sporangium” according to Johnson and Kaska (1965, pl. 5, fig. 1); **d** small broken piece showing division of the laterals (mostly secondaries and tertiaries); **e** broken piece showing division of the laterals (primaries to tertiaries), “detail (...) with several sporangia” according to Johnson and Kaska (1965, pl. 5, fig. 5); **f, g** oblique sections showing division of the laterals (mostly secondaries and tertiaries); **h** two transverse sections showing division of the laterals (primaries to tertiaries), “cross sections” according to Johnson and Kaska (1965, pl. 5, fig. 3); **i** oblique section, “long section” according to Johnson and Kaska (1965, pl. 5, fig. 4); **j** subtransverse section

illustrated by Johnson and Kaska (1965: Pl. 5, fig. 4; here Fig. 5i).

Measurements: $D = 825\text{--}1100\text{ }\mu\text{m}$ according to Johnson and Kaska (1965), $935\text{--}1235\text{ }\mu\text{m}$ according to us. l_1 more than $110\text{ }\mu\text{m}$, p_1 up to $95\text{ }\mu\text{m}$, l_2 from 120 to $185\text{ }\mu\text{m}$, p_2 up to $35\text{ }\mu\text{m}$, l_3 from 65 to $110\text{ }\mu\text{m}$. We do not provide measurements for d (and d/D) because the main axis is not mineralized and there is an irregularly shaped axial cavity instead.

Although the facies is very bioclastic, grains are mud-supported, which is indicative of a favorable environment to preserve calcareous algae. However, because there is only one thin section, data are insufficient to elaborate further on the algal thallus morphology.

Association and stratigraphy: in the unique thin section USNM 42 547, this form is associated to *Elianella elegans* Pfender et Basse, 1948, and *Marinella lugeoni* Pfender, 1939. According to Johnson and Kaska (1965), the sample comes from lowermost Cretaceous or uppermost Jurassic strata; however we consider that it is either Albian or Cenomanian in age.

Conclusions

1. Because the genus *Trinocladus* Raineri, 1922, is morphologically well constrained (e.g., with a typical three-fold division of its laterals), biometrics are requisite in order to distinguish species (Table 1). However we must keep in mind that the narrow Gaussian distribution observed for some algal measurements may actually result from a post-mortem dynamic sorting by size. For instance, the use of biometrics on Brazilian material of *T. tripolitanus* Raineri, 1922, suggests that the thallus morphology was slightly club-shaped, not cylindrical as previously thought on the basis of the Libyan material. Low-energy facies with mud-supported fabrics are more favorable to better estimate the real range of size variations within a species, but this same material might

be micritized and poorly preserved. High-energy facies with grain-supported fabrics will artificially narrow the range of size variations; in addition, this material might be mechanically abraded. These examples help demonstrating, if necessary, that taphonomy, particularly the depositional facies, should always be taken into account when describing or re-examining many fossil calcareous algae.

2. Regarding the systematics, two “false *Permocalculus*” species (Bryopsidales, Gymnocodiaceae) are reascribed to the genus *Trinocladus* (Dasycladales, Triploporellaceae). *T. budaensis* Granier et al. (this work) is smaller than both *T. tripolitanus* Raineri, 1922, i.e., the genus type-species, and *T. elliotti* (Deloffre, 1992), which is characterized by a weak mineralization (its main axis was not mineralized). In addition, we found that *Dissocladella bonardii* Radoičić et al., 2005, should be treated as an objective junior synonym of *D. undulata* (Raineri, 1922), a species that accompanies to *Trinocladus tripolitanus* in Cenomanian strata of Libya.

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