

On the fossil alga *Marinella lugeoni* PFENDER, 1939, *nom. cons.*, and its seven unfortunate avatars

Revision of the Juliette PFENDER Collection. Part 2. Revision of the Jesse Harlan JOHNSON Collection. Part 2

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Abstract: A review of eight lookalike fossil species led to their being synonymized. Although *Marinella lugeoni* PFENDER, 1939, is not the senior synonym, it is proposed to ascribe it the status of a "*nomen conservandum*". The age of its type-locality in Spain is Late Jurassic, not Early Jurassic. We also document small *Marinella* lumps found in Albian-Cenomanian strata of Brazil.

Key Words: Rhodogorgonales; Elianellaceae; Solenoporacea; *Marinella*.

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Résumé : À propos de l'algue fossile *Marinella lugeoni* PFENDER, 1939, *nom. cons.*, et ses sept avatars malheureux. Révision de la Collection Juliette PFENDER. 2e partie. Révision de la Collection Jesse Harlan JOHNSON. 2e partie.- Le réexamen de huit espèces fossiles très semblables se conclut sur leur mise en synonymie. Bien que *Marinella lugeoni* PFENDER, 1939, ne soit pas le synonyme senior, nous proposons de lui attribuer le statut de "*nomen conservandum*". L'âge de sa localité-type en Espagne est Jurassique supérieur et non Jurassique inférieur. Enfin, nous consignons la découverte de petits nodules à *Marinella* dans des couches albo-cénomaniennes du Brésil.

Mots-clefs : Rhodogorgonales ; Elianellaceae ; Solenoporacea ; *Marinella*.

Introduction

Marinella lugeoni PFENDER, 1939, is a fossil "calcareous alga" familiar to those people working on Upper Jurassic and Lower-"middle" Cretaceous limestones. It is not our intention to duplicate here the observations of earlier researchers on this nodular, sometimes encrusting alga, and it is particularly not our intention to duplicate the detailed information published by BARATTOLO and del RE (1984), supplemented by LEINFELDER and WERNER (1993), but we intend to present a summary of our understanding of the delimitation of this species: seven authors contributed to introduce one genus and eight species that were all synonymized (JOHNSON contributed twice). *Marinella lugeoni* was first found in Albian-Cenomanian strata of South Atlantic marginal basins in Angola (ROMANES, 1916), and later in Brazil (MAURY, 1937), before PFENDER (1939) reported its occurrence in Jurassic strata from Spain. To complete this study, we reexamine the age of

its *stratum typicum* in Spain and describe a particular morphotype commonly found in our Brazilian material.

Material studied

The first author (B.G.) examined material from the Juliette PFENDER Collection in Paris, from the Jesse Harlan JOHNSON Collection in Washington D.C. and from the UNESPetro Collection in Rio Claro (São Paulo).

When revising the type-material of *Marinella lugeoni* PFENDER, 1939, hosted at the "Laboratoire de Micropaléontologie" of the "Université Pierre et Marie CURIE" (Paris, France), BARATTOLO and del RE (1984) had the opportunity to examine four thin sections, "probably those used by PFENDER for the diagnosis of the genus" (the first author found only three of them), and ten additional thin sections "made in 1967" (the first author found only eight of them). In the meantime, some material (four thin sections) was lost (!). The eleven remaining thin sections

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Figure 1: The 11 thin sections remaining of the Juliette PFENDER Collection. The lectotype (defined here: Fig. 4 ; PFENDER, 1939, Pl. II, fig. 1) is in the last thin section (the third from the left) of the first row. [All photos with 1 cm scale bar]

(Fig. 1) will be relocated and deposited with a "PC" label at the "Herbier Cryptogamique, Département Systématique et Évolution, Muséum National d'Histoire Naturelle" (Paris, France) with the rest of the Juliette PFENDER Collection. Two rock samples (Pl. 1) complete this partial inventory.

With respect to JOHNSON's material, hosted by the Smithsonian Institution, the first author managed to locate four key thin sections (Fig. 2) with USNM registration numbers D992-a-843 and D992-a-844 (JOHNSON, 1961), 42547 (JOHNSON & KASKA, 1965) and 42606 (JOHNSON, 1968), but not a fifth one with the USNM number 42467 (JOHNSON, 1965).

Discussion

It is easy today (half a century later) to blame the pioneers in paleophycology for their lack of scientific rigor. For instance:

- ELLIOTT (1959, p. 220 & 222) said "*Lithothamnium angolense* ROMANES (1916) from the African Albian is also to be compared" to it, but he did not;

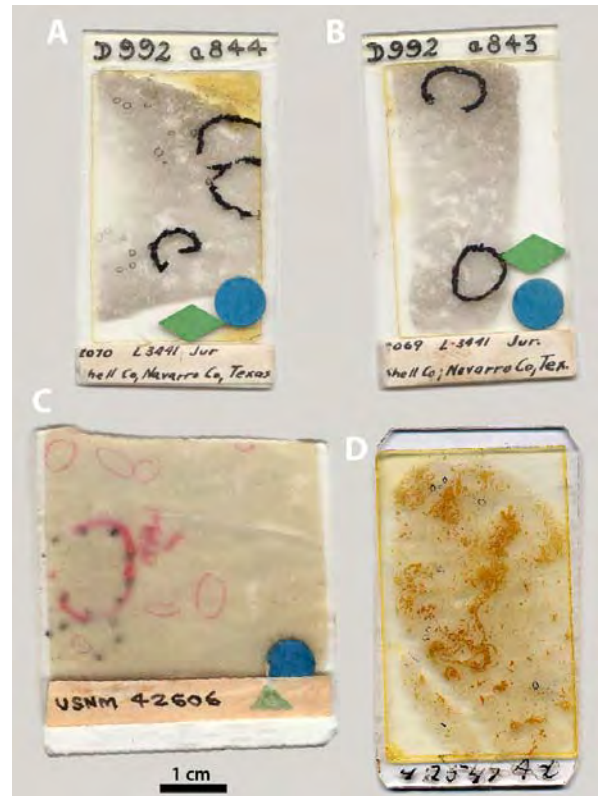


Figure 2: The 4 thin sections of the Jesse Harlan JOHNSON Collection:

- A) D992 a844 / 2070 L 3441 Jur / Shell Co, Navarro Co, Texas;
- B) D992 a843 / 2069 L-3441 Jur. / Shell Co; Navarro Co, Tex.;
- A-B) both with *Marinella lugeoni* according to JOHNSON, 1961;
- C) USNM 42606 with a *Lithophyllum* ? sp. or a *Lithothamnium* ? sp. according to JOHNSON, 1968;
- D) USNM 42547 A-D with the type of *Lithothamnium* ? *primitiva* JOHNSON & KASKA, 1965. [All photos with 1 cm scale bar]

- JOHNSON & KASKA (1965) described *Lithothamnium* ? *primitiva* n. sp. (*op. cit.*, p. 30-31, Pl. 6, fig. 1) from the same slide, USNM no. 42547 (Slide 18587: Fig. 2), from which they illustrated *Marinella lugeoni* on the same plate (*op. cit.*, Pl. 6, fig. 2) and *Girvanella minuta* on another plate (*op. cit.*, Pl. 30, fig. 1). See Fig. 3 ;
- when JOHNSON (1965) described *Lithothamnium* ? *venezuelaensis* n. sp. (*op. cit.*, p. 719, Pl. 89, figs. 1-3) from the slide USNM no. 42467 (not found), he only mentioned that "this species closely resembles ELLIOTT's (1959, p. 220) *Lithophyllum* ? *shebae*", but he did not push further his investigation.

However, knowledge on modern and fossil red algae has significantly grown since that time. In addition, access to information is getting easier.

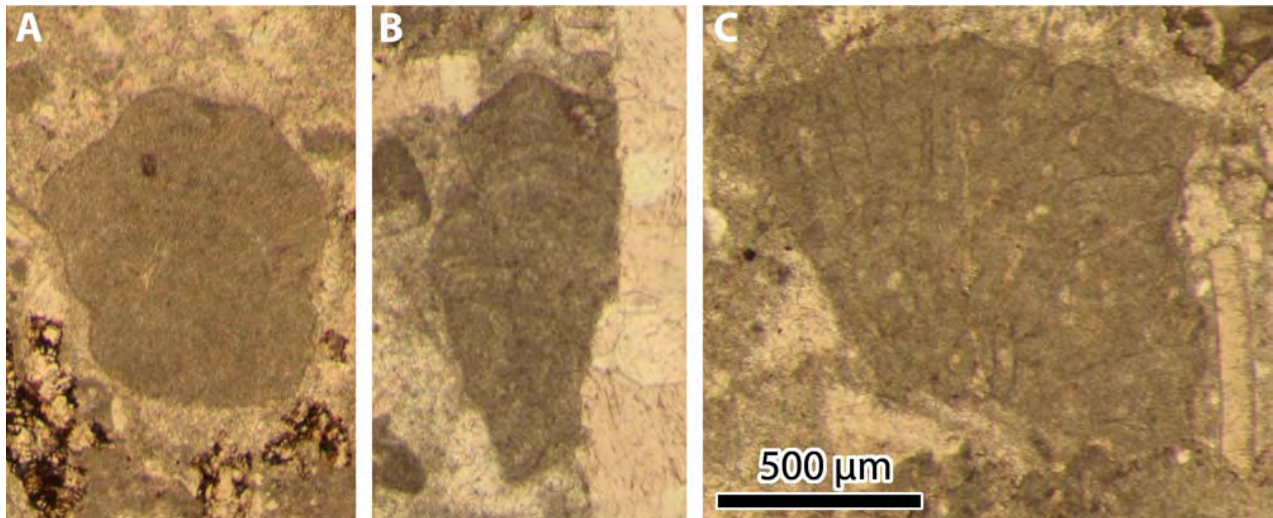


Figure 3: *Marinella lugeoni* in thin section USNM no. 42547 of the Jesse Harlan JOHNSON Collection as:

A) *Lithothamnium? primitiva* n. sp. (JOHNSON & KASKA, 1965, Pl. 6, fig. 1);

B) *Marinella lugeoni* (*op. cit.*, Pl. 6, fig. 2);

C) *Girvanella minuta* (*op. cit.*, Pl. 30, fig. 1). [All photos with 500 µm scale bar]

Early paleophycologists studying calcareous red algae and related forms were commonly relying on the external morphology and related features (measurements) to discriminate species. However, modern studies on the living and fossil forms (WOELKERLING *et al.*, 1993) have clearly demonstrated that these characters are unreliable due to the overlaps observed between discrete species and to the wide range of variation recorded within a single species.

Another set of key parameters used to split species apart consisted of measurements: the width and height of the thallus, as well as the diameter of the "branches" (all three of which are connected to morphology and therefore irrelevant for taxonomy), the height of cell rows or of the zones comprised between successive constrictions and the diameter of the filaments. Should we plot on a graph the last two parameters for the eight species, we would get a figure with overlapping clusters. For instance, according to PFENDER (1939), the filament diameters and the zone heights are respectively 6-9 and 25-40 µm in her species whereas, according to BARATTOLO & del RE (1984), they are respectively 2-10 and 20-40 in *Marinella yugoslavica* MASLOV, 1962 (*a nomen nudum*).

In conclusion, these eight species should be synonymized because external morphology and related features (measurements) cannot be used (WOELKERLING *et al.*, 1993) and because the remaining measurements (zone heights and filament diameters) fail to differentiate species from each others.

Marinella lugeoni is ascribed to the Family Elianellaceae GRANIER in GRANIER & DIAS-BRITO, 2016 (in replacement of the Family Solenopora-ceae PIA, 1927), that groups those extinct "calcareous algae" sharing some morphological features:

A) they are either encrusting or form free structures;

B) they have a framework made of erected filaments, more or less densely juxtaposed, with common to rare horizontal partitions (*i.e.*, they are pluricellular algae), defining a more or less preserved lattice-network with columns and rows. Horizontal partitions have been documented in *Marinella* by BARATTOLO & del RE (1984), LEINFELDER & WERNER (1993), and BUCUR (1994);

C) their mineralization is intracellular, centripetal (starting from the cell walls inwards), and consists of elongated fibrous calcite (probably high-Mg calcite) crystals, another feature that justifies their ascription to the calcifying red algae;

D) they are deprived of fossilized reproductive organs (which were possibly external). The "sporangia" reported by GOLONKA (1970) or LEINFELDER & WERNER (1993) in *Marinella* are probably microborings *sensu* GRANIER (2014), which was the conclusion of BARATTOLO & del RE (1984).

This family was tentatively assigned to the Order Rhodogorgonales FREDERICQ & NORRIS, 1995, a sister group to the Sporolithales (GRANIER & DIAS-BRITO, 2016).

Systematics (B.G.)
Division Rhodophyta
Class Florideophyceae
CRONQUIST, 1960
Subclass Corallinophycidae
LE GALL & SAUNDERS, 2007
Order ? Rhodogorgonales
FREDERICO & NORRIS, 1995
Family Elianellaceae
GRANIER in GRANIER & DIAS-BRITO, 2016
(formerly Family Solenoporaceae
PIA, 1927)

Genus *Marinella* PFENDER, 1939

Type: *Marinella lugeoni* PFENDER, 1939, p. 215-216, Pl. II, figs. 1-2. Lectotype (defined here): Fig. 4 ; PFENDER, 1939, Pl. II, fig. 1.

***Marinella lugeoni* PFENDER, 1939,**
nomen conservandum

(Figs. 3.A-C, 4, 5.A-C, 6-9;
 Pl. 2, figs. A-K)

Synonymy list (not exhaustive):

- 1916** *Lithothamnion angolense* n. sp.- ROMANES, p. 582-583, Pl., figs. 2 [here Fig. 5.A], 3 & 4 [here Fig. 5.B]
 Lectotype (defined here): ROMANES, 1916, Pl., fig. 4 [here Fig. 5.B]
- non 1916** *Lithothamnion angolense* n. sp., "conceptacles".- ROMANES, p. 582-583, Pl., figs. 5-6
- 1928** *Lithothamnium* (?) sp.- YABE & TOYAMA, p. 150-151, Pl. XIX, fig. 5 pars
- 1937** *Lithothamnium ? regonis* n. sp.- HOWE in MAURY, p. 45, Pl. XXVII, figs. 2-4; Pl. XXVIII, figs. 2-3
- 1939** *Marinella lugeoni* nov. gen. nov. sp.- PFENDER, p. 215-216, Pl. I, fig. 1 pars; Pl. II, figs. 1-2
 Lectotype (defined here): PFENDER, 1939, Pl. II, fig. 1
- 1959** *Lithophyllum* (?) *shebae* sp. nov.- ELLIOTT, p. 220 & 222, Pl. 1, fig. 7
- 1961** *Marinella lugeoni*- JOHNSON, p. 147-148, Pl. 31, figs. 1 [here Fig. 6, USNM D992 a843] - 2 [here Fig. 7, USNM D992 a844]
- nom. nud. 1961** *Archaeolithothamnium somensis* n. sp.- ENDO, p. 56, Pl. 3, figs. 1-2; Pl. 4, figs. 1-4; Pl. 17, fig. 1 [Note: according to its author, the "Holotype" consists of the "Slide no. 675" with two figures (Pl. 4, figs. 2-3) assigned to it]
 Lectotype (defined here): ENDO, 1961, Pl. 4, fig. 2
- nom. nud. 1962** *Marinella yugoslavica* sp. nov.- MASLOV, p. 189-192, Fig. 127.a-e; Pl. XXXIV, figs. 1-5 [Note: according to its author, the holotype is the (?) sample "no. A 1"; the figures consist of a rock sample (x2), three specimens in thin section (x10) and an enlargement (x200)]
 Lectotype (defined here): MASLOV, 1962, Pl. XXXIV, fig. 2
- 1964** *Marinella lugeoni*- JOHNSON, p. 25, Pl. 2, fig. 10; Pl. 23, figs. 1 (excerpt from PFENDER, 1939, Pl. II, fig. 2) & 3 (excerpt from PFENDER, 1939, Pl. II, fig. 1)
- 1964** *Marinella lugeoni*- JOHNSON, Pl. 23, fig. 2 pars (excerpt from PFENDER, 1939, Pl. I, fig. 1)
- 1964** *Archaeolithothamnium somensis*- JOHNSON, Pl. 40, figs. 1 (excerpt from ENDO, 1961, Pl. 3, fig. 1) & 2 (excerpt from ENDO, 1961, Pl. 3, fig. 2)
- nom. nud. 1965** *Lithothamnium ? venezuelaensis* n. sp.- JOHNSON, p. 719, Pl. 89, figs. 1-3 [Note: according to its author, the figures correspond to "cotypic sections"]
 Lectotype (defined here): JOHNSON, 1965, Pl. 31, fig. 1
- 1965** *Marinella lugeoni*- IMAIZUMI, p. 57-60, Pl. 11, figs. 7-17; Pl. 12, figs. 1-9; Pl. 13, figs. 1 (excerpt from JOHNSON, 1964, Pl. 2, fig. 10) & 2-4; Pl. 14, figs. 1-2
- 1965** *Lithothamnium ? primitiva* n. sp.- JOHNSON & KASKA, p. 30-31, Pl. 6, fig. 1 [here Fig. 3.A, USNM 42457]
- 1965** *Marinella lugeoni*- JOHNSON & KASKA, p. 74, Pl. 6, fig. 2 [here Fig. 3.B, USNM 42547]
- 1965** *Girvanella minuta*- JOHNSON & KASKA, p. 96, Pl. 30, fig. 1 [here Fig. 3.C, USNM 42547]
- 1968** *Lithothamnium ?* sp.- JOHNSON, p. 7
- 1968** *Lithophyllum ?* sp.- JOHNSON, Pl. 1, fig. 1 [here Fig. 8, USNM 42606]
- 1968** *Marinella lugeoni*- BOUROULLEC & DELOFFRE, p. 218-219, Pl. 1, figs. 7-9
- 1969** *Lithothamnium ? primitiva*- JOHNSON, p. 11, Pl. 3, fig. 1 = Pl. 4, fig. 1 (excerpt from JOHNSON & KASKA, 1965, Pl. 6, fig. 2 [here Fig. 3.B, USNM 42547])
- 1969** *Lithothamnium* (?) *shebae*- JOHNSON, p. 11, Pl. 3, fig. 1 (excerpt from ELLIOTT, 1959, Pl. 1, fig. 7)

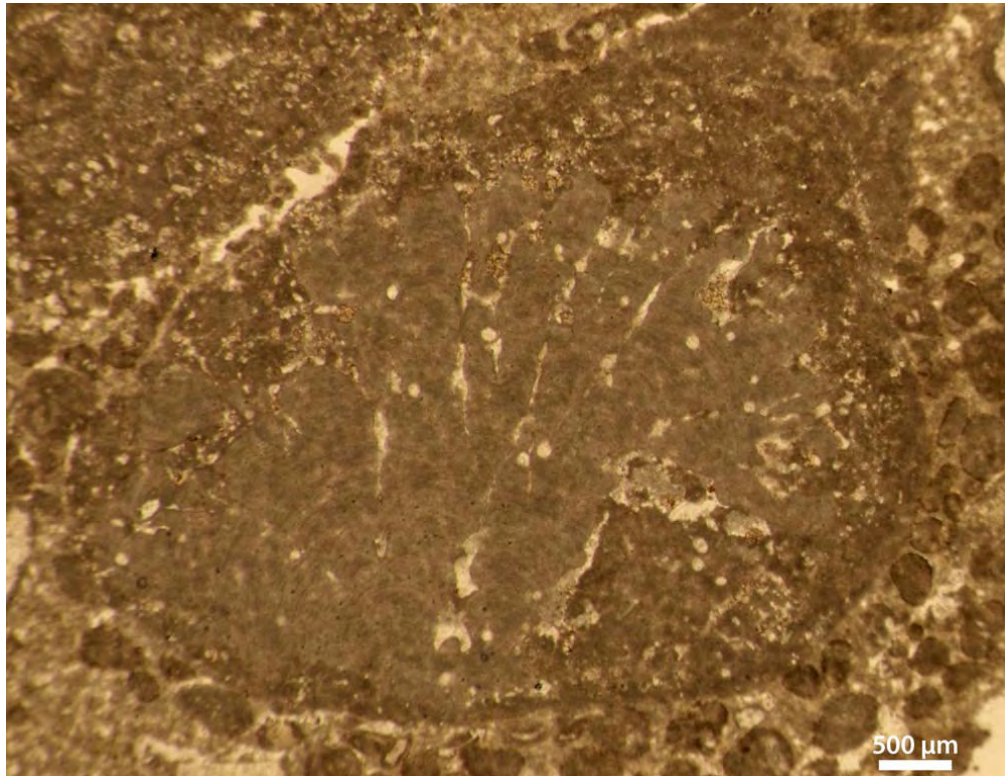


Figure 4: Lectotype (defined here) of *Marinella lugeoni* PFENDER, 1939 (*op. cit.*, Pl. II, fig. 1). Small rounded structures up to 100 µm in diameter are microborings. Thin section of the Juliette PFENDER Collection with labels "2" and "*Marinella*". [Scale bar 500 µm]

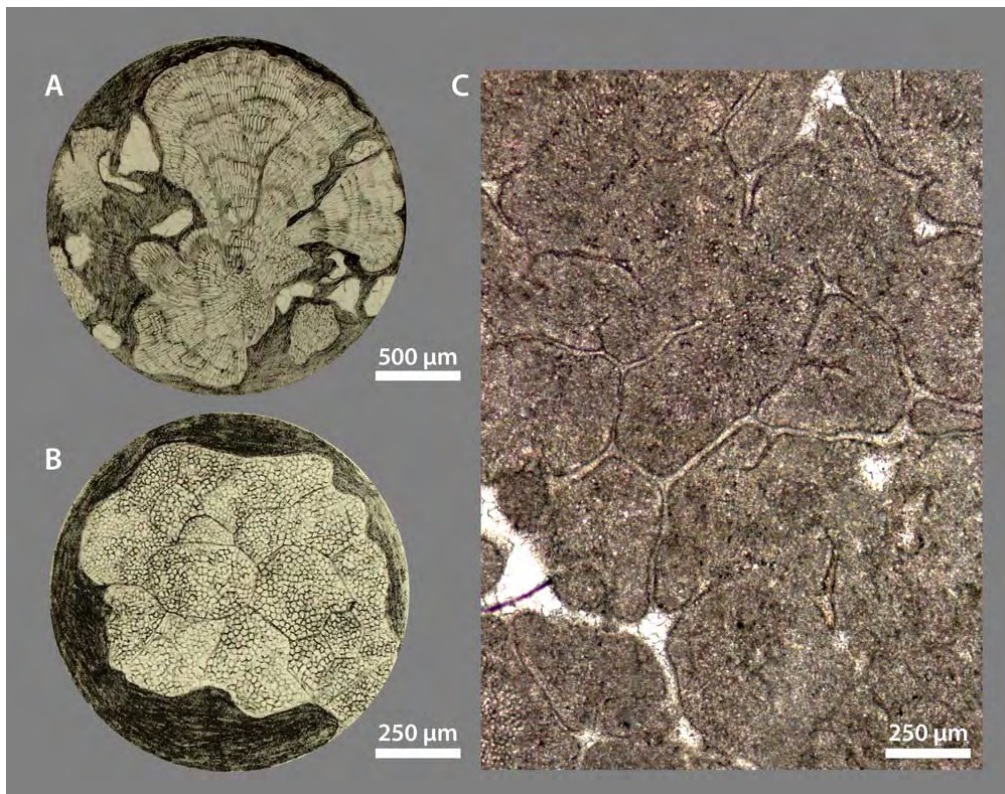


Figure 5: A-B) *Lithothamnion angolense* ROMANES, 1916; A) "Longitudinal section of 290" (excerpt from ROMANES, 1916, Pl., fig. 2); B) "Transverse section of 290, showing lines produced by compression, due to growth" (excerpt from ROMANES, 1916, Pl., fig. 4). It is the lectotype defined here; C) transverse section of *Marinella lugeoni* PFENDER, 1939, for comparison. Thin section UPAFSE 149, locality SE 6, Sergipe, Brazil; Albian, Riachuelo Formation (enlarged view of Pl. 9, up right figure in GRANIER, 2015). [A] scale bar 500 µm; B-C) scale bar 250 µm]

- 1969 *Marinella lugeoni*.- JOHNSON, p. 34, Pl. 4, fig. 2 (excerpt from JOHNSON & KASKA, 1965, Pl. 6, fig. 2 [here Fig. 3.B, USNM 42547]); Pl. 21, figs. 1 (excerpt from PFENDER, 1939, Pl. II, fig. 2), 2 pars (excerpt from PFENDER, 1939, Pl. I, fig. 1) & 3 (excerpt from PFENDER, 1939, Pl. II, fig. 1); Pl. 22, figs. 1 (excerpt from IMAIZUMI, 1965, Pl. 13, fig. 2) & 2 (excerpt from IMAIZUMI, 1965, Pl. 13, fig. 1)
- nom. nud.** 1969 *Lithothamnium ? venezuelaensis*.- JOHNSON, p. 13, Pl. 5, figs. 1 (excerpt from JOHNSON, 1965, Pl. 89, fig. 2), 2 (excerpt from JOHNSON, 1965, Pl. 89, fig. 1) & 3 (excerpt from JOHNSON, 1965, Pl. 89, fig. 3)
- 1970 *Marinella lugeoni*.- GOLONKA, p. 82-84, Photos 8-9
- 1971 *Lithophyllum (?) shebae*.- BASSON & EDGELL, p. 426 & 428, Pl. 7, figs. 1-2
- 1982 *Marinella lugeoni*.- BENGTSOEN & BERTHOUS, Pl. 4, fig. 5
- 1984 *Marinella lugeoni*.- BARATTOLO & del RE, p. 205-207 & 212-214, Fig. 1; Pl. I, figs. 1-2; Pl. II, figs. 1-2
- nom. nud.** 1984 *Marinella yugoslavica*.- BARATTOLO & del RE, p. 207-208 & 215-223, Figs. 3-6; Pl. III, figs. 1-5; Pl. IV, figs. 1-2; Pl. V, figs. 1-2; Pl. VI, figs. 1-4; Pl. VII, figs. 1-2; Pl. VIII, figs. 1-3; Pl. IX, figs. 1-4; Pl. X, fig. 1
- nom. nud.** ? *Marinella yugoslavica*.- BARATTOLO & del RE, p. 224-225, Pl. XI, figs. 1-3; Pl. XII, figs. 1-2; Pl. XIII, figs. 1-3
- 1987 *Marinella lugeoni*.- GRANIER, p. 266, Pl. 49, figs. a-d & f
- 1991 *Lithothamnium angolense*.- GRANIER *et al.*, p. 173-175, Pl. 3, fig. 2
- 1991 *Marinella lugeoni*.- GRANIER *et al.*, p. 175, Pl. 5, fig. 8 pars
- 1991 *Marinella lugeoni*.- SCHLAGINTWEIT, p. 47, Pl. 16, figs. 6-7
- 1993 *Marinella lugeoni*.- LEINFELDER & WERNER, p. 107-116, Pl. 1, figs. 1-4 pars, 5, 6-7 pars & 8-10; Pl. 2, figs. 1-12; Pl. 3, figs. 1-2 pars & 3-9
- 1994 *Marinella lugeoni*.- BUCUR, p. 162, Pl. XIX, figs. 9-12
- non** 2007 *Lithothamnion angolense*.- TOMÁS *et al.*, p. 91, Fig. 8
- 2008 *Marinella lugeoni*.- GRANIER *et al.*, p. 175, Pl. 2, fig. 1
- 2015 *Marinella lugeoni*.- GRANIER *et al.*, p. 527, Pl. 9

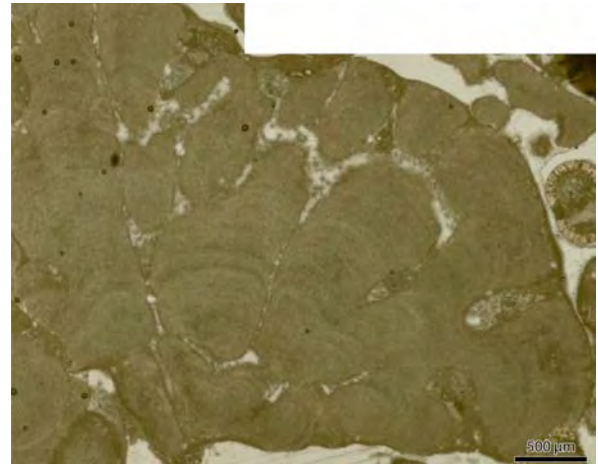


Figure 6: *Marinella lugeoni* in thin section USNM no. D992 a843 of the Jesse Harlan JOHNSON Collection (JOHNSON, 1961, Pl. 31, fig. 1). [Scale bar 500 µm]

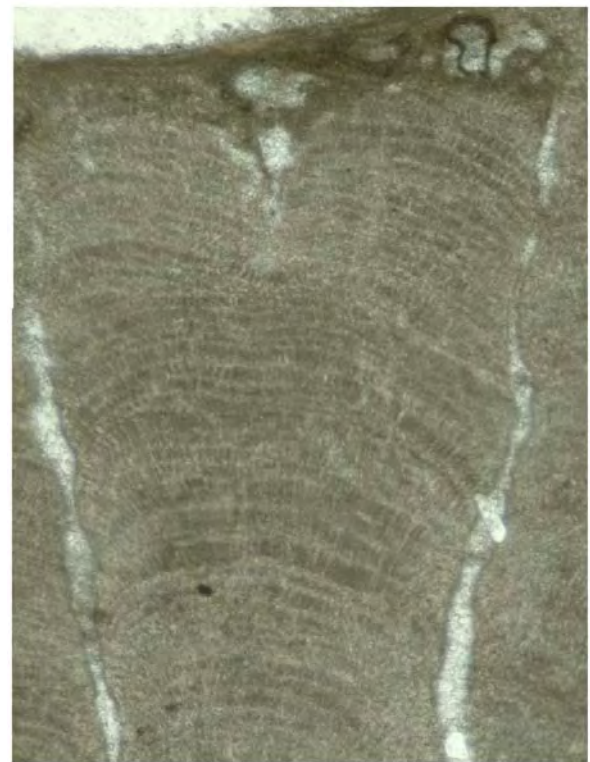


Figure 7: *Marinella lugeoni* in thin section USNM no. D992 a844 of the Jesse Harlan JOHNSON Collection (JOHNSON, 1961, Pl. 31, fig. 2). [Scale bar 100 µm]

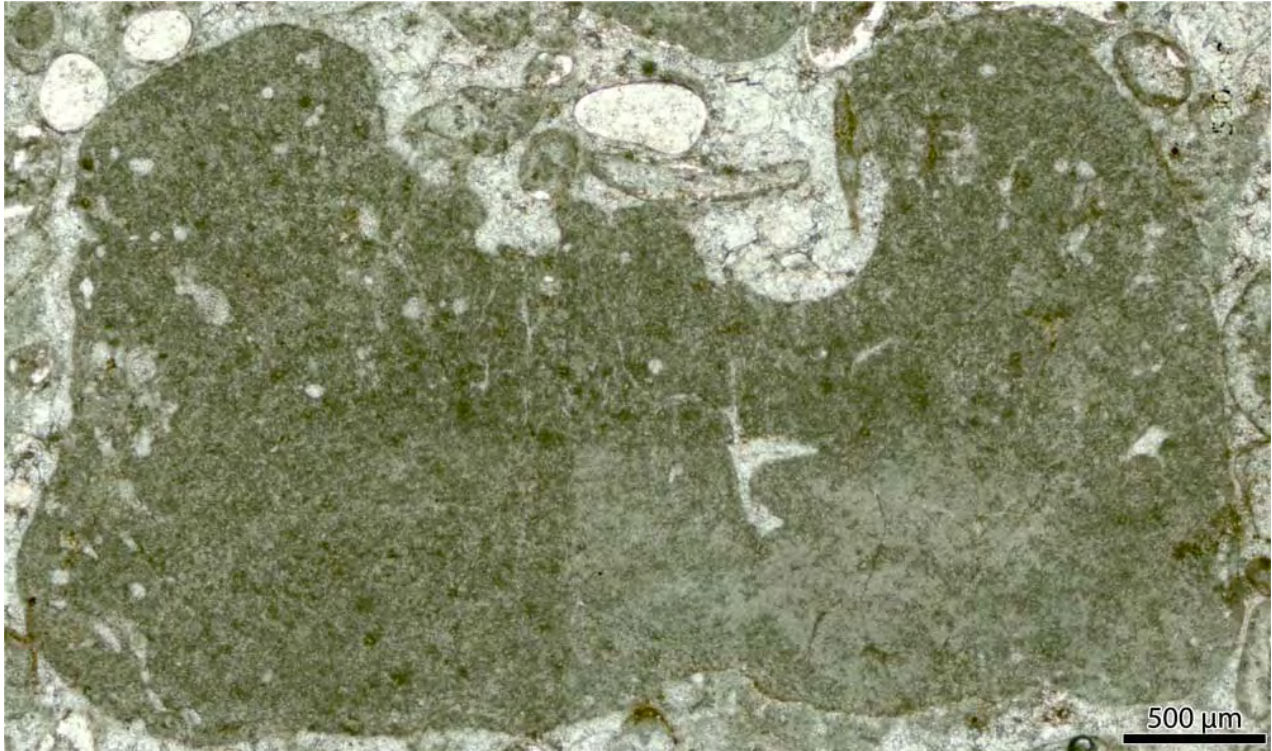


Figure 8: *Marinella lugeoni* in thin section USNM no. 42606 of the Jesse Harlan JOHNSON Collection as *Lithophyllum* ? sp. (JOHNSON, 1968, Pl. 6, fig. 1). [Scale bar 500 μm]

Taxonomic note: Considering the *International Code of Nomenclature for algae, fungi, and plants* (MCNEILL *et al.*, 2012), *Lithothamnion angolense* ROMANES, 1916, or *Lithothamnium* ? *regonis* HOWE in MAURY, 1937, have priority [cf. Art. 11 of the ICBN] over *Marinella lugeoni* PFENDER, 1939. However, the use of the last name is by far the most common and it is permanently attached (the nomenclatural type) to the genus *Marinella* PFENDER, 1939, the validity of which is established beyond doubt; on the other hand, the first two names were correctly used only once, in their original descriptions (remark: the *Lithothamnion angolense* quoted by TOMÁS *et al.*, 2007, refers to a discrete species, *i.e.*, a genuine *Lithothamnion* species, but not the Angolan form). For these reasons and for stability of the nomenclature, as in GRANIER *et al.* (1991) earlier, the first author (B.G.) proposes to conserve the name *Marinella lugeoni* PFENDER, 1939.

Description: Except for an additional remark on the occurrence of cross partitions within the filaments, there is no need to alter the original description (PFENDER, 1939, p. 215-216):

"Il s'agit probablement d'une algue filamenteuse, (...) zonée, genre 'bouffée de pipe' de H. DERVILLE (...). Le thalle est formé par des filaments juxtaposés, sans cloisons*, mais avec des constriction ; ils changent de direction fréquemment, tout en restant rayonnants, jamais pelotonnés. Le tissu forme un chevelu plutôt qu'un réseau. L'ensemble constitue un thalle digité, cranté, en éventail, d'aspect sombre, car le diamètre des filaments tubuleux est très petit, 6 à 9 μ généralement (pl. II, fig. 1). Les constriction, dans les filaments, sont souvent à un même niveau et forment des lignes concentriques sur le thalle (pl. II, fig. 2). La section transversale des tubes, juxtaposés, est polygonale ou arrondie et semble de dimension un peu variable ; 9 μ de diamètre généralement. Ces thalles sont aisément reconnaissables, dans les préparations, où ils paraissent plus sombres, étant formés d'un tissu plus serré, plus régulier, et non orientés concentriquement comme les filaments des Girvanelles."

* Actually, BARATTOLO and del RE (1984: Fig. 6.c-d; Pl. II, figs. 2-3; Pl. VIII, figs. 1-2) and later LEINFELDER and WERNER (1993: Pl. 2, figs. 2-4) and (BUCUR, 1994, Pl. XIX, figs. 10-12) did document the occurrence of such partitions (rather rare).

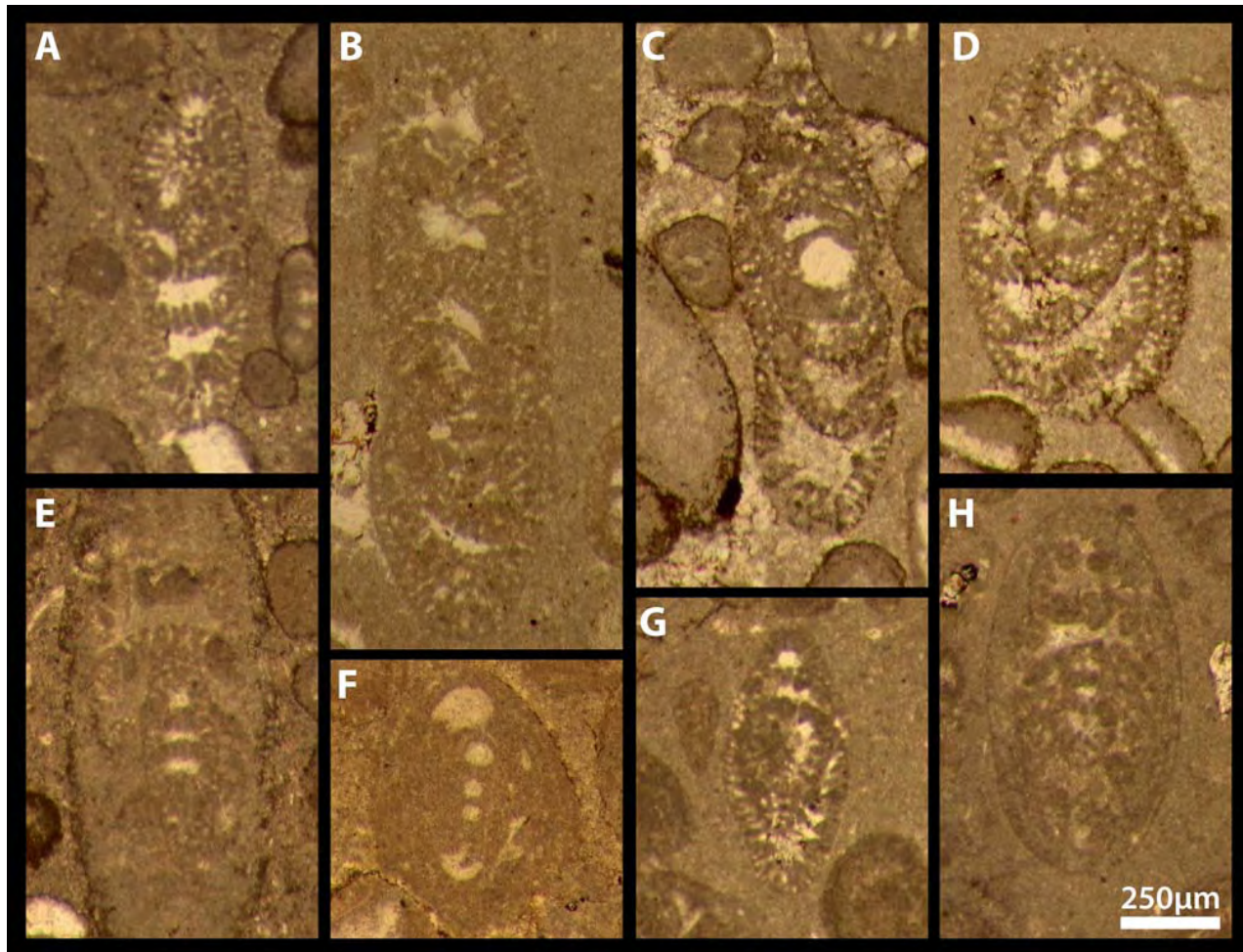


Figure 9: A-E & G-H) *Alveosepta jaccardi* (SCHRODT, 1894); F) *Nautiloculina oolithica* MOHLER, 1938. Thin sections: A) Navajas 12, B) Navajas 11, C-E) Navajas 7, F) Navajas 3, G-H) Navajas 5, Juliette PFENDER Collection. [All photos with 250 μ m scale bar]

["It is probably a filamentous alga, (...) zoned with the H. DERVILLE's 'puff of pipe smoke' type (...). The thallus consists of juxtaposed filaments, without cross partitions*, but with constrictions; they frequently vary in direction, while remaining radiating, never curled up. The fabric looks hairy rather than forming a lattice. The whole thing forms a finger thallus, notched, fan-shaped, dark, because the diameter of the tube-like filaments tubuleux is very small, usually 6 to 9 μ (Pl. II, fig. 1). The constrictions within the filaments are often at the same level and form concentric lines on the thallus (Pl. II, fig. 2). Transverse sections of juxtaposed tubes are either polygonal or rounded and apparently may slightly vary in size; with a diameter of 9 μ in average. These thalli are readily identifiable in the thin sections where they appear darker, being formed of a denser, more regular fabric, which is not concentrically oriented like the *Girvanella* filaments."]

Finally, as pointed out by our predecessors (e.g., JOHNSON, 1965; JOHNSON & KASKA, 1965; BARATTOLO & del RE, 1984, *inter alia*), one should add that there is "no evidence of reproductive structures".

Age of the *stratum typicum*

According to LUGEON (in PFENDER, 1939, p. 213), the *stratum typicum* should correspond to the lower Liassic (lowermost Jurassic). However that was not the opinion of BATALLER (1943, p. 9) who stated: "Recientemente M.^{lle} PFENDER (...) ha descrito unas algas nuevas procedentes de Navajas (Castellón de la Plana) y que según LUGEON y A. MARIN, que las recogieron, pertenecen al Liasico inferior sin mas precisión de nivel: por el aspecto de la roca simplemente, pues no hemos explorado nunca esta zona, hubiéramos creído tratarse del Jurásico superior, pues el Liasico tiene aquí poco desarrollo en comparación con el que se encuentra más al Norte, especialmente en la provincia de Teruel" [Recently Miss PFENDER (...) described some new algae from Navajas (Castellón de la Plana) and that according to LUGEON and A. MARIN, who collected them, belong to lower Liassic strata without further precision on the level: simply on the basis of the aspect of the rock, because we have never explored this area, we would have believed it to be Upper Jurassic, because the Liassic in this region is very little developed

compared with that which is found farther northwards, especially in the Province of Teruel]. In the notice of the *Mapa geológico de España* for Jerica (ORTÍ CABO, 1977), the strata bearing *Marinella*, together with *Alveosepta jaccardi* (SCHRODT, 1894), are given a Middle-Late Kimmeridgian age. The latest foraminifer, which is a marker for the Upper Oxfordian - Kimmeridgian interval, is present in our set of thin sections (Fig. 9.A-E & G-H). PFENDER (1939) probably misidentified it as "très petites *Choffatella* SCHLUMBERGER" ["very small *Choffatella* SCHLUMBERGER"].

The Brazilian morphotypes

In some thin sections from the Albian limestones of the Riachuelo Formation (Sergipe basin, Brazil), we identified two type of grains or structures with *Marinella*: 1) *Marinella* is a main contributor to some biolithites (framestones) and rhodolithes, commonly asymmetrical, 2) *Marinella* is also found in the form of small lumps, rarely exceeding 1 mm in diameter. The characteristic feature of these *Marinella* lumps is to have a hollow structure (filled by a late drusy calcitic cement), subcircular (Pl. 2, figs. B-F & I-K; GRANIER, 2015, Pl. 9, down left figure) to ovoid (Pl. 2, fig. G) in section, and eventually elongated and rounded on one end and open on the opposite end (Pl. 2, figs. A & H). This hole is not a sporangia nor a microboring (see discussion on "empty sporangial complexes versus trace fossils" in WOELKERLING *et al.*, 2014). It is located in the core of the lump and at the base of the *Marinella* filaments. Such cylindrical holes (with a maximum diameter of 300 µm) probably represent moulds of parts of larger organisms that did not fossilize, such as the stipes of non-calcifying brown, green or red algae or of seagrasses, upon which *Marinella* was growing. When these organisms died, lumps were freed like the pearls of a broken necklace.

Conclusions

This study of *Marinella* specimens, which include type-materials from Juliette PFENDER and Jesse Harlan JOHNSON collections, helped us to sort out some of the details pertaining to the alga systematics, its stratigraphy and its paleoenvironments:

- *Marinella lugeoni* PFENDER, 1939, is not the senior synonym out of eight taxa listed above, but it is proposed in order to conserve the specific epithet *lugeoni*, as it is attached to the generic name *Marinella*;
- its stratum typicum in Spain is not Liassic (Early Jurassic) in age but Malm (Late Jurassic), more specifically Kimmeridgian, in age;
- the common occurrence of characteristic small *Marinella* lumps documents its epithelial behaviour and could be used as a paleoenvironmental criterion to identify ancient seagrass and seaweed meadows.

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Appendix (list of species)

- *Archaeolithothamnium somensis* ENDO ex GRANIER, 2016 [cf. Art. 46.4 of the ICBN, McNEILL *et al.*, 2012]
- *Lithophyllum* ? *shebae* ELLIOTT, 1959
- *Lithothamnion angolense* ROMANES, 1916
- *Lithothamnium* ? *regonis* HOWE in MAURY, 1937
- *Lithothamnium* ? *primitiva* JOHNSON & KASKA, 1965
- *Lithothamnium* ? *venezuelaensis* JOHNSON ex GRANIER, 2016
- *Marinella lugeoni* PFENDER, 1939, *nom. cons.*
- *Marinella yugoslavica* MASLOV ex GRANIER, 2016

Plates

Plate 1: Two rock samples representing the original material used to make the thin sections. Figs. A-B) label 29261 / Algues / Lias inf. / Navajas (Espagne) / Province de Valence / M. LUGEON et MARIN 1928 / M. 2379. Figs. C-D) label 29261 / Algues / Lias inf. / Navajas / Province de Valence / Espagne / M. LUGEON 1928 / M. 2379 ; fig. C) see PFENDER, 1939, Pl. I, fig. 1. [All photos with 1 cm scale bar]

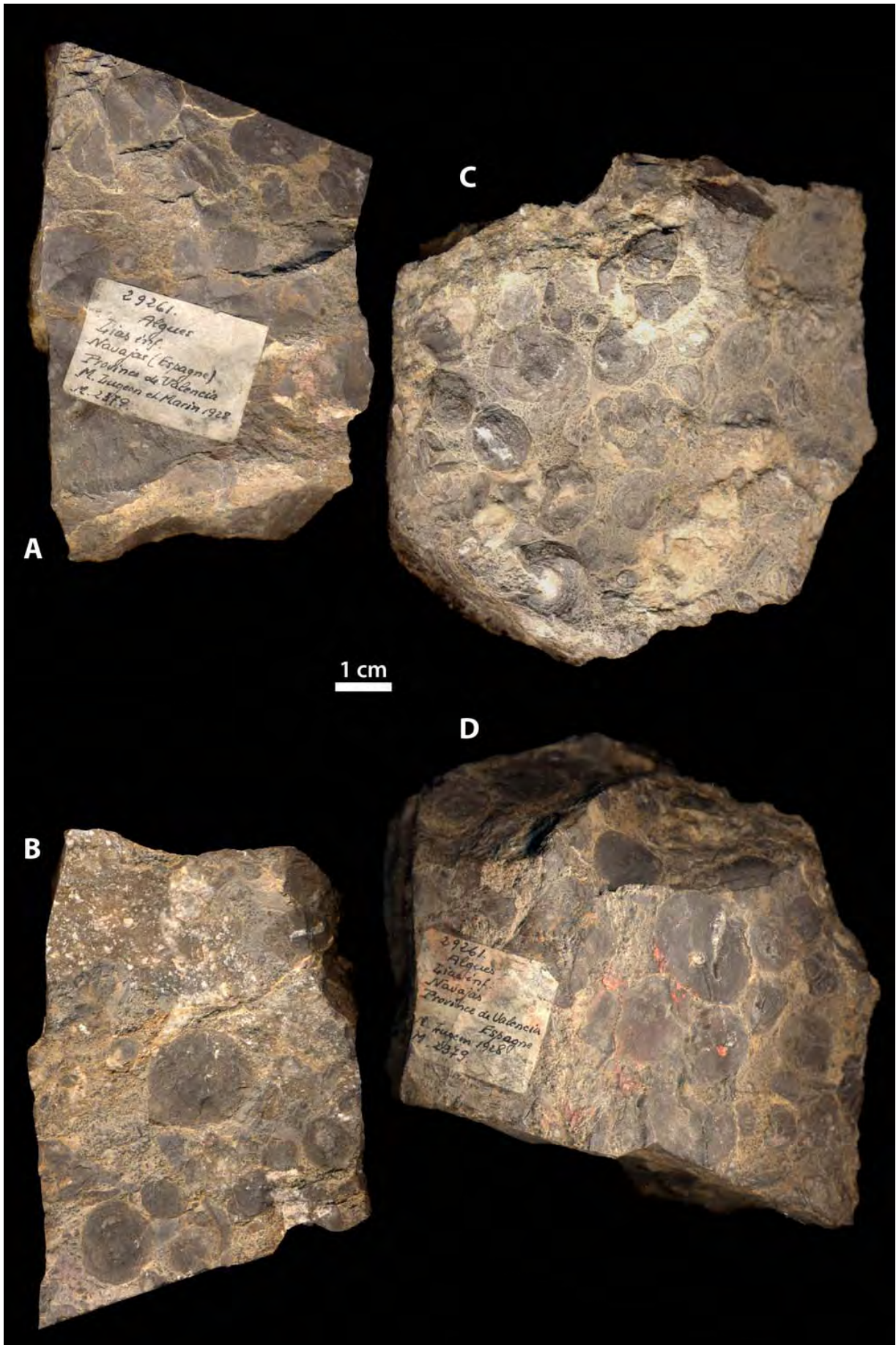


Plate 2: *Marinella* lumps. Fig. A) thin section UPAFSE 117; fig. B) thin section UPAFSE 99; fig. C) thin section UPAFSE 118; fig. D) thin section UPAFSE 94; fig. E) thin section UPAFSE 117; fig. F) thin section UPAFSE 121; fig. G) thin section UPAFSE 99; fig. H) thin section UPAFSE 99; fig. I) thin section UPAFSE 108; fig. J) thin section UPAFSE 118b; fig. K) thin section UPAFSE 118. Fig. D, locality SE1, and figs. A-C and E-K, locality SE 3, Sergipe, Brazil; Albian, Riachuelo Formation. [All photos with 250 μ m scale bar]

