Dissocladella hauteriviana MASSE *in* MASSE *et al.*, 1999 (*non* MASSE, 1976), another lower Urgonian Dasycladalean alga revisited

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Abstract: First ascribed to the Triploporellacean genus *Dissocladella* (PIA *in* RAO & PIA, 1936), the species *D. hauteriviana* MASSE *in* MASSE *et al.*, 1999, was supposedly characterized by a thallus bearing whorls of laterals each consisting of a stumpy primary with a tuft of four slim secondaries at its top. A restudy of the laterals proves that they split, not only once, but several times, and stepwisely decrease in diameter. The species is re-ascribed to the Family Thyrsoporellaceae in a new combination to the genus *Deloffrella* GRANIER & MICHAUD, 1987. Its known stratigraphic range is rather short (Late Valanginian-earliest Barremian). In addition, it disappears earlier than its companion Polyphysacean alga, *i.e.*, *Clypeina paucicalcarea* (CONRAD, 1970), and its geographical distribution is broader, which makes it a good index fossil for lower Urgonian carbonate platform series.

Key Words: Calcareous fossil algae; Dasycladales; Thyrsoporellaceae; *Deloffrella*; Hauterivian; lowermost Barremian.

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Résumé : Dissocladella hauteriviana *MASSE* in *MASSE* et al., *1999* (non *MASSE, 1976*), *révision d'une autre algue dasycladale urgonienne ancienne.-* Attribuée à l'origine au genre *Dissocladella* (PIA *in* RAO & PIA, 1936) de la Famille des Triploporellacées, l'espèce *D. hauteriviana* MASSE *in* MASSE *et al.*, 1999, était supposément caractérisée par un thalle portant des verticilles de latérales constituées chacunes d'une ramification primaire trapue portant un bouquet de quatre ramifications secondaires minces à leur extrémité distale. Une révision de ces latérales démontre qu'elles se divisent plusieurs fois, et non une seule, et ce faisant diminuent de diamètre à chaque étape. L'espèce est ré-attribuée à la Famille des Thyrsoporellaceae dans une nouvelle combinaison au genre *Deloffrella* GRANIER & MICHAUD, 1987. Dans l'état actuel des connaissances, sa distribution stratigraphique est relativement courte (Valanginien supérieur-Barrémien basal) ; de plus, elle disparaît plus tôt que sa compagne Polyphysacée, *i.e.*, *Clypeina paucicalcarea* (CONRAD, 1970), et sa répartition géographique est plus importante, ce qui en fait un bon marqueur pour les séries de plate-forme de l'Urgonien ancien.

Mots-Clefs : Algues calcaires fossiles ; Dasycladales ; Thyrsoporellaceae; *Deloffrella* ; Hauterivien ; Barrémien basal.

1. Introduction

Following the recent revision of *Clypeina paucicalcarea* (CONRAD, 1970) (GRANIER, 2013), this report is the second systematic revision of a key Dasycladalean alga found in lower Urgonian (Hauterivian-Lower Barremian *pro parte*) limestones. The scientific name (*i.e.*, the binomial name followed by the authors' citation) of *Dissocladella hauteriviana* MASSE *in* MASSE *et al.*, 1999 (non MASSE, 1976), summarizes the successive changes of its nomenclatural status: first described by MASSE, 1976, this species was long considered a *nomen nudum* (see discussion in GRANIER & DELOFFRE, 1993), before it was validated more than two decades after its original description (MASSE *et al.*, 1999). However, the story does not end there as we are about to write a new chapter.

2. New data and discussion

Dissocladella hauteriviana was first reported from "Lower Hauterivian" strata cropping out in Marseilles area, Provence (France), by MASSE (1976) who illustrated 9 sections of the alga (*op. cit.*: Pl. 4, figs. 8-16; Fig. 1 herein). As he thought the verticillated laterals divide only once he ascribed his new species to the genus *Dissocladella* (PIA *in* RAO & PIA, 1936).

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He gave the following description (MASSE, 1976: p. 180): "Cette forme présente des ramifications primaires renflées (attachées directement à l'axe principal) qui donnent naissance à 4 ramifications secondaires situées dans 2 plans perpendiculaires. La portion proximale des ramifications primaires dilatées (en ampoule fertile) est légèrement rétrécie et présente l'aspect d'un court pédoncule, mal différencié. L'axe principal est cylindrique ou présente de faibles étranglements entre les verticilles" [translation: This form has swollen primary branches (attached directly to the main axis) that give rise to four secondary branches arranged in two perpendicular planes. Primary branches are dilated (in

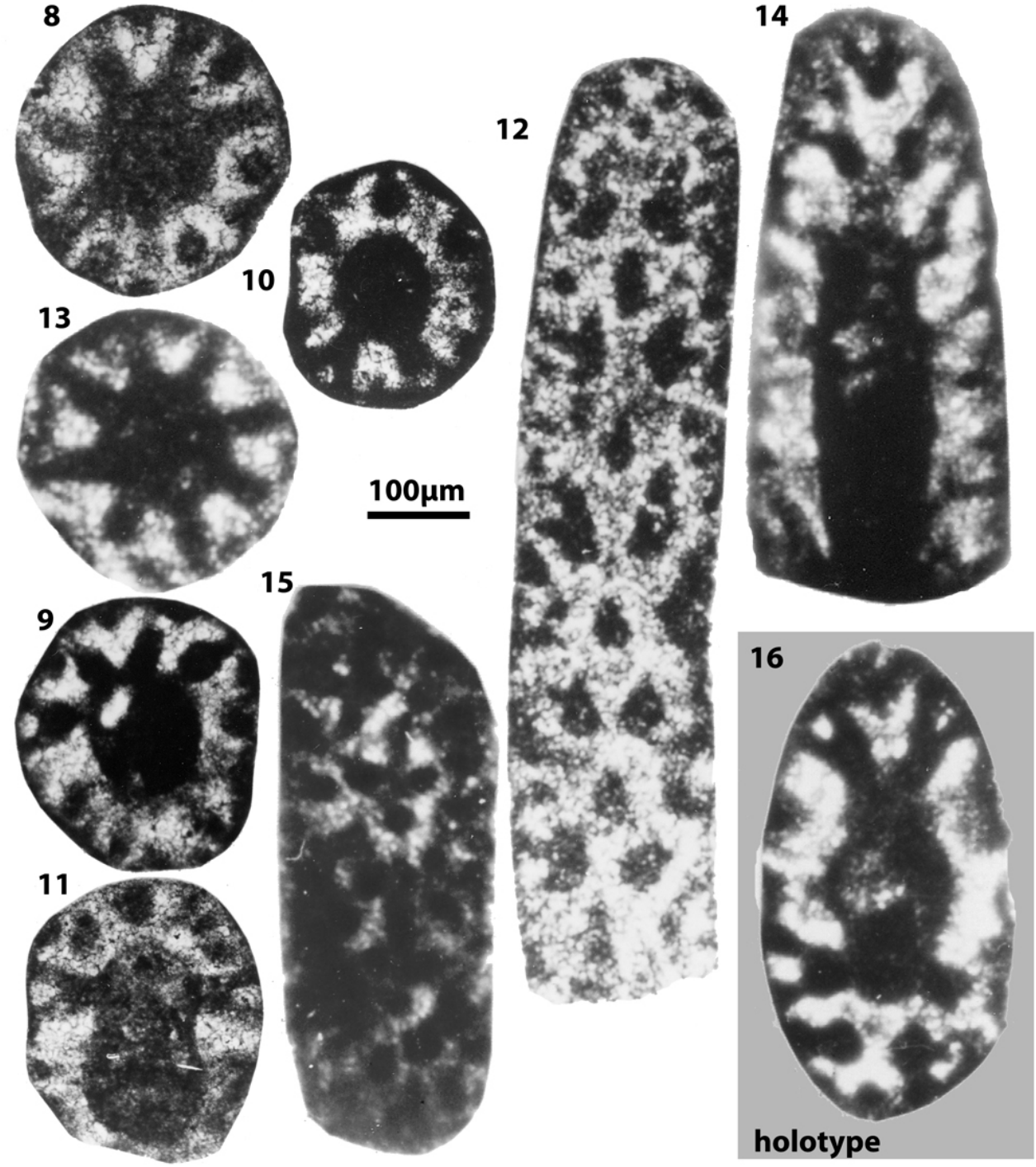

Figure 1: 8-14 & 16: *Dissocladella hauteriviana* MASSE *in* MASSE *et al.* **15:** see discussion below regarding this figure. I retained the original numbering for these duplicates of the original photomicrographs (MASSE, 1976: Pl. 4, figs. 8-16). Because most of them came with discrete scales (x 64, 80, 84, 140, 160, 170), they were modified in order to get the same scaling factor. As a result of this unitization, they can be compared with a single graphical scale bar representing 100µm. All thin sections are stored in the J.-P. MASSE's collection, Université de Provence, Marseilles (France) [Some rights reserved].

fertile ampulla), however their proximal part is slightly narrower and has the appearance of a short, poorly differentiated stalk. The main axis is cylindrical or displays slight narrowings between successive whorls]. He also gave measurements (*op. cit.*: p. 181), a part of them is duplicated in the first column of Table 1.

This description fits with the generic diagnosis that was given by BASSOULLET *et al.* (1978: p. 90) because PIA (RAO & PIA, 1936) did not provide one, but a description of the type species: "Cylindrical to club-shaped thallus. The skeleton may be linked in successive rings. The primary branches are short, globular, or widened. At the distal end of the primary branches, there are, at least, 4 secondary phloiophorous branches having a shape similar to the primary branches. Possible adaptation of slightly modified primary branches into fertile ampulla."

However, revision of the original figures as well as new finds prove that this interpretation was wrong. For instance, the uppermost lateral of the original fig. 14 of his Pl. 4 (MASSE, 1976; Fig. 1.14 herein) shows that divisions occur at least at two discrete levels, *i.e.*, the lateral divides at least twice, and consequently that there are three orders of ramifications within the laterals, not two as previously thought. When this point is agreed it becomes also clear, even in complementary sections (such as Pl. 4, figs. 12 & 16, *op. cit.*; Fig. 1.12 & 1.16 herein), that the branching pattern is not that advocated by MASSE (1976). The branching is probably dichotomous: a primary divides into two secondaries that are arranged longitudinally, these secondaries divide in turn into two tertiaries that are arranged transversally. In transverse sections (*op. cit.*: Pl. 4, figs. 9-11; Fig. 1.9-11 herein), the tertiaries form the short portions visible at the distal ends of the laterals; the long portions in the proximal part of the laterals correspond to the combination of the primaries and their associated secondaries.

The cruciform pattern of the secondaries observed in the original fig. 15 of his Pl. 4 (Fig. 1.15 herein) looks like it is incompatible with the layout of the previously discussed lateral (MASSE, 1976: Pl. 4, fig. 14; Fig. 1.14 herein) that gets three distal openings set in the same plane: such a cruciform pattern would not have more than two. However, this cruciform pattern can also be observed in genuine *Deloffrella quercifoliipora* GRANIER & MICHAUD, 1987 (see Fig. 4.10 herein), as it depends on the orientation of the cut.

Actually the material of *Dissocladella hauteriviana* originally illustrated by MASSE (1976: Pl. 4, figs. 8-16; Fig. 1 herein) is heavily calcified. But the new material, which originates from several localities including the Gulf of Gascony, France (Fig. 2.2 & 2.5-6), and Oman (Fig. 2.3-4, 2.8-9 & 2.13), is weakly calcified. It helps for a better understanding of the division pattern of the laterals.

In the new material, for instance, four sections (Fig. 2.2-3, 2.9 & 2.13) can be compared with one of the originals (MASSE, 1976: Pl. 4, fig. 12; Fig. 1.12 herein) as they all display almost the same type of tangential section with laterals looking like "oak leaves" ("feuilles de chêne" in French). This structure is characteristic of the genus *Deloffrella* GRANIER & MICHAUD, 1987, with the type species *D. quercifoliipora* GRANIER & MICHAUD, 1987 (the name of which means "having pores with the shape of an oak leaf"). The sections listed above can also be compared with sections of *D. quercifoliipora* illustrated by the authors (GRANIER & MICHAUD, 1987: Pl. I, figs. 6 & 9-10; Fig. 2.10-11 herein). The sole notable difference is the size of *quercifoliipora* being larger than *hauteriviana*. In addition, two of these sections (Fig. 2.3 & 2.13) illustrate pore shapes looking like "tea pots" ("théières" in French) and may in turn be compared with sections of *Deloffrella quercifoliipora* illustrated by the authors (*op. cit.*: Pl. I, figs. 5 & 7; Fig. 2.7 herein). The combination of "oak leaf" and "tea pot" (Fig. 3) suggests that the branching pattern of *hauteriviana* is identical to that of *quercifoliipora*, that is a branching formula 1:2:4:8, which justifies the transfer of the species *hauteriviana* to the genus *Deloffrella* GRANIER & MICHAUD, 1987. This combination excludes the genus *Dobuniella* ELLIOTT, 1975 (with a short branching formula 1:2:4) and *Belzungia* L. MORELLET, 1908, or *Thyrsoporella* GÜMBEL, 1872 (with long branching formulae).

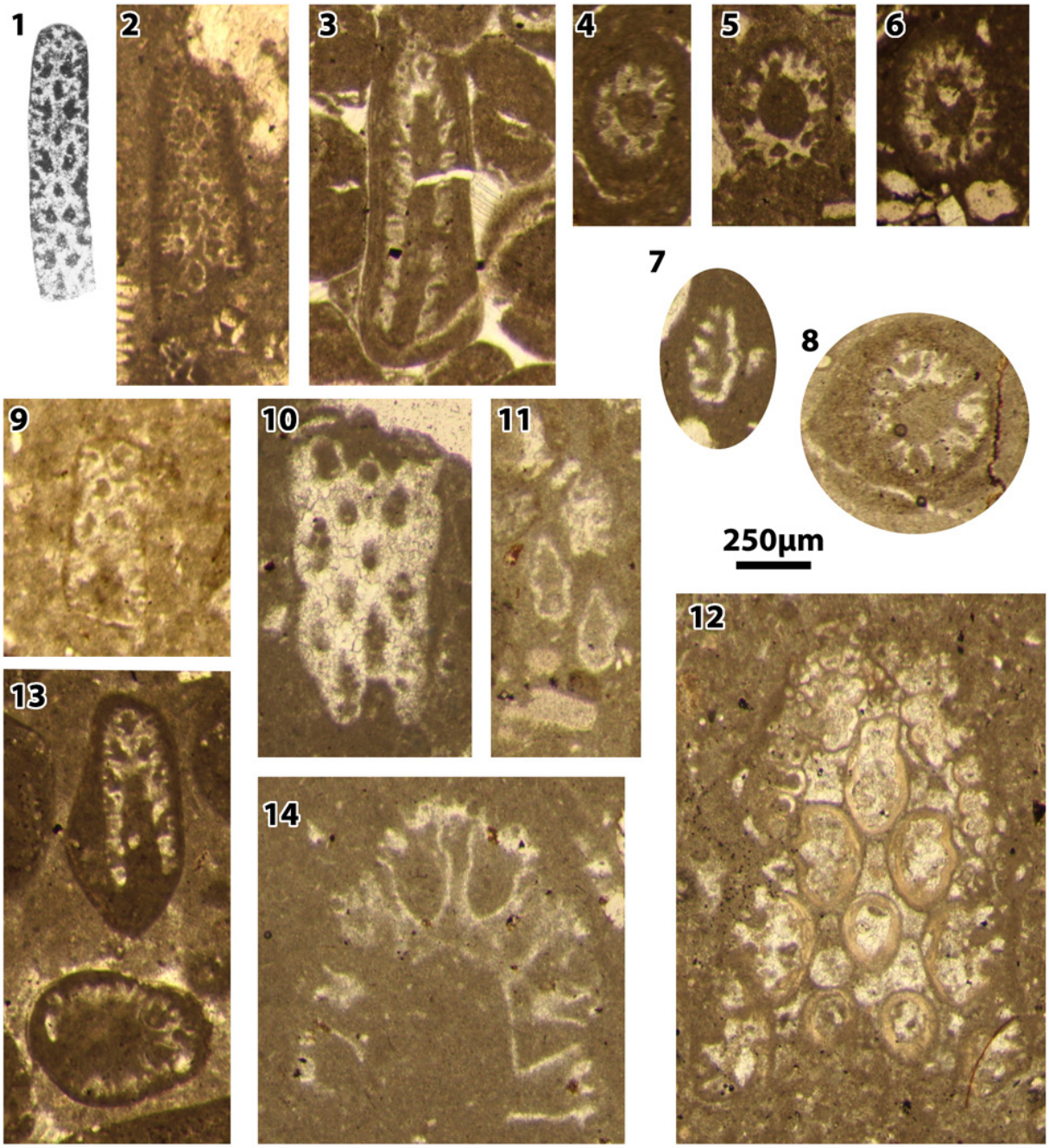

Figure 2: 1-6, 8-9 & 13: *Dissocladella hauteriviana* MASSE *in* MASSE *et al.* = *Deloffrella hauteriviana*, nov. comb.; **1:** tangential-longitudinal section (MASSE, 1976: Pl. 4, fig. 12; Fig. 1.12 herein) to be used as a reference specimen for direct visual comparison; **2:** tangential section. Well Orion, 3148.40m, Gulf of Gascony (France) [J. CUVILLIER collection]; **3:** subaxial section. Mu Aydin, MU base (Oman) [M. DUJONCQUOY leg.]; **4:** subtransverse section. Wadi Kamah 1, K3 (Oman) [M. DUJONCQUOY leg.]; **5:** subtransverse section. Well Orion, 3148.40m, Gulf of Gascony (France) [J. CUVILLIER collection]; **6:** subtransverse section. Well Orion, 3148.40m, Gulf of Gascony (France) [J. CUVILLIER collection]; **8:** subtransverse section. Wadi Kamah 1, K16 (Oman) [M. DUJONCQUOY leg.]; **9:** oblique section. Wadi Kamah 1, K2 (Oman) [M. DUJONCQUOY leg.]; **13:** two oblique sections (one subaxial). Wadi Kamah 1, K7 (Oman) [M. DUJONCQUOY leg.]; **7, 10-12 & 14:** *Deloffrella quercifoliipora* GRANIER & MICHAUD, 1987; **7:** section of an isolated lateral showing the branching pattern.- MX 85-752a, Tithonian, Veracruz-Oaxaca (Mexico) [F. MICHAUD leg.]; **10:** tangential section of an heavily calcified thallus.- MX 84-78c, Tithonian, Veracruz-Oaxaca (Mexico) [F. MICHAUD leg.]; **11:** tangential section of a poorly calcified thallus.- MX 84-22a, Tithonian, Veracruz-Oaxaca (Mexico) [F. MICHAUD leg.]; **12:** tangential section of a thallus with its original aragonitic sheath. 12071, Berriasian, N Sarajevo (Bosnia-Herzegovina) [J.-P. MASSE leg.]; **14:** "oblique section of a poorly calcified thallus, MX 85-751a = FSL 411.123" (= Pl. I, fig. 3 in GRANIER & MICHAUD, 1987), Tithonian, Veracruz-Oaxaca (Mexico) [F. MICHAUD leg.].

The genus *Deloffrella* GRANIER & MICHAUD, 1987, includes another representative: *Deloffrella* ? *berthoui* GRANIER & BERTHOU, 2002. The species newly combined cannot be mistaken with the other two as it is by far the smallest of them all (Table 1).

3. Systematics

Phylum Chlorophyta

Class Dasycladophyceae HOEK *et al.*, 1995

Order Dasycladales PASCHER, 1931

Family Thyrsoporellaceae GRANIER & BUCUR *in* GRANIER *et al.*, 2012

Genus *Deloffrella* GRANIER & MICHAUD, 1987

Deloffrella hauteriviana MASSE *in* MASSE *et al.*, 1999 (non MASSE, 1976), nov. comb.

(Figs. 1.4-14 & 1.16 - 2.1-6, 2.8-9 & 2.13 - 3 - 4.1-8)

1976 *Dissocladella hauteriviana* n.sp. (*nomen nudum*).- MASSE, p. 180-181, Pl. 4, figs. 8-14 & 16, Hauterivian, Provence (France); "holotype": Pl. 4, figs. 9-10 et 16 [duplicated in Fig. 1 herein];

? 1976 *Dissocladella hauteriviana* n.sp. (*nomen nudum*).- MASSE, p. 180-181, Pl. 4, fig. 15, Hauterivian, Provence (France);

1976 *Dissocladella hauteriviana* (*nomen nudum*).- CONRAD & PEYBERNÈS, p. 184, Fig. 9.c, Hauterivian, Catalonia (Spain);

1982 *Dissocladella hauteriviana* (*nomen nudum*).- CANÉROT & CUGNY, Fig. 5.g, Hauterivian, Maestrazgo (Spain);

1989 *Dissocladella hauteriviana* (*nomen nudum*).- CONRAD & MASSE, p. 281, Pl. II, fig. 4, Lower Hauterivian, Switzerland; Pl. II, fig. 5, (Upper ?) Hauterivian, Doubs (France) [duplicated in Fig. 4.5-6 herein];

1993 *Dissocladella hauteriviana*.- MASSE, Pl. 1, fig. 11 = Pl. 4, fig. 9 in MASSE, 1976 [duplicated in Fig. 1.9 herein], Lower Hauterivian, Marseille (France);

1993 *Dissocladella hauteriviana* (*nomen nudum*).- GRANIER & DELOFFRE, p. 30 (not illustrated);

non 1994 *Dissocladella* ? sp. aff. *hauteriviana* (*nomen nudum*).- BUCUR, p. 152, Pl. V, fig. 1, Lower Barremian, Romania; Pl. V, figs. 2-11, Upper Barremian-Bedoulian, Romania;

1995 *Dissocladella hauteriviana* (*nomen nudum*).- BLANC-ALÉTRU, p. 68, Pl. XII, figs. 1-4, Hauterivian, Switzerland [duplicated in Fig. 4.1-4 herein];

1999 *Dissocladella hauteriviana*.- MASSE *in* MASSE *et al.*, p. 234, selection of the holotype as been Pl. 4, fig. 16 in MASSE, 1976 [duplicated in Fig. 1.16 herein];

2002 *Dissocladella hauteriviana*.- GRANIER & BRAIK, p. 130 (not illustrated);

2007 *Piriferella paucicalcarea*.- CLAVEL *et al.*, Pl. 6, fig. Q (labelling error) [duplicated in Fig. 4.9 herein];

2007 *Dissocladella hauteriviana*.- CLAVEL *et al.*, Pl. 6, fig. R, Upper Hauterivian, France; Pl. 6, fig. S, Upper Hauterivian, Switzerland [duplicated in Fig. 4.7-8 herein].

Emended diagnosis: A small-sized representative of the genus *Deloffrella* GRANIER & MICHAUD, 1987. Thallus tubular, simple or branched. Laterals arranged in quincunx along the main axis. After a proximal narrowing they rapidly increase in diameter, then they divide dichotomously, probably three times, at more or less regular intervals, and doing so they stepwisely decrease in diameter. Biometric measurements (Table 1) help discriminating this species from the other representatives of the genus. The amount of calcification is variable from one specimen to the other.

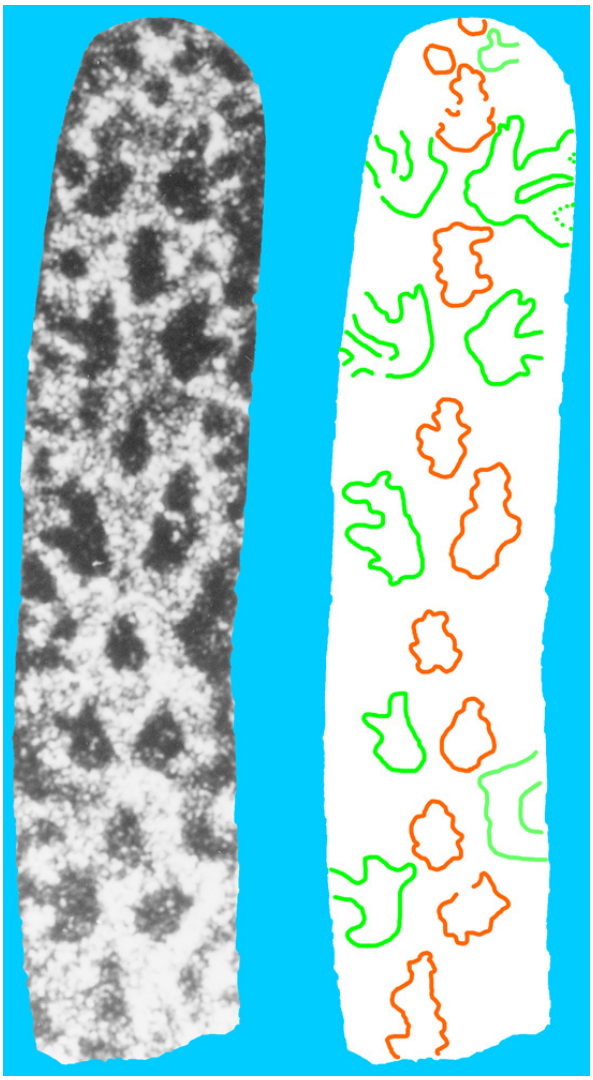

Figure 3: Tentative decryption of the tea pot structures (green) and oak leave structures (orange) on a poorly preserved segment of *Dissocladella hauteriviana* (MASSE, 1976: Pl. 4, fig. 12). These features are better seen on Fig. 2.2-3, 2.9 & 2.13.

Measurements	*Dissocladella hauteriviana* Masse, 1976	*Deloffrella hauteriviana* (OMAN)	*Deloffrella quercifoliipora* (MEXICO)	*Deloffrella ? berthoui* (PORTUGAL)
L		1.1 mm	2.5 mm	2.18 mm
D	0.22 - 0.28 mm (0.25 in average)	0.185 - 0.415 mm	0.785 - 0.925 mm	0.54 - 0.68 mm
d	0.10 - 0.12 mm (0.12 in average)	0.120 - 0.175 mm	0.385 - 0.525 mm	0.30 - 0.32 mm
d/D	23% in average	40 - 60%	40 - 67%	47 - 56%
l		0.055 - 0.085 mm	0.285 - 0.415 mm	0.19 mm
h		0.110 mm	0.175 mm	0.13 mm
p	0.03 - 0.04 mm + 0.06 - 0.07 mm	0.065 mm	0.085 - 0.110 mm x 0.120 - 0.165 mm	0.06 mm
w	6 - 8	6 - 8	6 - 8	? 8
w''	4	2	2	2
w'''		4	4	4
w''''		? 8	8	? 8

Table 1: Biometric data of 1) *Dissocladella hauteriviana sensu* Masse, 1976, 2) *Deloffrella hauteriviana* (Masse, 1999) from Oman, and 3) *Deloffrella quercifoliipora* Granier & Michaud, 1987, from Mexico. Legend: L: maximum length; D: external diameter; d: diameter of the stem; h: interverticillar spacing *sensu lato*, *i.e.*, distance from a reference plane in one whorl to the same plane in the next; l: length of the laterals (R); p: width of the laterals (R) near their proximal end; w: number of laterals (R) per verticil; w'': number of secondaries (R2) per primary (R1); w''': number of tertiaries (R3) per primary (R1); w'''': number of quaternaries (R4) per primary (R1).

4. Conclusion

Deloffrella hauteriviana (Masse, 1999) is reported from strata ranging in age from the Early Hauterivian to the earliest Barremian (Masse, 1993; Granier & Deloffre, 1993; Clavel *et al.*, 2007). There it is commonly found associated to the classical "lower" Urgonian species: *Clypeina paucicalcarea* (Conrad, 1970), *Falsolikanella danilovae* (Radoičić *ex* Barattolo, 1978), *Montiella elitzae* (Bakalova, 1971), *Pseudoactinoporella fragilis* Conrad, 1970, *Salpingoporella genevensis* Conrad *ex* Conrad *et al.*, 1973, *Montenegrella corbarica* Jaffrezo *ex* Granier & Deloffre, 1993, *etc.* However the finds with illustrations are from the Lower Hauterivian (Conrad & Masse, 1989; Masse, 1993), undifferencied Hauterivian (Masse, 1976; Conrad & Peybernès, 1976; Canérot J. & Cugny, 1982; Blanc-Alétru, 1995), (Upper ?) Hauterivian (Conrad & Masse, 1989) and Upper Hauterivian (Clavel *et al.*, 2007). The Omanese specimens (Granier *in* Dujoncquoy, 2011) were collected in the median part of the Lekhwair Fm (*i.e.*, Lekhwairian regional stage), which spans the Valanginian-Lower Barremian interval (Granier, 2008). The youngest record (Bucur, 1994) does not expressly refer to the species (*op. cit.*: "*Dissocladella* ? sp. aff. *hauteriviana*"). According to Clavel *et al.* (2007), the species is not known above the Hugii Zone (lowermost Barremian), *i.e.*, not above the first ammonite zone of the (Lower) Barremian. Finally, its first occurrence is not accurately defined but Masse (personal communication, Oct 7, 2013) found it below levels with *Neocomites peregrinus* Rawson & Kemper in Upper Valanginian strata.

This lower Urgonian (Upper Valanginian, Hauterivian and Lower Barremian *pro parte*) species was found in several localities of southwestern Europe: France (Provence: Masse, 1976, 1993; Jura: Conrad & Masse, 1989; Clavel *et al.*, 2007), Switzerland (Jura: Conrad & Masse, 1989; Blanc-Alétru, 1995; Clavel *et al.*, 2007) and Spain (Catalonia: Conrad & Peybernès, 1976; Maestrazgo: Canérot & Cugny, 1982). First the find in the Gulf of Gascony (Fig. 2.2 & 2.5-6) was confirming the hypothesis of a possible algal provincialism in Western Europe (as for its companion *Clypeina paucicalcarea* (Conrad, 1970), see

GRANIER, 2013), but the recent find in Oman (GRANIER *in* DUJONCQUOY, 2011; Fig. 2.3-4, 2.8-9 & 2.13 herein) demonstrates this hypothesis is not valid.

With a rather short stratigraphic range (Late Valanginian-earliest Barremian) and a broad geographical distribution (from Spain to Oman) *Deloffrella hauteriviana* (MASSE, 1999) should help correlating relatively well-known European sections and their commonly poorly age-constrained Middle-East counterparts. In conclusion, it is potentially a good index fossil for lower Urgonian carbonate platform series of the Tethyan realm.

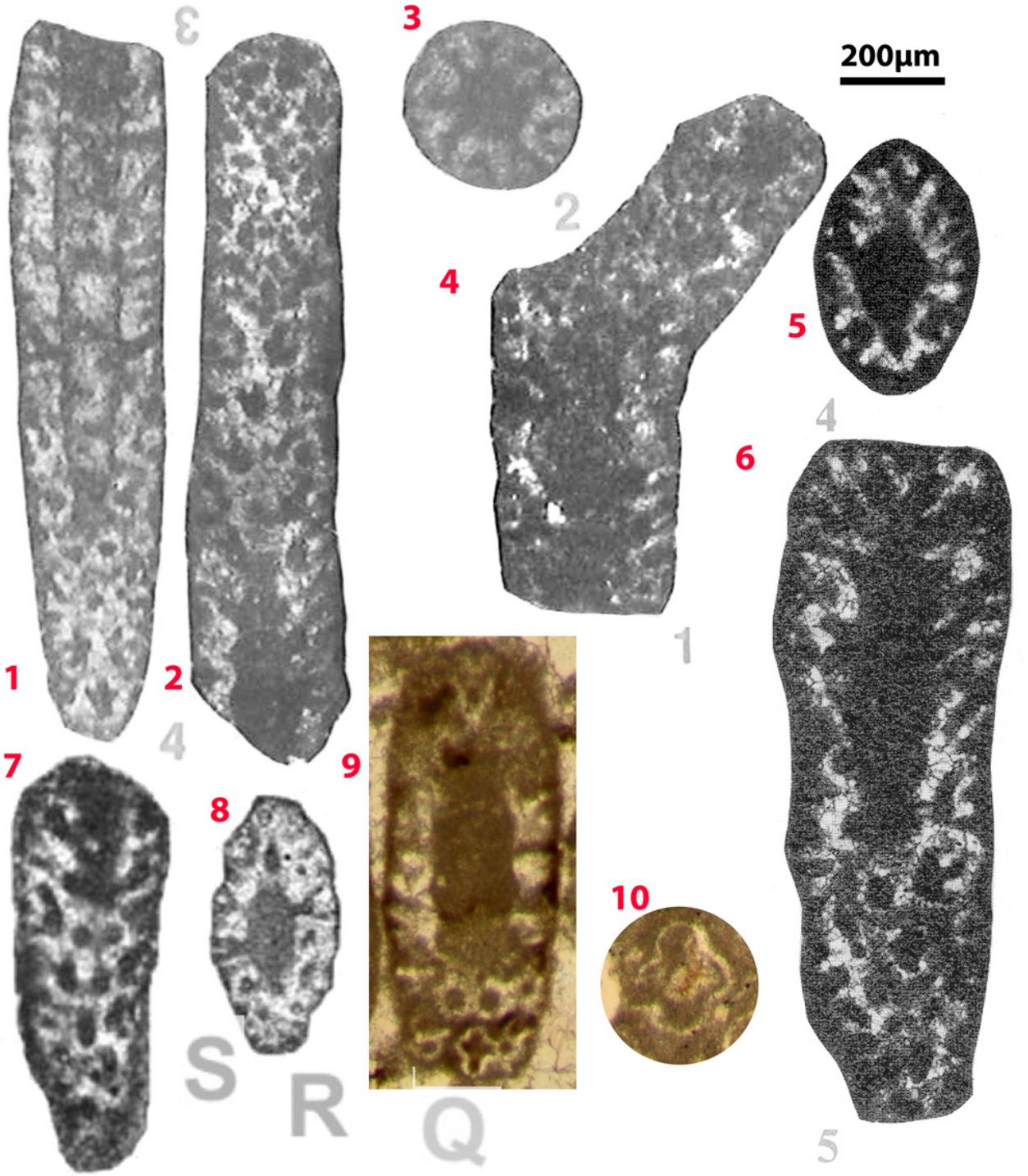

Figure 4: 1-4: *Dissocladella hauteriviana* from BLANC-ALÉTRU (1995: Pl. 12, figs. 4, 3, 2 & 1); **5-6:** *Dissocladella hauteriviana* from CONRAD & MASSE (1989: Pl. II, figs. 4-5); **7-8:** *Dissocladella hauteriviana* from CLAVEL *et al.* (2007: Pl. 6, figs. S & R); **9:** "*Piriferella paucicalcarea*" from CLAVEL *et al.* (2007: Pl. 6, fig. Q) [Some rights reserved]; **10:** section of a lateral with a cruciform pattern in a *Deloffrella quercifoliipora* GRANIER & MICHAUD, 1987, Morand borehole, -271m, Vions Fm., Upper Berriasian, Montricher, Vaud (Switzerland).

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