



## *Parviphycus bompardii* sp. nov. and *P. albertanoae* (Gelidiales, Rhodophyta), two species misidentified as *Gelidiella ramellosa* in the Mediterranean Sea

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### Abstract

A critical re-examination of both recent and historical herbarium specimens from the Mediterranean Sea attributed to *Gelidiella ramellosa* highlighted that previous identifications were incorrect. Our investigations have demonstrated that the examined specimens actually belong to the genus *Parviphycus*; some of them must be attributed to the recently described *P. albertanoae* and some to the undescribed species *Parviphycus bompardii*. The new species shows morphological features that distinguish it from the other congeners and represents the fifth species of the genus occurring in the Mediterranean Sea. *Parviphycus bompardii* is readily recognizable for both branching pattern and characteristics of tetrasporangial sori. Results of this study suggest a re-examination of previous Mediterranean records attributed to *G. ramellosa* and a much more accurate approach to future records of Gelidiales. An identification key to Mediterranean species of *Parviphycus* is also presented based on our results and also on a review of the literature.

**Key words:** *Gelidiella*; Gelidiellaceae; identification key; Mediterranean Sea; new species; *Parviphycus*; seaweeds

### Introduction

To date, the genus *Parviphycus* Santelices (2004: 322) (Gelidiales, Gelidiellaceae) is represented by eight species worldwide (Guiry & Guiry 2015), four of which were recorded from the Mediterranean Sea: *P. antipae* (Celan) B. Santelices (2004: 324), *P. pannosus* (Feldmann) G. Furnari in Furnari *et al.* (2010: 828), *P. felicinii* Perrone & Delle Foglie (2006: 201) and *P. albertanoae* A. Bottalico, G.H. Boo, C. Russo, S.M. Boo & C. Perrone (2014: 244). During a re-examination of previous collections of Gelidiellaceae Fan (1961: 317) from southern Italy, some misidentifications of specimens attributed to both *Gelidiella ramellosa* (Kützinger) Feldmann & G. Hamel (1934: 533) and *P. pannosus* were found. In particular, collections from Apulia and Sicily identified as *G. ramellosa* resulted to belong to the genus *Parviphycus* (Bottalico *et al.* 2014). The characteristic features highlighted by Santelices (2004) to distinguish *Gelidiella* Feldmann & G. Hamel (1934: 529) from *Parviphycus*, are crucial for a correct identification of such genera. In *Gelidiella*, subapical cells undergo a decussate pattern of division; consequently, both thallus anatomy and tetrasporangial sori maintain a radial symmetry; both axes and tetrasporangial sori are terete to slightly compressed; axial and periaxial cells are not obvious in the erect thallus; tetrasporangia are initiated from the inner cortical cells, ellipsoid when mature and arranged in irregular whorls, with 8–12 sporangia evident in surface view. In *Parviphycus*, subapical cells undergo a distichous pattern of division; consequently, both thallus anatomy and tetrasporangial sori maintain a bilateral symmetry; both axes and tetrasporangial sori are usually compressed to flattened; axial and periaxial cells form a distinctive row in the erect thallus, as seen in transverse section, and an ideal plane of symmetry; tetrasporangia are initiated from the pericentral cells, are rounded when mature and arranged in parallel rows, transverse or in chevrons. On the basis of these distinctive characters four species of *Gelidiella* [*G. adnata* E.Y. Dawson (1954: 422), *G. antipae* Celan (1938: 77), *G. tenuissima* Feldmann & G. Hamel (1936: 102), *G. womersleyana* Kraft & I.A. Abbott (1998: 56)] were then transferred to *Parviphycus* (Santelices 2004), and others are good candidates, for example *G. tinerfensis* Seoane-Camba (1977: 127).

*Gelidiella ramellosa*, a rarely collected small turf-forming red alga, is known with certainty only from the type material (Womersley & Guiry 1994), but the exact type locality is unknown (near Perth, south-western Australia). A few years ago it has been re-collected near the type locality and described in detail (Huisman *et al.* 2009). According to Guiry & Guiry (2015), *G. ramellosa* also counts several records throughout the Mediterranean Sea from Spain to Turkey. Feldmann (1931), based on specimens collected at Kerkennah in Tunisia, proposed the new combination *Echinocaulon ramellosum* (Kützinger) Feldmann (1931a: 8) [bas. *Acrocarpus ramellosus* Kützinger (1843: 405)]. Later, Feldmann & Hamel (1934: 533) transferred *Acrocarpus ramellosus* to the genus *Gelidiella* as *Gelidiella ramellosa*. In that paper Feldmann & Hamel (1934) stated that specimens held in the Erbario Crittogamico Italiano ser. II No. 175, collected by Bompard at San Giuliano's beach (Genoa, Italy) in 1868 and erroneously identified as *Acrocarpus spinescens* Kützinger (1843: 405) also belonged to *Gelidiella ramellosa*. The authors, however, did not specify which specimen of Bompard's collection they referred to. This taxonomic treatment had been previously made by both Ardissonne (1874: 26) and Ardissonne & Strafforello (1877: 194) who quoted *Acrocarpus spinescens non* Kützinger (Ardissonne 1874: 26), also based on Bompard's specimens No. 175 in the Erbario Crittogamico Italiano ser. II, as synonym of *Gelidiella ramellosa* [as *Gelidium ramellosum* (Kützinger) Ardissonne (1874: 26), *nom. illeg.*, being a late homonym of *G. ramellosum* (Kützinger) Trevisan (1845: 17)].

Therefore, the first record of *Gelidiella ramellosa* from the Mediterranean Sea should be that of 1868 from Genoa. We must wait for about thirty years before Molinier recorded *G. ramellosa* from Cap Corse (Molinier 1960). Later, more than fifteen records of this species can be found in several floristic lists from Mediterranean localities. Unfortunately, very few dried and liquid-preserved specimens of these records, either in herbaria or as personal collections, are currently available; furthermore, they are not documented except for that by Boudouresque (1967) in which a brief description similar to those by Feldmann & Hamel (1934; 1936) is reported. As a matter of fact, the few available drawings of Feldmann & Hamel's and Boudouresque's samples clearly show all the distinctive characters of *Parviphycus*, first of all the apical pattern of cell division and the tetrasporangial arrangement. On the other hand, the correct identification of Mediterranean records of *G. ramellosa*, has been already questioned by different authors (Maggs & Guiry 1988; Womersley & Guiry 1994; Kraft & Abbott 1998; Lapenna & Perrone 1999; Huisman *et al.* 2009). Perrone & Delle Foglie (2006) in describing *P. felicinii* from Bari (Apulia, Italy) also questioned the attribution to *G. ramellosa* of specimens from the Cheradi Islands (Apulia, Italy) (Cecere *et al.* 1996) quoting that they were distinct from the Australian type material just at a first observation.

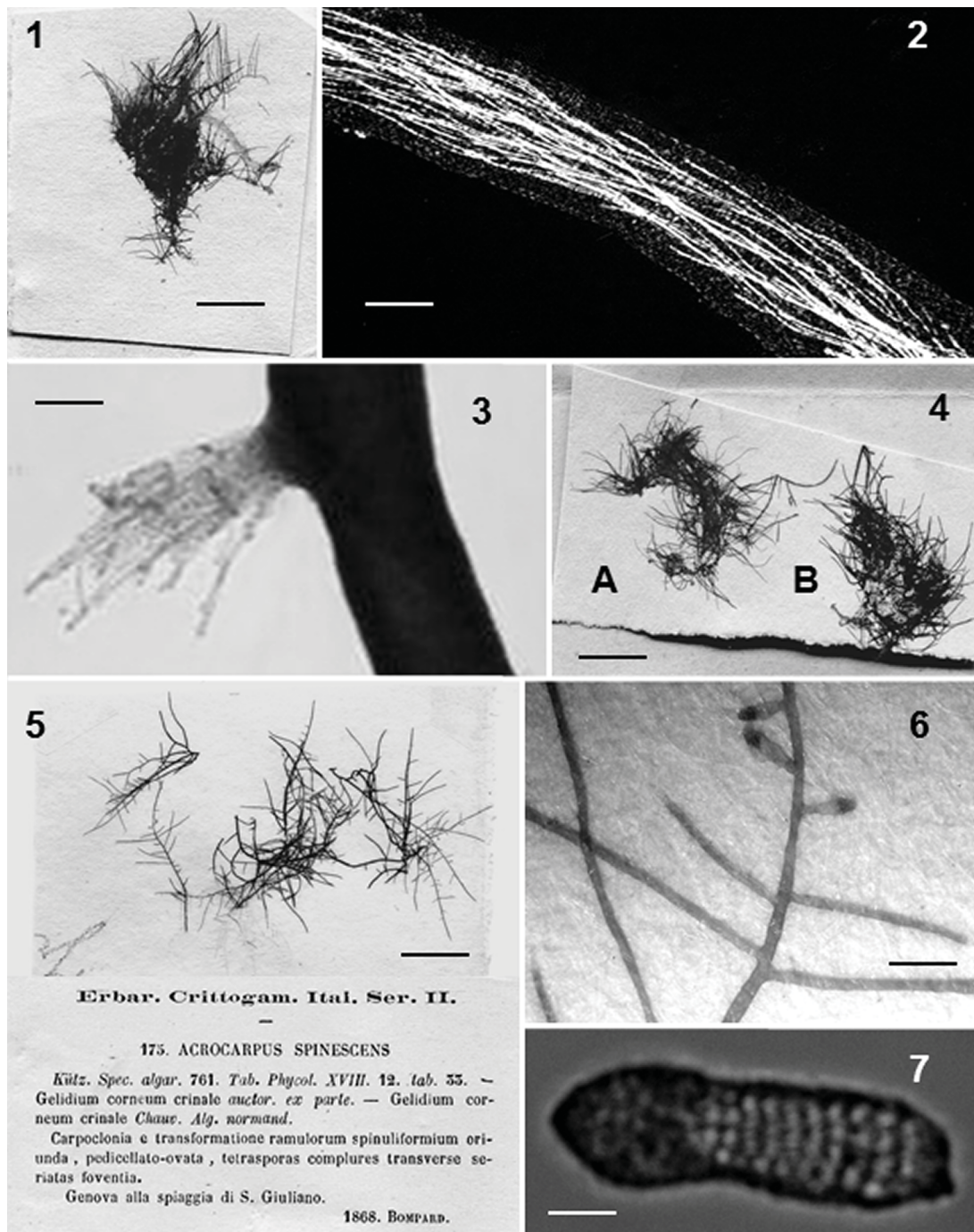
*Parviphycus bompardii* sp. nov. is described on the basis of a careful morphological examination of recent and ancient herbarium collections from the Mediterranean Sea previously attributed to *G. ramellosa* as well as of ancient collections of *Acrocarpus spinescens*.

## Materials & Methods

Morpho-anatomical investigations were performed on the following available specimens: 1) 20 (all tetrasporiferous) formalin-preserved specimens labelled as *G. ramellosa* from Mola di Bari, Bari, held in the Herbarium Horti Botanici Barenensis (BI 38467); 2) formalin-preserved specimens labelled as *G. ramellosa*, 5 (3 tetrasporiferous) from Castelluccio, Syracuse, Sicily, and 9 (2 tetrasporiferous) from S. Paolo, Cheradi Islands, Taranto, Apulia, held in the Herbarium at the Department of Biological, Geological and Environmental Sciences—Plant Biology Section of the University of Catania (CAT 71 and CAT 1270, respectively); 3) 2 *exsiccata* labelled as *G. ramellosa* from Kerkennah, Tunisia, held in the Herbarium J. Feldmann at the Muséum National d'Histoire Naturelle of Paris (MNHN-PC-PC0167206 and MNHN-PC-PC0167207); 4) 3 *exsiccata* labelled as *Acrocarpus spinescens* from S. Giuliano, Genoa, Liguria (Erbario Crittogamico Italiano ser. II, No. 175) held in the Herbarium Universitatis Senensis (SIENA), Herbarium Horti Botanici Barenensis (BI) and Herbarium Universitatis Florentinae (FI 5607), respectively. Herbarium abbreviations follow Thiers (2015). The Erbario Crittogamico Italiano collection, compiled between 1858 and 1885, is distributed in various herbaria and museums in Italy and abroad (Cuccuini 1997).

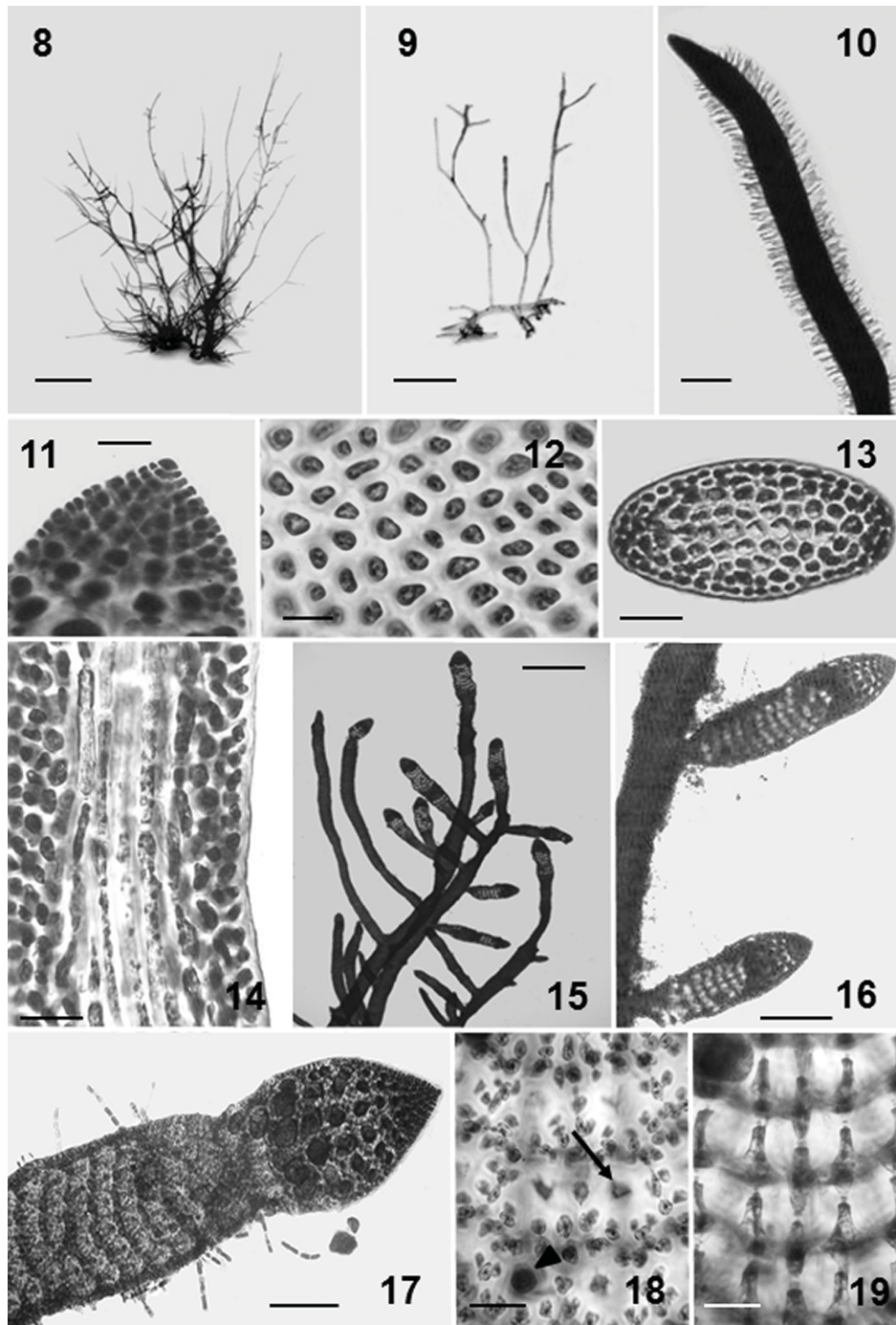
Detailed morphological and anatomical observations were carried out under a Leica MZ 7.5 stereomicroscope (Leica, Wetzlar, Germany) and an Olympus BX-40 light microscope (Olympus, Melville, USA). Sections of thalli were obtained by hand or with a DSK-1000 vibratome (Dosaka, Kyoto, Japan) and stained by 1% aqueous aniline blue acidified by 1 N HCl. The presence of internal rhizoidal filaments was checked under polarized light (Felicini & Perrone 1986). Photographs were taken using an Olympus DP21 digital camera (Olympus, Melville, USA) equipped with a software for measurements.

The authors are aware of the fact that molecular analyses could have been useful to support our findings, but during this study DNA extraction from formalin-preserved specimens as well as new collections of fresh material resulted unsuccessful. Furthermore, we did not succeed in receiving samples from other research groups.



**FIGURES 1–7** *Acrocarpus spinescens* (Genoa, Italy), Erbario Crittogamico Italiano ser. II, No. 175.

Fig. 1. Herbarium specimen held in SIENA, vegetative, referable to *Gelidium crinale*. Habit. Scale bar = 0.6 cm. Fig. 2. Refractive internal rhizoidal filaments observed in polarized light. Scale bar = 120  $\mu$ m. Fig. 3. Brush-like hapteron. Scale bar = 150  $\mu$ m. Fig. 4. Herbarium specimen held in BI. A). Vegetative thallus referable to *Gelidium crinale*. B). Vegetative thallus referable to *Parviphycus albertanoae*. Scale bar = 0.6 cm. Fig. 5. Herbarium specimen held in FI designated as holotype of *Parviphycus bompardii* sp. nov. (FI! 5607). Scale bar = 0.6 cm. Fig. 6. Stichidium-like tetrasporangial branchlets (FI! 5607). Scale bar = 0.4 cm. Fig. 7. Tetrasporangial sorus with tetrasporangia regularly arranged in chevrons (out of focus on purpose) (FI! 5607). Scale bar = 120  $\mu$ m.



**FIGURES 8–19.** *Parviphycus bompardii* sp. nov.

Fig. 8. Paratype (CAT! 71) (Castelluccio, Syracuse, Sicily). Scale bar = 3 mm. Fig. 9. Paratype (BI! 38467) (Mola di Bari, Bari, Apulia). Scale bar = 4 mm. Fig. 10. Apical part of an erect axis covered by hairs (paratype CAT! 71). Scale bar = 155 µm. Fig. 11. Apex of an upright branch showing the distichous pattern of division of the subapical cells (isoparatype BI! 38466). Scale bar = 30 µm. Fig. 12. Irregularly arranged outermost cortical cells in surface view (paratype CAT! 71). Scale bar = 8 µm. Fig. 13. Transverse section of a compressed upright branch; seven cells (axial and periaxials) are aligned along the major axis in an evident row (paratype BI! 38467). Scale bar = 50 µm. Fig. 14. Longitudinal section of an erect axis: elongated axial and periaxial filaments composing the medullary region are well distinct from the isodiametric subcortical cells (paratype BI! 38467). Scale bar = 50 µm. Fig. 15. Apical and lateral tetrasporangial sori inserted at 90° on the axes (paratype BI! 38467). Scale bar = 650 µm. Fig. 16. Stichidium-like tetrasporangial branchlets constricted at their bases and shortly stalked (paratype BI! 38467). Scale bar = 230 µm. Fig. 17. Tetrasporangial sori with tetrasporangia regularly arranged in chevrons (6 per row) and a sterile margin (paratype CAT! 71). Scale bar = 100 µm. Fig. 18. An empty sori in surface view: in the gaps of the outer cortex the tetrasporangium basal cells are visible (arrow). Regenerated tetrasporocysts (arrowhead) (paratype BI! 38467). Scale bar = 60 µm. Fig. 19. Longitudinal section of tetrasporangial sori along the medullary row of axial and periaxial filaments forming a cubic-mesh network (paratype BI! 38467). Scale bar = 60 µm.

## Results

All the examined specimens previously attributed to *G. ramellosa* showed the typical characters of the genus *Parviphycus*. In particular, specimens from Castelluccio (Syracuse, Sicily, Ionian Sea) (CAT 71) (Fig. 8), from Mola di Bari (Bari, Apulia, Adriatic Sea) (BI 38467) (Fig. 9) and some of the historical specimens of *Acrocarpus spinescens* from Genoa (Liguria, Ligurian Sea) (Figs 5–7) all sharing the same morphological and reproductive features, were distinct from the other known species of the genus. They belong to the new species here proposed (see Table 1).

Observations on specimens held in the Erbario Crittogamico Italiano ser. II No. 175 labelled as *Acrocarpus spinescens* (Figs 1–7) highlighted that they consisted of a heterogeneous collection. The specimen held in SIENA (Fig. 1) was vegetative and belonged to the Gelidiales due to the presence of numerous refractive internal rhizoidal filaments, as observed in polarized light (Fig. 2) and to the family Gelidiaceae because of the presence of brush-like rhizoidal haptera (Fig. 3) (Perrone *et al.* 2006). Its morphological features such as gross morphology, size and branching pattern could correspond to those of *Gelidium crinale* (Hare ex Turner) Gaillon (1828: 362). The specimen held in BI (Fig. 4) contained two vegetative thalli: one of them belonged to *Parviphycus albertanoae*, according to apical structure, thallus gross morphology, size and branching (Fig. 4A); the other one belonged to the Gelidiaceae and should be probably referred to as *G. crinale*, as the SIENA specimen (Fig. 4B). The specimen held in FI (Fig. 5) consisted of tetrasporic thalli belonging to *Parviphycus*, according to both the apical pattern of cell division and the tetrasporangial sorus structure, but other morphological and reproductive characters, such as size and branching (Figs 5–6), tetrasporangial sorus shape and position (Fig. 6) and tetrasporangium arrangement (Fig. 7) corresponded to both those from Sicily (CAT 71) and from Apulia (BI 38467) (Figs 8–19); this specimen has been designated as holotype of the proposed new species.

***Parviphycus bompardii*** A. Bottalico, C. Russo, G. Furnari & C. Perrone, *sp. nov.* (Figs 5–7, 8–19)

Thallus consisting of terete prostrate stolons, attached to the substratum by independent rhizoids, and compressed uprights, 6–18 (20) mm high and 140–320 µm wide, sparsely and subpinnately branched up to the second order; lateral branches are inserted at approximately 90° on main axes (Figs. 8–9). The apical parts are usually covered by hairs (Fig. 10). Erect and prostrate axes grow from a dome-shaped apical cell undergoing transverse divisions; the subapical cells divide distichously (Fig. 11); the outermost cortical cells are polyhedral, isodiametric (up to 10 µm in diam.) and irregularly arranged throughout in surface view (Fig. 12). In the erect axis transection, a central row of 7–9 medullary cells (20 µm in diam.), axials and periaxials, are always evident (Fig. 13); in longitudinal section, the medullary cells (45–50 µm long), are well distinct from the isodiametric cortical ones (Fig. 14). No internal rhizoidal filaments were found in the whole thallus. Compressed to flattened tetrasporangial sori are more often in lateral stichidium-like branchlets (up to 220 µm wide), constricted at their bases and inserted at 90° on the axes by short stalks; sometimes apical in summer (Figs 15–16). The tetrahedrally divided subspherical tetrasporangia (up to 34 µm in diam.) are regularly arranged in 10–20 chevrons, 4–6 per row; a steril margin is always present (Fig. 17). In empty sori, the cortical cells surrounding the hollow portions through which the sporangia are discharged can be observed in surface view (Fig. 18), whereas longitudinal median sections show the regular cubic-mesh network of medullary cells (Fig. 19). Regenerated tetrasporocysts occasionally occur (Fig. 18). No other reproductive structures were found.

**Type:**—ITALY. Liguria: San Giuliano's beach (Genoa), 44° 23' 30" N, 8° 57' 50" E, coll. *Bompard*, 1868 (holotype FI! 5607, Erbario Crittogamico Italiano ser. II, No. 175, as *Acrocarpus spinescens* Kützinger, tetrasporic specimens) (Fig. 5).

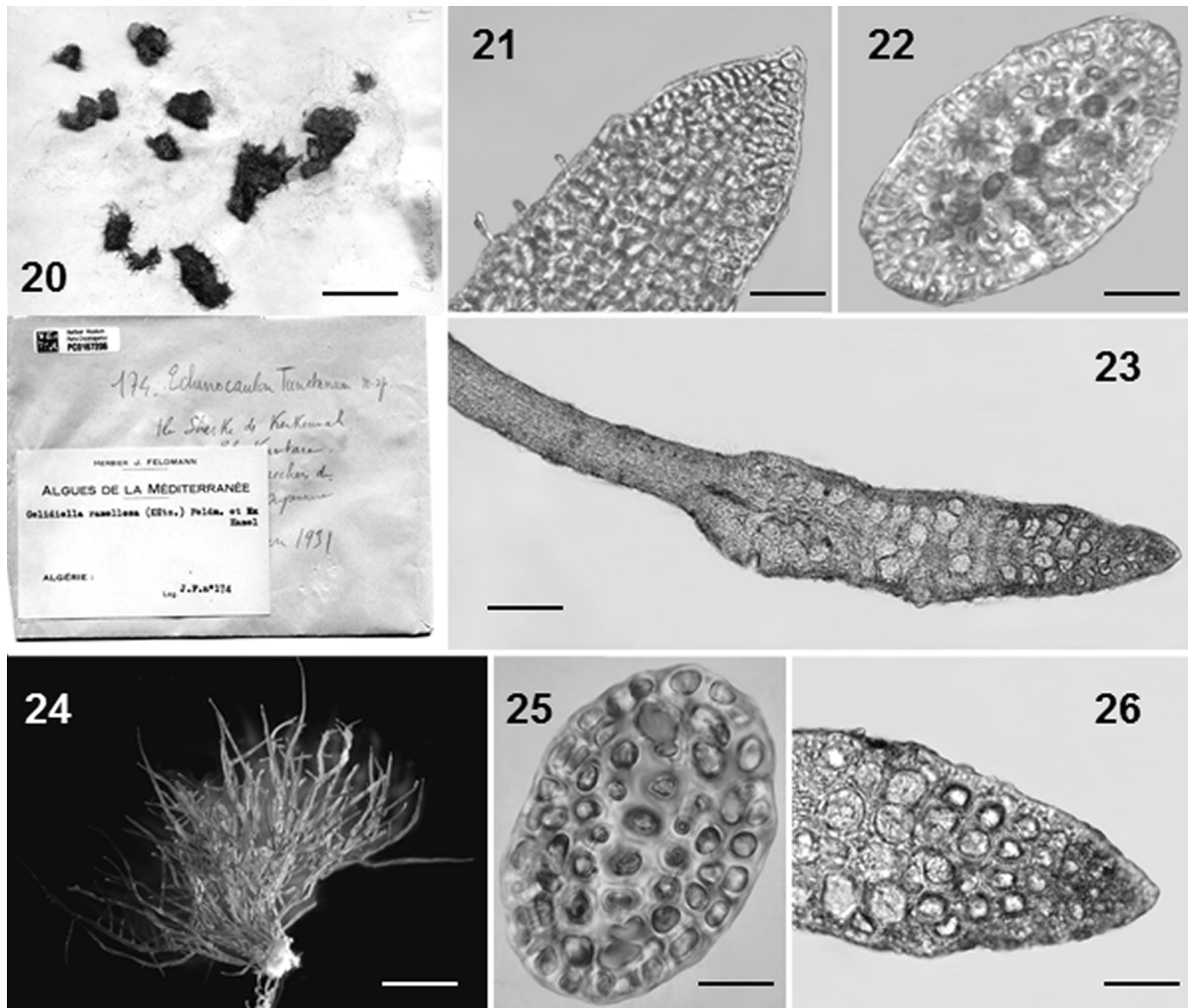
**Paratypes:**—Castelluccio (Syracuse, Sicily, 37° 18' 20" N and 15° 8' 28" E) CAT! 71 (as *G. ramellosa*, formalin-preserved, tetrasporic specimens) (Fig. 8), coll. *G. Furnari*, 10 August 1974 (isoparatype BI! 38466, formalin-preserved); Mola di Bari (Bari, Apulia, 41° 04' 00" N and 17° 05' 00" E) BI! 38467 (as *G. ramellosa*, formalin-preserved, tetrasporic specimens) (Fig. 9), coll. *C. Perrone*, 12 August 1999.

**Distribution:**—Genoa (Italy), Castelluccio (Syracuse, Italy), Mola di Bari (Bari, Italy), Tour Fondue (Giens, France) (for the last locality, see below).

**Etymology:**—The specific epithet *bompardii* refers to Enrico Bompard, the collector of the first sample of the new species.

The other specimens examined, viz. those collected by Feldmann in 1931 at Kerkennah (Tunisia) (Figs 20–23) and those from the Cheradi Islands (Taranto, Apulia, Ionian Sea) (Figs 24–26) bore all the characters of the already described species *Parviphycus albertanoae*. They showed, indeed, a suite of characters that confirm this attribution: compressed uprights (1–1.3 cm high and 100–200 µm wide) subdistichously branched up to the first order; subapical

cells distichously dividing (Fig. 21); the outermost cortical cells (5–6  $\mu\text{m}$  in diam.) longitudinally aligned only in the subapical region, but irregularly arranged below, as seen in surface view; 3–5 cells (the axial and periaxials) aligned in the median plane, as seen in the erect thallus transverse section (Figs 22, 25); tetrasporangial sori clavate, mostly apical on main axes and lateral branches; tetrasporangia arranged in transverse rows, usually 4 per row visible in surface view; no sterile margins present (Figs 23, 26).



**FIGURES 20–26.** Mediterranean herbarium specimens of *Parviphycus albertanoae*, previously misidentified as *Gelidiella ramellosa*. Figs 20–23. Herbarium specimens (MNHN! PC-PC0167206) from Kerkennah, Tunisia. Fig. 20. Herbarium sheet. Scale bar = 2.5 cm. Fig. 21. Apex of an upright branch of a specimen showing the distichous pattern of division of the subapical cells. Scale bar = 30  $\mu\text{m}$ . Fig. 22. Transverse section of a compressed upright branch; five cells (axial and periaxials) are aligned along the major axis in an evident row. Scale bar = 27  $\mu\text{m}$ . Fig. 23. Tetrasporangial sorus with tetrasporangia regularly arranged in transverse parallel rows (four per row). Scale bar = 180  $\mu\text{m}$ . Figs 24–26. Herbarium specimens from the Cheradi Islands (CAT 1270). Fig. 24. Habit. Scale bar = 3 mm. Fig. 25. Transverse section of an erect axis. Scale bar = 17  $\mu\text{m}$ . Fig. 26. Detail of a tetrasporangial sorus. Scale bar = 50  $\mu\text{m}$ .

## Discussion

Our observations have demonstrated that the historical specimens on which researchers generally based their identifications of *Gelidiella ramellosa* in the Mediterranean area, belong to either the new species *Parviphycus bompardii* or the recently described *P. albertanoae*. In fact, the ancient record of Bompard from Genoa, not well known, and the famous one of Feldmann from Kerkennah, belong to the new species *Parviphycus bompardii* and the recently described *P. albertanoae*, respectively.

TABLE 1. Morphological and reproductive characters distinguishing species of *Parviphycus*.

Characters	<i>P. adnatus</i> <sup>1</sup>	<i>P. albertanoae</i> <sup>2</sup>	<i>P. antipae</i> <sup>3,4,5</sup>	<b><i>P. bompardii</i></b> <sup>6</sup>	<i>P. felicitii</i> <sup>7</sup>	<i>P. pannosus</i> <sup>5,8,9</sup>	<i>P. setaceus</i> <sup>10,11</sup>	<i>P. trinitatis</i> <sup>5,12,13</sup>	<i>P. womersleyanus</i> <sup>5</sup>
Upright height (mm)	<1–2.5	8–12	0.6–1.9	<b>6–18</b>	0.6–11	2–3	20–30	2–15	<1
Upright width (µm)	60–80	50–200	30–56	<b>140–320</b>	90–140	50–135	150–200	52–100	30–70
Branching	none	subdistichous (1 <sup>st</sup> ord.)	none	<b>subpinnate (2<sup>nd</sup> ord.)</b>	none or 1 <sup>st</sup> ord.	none	scarce, radial	irregular	none
Outermost cortical cells in surface view:									
- shape	quadrangular	irregular	quadrangular	<b>polygonal</b>	transversally elongated	quadrangular	rounded to angular	not specified	not specified
- size (µm)	4 × 5	2 × 6	5–11	<b>10 × 10</b>	6 × 13	3 × 10	7–9	not specified	not specified
- arrangement	aligned	irregular	irregular	<b>irregular</b>	aligned	aligned	irregular	not specified	aligned
Tetrasporangial sorti:									
- position	lateral	apical	apical	<b>apical and more often lateral</b>	apical and lateral	apical	lateral	apical and lateral	apical and lateral
- shape	terete, short-stalked	clavate	terete	<b>compressed, short-stalked</b>	compressed	flattened	lanceolate, sessile or short-stalked	flattened, pinnately to subpalmately branched	swollen, terete
Tetrasporangia:									
- no. per tier	6	8–10	4	<b>8–12</b>	8–9	8–12	8–10	6–10	5–6
- arrangement	transverse rows	transverse rows	transverse rows	<b>chevrons</b>	chevrons	transverse rows	chevrons	chevrons	U-shaped, convex rows

<sup>1</sup>Santelices (2002); <sup>2</sup>Botalico *et al.* (2014); <sup>3</sup>Celan (1938); <sup>4</sup>Boudouresque (1972); <sup>5</sup>Kraft & Abbott (1998); <sup>6</sup>this paper; <sup>7</sup>Perrone & Delle Foglie (2006); <sup>8</sup>Feldmann & Hamel (1936); <sup>9</sup>Rico *et al.* (2002); <sup>10</sup>Feldmann & Hamel (1934); <sup>11</sup>Afonso-Carillo *et al.* (2007); <sup>12</sup>Taylor (1943); <sup>13</sup>Wynne (2010). Data were based on the available literature and/or obtained by related figures. The new species *P. bompardii* is reported in bold.

*Parviphycus bompardii* shows morphological features that distinguish it from the other congeners (Table 1). Among the Mediterranean representatives of *Parviphycus* the new species is readily recognizable for its gross morphology, being the most robust, tall and branched, and for its characteristic tetrasporangial sori (see the identification key below); on the other hand, it shares some features with two species out of the Mediterranean Sea: *P. setaceus* (J. Feldmann) J. Afonso-Carrillo, M. Sanson, C. Sangil & T. Diaz-Villa in Afonso-Carrillo *et al.* (2007: 122) and *Gelidiella myrioclada* (Børgesen) Feldmann & Hamel (1934: 533), two very similar taxa. *P. setaceus* for a long time was only known as vegetative and confined to the Western Atlantic Ocean [as *Gelidiella setacea* (J. Feldmann) Feldmann & Hamel (1934: 533)]. Recently, tetrasporic plants referred to *Gelidiella setacea* have been reported, described and illustrated from Gran Canaria, extending its geographic distribution to the Eastern Atlantic Ocean (Afonso-Carrillo *et al.* 2007). In the past this taxon has received only concise descriptions as *Echinocaulon setaceum* Feldmann (1931b: 13) and as *G. setacea* (Feldmann & Hamel 1934; Taylor 1960; Littler & Littler 1997, 2000). On the basis of vegetative and reproductive characters of plants from Canary Islands, *Gelidiella setacea* was transferred to *Parviphycus* (Afonso-Carrillo *et al.* 2007). Although in *P. setaceus* and *P. bompardii* thallus anatomy and tetrasporangial sorus characters are similar, *P. setaceus* is very different in size, as it is taller and slender than *P. bompardii*, for the branching pattern that is scarce and radial to the first order (subpinnate to the second order in *P. bompardii*) and for the outermost cortical cell characteristics (Table 1). *G. myrioclada* has been recorded from the Indian and Pacific Oceans and southern Red Sea. Børgesen's drawings of this taxon [as *Echinocaulon myriocladum* Børgesen (1934: 5)] show branches resembling those of *P. setaceus*. Børgesen asserts that "the Indian plant seems to be closely related to the West Indian *Echinocaulon setaceum*" but researchers yet refrain from establishing conspecificity because of different geographical distribution of the two taxa (Børgesen 1934). Unfortunately, *G. myriocladia* has not been revised any longer. Although molecular analyses on new collections of *P. bompardii* as well as on *P. setaceus* and *G. myrioclada* would be helpful to establish their phylogenetic relationships, as previously carried out with *P. felicinii* and *P. albertanoae* (Bottalico *et al.* 2014), morphological characters are currently sufficient to support the new species *P. bompardii*.

In the past both *P. bompardii* and *P. albertanoae* have been misidentified as *Gelidiella ramellosa* in the Mediterranean Sea, probably due to the branches inserted at 90° on the axes and the tetrasporangial sorus shape and position, that especially in *P. bompardii* are similar to those of *G. ramellosa*. These analogies could justify the incorrect attribution to *G. ramellosa* of some records, or maybe all, before Santelices established the genus *Parviphycus* (Santelices 2004). Other misidentifications could derive from the heterogeneity of the collection of *Acrocarpus spinescens* from Genoa, which *G. ramellosa* was at first referred to (Ardissone 1874; Feldmann & Hamel 1934). As above mentioned we examined only three of the numerous specimens of the Erbario Crittogamico Italiano ser.II labelled No. 175. That held in SIENA was identified as *G. crinale*, the two thalli held in BI belonged the one to *G. crinale* and the other one to *P. albertanoae*, while samples held in the Herbarium Universitatis Florentinae (FI), the only tetrasporic specimens we found in that collection, have been designated by us as the holotype of *P. bompardii* (Fig. 5).

From both description and illustrations by Boudouresque (1967), *G. ramellosa* from Giens also shows all the characters of *P. bompardii*. The author asserts that samples collected at Giens as well as those collected at Port Cros were related to both *Acrocarpus spinescens* from Genoa and *G. ramellosa* from Kerkennah; it is not mentioned, however, any observation of the corresponding herbarium samples. As a result Giens was temporarily included in the geographic distribution of *P. bompardii*.

The current state of facts does not allow us to state that genuine *Gelidiella ramellosa* does not occur in the Mediterranean at all, but our results strength this thesis in agreement with Huisman *et al.* (2009). With this study we intend to pave the way for a detailed re-examination of previous records and a much more accurate approach to future records is also strongly advocated.

### Identification key to Mediterranean species of *Parviphycus*

- 1a. Uprights unbranched or scarcely branched (first order).....2
- 1b. Uprights subdistichously to subpinnately branched.....3
- 2a. Thallus 0.4–3 mm high and 30–60 µm broad, unbranched; apical tetrasporangial sori terete, tetrasporangia in transverse rows (4 per tier) .....*P. antipae*
- 2b. Thallus 1–15 mm high and 50–120 µm broad, scarcely branched; apical tetrasporangial sori flattened; tetrasporangia in transverse or irregular rows (2–12 per tier) .....*P. pannosus*\*
- 2c. Thallus 0.6–10 mm high and 70–140 µm broad, rarely branched; uprights spaced about 1 cm on long stolons; internal structure with 3–5 medullary aligned cells; apical and lateral tetrasporangial sori compressed; tetrasporangia in chevrons (8–9 per tier).....



- .....*P. felicinii*
- 3a. Thallus 8–12 mm high and 50–200 µm broad, subdistichously branched (first order); internal structure with 3–5 medullary aligned cells; apical and lateral (not forming stichidium-like branchlets) tetrasporangial sori clavate; tetrasporangia in transverse rows (8–10 per tier)..... *P. albertanoae*
- 3b. Thallus 6–18 mm high and 90–320 µm broad, subpinnately branched (second order); internal structure with 7–9 medullary aligned cells; tetrasporangial sori compressed to flattened, in lateral stichidium-like branchlets constricted at their bases and short-stalked; tetrasporangia in chevrons (8–12 per tier); sterile margin present..... *P. bompardii*

Note: size ranges derive from the literature as well as from personal observations.

\* Since Apulian samples previously ascribed to *P. pannosus* show differences from the lectotype (Santelices & Rico 2002), data regarding this species were exclusively taken from the literature.

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