

Evidence for the proposal of *Hymenocladopsis prolifera* (Reinsch) comb. nov. (Rhodymeniales, Rhodophyta)¹

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Abstract — A collection of cystocarpic, spermatangial, and tetrasporangiate specimens of a red algal species from the South Sandwich Islands in the Antarctic presents evidence to identify this material as *Gracilaria prolifera* Reinsch and to conclude that this is an older available name for *Hymenocladopsis crustigena* Moe. Thus, the binomial *Hymenocladopsis prolifera* (Reinsch) comb. nov. is proposed.

Gracilaria prolifera / Hymenocladopsis / H. crustigena / H. prolifera / marine red algae / Rhodophyta / South Sandwich Islands

Résumé — Proposition de *Hymenocladopsis prolifera* (Reinsch) comb. nov. (Rhodymeniales, Rhodophyta). Un ensemble d'échantillons avec cystocarpes, spermatocystes et tétrasporocystes d'une espèce d'algue rouge des Îles Sandwich dans l'Antarctique, s'identifie avec évidence comme *Gracilaria prolifera* Reinsch. Ce dernier est un nom plus ancien disponible pour *Hymenocladopsis crustigena* Moe. Aussi, le binome *Hymenocladopsis prolifera* (Reinsch) comb. nov. est proposé. (Traduit par la Rédaction).

algue rouge marine / Gracilaria prolifera / Hymenocladopsis / H. crustigena / H. prolifera / Iles Sandwich / Rhodophyta

INTRODUCTION

Despite their remoteness and the inherent climatic difficulties imposed by their high latitudes, the Antarctic and Subantarctic regions have long held the interests of phycologists, going back to the intrepid explorers and collectors Joseph Dalton Hooker and Carl Skottsberg. Thus, a fairly detailed literature on the benthic marine algae now exists, both old and recent (Hooker & Harvey, 1845; Hooker, 1846-1847; Reinsch, 1888, 1890; Skottsberg, 1907, 1921, 1923; Gepp & Gepp, 1907; Gain, 1912; Kylin & Skottsberg, 1919; Papenfuss, 1964; Zaneveld, 1968; Lamb & Zimmermann, 1977; Clayton, 1994; Wiencke & Clayton, 2002).

1. Dedicated to Dr. I. A. Abbott on the happy occasion of her 85th birthday. Congratulations!

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One region, however, that has remained very little collected relative to the rest of this large area is the South Sandwich Islands. Lying 760 km southeast of South Georgia, the South Sandwich Islands occupy an intermediate location between South Georgia and the maritime Antarctic region of the South Orkney Islands. Even though the South Sandwich Islands are located more northerly than the South Shetlands and the South Orkneys, they have a much colder climate owing to the cold ocean current coming from the Weddell Sea. The South Sandwich Islands, which are uninhabited, are presently claimed by both Great Britain and Argentina. About a million breeding pairs of chinstrap penguins live on Zavodovski Island alone, making it one of the world's largest penguin colonies (Rubin, 2000). Both the South Sandwich Islands and South Georgia lie within the Antarctic Convergence (Ricker, 1987), although opinion has differed on how to classify South Georgia. In Knox's (1960) opinion South Georgia forms a distinctive biogeographic unit, whereas Hedgpeth (1969), Dell (1972), and South (1979) treated the marine benthos of South Georgia as Antarctic. Neushul's (1968) data led him to conclude that the benthos of South Georgia represented a transition between the Antarctic and Subantarctic. Longton & Holdgate (1979) characterized the terrestrial vegetation of the South Sandwich Islands as essentially Antarctic. Unlike South Georgia, which is amenable to visitors, the South Sandwich Islands are nearly inaccessible and difficult to approach because of the prevailing weather conditions and the fact that they rise steeply out of the sea. Also, they are a region of active volcanism (Coombs & Landis, 1966; Gass *et al.*, 1963). The single volcano on Zavodovski Island is constantly erupting with hot smoke issuing from the cone.

According to Kemp & Nelson (1931) the first seaweeds to be collected at the South Sandwich Islands were some red and brown algae brought up by dredging and trawling by the British ship R.R.S. "Discovery", but the taxa were not specified. It was mentioned that the kelp *Macrocystis pyrifera* was conspicuously absent. The first list of macroalgal species from the South Sandwich Islands was that made by Zinova (1966), who listed 8 species collected by A. I. Ivanov in 1957-1958. She reported a few torn specimens of *Gracilaria prolifera* Reinsch, the biggest specimen 36 cm tall, with two branches up to 1.5 cm in width and densely beset with marginal proliferations. She also observed large cystocarps located on the surface of two of the specimens. Her description exactly matches the specimens to be described in this account. Earlier, I reported on four species of Delesseriaceae (Rhodophyta) from the South Sandwich Islands (Wynne, 1982). The specimens that are the basis of this report were collected at the same time as the material for the previous paper. The unresolved relationship of *Hymenocladopsis crustigena* R.L. Moe to *Gracilaria prolifera* and to *Phyllophora* (?) *abyssalis* Skottsb. led me to borrow type specimens of the latter pair of species and to compare these materials with the collections of similar material from the South Sandwich Islands and the description of *H. crustigena*.

MATERIALS AND METHODS

The specimens were dredged with a trawl on 30 Sept. 1978 off Zavodovski Island (56.28° S, 27.67° W), the northernmost island of the archipelago comprising the South Sandwich Islands. The collection was preserved in 5%

Formalin in sea-water, and later some of the specimens were processed as pressed herbarium specimens. The pressed specimens are deposited in the Herbarium (MICH) of the University of Michigan, Ann Arbor. Small parts of both wet-preserved and pressed specimens were placed on slides as whole mounts or sectioned with single-edged razor blades for examination with a Zeiss compound microscope. A dilute acidified solution of aniline blue was used to stain the sectioned blades to enhance visibility of the cellular arrangement.

The holotype of *Gracilaria prolifera* Reinsch was received on loan from the Botanische Staatssammlung, Munich, Germany, and observations were made. Cross-sections of a part of a blade were made with a single-edged razor blade and mounted for microscopic examination. Three syntype specimens of *Phyllophora abyssalis* Skottsbo. were received on loan from the Swedish Museum of Natural History, Stockholm, and observations were similarly made on this material.

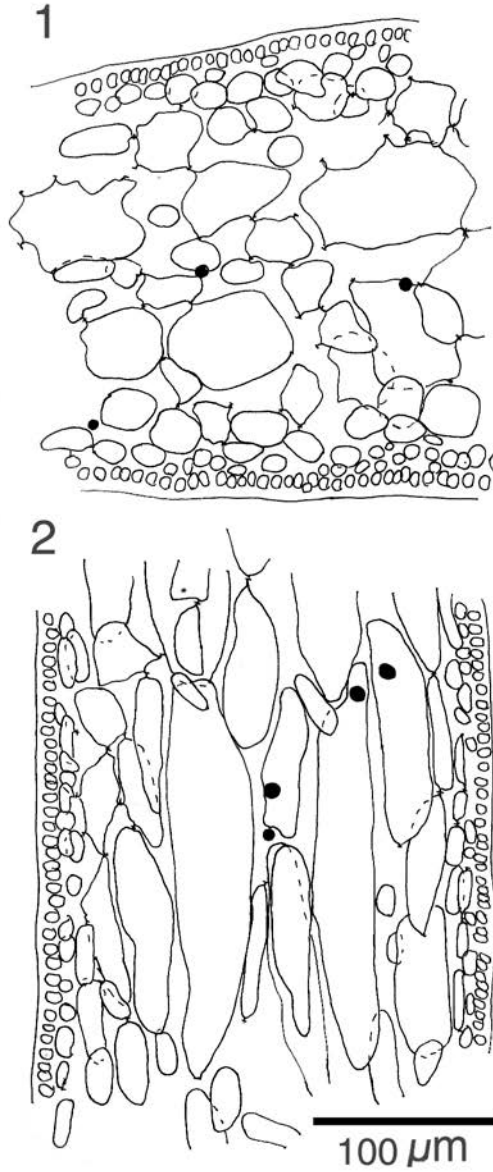
OBSERVATIONS

About a dozen specimens of the alga under discussion were involved in this report. Transverse sections (Fig. 1) and longitudinal sections (Fig. 2) of blades show thicknesses of 430-470 μm . In transverse sections of blades, surface cells are elongate, 4-6 μm wide and 6-8 μm in height. Beneath the cortex is a layer of sub-cortical cells, approximately 2-3 times larger than the surface cells. The medulla consists of a mixture of large and small cells, fairly loosely arranged such that spaces are apparent. The larger medullary cells are aligned in the long axis of the blades. Gland cells, which are conspicuous because they absorb aniline blue stain more intensely, are borne in a random manner on medullary cells (Figs 1 and 2).

Some of the largest specimens are cystocarpic. The two specimens depicted (Fig. 3) are 37 cm and 51 cm tall, respectively, and measure 10-16 mm in width. As is true for all of the specimens of this species collected, these specimens are densely proliferous along the margins, the lateral branches extending to 9 cm in length. A few of these lateral branches are themselves proliferous along their margins. The cystocarps are randomly scattered over the surface of both primary and secondary blades. Progressive stages of maturation of cystocarps were observed (Figs 4-9), starting with a small swelling out from the blade surface (Fig. 4) and gradually developing a conspicuous cylindrical, peg-like structure with a flat outer surface and a curved lip-like rim (Figs 8-10). Cystocarps have an obvious ostiole. Mature cystocarps measure to 2 mm in diameter and prominently protrude about 1.5 mm from the surface of the blade (Figs 11 and 15). The pericarp arises perpendicularly from the blade surface.

Tetrasporangia are randomly scattered on both surfaces of a tetrasporangiate specimen, that is, they are not localized in discrete sori. The tetrasporangia are located close to the surface (Figs 12-14) and appear to be pit-connected only at their basal ends, thus terminally produced. Tetrasporangia are elongate, 55-75 μm long and 30-44 μm broad and are tetrahedrally to irregularly divided. A single male specimen was observed. It bore spermatangial sori in a diffuse arrangement over the surface of the blades.

Because these specimens from the South Sandwich Islands had been dislodged from their attachment by an anchor, most had been ripped from their basal system. But at least two of the specimens still had retained a portion of their base.



Figs 1-2. *Hymenocladopsis prolifera*. Fig. 1. Transverse section of blade. Fig. 2. Longitudinal section of blade. Camera-lucida drawings. Gland cells (dark) borne on medullary cells. Specimens from Zavadoski Island.

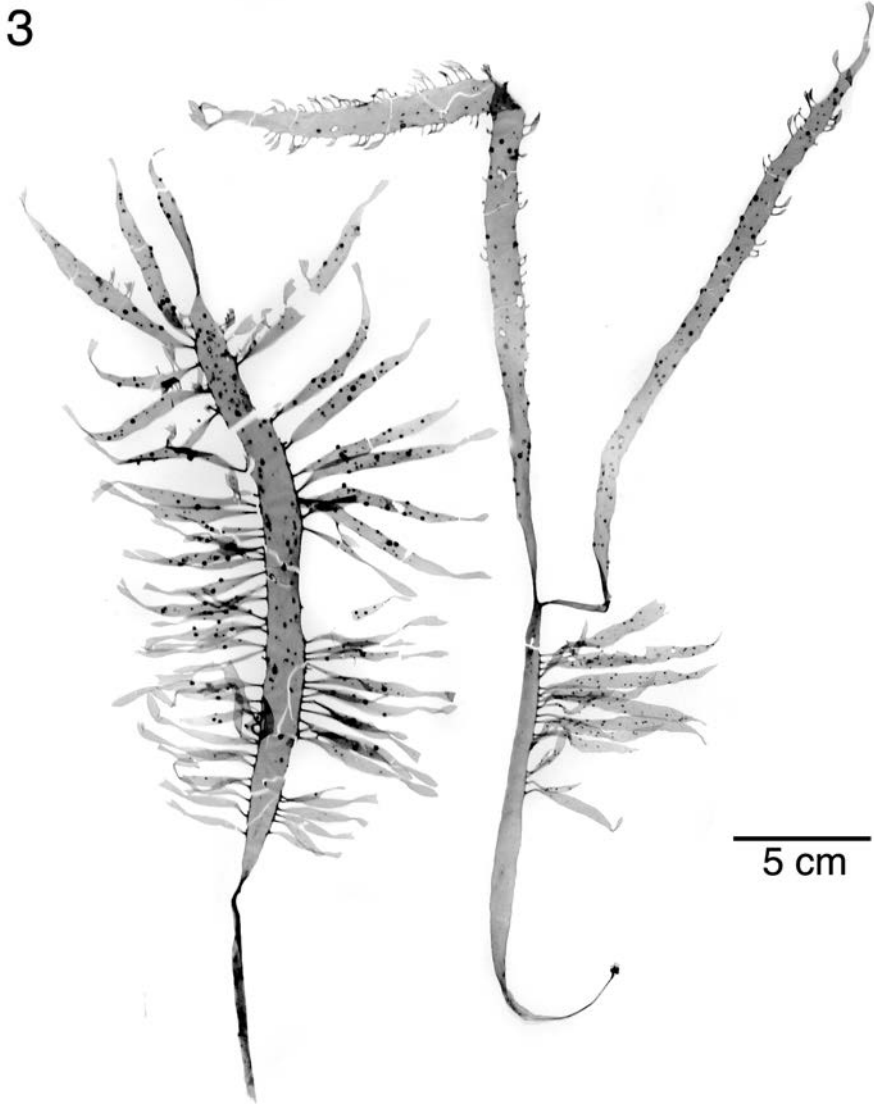
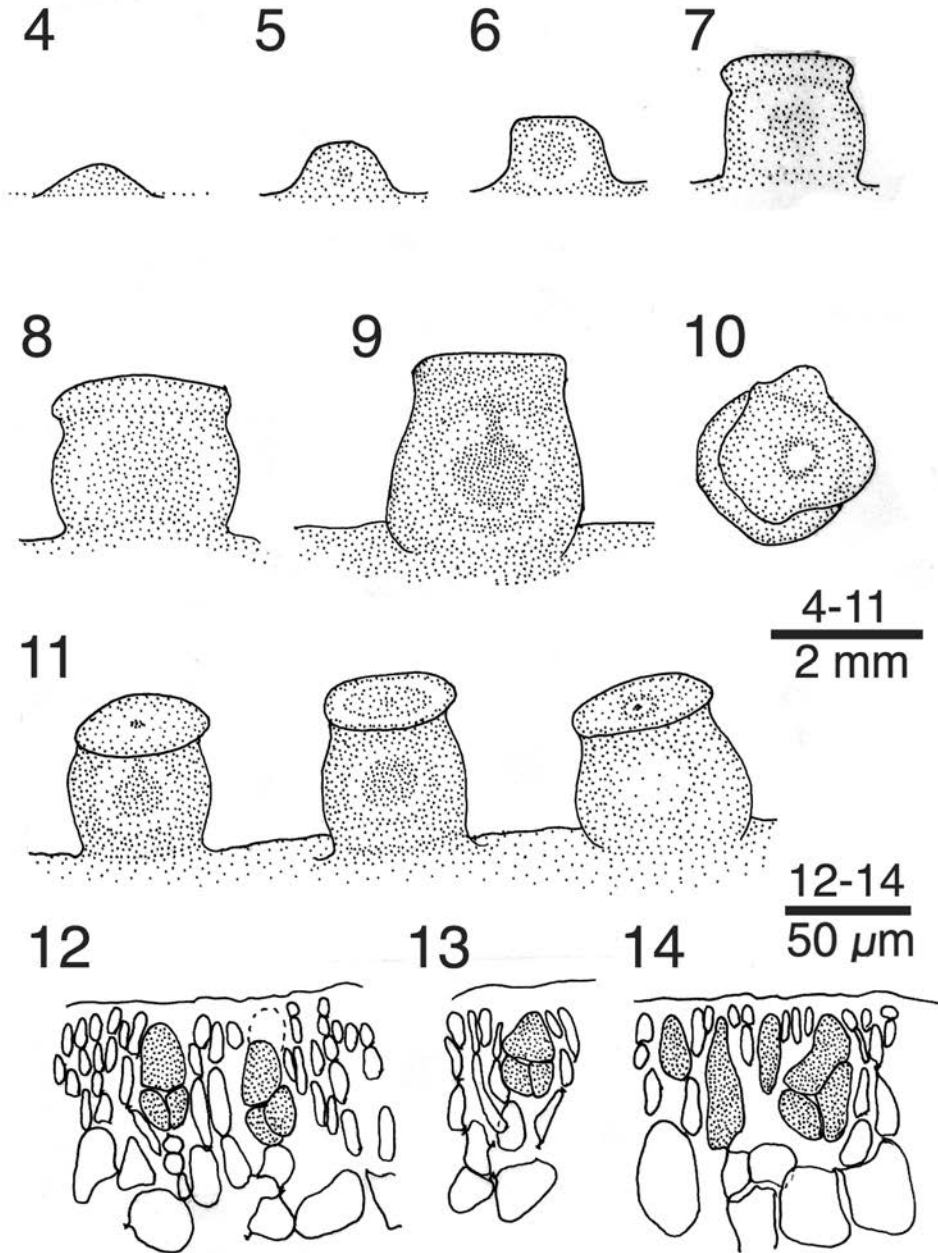


Fig. 3. *Hymenocladopsis prolifera*. Two cystocarpic specimens from Zavadovski Island. Scale bar: 5 cm.



Figs 4-14. *Hymenocladopsis prolifera*. Figs 4-9. Progressive stages in the development of emergent cystocarps of wet-preserved specimen. Fig. 10. Top view of cystocarp with ostiole. Fig. 11. Three mature cystocarps arising from blade surface in close proximity. Figs 12-14. Terminal production of tetrasporangia in cortex. Camera-lucida drawings. Specimens from Zavadovski Island.

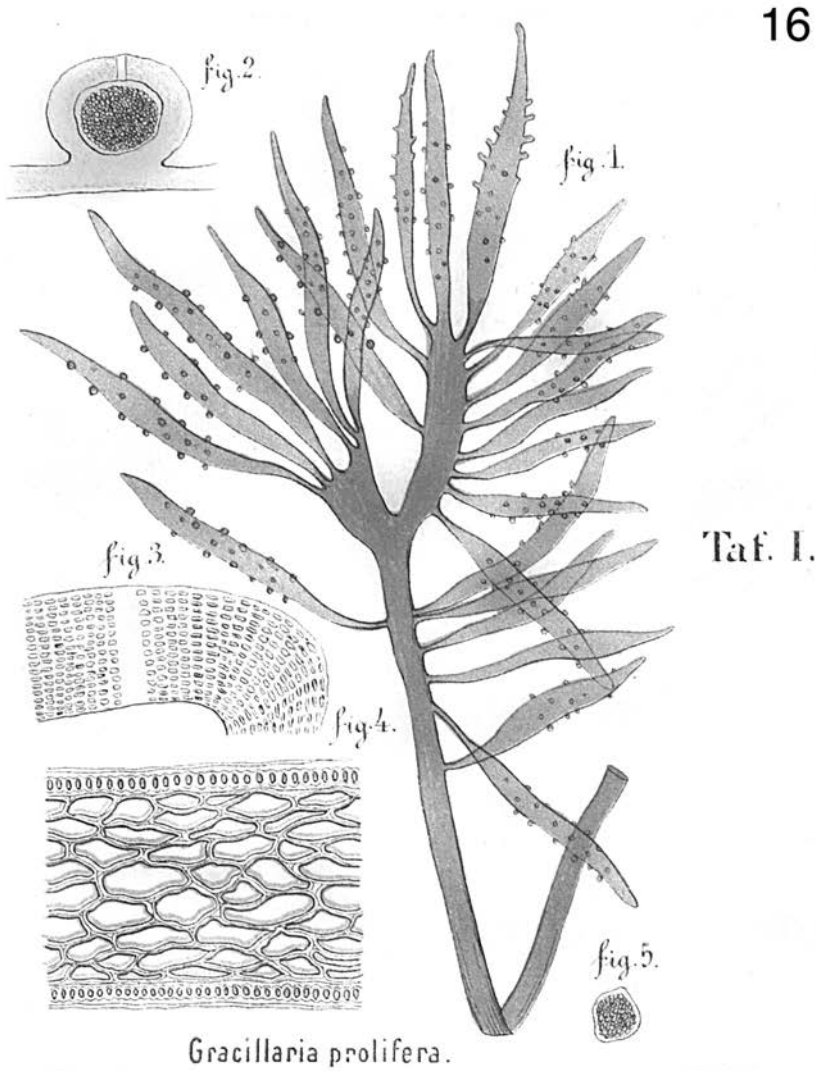
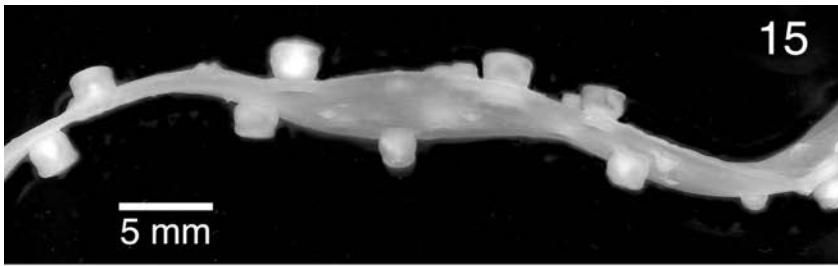


Fig 15-16. *Hymenocladopsis prolifera*. Fig. 15. Lateral blade bearing cystocarps in a wet-preserved specimen from Zavadvoski Island. Fig. 16. Reproduction of pl. I ["Taf. I"] of *Gracilaria prolifera* Reinsch (1890).

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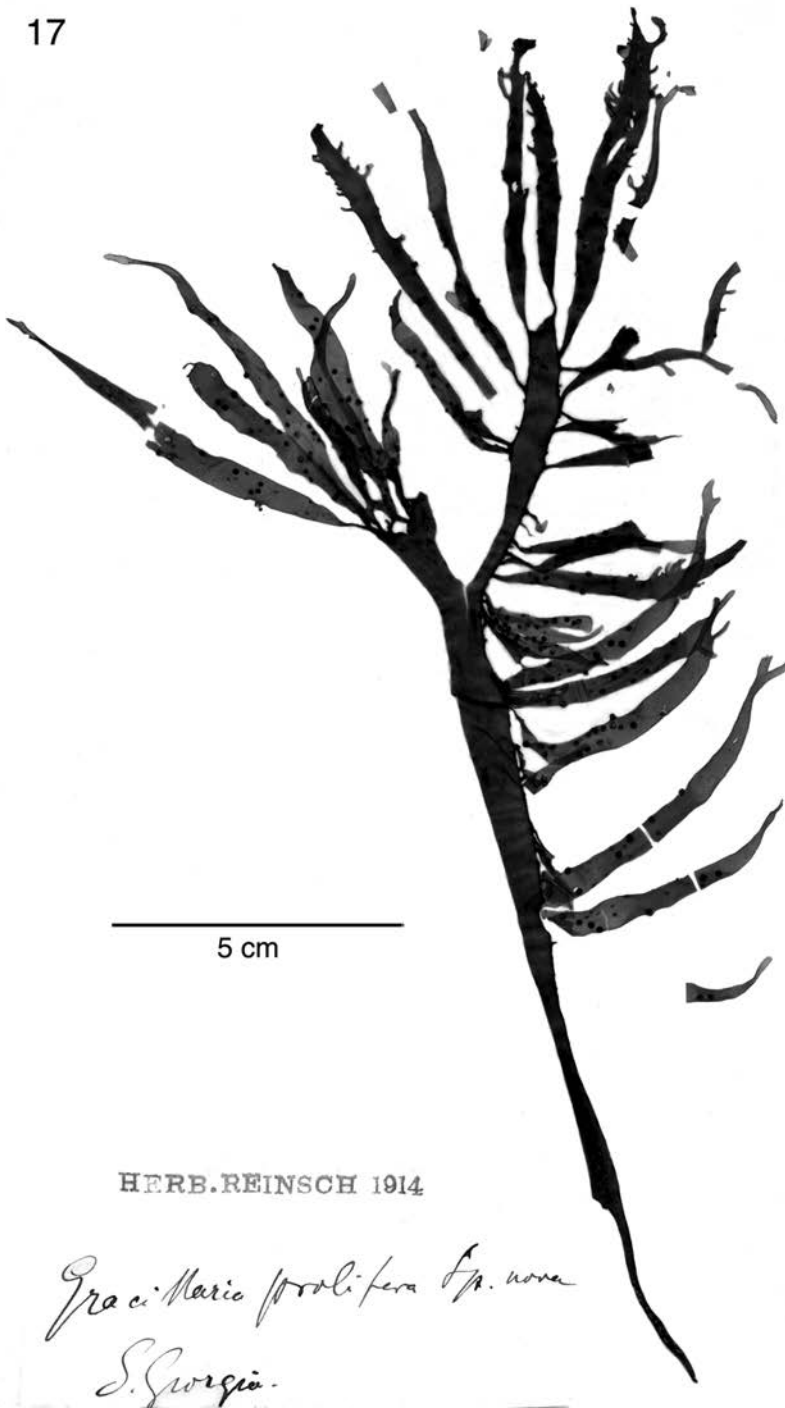
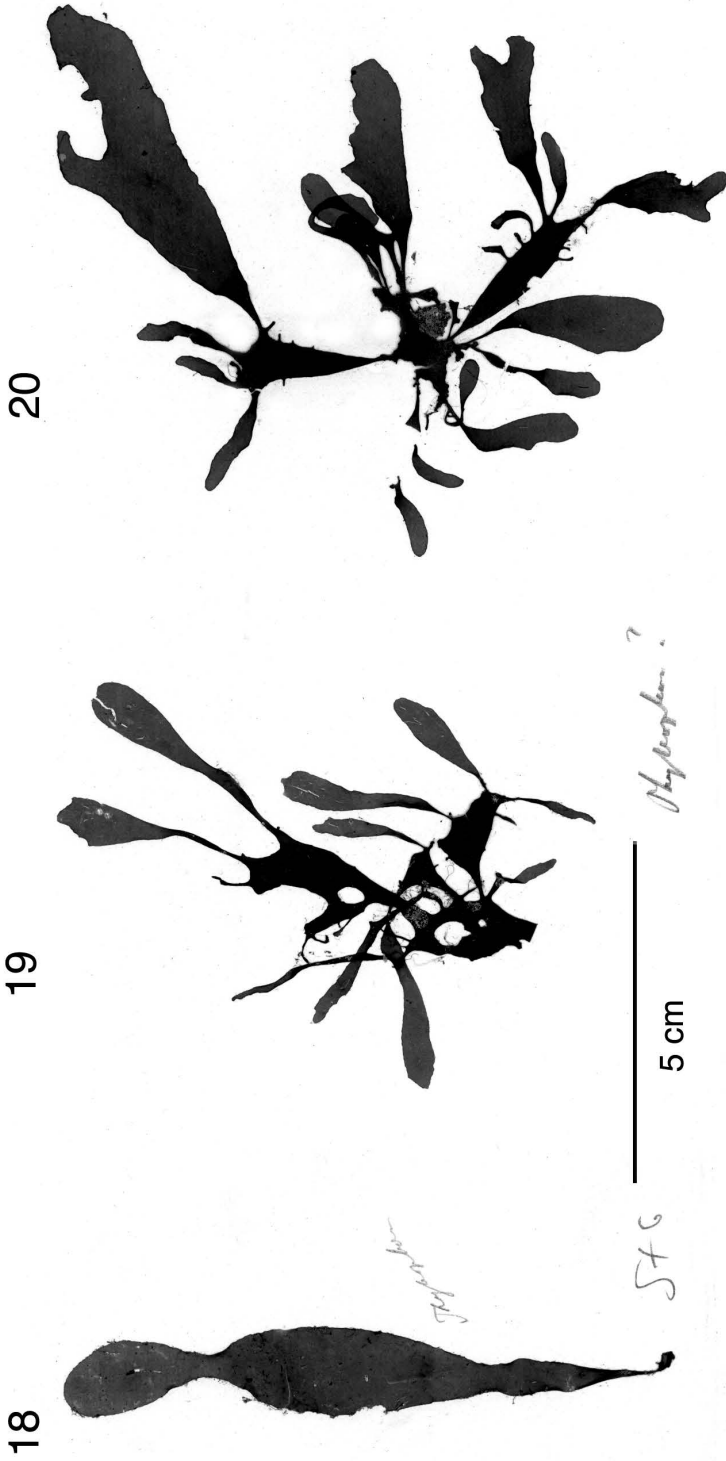


Fig. 17. *Gracilaria prolifera* Reinsch. Holotype in M.



Figs 18-20. *Phyllophora* (?) *abyssalis* Skottsb. Syntypes in S.

The base of one of these was 1.0 cm in diameter and appeared fleshy and thick, which is suggestive of a relatively extensive basal crust.

The holotype of *Gracilaria prolifera* is a cystocarpic specimen (Fig. 17), with conspicuously protuberant cystocarps randomly scattered on both surfaces of the blades. The cystocarps have an identical appearance to that of those in the specimens from the South Sandwich Islands: a squat cylindrical structure, to 2 mm in diameter, flattened at the outer surface, ostiolate, and with a slight rim at the outer periphery. The pericarp emerges at a right angle from the bearing blade. The anatomy of a blade as seen in a cross-section shows the medulla to be composed of a mixture of large colorless, elongated cells and smaller cells. Also, densely staining gland cells were seen to be borne from the large medullary cells.

Skottsberg (*in* Kylin and Skottsberg, 1919) based his description of *Phyllophora* (?) *abyssalis* on a total of five incomplete syntype specimens from two stations. Three syntype cards (Figs 18-20) were received from Stockholm. Skottsberg did not mention reproductive structures in his original description, and no sign of reproduction was seen in the three syntypes. The blades as seen in cross-section were relatively thin, measuring 95-128 μm in thickness. The cortex was only one or two cell layers, and the medulla was only a few cells across, sometimes only the thickness of two medullary cells from cortical layer to cortical layer. All of the medullary cells were uniformly rounded and the organization pseudoparenchymatous. There was no indication of air spaces or small gland cells cut off from the medullary cells.

DISCUSSION

Observations on the specimens from the South Sandwich Islands discussed above lead to the conclusions that these specimens can be identified as *Hymenocladopsis crustigena* and that these specimens morphologically and geographically link this taxon to the earlier described *Gracilaria prolifera*. The name *Gracilaria prolifera* was validated by Reinsch (1888), describing this alga from South Georgia. Later (Reinsch, 1890), he depicted it (Fig. 16). It was included in Papenfuss' (1964) catalogue of Antarctic and Sub-Antarctic benthic marine algae but without any additional records. The only subsequent report of this species being re-collected was that of Zinova's (1966) record of its occurrence from the South Sandwich Islands. The additional specimens from the South Sandwich Islands collected by M. Hoban, which have been described above, provide evidence that *G. prolifera* is taxonomically identical to *Hymenocladopsis crustigena*. This latter taxon was described as a new genus and species by Moe (1986) and assigned to the Rhodymeniaceae. From its most closely related genus *Hymenocladia*, it was separated by the terminal rather than the intercalary position of the tetrasporangia and the gland cells being located in the medulla rather than in the cortex. Another feature of *Hymenocladopsis* is the extensive crust from which the erect blades arise. A summary of the salient characteristics used in comparing and in distinguishing *Hymenocladopsis crustigena*, *Gracilaria prolifera*, the related specimens from the South Sandwich Islands, and the genus *Hymenocladia* is presented in Table 1.

Hymenocladopsis crustigena was originally reported to have a range including the Antarctic Peninsula, the South Shetland Islands, and the South

Table 1. A comparison of the related taxa in this report.

	<i>Hymenocladopsis crustigena</i>	<i>Gracilaria prolifera</i>	S. Sandwich Is. specimens	<i>Hymenocladia</i>
habit of thallus	pinnately branched, wide blades, proliferous from margin	pinnately branched, more narrow blades, proliferous from margin	pinnately branched, more narrow blades, proliferous from margin	variously branched blades, proliferous from margin
extensive basal crust	present	not stated	evidence in some specimens	absent
structure of medulla	large and small cells	large and small cells	large and small cells	large and small cells
medullary intercalary spaces	present (evident or obscure)	not stated	present	absent
production of gland cells	from medullary cells	from medullary cells (new observ.)	from medullary cells	in inner cortex (<i>H. kallymeniopsis</i> <i>vide</i> Sparling, 1957)
location of tetrasporangia	dispersed	not seen	dispersed	in scattered sori (<i>vide</i> Sparling, 1957); scattered (<i>vide</i> Womersley, 1996)
origin of tetrasporangia	terminal	not seen	terminal	transformed from intercalary cortical cells
mode of tetrasporangia division	tetrahedral or irregular	not seen	tetrahedral or irregular	tetrahedral
cystocarp	markedly protruding, ostiolate	markedly protruding, ostiolate	markedly protruding, ostiolate	external, hemispherical to conical, ostiolate
References	Moe (1986)	Reinsch (1888, 1890); Moe (1986)	this paper	Sparling (1957); Adams (1994); Womersley (1996)

Orkney Islands (Moe, 1986). Since its description, there have been additional reports from the Antarctic (Brouwer *et al.*, 1995; Gallardo *et al.*, 1999; Quartino *et al.*, 2001). Moe (1986) admitted that there was nothing in the anatomy of *Gracilaria prolifera* that precluded its assignment to *Hymenocladopsis*. But he hesitated to regard it as a taxonomic synonym of his *H. crustigena* for the reasons that he had not observed tetrasporangial specimens or seen gland cells in the type material of *G. prolifera*. The discovery of terminally produced tetrasporangia, gland cells borne on medullary cells, and evidence of a crustose base in the specimens from the South Sandwich Islands coupled with their strong resemblance to the type specimen and Reinsch's (1890) depiction of *Gracilaria prolifera* all lead to the conclusion that these entities are conspecific. Hence, the following binomial is effected:

Hymenocladopsis prolifera (Reinsch) **comb. nov.**

Basionym: *Gracilaria prolifera* Reinsch (1888, p. 147).

Taxonomic synonym: *Hymenocladopsis crustigena* Moe (1986)

In their study of Antarctic species of the Phylloporaceae, Fredericq & Ramírez (1996) stated that recent collections of subtidal specimens of *Phyllophora abyssalis* Skottsberg from King George Island, South Shetland Islands, resembled Skottsberg's (1953) illustration (his fig. 8) and suggested to them that it was a proliferating specimen of *Hymenocladopsis crustigena*. This may have led Wiencke & Clayton (2002) to list *Phyllophora abyssalis* in taxonomic synonymy with *H. crustigena*, even though they ignored the fact that the former name predates the latter and has nomenclatural priority. My own examination of three syntype specimens of *Phyllophora abyssalis*, however, has convinced me that this species is taxonomically distinct on the basis of the relatively thinness of the blades and the very different organization of the medulla (with the uniform size of the cells) and the cortical layers. Skottsberg (*in* Kylin & Skottsberg, 1919) had described the cortex to be 1-2 cell layers and the medulla to be 2-3 cell layers, and my observations of a syntype specimen confirm that organization, which is significantly different from the much more elaborate cortex and medulla described for *Hymenocladopsis crustigena* (Moe, 1986) and here observed in the type of *Gracilaria prolifera* and specimens from the South Sandwich Islands.

According to Clayton (1994) the largest non-endemic element in the Antarctic marine flora is made up of those species that also occur on various subantarctic islands and Tierra del Fuego. With a range including Antarctica, the South Sandwich Islands, and South Georgia, *Hymenocladopsis prolifera* would fit into this category. Many other species, such as the brown algae *Desmarestia menziesii* J. Agardh and *Ascoseira mirabilis* Skottsberg and the red algal species *Curdiea recovitzae* Hariot, *Georgiella confluens* (Reinsch) Kylin, *Delesseria salicifolia* Reinsch, *Microrhynchus carnosus* (Reinsch) Skottsberg, *Phycodrys austrogeorgica* Skottsberg, share such a distribution pattern, that is, including the Antarctic Peninsula, the South Shetland Islands, South Sandwich Islands, and South Georgia (Skottsberg, 1907, 1941; Papenfuss, 1964; Zinova, 1966; Wynne, 1982; Moe & Henry, 1982; Clayton *et al.*, 1997; Wiencke & Clayton 2002). So it is reasonable to conclude that *Hymenocladopsis prolifera* has a range also extending from the Antarctic Peninsula to the South Sandwich Islands and South Georgia.

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