*Cryptogamie, Algol., 2004, 25 (2): 113-124*


# *Myriogloea pedicellata* sp. nov. (Chordariaceae, Phaeophyceae) from the Sultanate of Oman, northern Arabian Sea

*Michael J. WYNNE**

*Department of Ecology and Evolutionary Biology and Herbarium, University of Michigan, Ann Arbor, MI 48109, U.S.A.*

*(Received 17 September 2003, accepted 8 January 2004)*

**Abstract** — *Myriogloea pedicellata*, a new species of brown algae, is described from the Sultanate of Oman, the Arabian Peninsula. The noteworthy features of this alga from exposed supralittoral rocks are its unbranched, or barely branched, habit, its length (often to 1 m) and diameter of several millimetres, its pseudoparenchymatous construction and its lack of true ("phaeophycean") hairs. In thallus construction the new species agrees with *Myriogloea* (Chordariaceae, Ectocarpales). Unilocular sporangia are borne usually on multicellular pedicels at the bases of assimilatory filaments. The multicellular nature of the pedicels distinguishes this species from others in the genus.

**Arabian Sea / Chordariaceae / *Myriogloea* / *Myriogloea pedicellata* sp. nov. / Phaeophyceae / Sultanate of Oman / taxonomy**

**Résumé** — ***Myrogloea pedicellata* sp. nov. (Chordariaceae, Phaeophyceae) au Sultanat d'Oman, nord de la Mer d'Arabie.** *Myriogloea pedicellata*, nouvelle espèce d'algue brune, est décrite au Sultanat d'Oman, Péninsule d'Arabie. Les caractères remarquables de cette algue des substrats rocheux exposés du supralittoral sont le port non ramifié ou rarement ramifié, la taille (souvent jusqu'à un mètre) et le diamètre de plusieurs millimètres, la structure pseudoparenchymateuse et l'absence de vrais poils (« phéophycéens »). En ce qui concerne la construction du thalle, la nouvelle espèce est en conformité avec le genre *Myriogloea* (Chordariaceae, Ectocarpales). Les sporocystes uniloculaires naissent habituellement sur des pédicelles pluricellulaires à la base des filaments assimilateurs. Le caractère pluricellulaire des pédicelles distingue cette espèce dans le genre. (Traduit par la Rédaction)

**Chordariaceae / Mer d'Arabie / *Myriogloea* / *Myriogloea pedicellata* sp. nov. / Phaeophyceae / Sultanat d'Oman / taxonomie**

* Correspondence and reprints: mwynne@umich.edu
Communicating editor: Olivier De Clerck

## INTRODUCTION

Over the period 1999-2002, marine algal specimens were collected from the Dhofar region of the Sultanate of Oman in connection with the Algal Biodiversity Project of Oman, funded by a grant from the British Government's Darwin Initiative. The project was managed by HTS Development, Ltd., U.K., working with the Natural History Museum of Muscat, Oman, and supported by the Herbarium of the University of Michigan, Ann Arbor, and the Natural History Museum, London. A handbook that has been prepared from this work (Richards & Wynne, 2003) includes an unknown species of brown algae referred to as "*Myriogloea* aff.". This brown alga has been collected on several occasions on the southern coast of Oman. In habit it resembles the cordlike kelp *Chorda filum* (L.) Stackh., but in construction it is chordariacean. In the present paper, the alga is described as a new species of *Myriogloea*.

## MATERIALS AND METHODS

The specimens cited in this paper were collected from rocky supralittoral habitats in Sept. 2000 and Sept. 2001 in Dhofar, Oman. Material was processed as herbarium mounts soon after collecting. Some specimens were preserved in 5 % Formalin/sea-water. Wet-preserved parts of thalli were hand-sectioned using a single-edged razor, and these sections were mounted on glass slides for observation with a standard Zeiss research microscope. Line-drawings were made with a camera lucida attached to the microscope. Digital images, using a Nikon D1 camera mounted on a photo-stand, were made with a camera-back attached to the same microscope. The digital images were then assembled into plates using Adobe Photoshop version 7.0. Co-ordinates were obtained in the field by using several GPS devices, primarily a model made by Garmin eTrex Summit (Garmin International Inc., 1200 E 151st St., Olathe, KS 66062). Herbarium abbreviations are according to Holmgren *et al.* (1990). Names of authors of plant taxa are according to Brummitt & Powell (1992).

## RESULTS

### Diagnosis

***Myriogloea pedicellata* M.J. Wynne sp. nov.**

*Aliis speciebus in genere combinatione secunda characterum distincta: altitudo thallorum 40-70 (-100) cm alti, atque diameter 4-6 mm; thallus plerumque simplex, interdum ramosus; textura moderate mucosa; cortex exterior filis assimilatibus liberis 1.0 mm longis formatus; cortex interior filis ramosissimis aliquantum hyalinis, quae fila assimilantia et sporangia unilocularia facient; sporangia unilocularia ovoidea vel ellipsoidea, 60-84 µm longa et 22-34 lata; sporangia pedecillata, plerumque terminala in pedicellis 3-9-cellularum, raro in pedicellis 1-2 cellularum, rarior sessilia; sporangia plurilocularia ignota.*

The epithet refers to the pedicellate nature of the unilocular sporangia, a trait distinguishing this species from others in the genus.

**Holotype**: Hatom Cove (16.96091° N, 54.82795° E), east of Mirbat, Dhofar, Sultanate of Oman: 8.ix.2001, *leg. M. Wynne 08092001-03-10*; attached to supra-littoral boulders; deposited in MICH.

**Isotypes**: deposited in BM, ON, PC, and US.

**Additional collections**: SULTANATE OF OMAN. Raaha (= Alto) Bay (16.95116° N, 54.81650° E), east of Mirbat, Dhofar: 6.ix.2001, *leg. M. Wynne 06092001-01-19* (BM, MICH, ON), attached to supra-littoral boulders. Western side of Wadi Zeid (Hoon's Bay) (16.94497° N, 54.80402° E), east of Mirbat, Dhofar: 10.ix.2000, *leg. M. Wynne 10092000-03-04* (BM, GENT, MICH, ON, and FI), attached to supra-littoral boulders; 17.ix.2001, *leg. M. Wynne 17092001-12-07* (BM, MICH, ON).

The new species occurred during the summertime monsoon season in the supralittoral zone on wave-exposed boulders, the axes hanging down from vertical faces. All of the specimens came from a rather limited stretch of the Omani coastline (Fig. 1) between Mirbat and Sadh, Dhofar. The thalli (Fig. 2) are usually around 40 to 70 cm long but may reach lengths of 1 m. They are mostly simple,

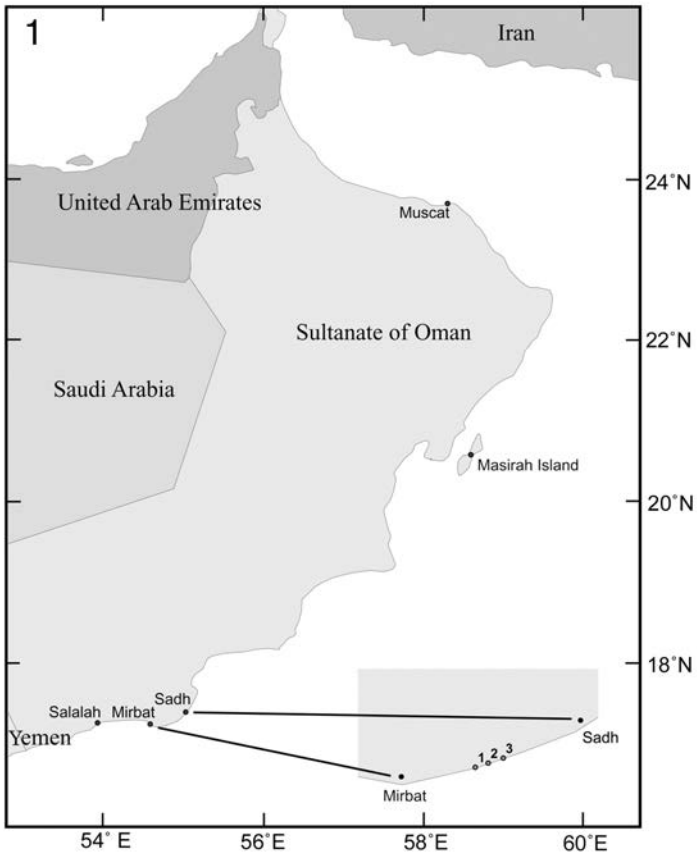



Fig. 1. Map of the Sultanate of Oman with inset of the coast of Dhofar with the three collections sites for *Myriogloea pedicellata*. 1: Hatom Cove; 2: Raaha (= Alto) Bay; 3: Western side of Wadi Zeid.

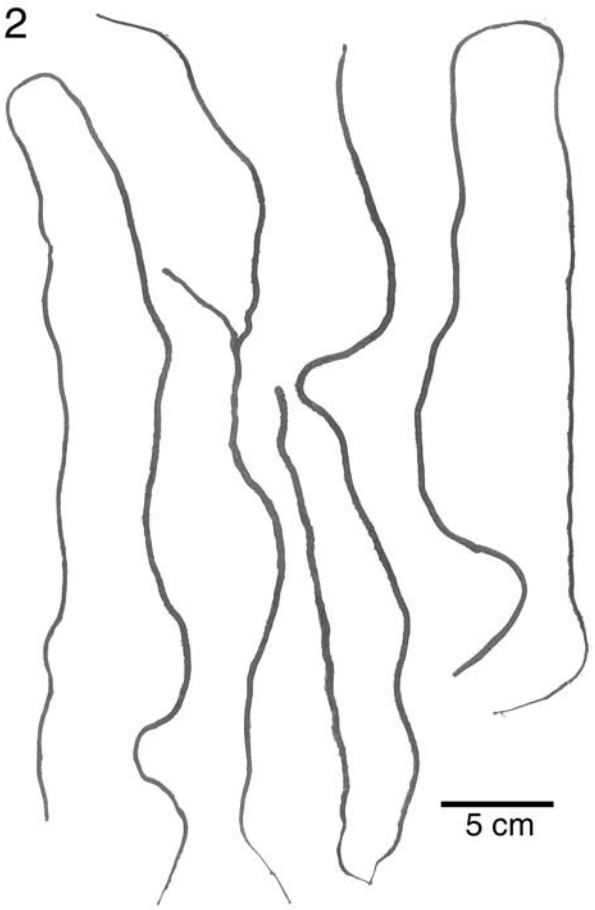
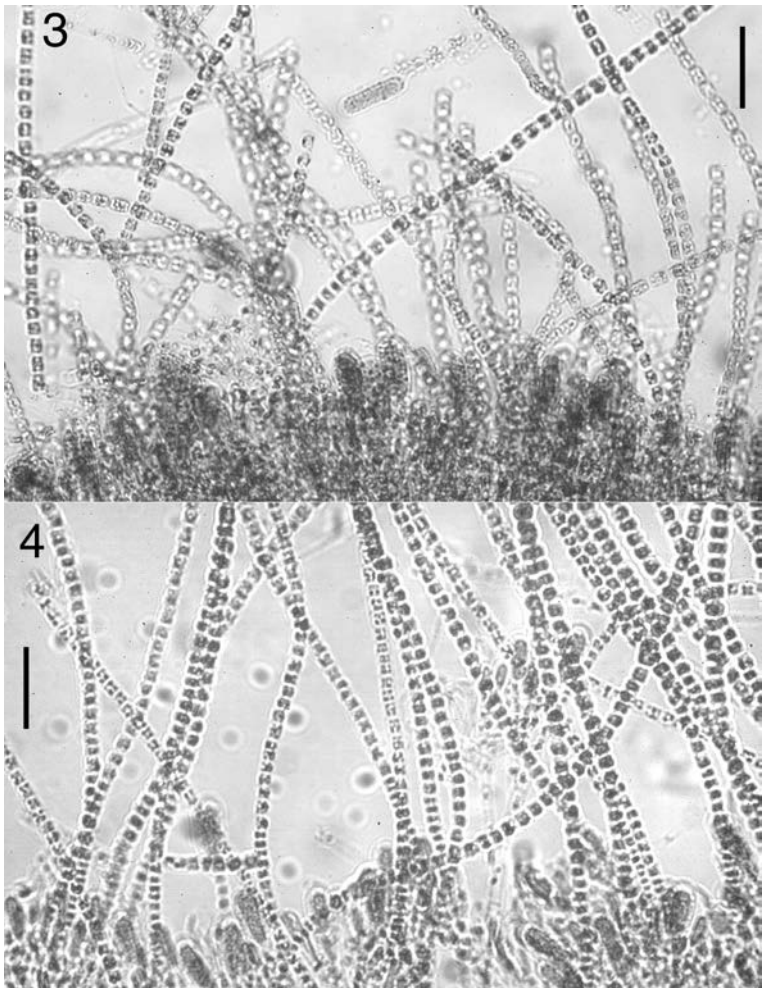



Fig. 2. *Myriogloea pedicellata.* Holotype collection.

but occasionally thalli are branched once or twice usually close to the base, more rarely from mid-thallus. The texture of the thalli in the field was only moderately slimy with a firm organization. Attachment to the rock substrate was made by a rather small, flat discoid base of 0.8-1.4 mm diameter.

## Anatomy

Wet specimens are 4-6 mm in diameter. In transverse sections of axes, a solid, pseudoparenchymatous inner core (3-4 mm in diameter) is surrounded by a loosely shaggy covering of assimilatory filaments of about 1 mm in length. The inner solid core can be divided visually into a medulla and a subcortex, in that the latter region is deeply pigmented (orange). The outer cortex (Figs 3 & 4) is comprised of a single kind of free assimilatory filaments (Figs 5-7), which are branched only near their points of origin and collectively give the thallus its shaggy aspect. The assimilatory filaments have a meristematic region (Fig. 7) in their proximal portion and are about 40 to 65 cells, or about 1,400 to about 1,700 μm, in length.

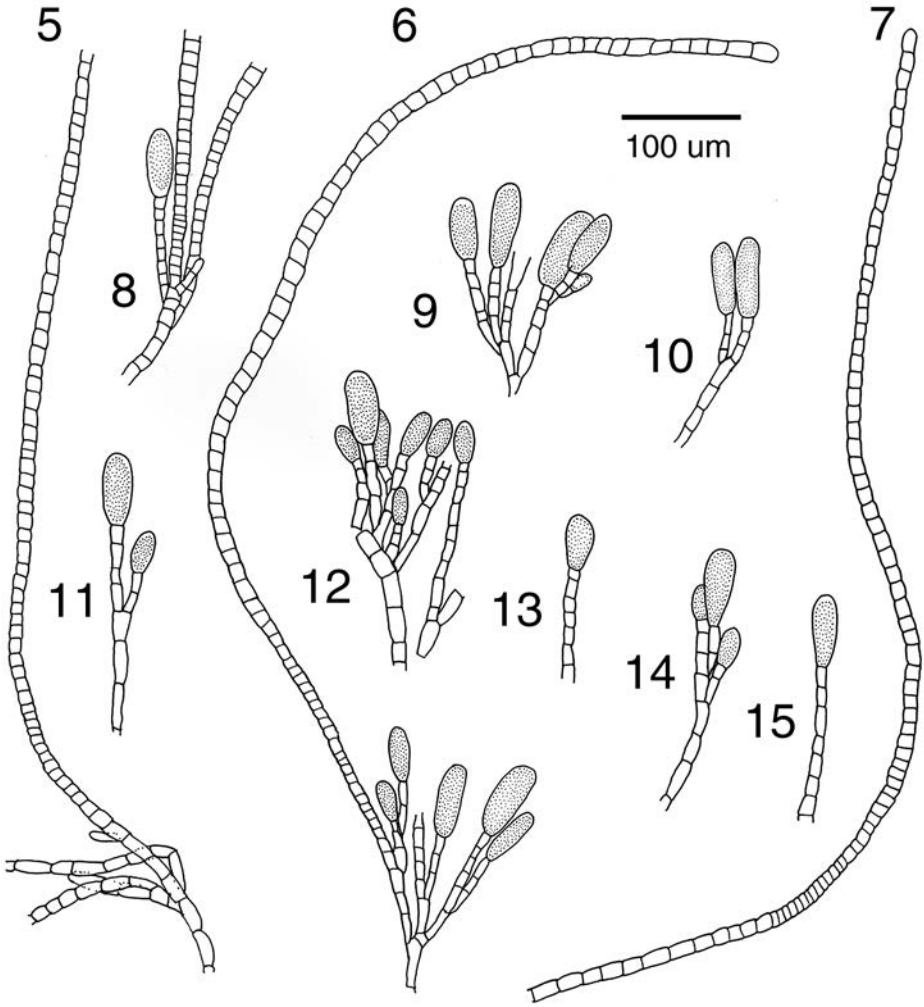



Figs 3-4. *Myriogloea pedicellata*. Cross-sections of axis, showing assimilatory filaments and unilocular sporangia arising from subcortex. Scale bar: 50 µm.

Their width measures 8-10 µm near their base and 10-14 µm in the mid-region and at the distal end. The cells of the assimilatory filaments are densely filled with chloroplasts, each provided with a pyrenoid. Colourless (true or phaeophycean) hairs (for definitions, see Bold & Wynne, 1985) are entirely lacking. The inner cortex, or subcortex, is composed of thin, much branched filaments, 6-12 µm in width, with meagre pigmented contents compared to the cells of the assimilatory filaments. It is these densely branched filaments that give rise to both the assimilatory filaments and the unilocular sporangia.

## Reproduction

The only reproductive organs observed are unilocular sporangia, which are present in great abundance. They occur at the interface of the outer cortex and




Figs 5-15. *Myriogloea pedicellata*. Figs 5-7. Assimilatory filaments. Fig. 6. Assimilatory filament associated with unilocular sporangia arising on subcortical filaments. Figs 8-15. Individual and groups of unilocular sporangia on their pedicels.

the subcortex, that is, in the region of origin of the assimilatory filaments (Figs 3 & 4). The unilocular sporangia are ovoid or ellipsoid, 60-84 μm in length and 22-34 μm in width. Typically, they are borne terminally on 3-9-celled pedicels (Figs 8-15). Rarely, the pedicels are only 1 or 2 cells long, and even more rarely the sporangia are sessile. Plurilocular sporangia were not observed.

## DISCUSSION

The expression of a simple, cordlike habit is a very common growth form in many unrelated genera of brown algae (Wynne, 1973). The Omani brown alga

with this form has several characteristics that suggest that it belongs to *Myriogloea* Kuck. *ex* Oltm. (1922). Several species of *Myriogloea* are recognized around the world, and they are often inhabitants of temperate surf-swept rocky coastlines similar to the Dhofar region of Oman. There appears to be a correlation of the branching pattern in Chordariaceous algae with the degree of wave exposure: the higher the degree of wave exposure, the higher the frequency of simple axes; the less degree of wave exposure, the more likely the axes are to be branched.

According to Kylin (1940) the salient features defining the genus *Myriogloea* include the following: the central axis is composed of many monopodially organized filaments with intercalary growth; the presence of a special transition zone with radial cells rows between the central axis and the assimilatory filaments; one kind of assimilatory filaments; the absence of phaeophycean hairs; and plurilocular sporangia, when present, formed by the modification of the upper parts of assimilatory filaments. Womersley (1987) referred to the presence of two types of assimilatory filaments making up the cortex: either determinate and lacking a basal meristem or a longer, indeterminate type with a basal meristem. However, other authors (e.g., Kylin, 1940; Nelson & Adams, 1983; and Stegenga *et al*., 1997) have discussed only one type of assimilatory filament. Certainly *Myriogloea* lacks the markedly dimorphic assimilatory filaments that occur in such genera as *Papenfussiella*, *Mesogloia*, and *Haplogloia* (Kylin, 1940).

Currently, *Myriogloea* is thought to include eight species. A synoptic comparison of the currently recognized species of *Myriogloea* and the new species is presented in Table 1.

*Myriogloea sciurus* (Harv.) Kuck. *ex* Oltm. (1922), the lectotype of the genus (Levring, 1939), occurs in southern Australian waters (Harvey, 1858; Womersley, 1987). Congeners include *M. intestinalis* (Harv.) Lindauer, V.J. Chapm. *et* Aiken from New Zealand (Harvey, 1855, as *Mesogloia intestinalis*; Lindauer *et al*., 1961); *M. chilensis* (Mont.) Llaña (1948) from Chile and Peru; *M. major* Asensi (1973) from Patagonia, Argentina [the same species soon after was described as *M. bonariensis* by Joly *et al*. (1974)]; *M. papenfussii* Kylin (1940) and *M. abbreviata* Kylin (1940) both from South Africa; *M. simplex* (Segawa *et* Ohta) Inagaki (1958) from Japan; and *M. ramosissima* (Zanardini) Papenf. (1968) from the Red Sea.

Several other described species have been reduced to synonymy. *Myriogloea grandis* (M. Howe) Levring (1939) [basionym: *Myriocladia grandis* M. Howe (1914)] has been regarded as conspecific with *M. chilensis* by Peters & Müller (1986) and Ramírez & Santelices (1991). *Myriogloia chilensis* Levring (1960) from southern Chile is a later homonym of *M. chilensis* (Mont.) Llaña (1948) and is regarded as a taxonomic synonym (Santelices, 1989). Nelson & Adams (1983) treated *M. chorda* (J. Agardh) Kuck. (1929) (J. Agardh, 1877, as *Myriocladia chorda*) and *M. lindaueri* Kylin (1940) as taxonomic synonyms of *M. intestinalis*. While recognizing both *M. abbreviata* and *M. papenfussii* from South Africa, Stegenga *et al.* (1997) expressed doubt that the distinguishing characters are sufficient to maintain them as distinct.

Børgesen (1934) and Wynne (2000) have pointed out that the coasts of the northern Arabian Sea and Japan share a high number of species. This fact caused me to consider the possibility that the Omani *Myriogloea* might be the Japanese *M. simplex*. That species, however, is of relatively small stature (to 15 cm) and bears clusters of usually sessile unilocular sporangia, rarely on a 1-2-celled stalk (Inagaki, 1958), quite distinct from these features in *M. pedicellata*.

Typically, unilocular sporangia in the Chordariaceae are located in a sessile position at the base of assimilatory filaments (Kuckuck, 1929; Kylin, 1940;

| | *thallus height* | *thallus thickness* | *branching pattern* | *texture (sliminess)* | *assim. fil. length* | *position unil. spor.* | *shape/size unil. spor.* | *pluriloc. sporangia* | *references* |
|---|---|---|---|---|---|---|---|---|---|
| *M. abbreviata* (S. Africa) | 7-14 cm | 4-6 mm | simple or with some short branches | –<br>--- | 1 mm | sessile from basal cells of assimil filament | 90-130 µm long; 40-60 µm wide | not seen | Kylin, 1940; Stegenga *et al.* 1997 |
| *M. chilensis* (Chile; Peru) | 14-20 cm; up to 65 cm | 4-7 mm; 7-15 mm | variously branched | mucilaginous | 0.2-0.25 mm; 0.5-1 mm | sessile, or on 1-cell pedicel, or terminating short branch | obovoid or pyriform, 66-75 × 38-44 µm | not seen | Howe, 1914; Levring, 1939, 1960 |
| *M. intestinalis* (New Zealand) | 0.3-1.0 m | 4-10 mm | simple or sparingly branched | slippery, lubricous, mucilaginous | 1-2 mm<br>2-3 mm<br>2-4 mm | sessile at base of assim. filament | ovoid, elliptical, 75-96 × 20-38 µm | intercalary transform. of assim. filaments | Lindauer *et al.* 1961; Nelson & Adams, 1983 |
| *M. major* (Argentina) | 16 cm – 1.3 m | to 10 mm | poorly branched from base | horny, slippery | 980 µm<br>1.5-1.9 mm | sessile or at apex of few-celled branch | ellipsoid, 80-100 (– 126) × 30-40 µm | not seen | Asensi, 1973; Joly *et al.* 1974 |
| *M. papenfussii* (S. Africa) | 40-80 cm | 4-6 mm<br>4-7 mm | simple or with a few short branches | very mucilaginous | 1 mm;<br>1-1.5 mm | sessile, below meristem of assim filament | clavate, ovoid 120-180 × 60-80 µm | not seen | Kylin, 1940; Stegenga *et al.* 1997 |
| *M. pedicellata* (Oman) | 40-70 cm | 4-6 mm | simple or sparingly branched | moderately slimy | 1400-1700 µm | on (1-) 5-9 celled pedicel | ovoid. 60-84 µm × 22-34 µm | not seen | present paper |
| *M. ramosissima* (Red Sea) | 15 cm | 1.5 mm | much branched to several orders | – | – | sessile or rarely 1-celled pedicel | cylindrical, obtuse apex, 80 µm × 28 µm | Transform. of upper cells of assim filaments | Zanardini, 1858; Nasr, 1947 |
| *M. sciurus* (Australia) | 10-50 (-120) cm | 3-5 (-10) mm | simple or long laterals from base | very mucoid | 2 kinds: 200-400 µm; 1-2 mm | sessile, on outer subcortical cells | clavate to ovoid, 60-100 × 20-40 µm | rare; subdiv. of upper cells of determ. cortical fil. | Harvey, 1858; Womersley, 1987 |
| *M. simplex* (Japan) | 8-15 cm | 5-13 mm | simple or sparingly branched | very lubricous | 1-2 mm | sessile or on 1-2-celled pedicel at base of assim. fil. | ellipsoid, 40-100 × 25-60 µm | not seen | Inagaki, 1958; Segawa & Ohta, 1951 |

Hamel, 1935). Unilocular sporangia in *Myriogloea* have most often been depicted to be sessile at the base of assimilatory filaments (Levring, 1939; Lindauer *et al*., 1961; Nelson & Adams, 1983) or sessile on outer subcortical cells (Womersley, 1987). In *M. pedicellata* the unilocular sporangia are located near the bases of assimilatory filaments, just above the subcortex, but often they are situated on several-celled stalks; very rarely are they sessile. The pedicellate condition of the unilocular sporangia is the most distinctive feature of the Omani *Myriogloia*. A unilocular sporangium on a stalk of 4 cells has been illustrated in *M. major* (Joly *et al*., 1974; as *M. bonariensis*). But the unilocular sporangia in *M. major* have been described as sessile both by Asensi (1973) and by Joly *et al.* (1974) and as being significantly larger than those of the new species (see Table 1). Furthermore, Asensi (1973) and Joly *et al*. (1974) described the unilocular sporangia in *M. major* as occurring in series (on successive cells of the bearing filament) and also with often one, two, or three sporangia arising from the same cell, features that have never been observed in *M. pedicellata*. These differences distinguish *M. major* from *M. pedicellata*.

According to Hoffmann & Santelices (1997) unilocular sporangia in *Myriogloea chilensis* are "borne singly or in groups of 3 to 8 among the assimilatory filaments" and "usually with a unicellular pedicel"; that species, however, differs from *M. pedicellata* in being irregularly and frequently branched. In *M. simplex* unilocular sporangia are usually borne as sessile organs (Segawa & Ohta, 1951, as *Tinocladia simplex*) but may occur on two-celled stalks (Inagaki, 1958). The Omani alga is not as lubricous as *M. major* and *M. simplex*. It is significantly larger than *M. simplex* (Table 1).

The question arises whether this Omani alga might have been reported in the general region of the Arabian Sea under another name, that is, a misapplied name. There has been a report of *Myriogloea grandis* [considered above to be conspecific with *M. chilensis*] from Pakistan by Qasim & Barkati (1985). *Myriogloea chilensis* is known from Pacific South America from Peru (Howe, 1914; Taylor, 1947) through much of Chile (Ramírez & Santelices, 1991). Efforts made to track down voucher material of so-called "*M. grandis*" from Pakistan have not been successful. Prof. M. Shameel (email, 4.i.2004), University of Karachi, said that voucher specimens of "*M. grandis*" no longer exist. He thought that it may have been a mis-identification of *Levringia boergesenii*. But owing to the many shared species between the Omani and Pakistani marine floras, it is certainly possible that it represents *M. pedicellata*.

An initial report of *Myriogloea sciurus* from India by Børgesen (1932, as *Myriocladia sciurus*) was later treated by Kylin (1940) to represent a new species of *Levringia*, namely, *L. boergesenii*. Kylin's (1940) "Myriogloia-Gruppe" of genera were those that lacked phaeophycean hairs. Kylin distinguished *Myriocladia* from *Levringia* by the plurilocular sporangia in the former genus arising by the modification of the upper parts of assimilatory filaments, but in the latter genus plurilocular sporangia are pod-shaped, pedicellate and arose from the upper cells of the transition zone between the central axis and the assimilatory filaments. Wynne & Jupp (1998) reported the occurrence of *Levringia boergesenii* from Al Ashkarah, Al Sharqiya, Oman. That material consists of erect axes reaching 18 cm in height, 2-3 mm in diameter, with some lateral branches, and bearing both unilocular sporangia and pod-shaped plurilocular sporangia. The assimilatory filaments are relatively short, 470-520 μm in length, and do not have the shaggy aspect characteristic of *Myriogloea pedicellata*.

Kylin (1940) did not refer to Børgesen's (1934, 1937) later reports of "*M. sciurus*", but it is likely that that material also belonged to *L. boergesenii*. Yet

a number of reports of *M. sciurus* have persisted for India, Pakistan, and Yemen (e.g., Shameel, 1987; Banaimoon, 1988; Silva *et al.*, 1996). Silva *et al.* (1996) continued to report the occurrence of *M. sciurus* from India, but if one examines at least one of these later reports (e.g., Srinivasan, 1969), one sees that it is merely a repetition of Børgesen's (1932) earlier account and thus clearly corresponds to *L. boergesenii*, not *M. sciurus*. The status of many of the other reports listed by Silva *et al.* (1996) would have to be checked out individually to determine whether they are merely a repeat of Børgesen's (1932) initial mis-identification. *Myriocladia sciurus* has been reported from the Khalf region of Yemen (Banaimoon, 1988; Ormond & Banaimoon, 1994). According to Shameel *et al.* (1996) the report of *Myriogloia sciurus* by Ahmad *et al.* (1994) for Pakistan was a misapplied name for *L. boergesenii*.

*Myriogloea ramosissima*, which is based on *Mesogloia ramosissima* Zanardini (1858) described from the Red Sea, is a heavily branched, smaller-statured species and obviously is very different from the Omani species. *Myriogloea ramossima* was not observed in collections made in the southern Red Sea (Lipkin & Silva, 2002).

**Acknowledgements.** This research is part of the Algal Biodiversity Project of Oman (1999-2002), funded by a British Government's Darwin Initiative grant for the Survival of Species. The project was managed by HTS Development Ltd., U.K., working with the Natural History Museum of Muscat, Oman, and supported by the Natural History Museum of London and the Herbarium of the University of Michigan. The Darwin Initiative is under the aegis of the British Government's Department of Environment Transport and the Regions (DETR). We acknowledge the following individuals for their contributions to this research: Dr Lynne Barratt, Mr Glenn Richards, and Ms Emma Dodsworth, all of whom were personnel of HTS Development Ltd, and to Mr Henry Ford, Mrs Gianna Minton, and Mr Tim Collins for their participation on the collecting trips. Dr Akira F. Peters of Station Biologique de Roscoff, France, kindly offered constructive criticism. I am grateful to Mr David Bay (DEEB, University of Michigan) for his help on the artwork.

## REFERENCES

AGARDH J. G., 1877 — De algis Novae Zealandiae marinis. *Lunds Universitets Årsskrift* 14(4): 1-32.

AHMAD V.U., PARVEEN S., UDDIN S., BANO S., SHAIKH W. & SHAMEEL M., 1994 — Isolation and structure elucidation of sterols from the brown algae *Myriogloia sciurus* and *Spatoglossum variabile*. *Hamdard Medicus* 37: 54-59. [Not seen.]

ASENSI A.O., 1973 — Una especie de alga Phaeophyta nueva para Argentina: *Myriogloia major* spec. nov. y el resultado de su cultivo "in vitro". *Darwiniana* 18: 153-161.

BANAIMOON S.A., 1988 — The marine algal flora of Khalf and adjacent regions, Hadramout, P.D.R. Yemen. *Botanica Marina* 31: 215-221.

BØRGESEN F.R., 1932 — Some Indian green and brown algae especially from the shores of the Presidency of Bombay-II. *Journal of the Indian Botanical Society* 11: 51-70, 2 pls.

BØRGESEN F.R., 1934 — Some marine algae from the northern part of the Arabian Sea with remarks on their geographical distribution. *Det Kongelige Danske Videnskabernes Selskabs, Biologiske Meddelelser* 11(6): 1-72, 2 pls.

BØRGESEN F.R., 1937 — Contributions to a South Indian marine algal flora. I. *Journal of the Indian Botanical Society* 16: 1-56, 1 pl.

BOLD H.C. & WYNNE M.J., 1985 — *Introduction to the algae. Structure and reproduction*. 2nd ed. Englewood Cliffs, NJ. Prentice-Hall, Inc. xvi + 720 p.

BRUMMITT R.K. & POWELL C.E. (eds), 1992 — *Authors of plant names*. Royal Botanic Gardens, Kew. 732 p.

HAMEL G., 1935 — *Phéophycées de France*. Fasc. II, p. 81-176. Paris, published by the author.

HARVEY W.H., 1855 — Algae. *In* J. D. Hooker, *The botany of the Antarctic voyage of H.M. discovery ships* Erebus *and* Terror, *in the years 1839-1843, under the command of Captain Sir James Clark Ross...II. Flora Novae-Zelandiae. Part II. Flowerless plants*. London, pp. 211-266, pls. 107-121.

HARVEY W.H., 1858 — *Phycologia Australica, or, a history of Australian seaweeds...* Vol. I. 60 pls. London, Reeve.

HOFFMANN A. & SANTELICES B., 1997 — *Flora Marina de Chile Central. Marine Flora of Central Chile*. Santiago, Ediciones Universidad Católica de Chile, 434 p.

HOLMGREN, P. K., HOLMGREN N.H. & BARNETT L.C., 1990 — *Index Herbariorum. Part I: the Herbaria of the World*. 8th ed. New York, New York Botanical Garden [*Regnum Vegetabile* vol. 120].

HOWE M.A., 1914 — The marine algae of Peru. *Memoirs of the Torrey Botanical Club* 15, 185 p., 66 pls.

INAGAKI K., 1958 — A systematic study of the order Chordariales from Japan and its vicinity. *Scientific Papers of the Institute of Algological Research, Hokkaido University* 4: 87-197.

JOLY A.B., CABERA S.M. & SAZIMA I.P., 1974 — A new *Myriogloia* from the American South Atlantic. *Rickia* 6: 71-79.

KUCKUCK P., 1929 — Fragmente einer Monographie der Phaeosporeen. *Wissenschaftliche Meeresuntersuchungen, Abteilung Helgoland,* Neue Folge, 17(4): 1-93.

KYLIN H., 1940 — Die Phaeophyceenordnung Chordariales. *Acta Universitatis lundensis* N. F., *Avd. 2*, 36(9): 1-67, 8 pls.

LEVRING T., 1939 — Über die Phaeophyceengattungen *Myriogloia* Kuck. und *Haplogloia* nov. gen. *Botaniska Notiser* 1939: 40-52.

LEVRING T., 1960 — Contributions to the marine algal flora of Chile. *Acta Universitatis lundensis*, N. F., *Avd. 2*, 56(10): 1-83 + [2].

LINDAUER V.W., CHAPMAN V.J. & AIKEN M., 1961 — The marine algae of New Zealand. II: Phaeophyceae. *Nova Hedwigia* 3: 129-350, pls. 57-97.

LIPKIN Y. & SILVA P. C., 2002 — Marine algae and seagrasses of the Dahlak Archipelago, southern Red Sea. *Nova Hedwigia* 75: 1-90.

LLAÑA A., 1948 — Dos notas ficológicas. *Revista de Biología Marina* [Montemar, Chile] 1: 59-61.

NASR A.H., 1947 — Synopsis of the marine algae of the Egyptian Red Sea coast. *Bulletin of the Faculty of Science, Fouad I University*, No. 26: 155 p., 14 pls.

NELSON W.A. & ADAMS N.M., 1983 — A taxonomic revision of the families Chordariaceae and Chordariopsidaceae (Phaeophyta) in New Zealand. *New Zealand Journal of Botany* 21: 77-92.

OLTMANNS F., 1922 — *Morphologie und Biologie der Algen*. Zweite, umgearbeitete Auflage. Zweiter Band. Phaeophyceae - Rhodophyceae. Jena, G. Fischer, iv + 439 p.

ORMOND R.F.G. & BANAIMOON S.A., 1994 — Ecology of intertidal macroalgal assemblages on the Hadramout coast of southern Yemen, an area of seasonal upwelling. *Marine Ecology Progress Series* 105: 105-120.

PAPENFUSS G.F., 1968 — A history, catalogue, and bibliography of Red Sea benthic algae. *Israel Journal of Botany* 17: 1-118.

PETERS A. & MÜLLER D.G., 1986 — Culture studies on the life history of *Myriogloia chilensis* (Mont.) Llaña (Phaeophyceae, Chordariales). *Botanica Marina* 29: 43-48.

QASIM R. & BARKATI S., 1985 — Ascorbic acid and dehydroascorbic acid contents of marine algal species from Karachi. *Pakistan Journal of Scientific & Industrial Research* 28: 129-133.

RAMIREZ M.E. & SANTELICES B., 1991 — *Catálogo de las algas marinas bentónicas de la costa temperada del Pacifico de Sudamérica*. Monografias Biológicas No. 5. Santiago, Facultad de Ciencias Biológicas Pontificia Universidad Católica de Chile, 437 p.

RICHARDS G. & WYNNE M.J., 2003 — *Macroalgal Biodiversity of Oman*. Produced by HTS Development Ltd. In association with: The Oman Natural History Museum, Ministry of Heritage and Culture; The Natural History Museum, UK; The Herbarium of the University of Michigan. Funded by the Darwin Initiative. iii + 57 p.

SANTELICES B., 1989 — *Algas Marinas de Chile Distribucion Ecología Utilizacion Diversidad*. Santiago, Ediciones Universidad Católica de Chile, 399 p.

SEGAWA S. & OHTA K., 1951 — Notes on some seaweeds of Hakata Bay. *Science Bulletin, Faculty of Agriculture, Kyûshû University* 13: 282-285.

SHAMEEL M., 1987 — A preliminary survey of seaweeds from the coast of Lasbela, Pakistan. *Botanica Marina* 30: 511-515.

SHAMEEL M., AISHA K. & KHAN S.H., 1996—A preliminary survey of seaweeds from the coast of Makran, Pakistan. *Botanica Marina* 39: 223-230.

SILVA P.C., BASSON P.W. & MOE R.L., 1996 — Catalogue of the benthic marine algae of the Indian Ocean. *University of California Publications in Botany* 79, xiv + 1,259 p.

SRINIVASAN K.S., 1969 — *Phycologia indica (Icones of Indian marine algae)*. Vol. 1. Calcutta, Botanical Survey of India. xix + 52 p., 51 pls.

STEGENGA H., BOLTON J.J. & ANDERSON R.J., 1997 — *Seaweeds of the South African West Coast*. Cape Town, Contributions from the Bolus Herbarium 18, 655 p.

TAYLOR W.R., 1947 — Algae collected by the "Hassler," "Albatross," and Schmitt expeditions. III. Marine algae from Peru and Chile. *Papers of the Michigan Academy of Science, Arts and Letters* 31: 57-90, 14 pls.

WOMERSLEY H.B.S., 1987 — *The marine benthic flora of southern Australia Part II.* Adelaide, South Australian Printing Division, 484 p.

WYNNE M.J., 1973 — A key to unbranched, cylindrical brown algae. *Contributions in Marine Sciences* [University of Texas] 17: 133-152.

WYNNE M.J., 2000 — Further connections between the benthic marine algal floras of the northern Arabian Sea and Japan. *Phycological Research* 48: 211-220.

WYNNE M.J. & JUPP B.P., 1998 — The benthic marine algal flora of the Sultanate of Oman: new records. *Botanica Marina* 41: 7-14.

ZANARDINI G., 1858 — Plantarum in mari Rubro hucusque collectarum enumeratio (juvante A. Figari). *Memorie del Reale Istituto Veneto di Scienze, Lettere ed Arti* 7: 209-309, pls. III-XIV.