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Pedobesia simplex (Kützing) comb. nov. (Chlorophyta), a new name for *P. lamourouxii* and its first report from the Indian Ocean

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Abstract — The green alga *Pedobesia lamourouxii* (J. Agardh) Feldmann *et al.* (Bryopsidales) is reported from the northern Arabian Sea on the basis of collections from the Sultanate of Oman and Socotra Island (Yemen). Vegetative and sporangial plants as well as the ecology are described. These collections constitute the first record of this widely distributed species for the Indian Ocean. In the course of this study we discovered that *Bryopsis simplex* Kützing is an older taxonomic synonym, and thus we propose *Pedobesia simplex* (Kützing) comb. nov. as the correct name for this species. A specimen of *Bryopsis simplex* in the Leiden Herbarium (L) is designated as lectotype. © 2001 Adac/Éditions scientifiques et médicales Elsevier SAS

biogeography / *Bryopsis simplex* / Chlorophyta / green algae / Indian Ocean / Oman / *Pedobesia lamourouxii* / *Pedobesia simplex* / Socotra

Résumé — Des collections du Sultanat d'Oman et de l'île de Socotra (Yémen) ont permis d'établir la présence de l'algue verte *Pedobesia lamourouxii* (J. Agardh) Feldmann *et al.* (Bryopsidales) dans la partie nord de la mer Arabique. Les thalles végétatives et fertiles, ainsi que l'écologie des algues, sont décrites. Ces collections constituent la première signalisation pour l'océan Indien de cette espèce largement répandue. Au cours de cette étude, nous avons découvert que *Bryopsis simplex* Kützing est un synonyme ancien de *P. lamourouxii*, et nous proposons donc *Pedobesia simplex* (Kützing) comb. nov. comme nom correct pour ce taxon. Un spécimen de *Bryopsis simplex* dans l'herbier de Leiden (L) a été désigné comme lectotype. © 2001 Adac/Éditions scientifiques et médicales Elsevier SAS

biogéographie / *Bryopsis simplex* / Chlorophyta / océan Indien / Oman / *Pedobesia lamourouxii* / *Pedobesia simplex* / Socotra

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INTRODUCTION

The only previous records of *Pedobesia* from the broad expanse of the Indian Ocean have been those of *P. clavaeformis* (J. Agardh) MacRaild *et* Womersley (1974) from Western Australia by Womersley (1984) and Huisman & Walker (1990). South African records of *Derbesia ryukyuensis* Yamada *et* T. Tanaka [= *Pedobesia ryukyuensis* (Yamada *et* T. Tanaka) Kobara *et* Chihara] by Bolton & Stegenga (1987) and Anderson & Stegenga (1989) were later recognized by Stegenga *et al.* (1997) to be *Derbesia marina* (Lyngbye) Solier. Thus, the identification of *Pedobesia lamourouxii* (J. Agardh) Feldmann *et al.*[1] in collections made from the Sultanate of Oman and from Socotra Island, Yemen, represent a noteworthy addition to the flora of this region of the northern Arabian Sea.

MATERIALS AND METHODS

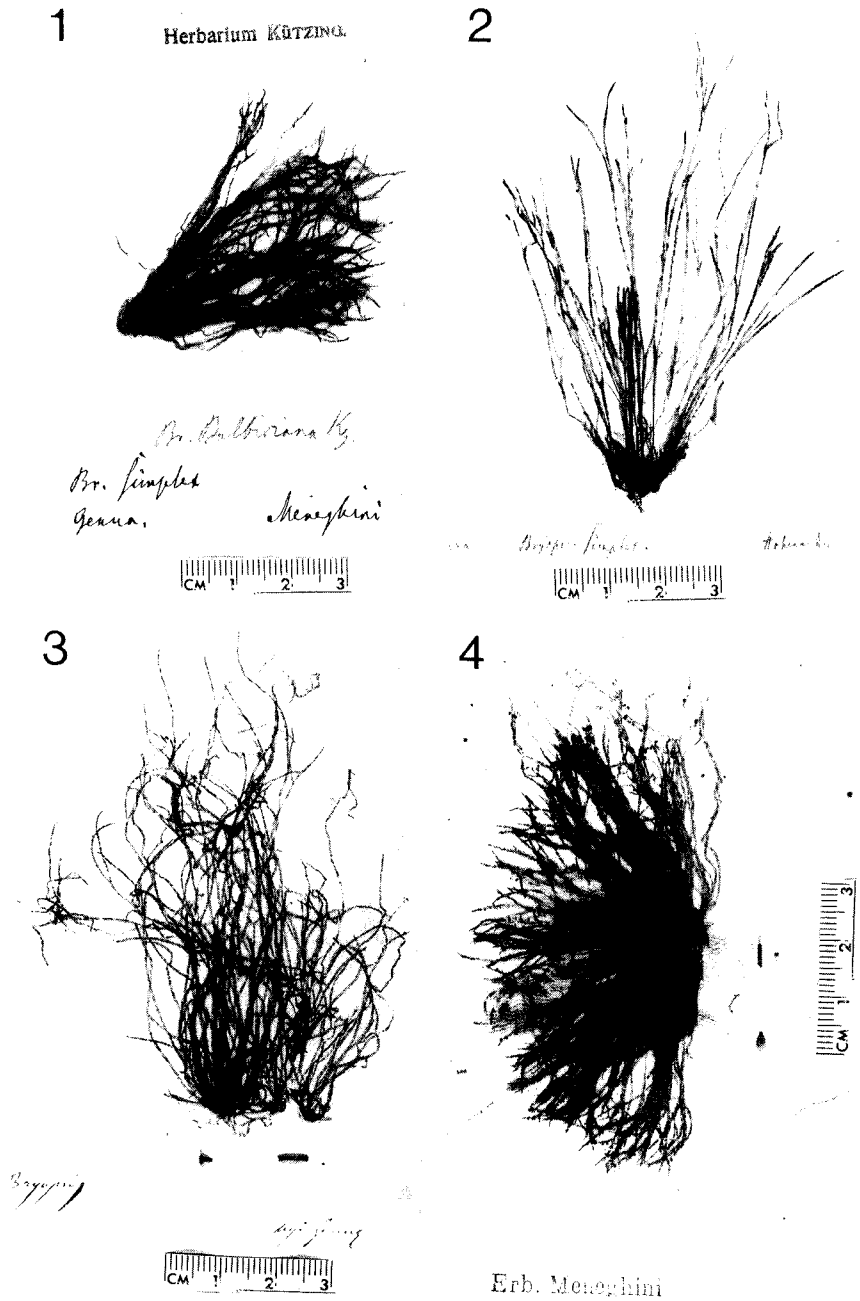
The Omani specimens used in this study were collected by Glenn Richards of Hunting Technical Services, Ltd., York, U.K., and Tim Collins of Muscat, whereas the Socotran specimens were collected by F. Leliaert. Protologue specimens of *Bryopsis simplex* Meneghini *ex* Kützing were borrowed by the first author from the Rijksherbarium, Leiden (L), and the University of Florence (FI). These are the two institutions that now house the Meneghini Herbarium (Koster, 1969). Collections of *Pedobesia* from the Mediterranean in GENT and MICH were also examined. Herbarium abbreviations are according to Holmgren *et al.* (1990).

RESULTS

In the course of this study we recognized that the name *Bryopsis simplex* Meneghini *ex* Kützing (1843), which has been applied to a taxon that has been traditionally regarded as conspecific with *Pedobesia lamourouxii*, has priority as an epithet-bearing name over *Derbesia lamourouxii* (J. Agardh) Solier (1846). The basionym of this latter name is *Bryopsis balbisiana* var. *lamourouxii* J. Agardh (1842), which has priority only at the varietal level (see Art. 11.2 of the ICBN, Greuter *et al.*, 1994). The first person to propose this taxonomic synonymy was Kützing (1849), who was followed, among others, by Hauck (1882–1885), Ardissone (1886), DeToni (1889), and Pignatti (1962).

In the protologue of *Bryopsis simplex*, Kützing's (1843) accredited the name to Meneghini and cited two collections: « Genua: Meneghini ! Nizza: Fr. Nees ! » Among the collections of *Pedobesia lamourouxii* borrowed from L was one sheet (L 0109995) marked 'Kützing Herbarium'. This sheet comprises two mounted specimens (Figs 1, 2) of erect, mostly simple axes bearing sporangia and a mica mount with some additional fertile axes. The maximum height of the erect axes is 8.5 cm (Fig. 2). This material is identical to *Pedobesia lamourouxii* (and is labeled as such). The label in pencil indicates 'Meneghini' and 'Genua' [although someone later wrote in ink 'Genna']. The specimen

[1] Womersley (1984) credited Rietema (1975) with authorship of *Pedobesia lamourouxii*. Feldmann *et al.* (1975), however, made the transfer earlier in the same year (Silva, pers. comm.).



Figs 1–4. *Bryopsis simplex* Meneghini *ex* Kützing. Four specimens conforming to the protologue. Figs 1, 2. Specimens from Herbarium Kützing in Leiden (L 0109995). Specimen in Fig. 1 is designated the lectotype. Figs 3, 4. Isolectotype specimens from Herbarium Meneghini in Florence (FI 4216). Specimens in Figs 1–3 are from Genua. The name of the locality is lacking on the specimen illustrated in Fig. 4.

bearing the more numerous sporangia (Fig. 1) is hereby designated the lectotype, and the second card (Fig. 2) is an isolectotype. Thus, Genoa, Italy, is here treated as the type locality.

The only other collection in the Leiden loan that appears to be relevant to Kützing's protologue is L 0065093, which is labeled 'Hab. prope Nice' and was from the Herbarium Persoon. Nice, France, corresponds to 'Nizza', the second syntype locality.

The loan from Florence contained a single sheet (FI 4216) with two mounted specimens (Figs 3, 4) labeled '*Bryopsis simplex* Meneghini' with the description: « Species nova a ceteri omnibus hujus generis distinctissima insigni simplicitate filorum ». One of the mounts bears the label 'Genua'. One of these specimens reaches 8.5 cm in height; both specimens are abundantly fertile with sporangia. These specimens are taxonomically identical to the two specimens from L discussed above and conform to what has been called *Pedobesia lamourouxii*. The evidence strongly supports the conclusion that these two specimens in FI are isolectotypes of *B. simplex*.

Because of the priority of the name *Bryopsis simplex* Meneghini *ex* Kützing (1843) over *Derbesia lamourouxii* (J. Agardh) Solier (1846) at the species level, we propose the following transfer:

Pedobesia simplex (Meneghini *ex* Kützing) M. J. Wynne *et* F. Leliaert comb. nov.

Basionym: *Bryopsis simplex* Meneghini *ex* Kützing 1843: 306.

Heterotypic synonym: *Pedobesia lamourouxii* (J. Agardh) J. Feldmann, J. Loreau, L. Codomier *et* A. Couté 1975: 2641–2644.

Basionym: *Bryopsis balbisiana* var. *lamourouxii* J. Agardh 1842: 18.

Homotypic synonym: *Derbesia lamourouxii* (J. Agardh) Solier 1846: p. 454; 1847: 162, pl. 9, figs 18–30.

Heterotypic synonyms: *Bryopsis dalmatica* Kützing 1856: 26, pl. 74, fig. I ('*Bryopsis adriatica*' on plate) (*fide* Hauck, 1885).

Bryopsis balbisiana var. *interrupta* Kützing 1845: 251; 1856: 27, pl. 74, fig. II (*fide* Hauck, 1885).

Bryopsis incompta Meneghini *in* Zanardini 1865: 407, pl. 48 A 1 & 2) (*fide* Hauck, 1885).

We accept Hauck's (1885) and later Pignatti's (1962) treatment of *Bryopsis incompta* Meneghini *in* Zanardini (1865) as conspecific with *Bryopsis lamourouxii* with some reservation. The habit of the alga depicted in Zanardini's pl. 48 A generally agrees with that of *B. lamourouxii*, whereas the erect axes measure only about one-eighth of the width of the axes known for *Pedobesia simplex* (= *P. lamourouxii*). This discrepancy may be the result of an error in the magnification given by Zanardini. On the other hand, after an examination of 22 collections of this taxon in GENT and MICH and in the loan from L, we have observed a fair degree of variation in the width of the erect axes.

Meneghini (1845) recognized four varieties of *Bryopsis simplex*: var. *nuda* Meneghini, var. *plumata* Meneghini, var. *prolifera* Meneghini, and var. *fasciculata* Montagne. Without referring to his own *B. simplex*, Kützing (1845) recognized *B. balbisiana* var. *nuda*, var. *interrupta*, and var. *disticha* J. Agardh. Later, De Notaris (*in* De Notaris & Baglietto, 1869) described *B. simplex* var. *versatilis*. The taxonomic value of these varieties within *Pedobesia simplex* is uncertain, and therefore formal recognition is not made here.

The present observations are based on the following three collections:
SULTANATE OF OMAN, rock 500 m east of Mirbat Island, southeast of Mirbat, Dhofar (16° 57.07' N, 54° 44.88' E): 28.ix.1999,12 m depth, *leg. G. Richards 28999-04-05* (deposited in BM, MICH, ON). Hoon's Bay, east of Mirbat (17.00517° N, 54.15339° E): 26.ix.2000, 6 m depth, *leg.: T. Collins 01092000-20-01* (deposited in BM, MICH, ON).

SOCOTRA. 3 km west of Bidholih, 400 m offshore, Nogid (south coast) (12° 19.22' N, 53° 54.63' E), 14.iii.1999, 15 m depth, epilithic, *leg. F. Leliaert SOC 382* (deposited in GENT).

Vegetative morphology

Thallus grass-green, 4–5 cm high, usually in tufts (Fig. 9) composed of erect, scarcely branched, siphonous filaments (Fig. 10), 440–800 µm in diameter in the middle part (narrower at the base: 300–350 µm diameter) (Fig. 5), obtuse to slightly tapering at the apex. Basal rhizoids much branched, 45–100 µm in diameter. Cell walls 3–10 µm thick. Chloroplasts numerous, 2.5–4.0 µm in length, lacking pyrenoids. Prostrate disc calcified with numerous pores (Fig. 11).

Reproductive morphology

Sporangia borne subapically on the erect filaments, 1–6 per filament (Figs 6–8, 10), arranged on one side of the filament or all around, mature sporangia spherical to reniform, 300–500 µm in diameter, length/width: 0.8–1.0.

Ecology

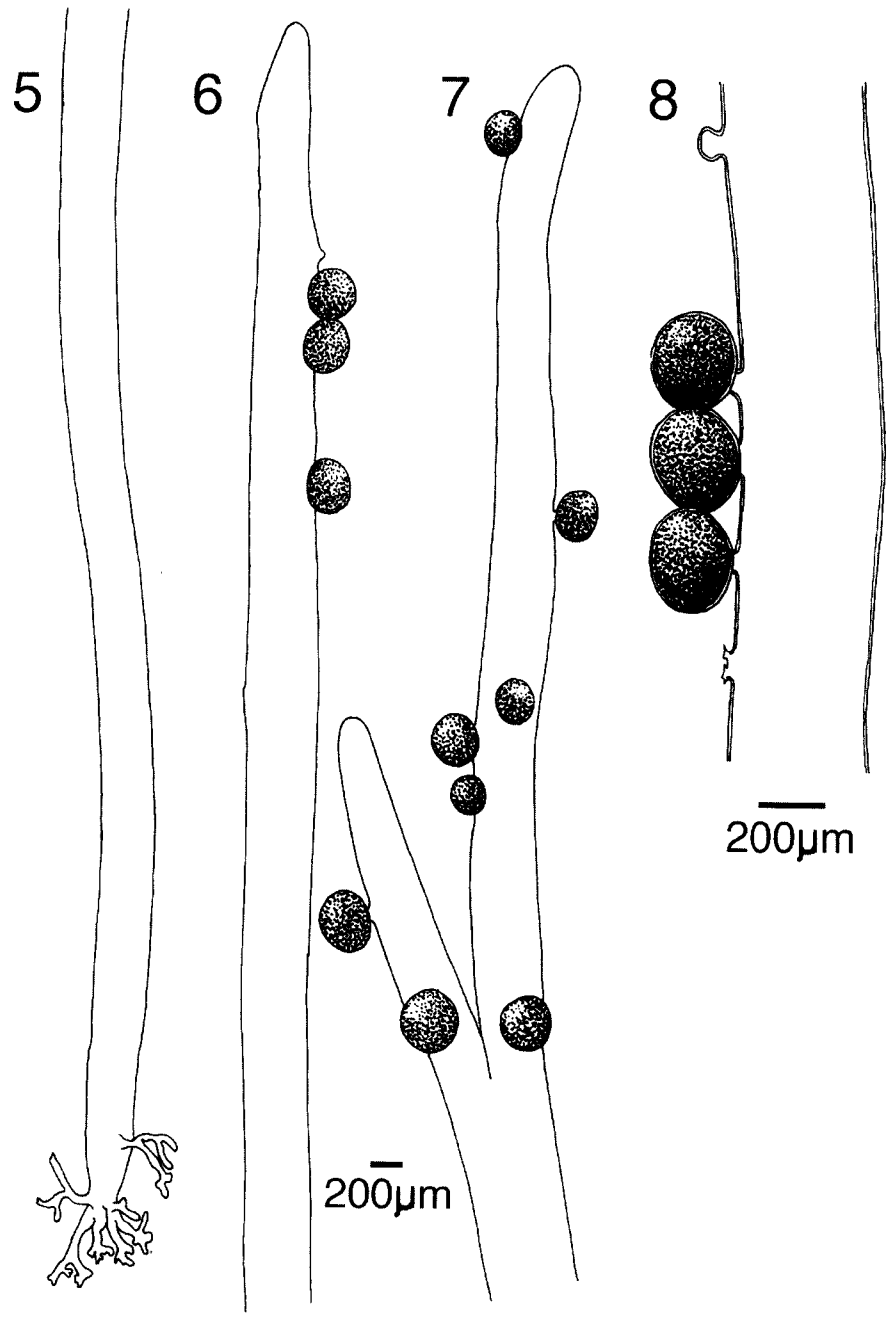
The Socotran specimen was found on the Nogid (southern) coast of the island, 400 m offshore and at a depth of 15 m. It was epilithic, on a horizontal rock face, the habitat characterized by rock grooves and spurs. The Nogid, like all of the southern coast of the Socotra Archipelago, is subject to upwelling of colder, nutrient-rich waters during the southwest monsoon between April and October. This biotope is covered by a rich and unique assemblage of macroalgal species along with soft and hard corals. Some of the other algae are *Caulerpa racemosa* (Forsskål) J. Agardh, *C. scapelliformis* (Turner) C. Agardh, *Chamaedoris auriculata* Børgesen (remarkably large plants), *Neomeris vanbosseae* M. Howe, *Udotea indica* A. Gepp *et* E. Gepp, *Botryocladia leptopoda* (J. Agardh) Kylin, *Solieria robusta* (Greville) Kylin, *Portieria hornemannii* (Lyngbye) P. Silva.

The Omani specimens were collected at depths of 6 to 12 m in a rocky habitat similar to that of the Socotran specimens in being impacted by the seasonal monsoon. Co-occurring algae included *Caulerpa peltata* Lamouroux var. *macrodisca* (Decaisne) Weber-van Bosse, *Lobophora variegata* (Lamouroux) Womersley *ex* Oliveira, and *Amphiroa beauvoisii* Lamouroux.

DISCUSSION

Morphology

The dimensions and other morphological characteristics of our Indian Ocean collections of *Pedobesia simplex* (= *P. lamourouxii*) are in general agreement with previous accounts of this species (Solier, 1847; Oltmanns, 1922; Funk, 1927; Kobara & Chihara, 1984). Christensen (1994) stated that in *Pedobesia* the upright filaments are



Figs 5–8. *Pedobesia simplex*. Fig. 5. Proximal portion of an erect axis. Figs 6–7. Distal portions of fertile erect axes. (A rare example of branching is in Fig. 7.) Fig. 8. A grouping of sporangia on an erect axis. (Figs 5–8 based on Socotran collection.)

usually unbranched and bear lateral sporangia in their apical part. He went on to say that the basal system, depending on growth conditions, may consist exclusively of irregularly branched creeping filaments or it may be an elaborate disc impregnated with crystals of aragonite inside forming 'a roof, a floor and numerous interconnecting pillars'. The basal system in our Indian Ocean collections agrees with this latter alternative. Descriptions of reproduction in *Pedobesia simplex* go back as far as Meneghini (1837) and Montagne (1839, as *Bryopsis balbisiana*), but incorrect names were applied to this species. Hamel (1931, as *Derbesia balbisiana*) depicted this species as having a height of 3–12 cm, with erect axes of 100–700 µm in thickness, and with laterally borne spherical sporangia 300–550 µm in diameter. Feldmann (1937, as *Derbesia lamourouxii*) described the chloroplasts to be of very small size, 2–3 µm long and only 1 µm wide and always lacking pyrenoids, in agreement with our observations.

Taxonomy and nomenclature

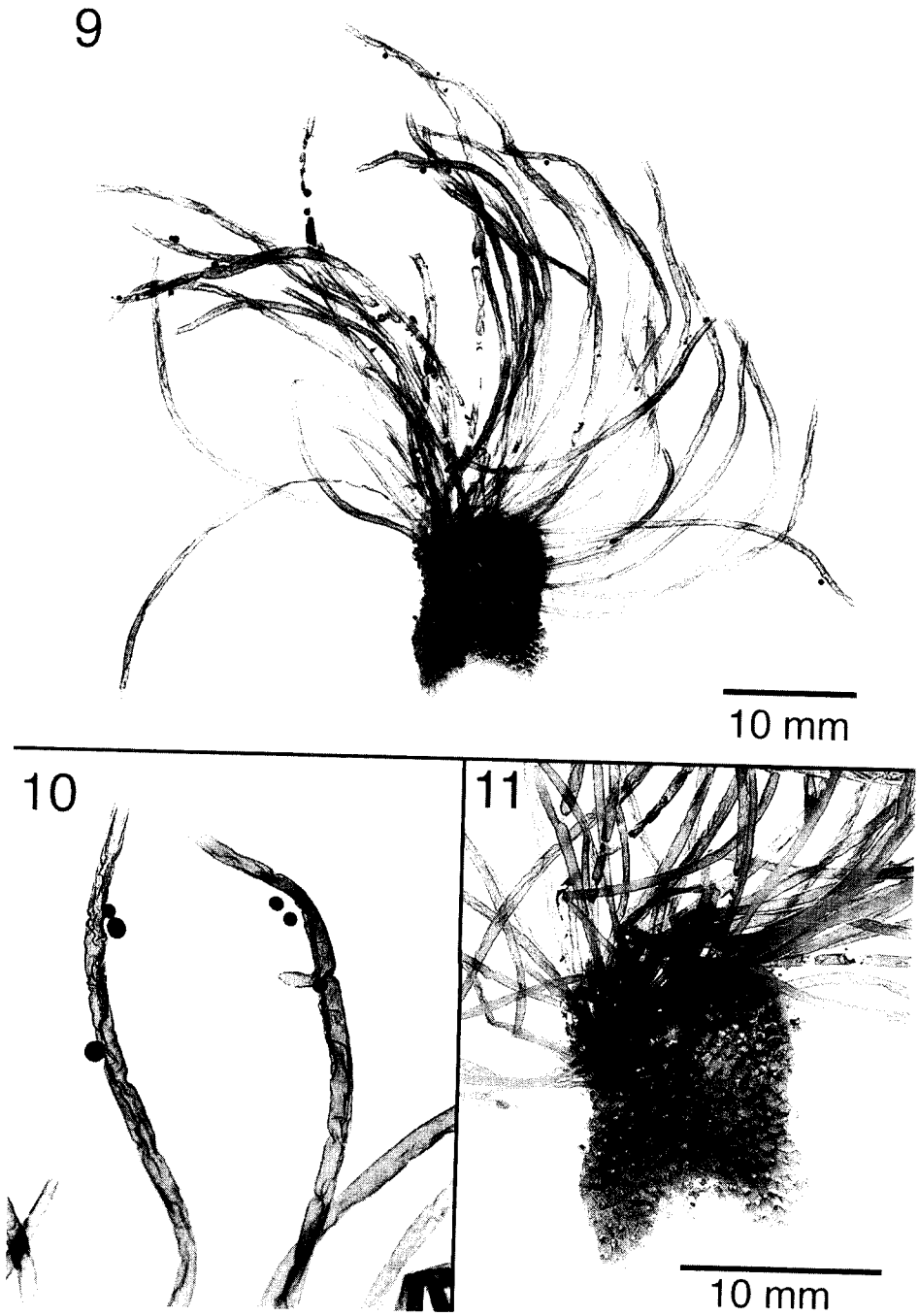
As early as 1839 Montagne proposed that this alga under discussion be segregated as a distinct genus and gave a diagnosis but without providing a generic name. As discussed by Schiffner (1935), J. Agardh (1887) greatly confused the situation by treating his var. *disticha* and var. *lamourouxii* to be one and the same species, *Bryopsis balbisiana* Lamouroux *ex* C. Agardh (1823). Feldmann (1937) rectified the earlier taxonomic confusion about the status of *B. balbisiana* and determined that the only specimen in Caen bearing a label in the hand of Lamouroux with the name '*Bryopsis Balbisiensis*' was a specimen that corresponded to the concept of *Bryopsis*, not to *Derbesia lamourouxii*. Despite Feldmann's observation and the later acceptance of *B. balbisiana* by Koster (1941) and Boudouresque & Perret (1977), Pignatti (1962) treated this name as a synonym of *Derbesia lamourouxii*. Although Lamouroux (1813), when publishing the name *Bryopsis balbisiana*, did not give a description, his figure (pl. 13, fig. 2) shows a habit (with branching to 3 or 4 orders) foreign to that of *Pedobesia simplex*, and thus we cannot agree with Pignatti.

Ecology

Feldmann (1937, as *Derbesia lamourouxii*) observed that *Pedobesia simplex* occurs on rocks in shaded stations close to the water surface. Athanasiadis (1987) reported it as occurring sublittorally in the Aegean Sea in shaded habitats from 1 to 6 m depth. Ardré (1970) observed this species on the coast of Portugal, where it occurs in exposed and sheltered habitats, particularly at the extreme low water mark on shaded rocks, rarely in illuminated tide pools. Abélard (1982) stated the habitat for this species is shaded rocks at the low-water mark. An examination of nine specimens (in GENT) from the Mediterranean collected by E. Coppejans showed that *Pedobesia simplex* commonly occurred either at the infralittoral fringe or in the subtidal from 25 to 35 m in depth.

Geographic Distribution

Pedobesia simplex has been reported (as *P. lamourouxii*) from various locations around the world, including the Atlantic coast of Europe (South & Tittley, 1986), the Mediterranean (Davis, 1908; Ben Maiz *et al.*, 1987; Cossu *et al.*, 1992; Papi *et al.*, 1992; Gallardo *et al.*, 1993), Japan (Okamura, 1922; Chihara, 1975), and Korea (Lee & Kang,



Figs 9–11. *Pedobesia simplex*. Fig. 9. Habit (wet-preserved specimen). Fig. 10. Erect axes bearing sporangia. Fig. 11. Calcified basal system. (Figs 9–11 based on Omani collection.)

1986). Reports of this species from the western Atlantic in Taylor (1960) and Wynne (1998) were based on earlier records from Bermuda by Collins & Hervey (1917) and from North Carolina by Williams (1948), but these records now appear dubious. Examination of *Phycotheca Boreali-Americana* #2168 in MICH (*Derbesia lamourouxii, leg. A. B. Hervey*, 21.iii.1916, Tucker's Town, Bermuda) reveals it to be an attenuate *Bryopsis* reduced to main axes for the most part and with some unilateral branching. *Bryopsis pennata* Lamouroux var. *secunda* (Harvey) Collins *et* Hervey seems to be the proper determination for the Bermuda collection. The record by Williams (1948) from North Carolina has been referred by Schneider & Searles (1991) to *Derbesia marina*. Examination of L.G. Williams' collection in MICH from Cape Lookout, North Carolina (#241, 10.vii.1949) confirms that it is *D. marina*, not *Pedobesia*.

Historical perspective and floristic affinities

Although the recent catalogue of benthic marine algae for the Indian Ocean by Silva *et al.* (1996) did not include any records from Socotra Island, a short list of marine and fresh-water taxa was included by Dickie (1888) in Balfour's "Botany of Socotra". Dickie's list was repeated in Forbes (1903), along with a list of algae from nearby Abd-el-Kuri identified by E. M. Holmes. Recently, the United Nations Development Programme (UNDP) started to show interest in the conservation and sustainable use of the biodiversity (both marine and terrestrial) of the Socotra Archipelago (UNDP/GEF Project YEM/96/G32). The Proceedings of the First International Symposium on Socotra Island, which arose from the UNDP project, included a paper on seaweeds (Banaimoon, 1998), but the list of species was based on mainland Yemeni collections. Kemp (1998a) reported the occurrence of the distinctive fucoid *Nizamuddinia zanardinii* (Schiffner) Silva from Socotra, reflecting the floristic affinity between this archipelago and the monsoon-impacted flora of the Yemeni and Omani coasts of the northern Arabian Sea. The unexpected occurrence of the kelp *Ecklonia radiata* (C. Agardh) J. Agardh on the Arabian coast (Lüning, 1990) reflects upwelling from the seasonal monsoon, which contributes to a diversified flora with a mixture of tropical, subtropical and warm temperate elements. Hiscock *et al.* (1984) have characterized the littoral algal cover of southern Oman as undergoing « drastic changes » because of the differences in the local weather conditions between pre- and post-monsoon periods.

Up to now there has been little known on the affinities of the Socotran seaweed flora. Previous zoogeographic studies (Salm, 1993; Kemp, 1998b) showed that the coral reef communities and associated fish fauna of the Socotran Archipelago mostly closely resembled those of the southern Arabian peninsula. The zoogeographic distribution of these corals and fishes in the southern Arabian area is mainly influenced by the seasonal Somali Current with its associated upwelling of cold nutrient-rich water. Despite the resemblance in coral reef communities, there are also some major differences. Those zoogeographic studies also showed that an east African influence is evident in Socotra, which is minimal on the mainland coast of Arabia.

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