Marine Algal Flora of French Polynesia
I. Phaeophyceae (Ochrophyta, brown algae)

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Abstract – This first paper in a monographic series on the marine algae of French Polynesia attempts to give a detailed coverage of the species of Phaeophyceae occurring in these islands. A total of 31 taxa are presented. Among these, seven represent new records for French Polynesia. The flora has affinities with neighbouring localities such as the Cook Islands, Hawai’i, Fiji, and Lord Howe Island, and there are taxa represented from both tropical and sub-tropical to temperate regions owing to the wide latitudinal distribution of the islands in French Polynesia, ranging from below the equator to well below the Tropic of Capricorn. New published records for French Polynesia include Cladosiphon novae-caledoniae, Cutleria irregularis, C. mollis, Hydroclathrus tumulis, Padina melemele, Sargassum cf. S. echinocarpum and Stypodium australasicum, all of which (excepted for Sargassum cf. S. echinocarpum) are restricted to the cooler waters of the southern Austral Islands (Rapa, Marotiri).

algae / biogeography / distribution / flora / French Polynesia / Phaeophyceae / new records / taxonomy


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INTRODUCTION

French Polynesia (Fig. 1) occupies nearly 5.5 million km² in the southern Pacific Ocean between 7° and 28° S and 134° and 155° W. It is composed of 118 islands, of which 34 are volcanic high islands and 84 are atolls, grouped in 5 archipelagos: Society, Tuamotu, Gambier, Austral and Marquesas. The islands of French Polynesia are oceanic islands which originated from emerged peaks of now extinct volcanoes, which were built up from the ocean floor. Climatic contrast between the Marquesas close to the equator and the subtropical Austral islands, combined with diversity in habitats between high islands and atolls, offers a range of possibilities for the marine flora. Main historical collectors of French Polynesian algae have been Captain H. Moseley (March 1875), Mrs. Josephine

![Map of French Polynesia](image)

**Fig. 1.** Map of French Polynesia, showing the five main archipelagos.
Tilden (October 1909), Dr. W. A. Setchell and Mr. H. E. Parks (May-July 1922, published in Setchell, 1926) and Dr. Cyril Crossland (September 1928, February 1931), all from the main island of Tahiti. The recent history of French Polynesian phycological studies was highlighted in Payri & N’Yeurt (1997). The latter publication listed 425 taxa of marine algae, of which 117 were Cyanophyta, 42 Phaeophyceae, 96 Chlorophyta and 170 Rhodophyta; however they were for the most part unverified records based on previously published findings. A few years later, an illustrated guide was published on French Polynesian marine algae and seagrasses (Payri et al., 2000), which contained some new records not published in the 1997 checklist. In the context of ethnobotanical studies, Conte & Payri (2002, 2006) recorded six edible marine green and brown algae from Ua Huka, Marquesas, and also the Austral islands, which are still to date undercollected. More unpublished records are represented by vouchers at the University of French Polynesia herbarium (UPF), and these are included in this study, along with new collections and revision of older records.

**MATERIALS AND METHODS**

All material was collected using SCUBA, snorkelling or reef-walking. Herbarium specimens were pressed using standard techniques and representative parts of thalli and turf algae stored in buffered 4% formalin in sealed plastic bags packed in a light-proof container, for shipment and later anatomical examination in the laboratory. Herbarium specimens were photographed using a bench-mounted digital camera (NIKON Coolpix 995).

Photomicrographs were obtained using an OLYMPUS C-4040 digital camera fitted atop an OLYMPUS BH2 microscope. Voucher specimens are housed at the Phycological Herbarium of the Université de la Polynésie française in Tahiti (UPF), with “S” referring to slide collections. “IFR” refers to holdings in the herbarium of the French Institute of Research on Coral Reef Environment (IFRECOR) in Bora Bora, French Polynesia (curated by Mr. Denis Schneider). Whenever necessary, available French Polynesian herbarium records in BM, UC and UPF have been re-verified in the light of new taxonomic information, either in person or through loan. Unfortunately, herbarium vouchers of algae from Moorea listed in Payri (1987), which contain some taxa not held at UPF, could not be located and are presumed for the majority lost, although some liquid-preserved and pressed duplicates of common species are housed at the Antenne EPHE at Opunohu, Moorea. Consequently, only those records which could be confirmed on the basis of existing collections have been included in this study.

The taxonomy adopted is that of Silva et al. (1987, 1996), Reviers (2003), or updated with other sources as cited in the text. Bibliographic distributional records following species binomials are limited to previous French Polynesian, followed by regional, records with illustrations, in order of date of publication. Basionyms are listed for each species where needed, and synonyms are restricted to those having been reported from French Polynesia or nearby localities in the literature used. Asterisks (*) indicate new published records for French Polynesia. A total of 31 taxa are presented.
RESULTS AND OBSERVATIONS

Key to genera of French Polynesian Ochrophyta (Phaeophyceae)

1. Thallus crustose ................................................................. 18
2. Thallus not crustose ........................................................... 2

3. Thallus filamentous ........................................................... 3
4. Thallus not filamentous ....................................................... 5

3. Filaments apically tapered; propagules absent; plurilocular sporangia elongate or spherical .............................................. 4
4. Filaments not apically tapered; triangular propagules sometimes present .

5. Plurilocular sporangia elongate, filaments straight or curved, but not hooked .............................................................. 8
6. Plurilocular sporangia spherical, filaments generally terminally hooked ....

5. Thallus branched in one plane only ........................................ 6
6. Thallus branched in more than one plane ................................ 7

7. Thallus fan-shaped; uncalcified or calcified on inferior surface; margin inrolled or straight; branching not dichotomous, stipe absent to conspicuous ..................................................... 15
8. Thallus not fan-shaped or calcified; margin not inrolled; branching dichotomous ............................................................. 8
9. Thallus dichotomously branched ............................................ 9
10. Thallus irregularly or alternately branched, or unbranched ......... 10
11. Thallus branched in more than one plane ................................ 7

8. Branches without midrib ..................................................... 12
9. Branches with midrib .......................................................... 12
10. Branches tough and solid ................................................... 12
11. Branches soft and hollow .................................................... 11
12. Branches an unbranched hollow or reticulate mass ................ 11
13. Branches cylindrical, strap-like, leaf-like or obconica ............. 12
14. Branches membranous, sometimes perforate, but never clathrate; sori with paraphyses ............................................... 12
15. Branches clathrate, with perforations, sori lacking paraphyses ... 12
16. Branches thickened, strap-like branches .............................. 12
17. Branches flattened, strap-like branches .............................. 12
18. Branches not flattened or strap-like ..................................... 12
20. Branches not lubricious, cylindrical or alternately branched .... 13
21. Ultimate branchlets leaf-like, not obconical ......................... 14
22. Ultimate branchlets obconical ........................................... 14
23. Thallus lightly to heavily calcified on inferior surface .................. 14
24. Thallus never calcified ..................................................... 14
25. Thallus soft and thin, never more than 5 cells thick in mature portions, gametangia pedicellate, adheres well to paper on drying, stipe absent ......................................................... 18
26. Thallus coarse and more than 5 cells thick in mature portions, sporangia in sori, never pedicellate, does not adhere so well to paper on drying, stipe sometimes present 18
17. Blades with concentric zonations, sporangia non-indusiate, central medullary cells irregularly arranged, same size as outer cells, stipe supose, inconspicuous.......................... *Stypopodium*
17. Blades without concentric zonations, sporangia indusiate, medullary cells elongate and regularly arranged, much larger than outer cells, stipe if present conspicuous and supose .................. *Lobophora* (stipit form)
18. Thallus forming overlapping crusts; in cross section cells bilaterally arranged, without a clear central medullary layer of elongate cells ......
.................................................. *Ralfsia*
18. Thallus not usually overlapping; in cross section medullary cells elongate and in a clear central layer surrounded by smaller cells.............
.................................................. *Lobophora* (decumbent form)

Division *Ochrophya*
Class *Phaeophyceae*
Order *Cutleriaceae*
Family *Cutleriaceae*
Genus *Cutleria* Greville

**Key to the French Polynesian species of Cutleria**

1. Thallus 3 cells thick, margins smooth, not trichothallic ........ C. *irregularis*  
1. Thallus 4-5 cells thick, margins trichothallic, never smooth........ C. *mollis*

(Figs 2-4)

**Material examined:** MacDonald undersea mount, 09 Nov. 2002, *leg. IRD*, BENTHAUS DW 1891, UPF 2144.

Thallus to 30 mm high and 40 mm wide, composed of thin tristromatic cuneate blades (Fig. 2) 43-57 μm in diameter. In cross section, composed of a single medullary layer of large vertically-oriented rectangular cells 27-34 μm high and 16-29 μm wide flanked on either side by a single layer of smaller subrectangular to cuboid cortical cells 8-12 μm high and 10-26 μm wide (Fig. 3). Margins slightly undulate, not trichothallic, composed of uninterrupted row of apical cells (Fig. 4). Reproduction not seen.

**Remarks:** Dredged from a depth of 100 metres atop the MacDonald undersea mount hot spot, along with *Microdictyon* sp. The specimens are small and sterile, but the anatomical features are consistently different from *Lobophora variegata* also occurring in the same locality, with which it could be confused. The plant is tristromatic with palisade-like medullary cells, while *L. variegata* (even the youngest blades sectioned) is always at least tetrasomatic with usually brick-like medullary cells. The lack of reproductive data precludes a firm placement of this unusual plant but it is most likely a species of *Cutleria*, very similar to *C. irregularis* Abbott et Huismar. It superficially resembles species of *Syringoderma* or *Chlanidophora*, but both of these gener are mono- or distromatic, and do not have the cortical layers and regular cell arrangement of the Polynesian species. The apical cells of *C. irregularis* (Fig. 4) are not elongate as in *Syringoderma* (Matsuyaga & Yamada, 1974) but are more characteristic of *Lobophora*, rather than the trichothallic margin of *Cutleria mollis*. 
*Cutleria mollis* Allender *et* Kraft, 1983: 122, figs 28-29 (type locality: Neds Beach, Lord Howe Island, Australia). Norfolk Island: Millar, 1999: 493, fig. 8. (Figs 5-7)


Gametophytic thallus (Fig. 5) soft and flabellate, golden-yellow and thin-translucent, to 30 mm high and 45 mm broad and 90-120 μm thick, attached to the substratum via basal rhizoids. The growing margins are distinctly lacerate and hair-fringed (trichothallic growth, Fig. 6). Internally composed of 4-5 cells layers, with smaller epidermal cells 8-14 μm wide and 7-10 μm tall, and larger medullary cells to 50 μm high and 75 μm wide. Phaeophycean hairs to 10 μm in diameter and 120 μm long scattered on surface; female gametangia (Fig. 7) ovoid, to 25 μm wide by 50 μm long, containing up to 12 loculi about 10 μm in diameter.

**Remarks:** A single, incomplete thallus from 42 m depth. The trichothallic margins are characteristic of the genus, while the golden yellow, thin translucent blades which adhere closely to the paper are distinctive of *C. mollis*, although the concentric arrangements of gametangia as described for the type of the species was not apparent in the Rapa plant, which tends to show more prominent radial lines. However, this could be a variable feature depending on the age of the plant, and where in the thallus the blade fragment came from; in our case the basal parts appear to be lacking and this seems to be where the concentric bands are the most visible (Allender & Kraft, 1983: 124, fig. 29A). It is also reported from Norfolk Island (Millar, 1999: 493, fig. 8) and possibly from Fiji (as *Cutleria* sp.) by Littler & Littler (2003: 176, photograph on p. 177, middle). The photograph of the latter Fijian species shows the *Aglaozioma* sporophyte stage of the plant. This genus appears to be restricted in French Polynesia to the cooler waters of the Australas. Setchell (1926: 90) mentioned a new species in the Cutleriaceae (*Aglaozioma pacifica*) from Papeete, Tahiti, but from the description (central layer of larger cells surrounded on either side by four layers of flattened cells) it likely was a crustose form of *Lobophora variegata*. Unfortunately, the type material of *A. pacifica* is misplaced in UC and cannot be examined at this time.

Order **Scytothamnales**

Family **Scytothamnaceae**

Genus *Asteronema* Trevison


Plants yellow-brown, tufted, 20-35 mm high, with irregular primary branching and numerous hooked secondary branchlets which hold the filaments in rope-like spongy strands. Filaments about 25 \( \mu \text{m} \) thick, composed of rectangular cells about up to \( 25 \times 50 \mu \text{m} \). Secondary hook-like branchlets (Fig. 8) up to 800 \( \mu \text{m} \) long and 25 \( \mu \text{m} \) broad, arising at 85-90\(^\circ\) to main filaments and spaced at 500-700 \( \mu \text{m} \) intervals. Plurilocular sporangia (Fig. 9) 40-45 \( \mu \text{m} \) high, short and pyriform, containing about eight spores and borne on a stalk cell.

Remarks: Found growing on wave-washed rocks in exposed areas, forming characteristic yellowish-brown wick-like clumps in typical association with Chnoospora minima. The association of Asteronema and Chnoospora is frequent, and reported also from Vietnam (Dawson, 1954), Micronesia and Hawaii (Tsuda, 1972) and the Cook Islands (N’Yeurt & Payri, in prep.). Recent molecular studies (Peters & Clayton, 1998; Draisma et al., 2001; Rousseau et al., 2001) indicate that Asteronema is polyphyletic and not related to the Ectocarpales; however the status of A. breviarticulatum remains uncertain until it is included in molecular analyses. In French Polynesia, it is found as far south as the Gambier Group, but not reported from the Austral Islands although it was recorded from Easter Island to the southeast (Børgesen, 1924).

Order Ectocarpales
Family Ectocarpaceae

Genus Hincksia J. E. Gray


Basionym: Ectocarpus mitchelliae Harvey, 1852: 142, pl. 12g (mitchelliae) (type locality: Nantucket, Massachusetts, USA). India: Børgesen, 1930: 165, fig. 8a-c; Iran: Børgesen, 1939: 75; Mauritius: Børgesen, 1941: 7, figs 1a-c, 2a-e, 3a-c, 4a-c, 5a-b, 1948: 44, fig. 23; Tasmania: Cribb, 1956: 184, pl. 2 fig. 1; Marshall Islands: Dawson, 1956: 43.


Thallus light brown, densely tufted and up to 10 mm high. Branching close and profuse throughout; filaments tapering towards the apex. Main axis 20-22 \( \mu \text{m} \) in diameter, with terminal branches 9-16 \( \mu \text{m} \) in diameter. Cells of main filaments subquadrate to rectangular, to 20 \( \mu \text{m} \) wide and 30 \( \mu \text{m} \) high, with a
central pyrenoid and apparently stellate chloroplasts (Fig. 10). Plurilocular sporangia (Fig. 11) cylindrical, up to 61 μm long and 20 μm in diameter; sessile with rounded ends. Locules in rows of 1-2 (3).

**Remarks:** Epiphytic on other algae (usually *Turbinaria* and *Sargassum*) on the reef crest (Tahiti, Moorea). The status of *H. mitchelliae* within the genus *Hincksia* remains uncertain, as it was not included in studies that transferred the species *H. breviarticulata* to the genus *Asteronema* (Ouirues, pers. com.). Polynesian plants possess stellate chloroplasts; on the other hand Clayton (1974: 779, fig. 23F) reports discoid chloroplasts in southern Australian plants. Plants from American Samoa (Setchell, 1924) and Hawaii (Abbott, 1947) referred to *Ectocarpus indicus* (now *Hincksia indica* (Sonder) J. Tanaka) were found to be conspecific with *H. mitchelliae* (Womersley & Bailey, 1970: 288); however *H. indica*, along with *H. mitchelliae*, are now reported from Hawaii by Abbott and Huisman (2004: 161). The Tahitian record of *E. indicus* (Tilden South Pacific Algae Nr. 32 in French Polynesia; Setchell 1926: 86), now in UC, was examined for this study and the material found to actually represent *H. mitchelliae*. *Hincksia indica* is characterised by very long, straight cylindrical plurilocular sporangia, which contrast to the short, stocky organs of *H. mitchelliae*, as well as by filaments with unbranched apices (Womersley & Bailey, 1970; Abbott and Huisman, 2004).

**Order Chordariales**
**Family Chordariaceae**
**Genus Cladosiphon** Kützing, 1843: 329

*Cladosiphon novae-caledoniae* Kylin, 1940: 29, pl. 4 fig. 10 (type locality: Freycinet Island, Nouméa, New Caledonia). New Caledonia: Ajisaka, 1991: 2, figs 2A-D, 3A-F.

(Figs 12-13)


Thallus dark golden brown in colour, lubricious, erect and filiform, with irregularly alternately branched cylindrical axes 10-30 cm high and 1 to 1.5 mm in diameter, attached to the substratum via a small discoid holdfast (Fig. 12). Medulla multiaxial, composed of elongated unpigmented and sympodially branched pseudoparenchymatous filaments 80-400 μm long and 40-150 μm in diameter. Subcortical layer 1-2 cell thick, bearing radially extended divaricate laterals 160-300 μm high composed of 10-30 cells 7-10 μm in diameter (Fig. 13), swollen and curved at the apex. Uniseriate hairs 8-10 μm in diameter, hyaline with a basal sheath. Sporangia not seen.

**Remarks:** Growing on various hard substrata at 10-68 meters depth, so far only found in the southern island of Rapa in the Australs. Kylin (1940) did not provide a description of his new species, but Ajisaka (1991) carefully examined and described the type specimen in LD and compared it with other species in the genus. *Cladosiphon okamuranus* (Tokida, 1942: 87, fig. 4) is superficially similar to *C. novae-caledoniae*, but differs in its smaller medullary cell diameters (20-50 μm) and in having a subcortical layers of 1-3 cells, as opposed to 1-2 only in the Rapa plant.
(Ajisaka, 1991: 5, tab. 1). Other morphological features are similar in both species, and perhaps future molecular studies might merge them, but they are kept apart for the time being. Species of Cladosiphon have economic potential in the region as a valuable edible commodity for the Japanese market, with successful culture projects in Japan (Toma, 1993), Tonga (Billings, 1996) and New-Caledonia (pers. obs., CEP).

Family Ralfsiaceae
Genus Ralfsia Berkeley


Basionym: Myrionema expansum J. Agardh, 1847: 7 (type locality: Veracruz, Mexico).


Thallus forming tightly adhering, dark brown, overlapping crusts 10-30 mm in diameter and 250 to 2000 μm thick, with golden margins. Cells in cross section bilaterally arranged; basal layer 3-4 cells thick, thallus more than 30 layers thick. Unilocular sporangia pedicellate on 2-4 stalk cells, borne in a lateral position and surrounded by paraphyses. Individual mature sporangia about 25 μm in diameter and up to 80 μm long. Plurilocular organs in two rows of 8-12 fertile cells, in sunken sori on separate plants from unilocular organs.

Remarks: growing on rock faces and coral debris in the upper littoral, and up to 5 m deep. We follow Womersley (1987) and Abbott & Huisman (2004) in referring this species to the order Chordariales. The related genus Hapalospondion Saunders is distinguished from Ralfsia by discrete crusts less than 12 layers thick, embedded plurilocular sporangia, and free unilocular organs with conspicuous paraphyses (Abbott & Huisman, 2004: 170).

Order Sphacelariales
Family Sphacelariaceae
Genus Sphacelaria Lyngbye

Key to the French Polynesian species of Sphacelaria

1. Propagules triangular, knobby, with short basally tapered pedicel. S. tribuloides
   1. Propagules Y-shaped, with extended arms and long non-tapered pedicel......

................................................................. S. rigidula


Heterotypic synonym: Sphacelaria furcigera Kützing, 1855: 27, pl. 90 fig. 11 (Type locality: Karak (Khark) Island, Iran) (vide Prud’homme van Reine, 1982: 203,
**French Polynesian brown algae**

thallus light-brown, 7-10 mm high, epiphytic, forming erect penicillate tuft; basal holdfast discoid. Branching sparse to frequent, at irregular narrow angles. Main axis linear and two cells thick, 30-35 µm in diameter with rectangular cells about 15 × 35 µm. Propagules abundant, Y-shaped with paired slender and slightly tapering arms 100-250 µm long and 15-20 µm broad with an approximate angle of 120° between them, borne on a pedicel 230-260 µm long and with a convex lenticular apical cell rising to 7.5-18 µm. Lateral unilocular sporangia subsphaerical and shortly pedicellate, 37-40 µm in diameter.

**Remarks:** Epiphytic on other algae. The long, Y-shaped propagules are characteristic for this species.

*Sphacelaria tribuloides* Meneghini, 1840: 2 (lectotype locality: La Spezia, Italy). Mauritius: Børgesen, 1941: 41, fig. 18a-c; Guam: Tsuda, 1972: 93, pl. 1 figs 6-9, pl. 2 fig. 4; South Australia: Womersley, 1987: 160, figs 45G, 52A-C; Belize: Littler & Littler, 1997: 71, fig. 89; French Polynesia: Payri & N’Yeurt, 1997: 876; China: Draisma *et al*., 1998: 189, fig. 22; Hawaii: Abbott & Huisman, 2004: 190, fig. 72D-E. *(Fig. 15)*


Thallus to 15 mm high, brownish-green and tufted, composed of irregularly branched segmented axes 40-100 µm in diameter. Triangular propagules 30-40 µm in diameter, with a pair of short knobby horns and pronouncedly tapered base occur on the sides of the main branches.

**Remarks:** Forming extended patch covers on reef surface. The knobby propagules with tapered bases are characteristic of this species.

**Order Dictyotales**

**Family Dictyotaceae**

**Genus Dictyopteris** Lamouroux


**Basionym:** Hallsiella repens Okamura, 1916: 8, fig. 3; pl. 1, figs 7-18 (type locality: Truk Island, Caroline Island).

Figs 14-26. **14. Sphacelaria rigidula** (UPF 2427) showing Y-shaped propagule on long pedicel (Scale = 25 μm). **15. Sphacelaria tribuloides** (UPF 483), triangular knobby propagule on short pedicel (Scale = 13 μm). **16. Dictyopteris repens** (In herb. UPF), habit showing characteristic midrib (Scale = 3 mm). **17. Dicryota acutiloba** (UPF 2360) showing distally crowded dichotomies of thallus (Scale = 5 mm). **18. Dicryota bartayresiana** (UPF 166), typical habit showing marginal proliferations (arrowhead) (Scale = 4 mm). **19. Dicryota bartayresiana** (UPF 2089), specimen from Rapa Island showing more elongate branches, with characteristic banding pattern (arrowhead) (Scale = 3 mm). **20. Dicryota ceylanica** (UPF 2029), habit, showing widely divaricate dichotomies (Scale = 5 mm). **21. Dicryota friabilis** (UPF 191), Habit (Scale = 3 mm). **22. Dicryota hamifera** (UPF 173), general habit (Scale = 3 mm). **23. Dicryota hamifera** (UPF 173), detail showing characteristic hooked side-branchlets (arrowheads) (Scale = 3 mm). **24. Lobophora variegata** (UPF 2234), crustose form (Scale = 3 mm). **25. Lobophora variegata** (UPF 1840), cross section of stiped form, showing large central cells surrounded on either side by four layers of flattened cells (Scale = 20 μm). **26. Lobophora variegata** (UPF 1887), habit of stiped form from Rapa Island (Scale = 10 mm).
Fronds recumbent, up to 3 cm long, branching dichotomous with branches 1-3 mm broad; thallus distromatic, 65 μm thick, with a prominent midrib 4-8-cells thick. Sporangia in sori, on either side of the midrib.

**Remarks:** Growing on coral rubble along the reef crest, and subtidally on the reef slope. The French Polynesian material lacks any marginal thickenings, which distinguishes it from similar-looking *D. delicatula* Lamouroux. It has been suggested (Taylor, 1960: 227; Tsuda, 1972: 94; Allender & Kraft, 1983: 108; Coppejans et al., 1995: 178; N’Yeurt, 2001: 742; Wysor & De Clerck, 2003: 152) that *D. delicatula* and *D. repens* are variants of the same entity. On the other hand, Phillips (2000: 304) reported that *D. repens* has oogonia external to the thallus, whereas in *D. delicatula* they are embedded in the thallus. No oogonia were seen in French Polynesian plants.

**Genus Dictyota Lamouroux**

**Key to the French Polynesian species of Dictyota**

1. Main branches with curved, hook-like side branchlets
2. Main branches without curved, hook-like side branchlets
3. Thallus translucent and strongly adherent, branches thin and friable, 2-3 mm wide, marginal proliferations absent
4. Thallus 3-4 cm long, dichotomies regularly spaced, branches generally not undulating; transverse bands present; sporangia with involucres
5. Thallus to 7 cm long, dichotomies crowded distally; branches wavy and undulating; transverse bands absent; sporangia lacking involucres


Thallus to 15 cm high and to 140 μm thick, with cervicorn branches dichotomously branched at angles of less than 90°. The dichotomies are lax below and crowded distally, with characteristically wavy undulating outlines. Peculiar small, dark blotches common along the middle portions of the thallus. Sporangia non-indusiatic.

**Remarks:** Found so far in French Polynesia only at Rapa Island, Australs group. A common species growing on hard substratum or epiphytic mixed with other brown algae in the *Sargassum* bed, intertidal to 25 m depth. This characteristic species can be distinguished from *D. bartayresiana* by its more filiform, undulating thallus with distally crowded dichotomies and central blotchy areas. It differs from the similar-looking *Dictyota cervicornis* Kützing by the absence of an indusium surrounding the sporangia, and the absence of surface proliferations (De Clerck, 2003: 51). Setchell (1926: 93) reports *D. acutiloba*, with some doubt, to occur in Tahiti in the Society group, but recent collections have not confirmed this, and its distribution is presently restricted to the cooler waters of the southern Australs.


Thallus ribbon-like, to 45 mm high, brownish-orange, 2-5 mm wide, with relatively tough, flattened, complanate axes regularly dichotomously branched at an angle of 70-80°. Branch tips are usually blunt and rounded, but can occasionally also be acute. Small proliferations 0.5-1 mm long sometimes occur on thallus margins (Fig. 18). Thallus not iridescent; characteristic transverse bands common, composed of darkly pigmented cell inclusions (Fig. 19). Medulla unlayered, without wall thickenings. Sporangia to 120 μm in diameter and with a single stalk cell, occurring singly on both surfaces of the thallus, lacking an involucrum.

**Remarks:** Commonly found growing in dense patches or balls to 15 cm across, on coral rubble in the lagoon (Tahiti, Moorea). The habit can be highly polymorphic, from elongate sparsely dichotomously branched thallii in deep water to densely overlapping tiers of blades wedged in coral in the lagoon. Tsuda (1972: 95) suggested that longer internodes in this plant are a result of habitats with limited light intensity, such as deeper turbid waters.


Thallus thin and ribbon-like, colour brownish-green, with a bluish iridescence on the surface; to 15 mm high, with dichotomous branches 0.3-1.5 mm wide, strongly divaricate at an angle of 100-120°; tapered gradually towards the apices which are very fine and filiform. Medulla unlayered, cells 25-50 μm in diameter, commonly with cell wall thickenings. Sporangia pedicellate, occurring singly on both sides of the thallus, often distributed in a narrow line in middle portions of branches. Involutcrum absent.

**Remarks:** Present throughout the year, forming entangled masses several centimetres across, attached to hard substrata such as coral rubble in shallow
lagoon areas (Moorea, Tahiti). The narrow, widely divaricate filiform axes with acuminate tips make this species easily distinguishable from other *Dictyota* species. This species was previously reported from Pacific localities under the name *Dictyota divaricata* Lamouroux. The absence of interbreeding between European, tropical Atlantic, and possibly Pacific populations strongly suggested that two species were involved (De Clerck & Coppejans, 1997: 413). The name *Dictyota ceylanica*, initially described from tropical Sri Lanka, has been used for Indian Ocean (De Clerck, 2003), Papua New-Guinean (Littler & Littler, 2003) and Hawaiian (Abbott & Huisman, 2004) populations previously listed under *D. divaricata*, and is a most likely choice for South Pacific members of the complex pending further studies (De Clerck, pers. com.).


Thallus imbricating, prostrate and friable, spreading to 3 cm in diameter, closely adherent to substratum. Colour yellowish green, translucent. Apices rounded, with prominent paired apical cells. Branching unequally dichotomous to irregular; angle of branching about 45-100°; segments up to 5 mm broad, tapered at base, often with hair tufts. Contiguous segments mutually attached by bundles of rhizoids. Thallus tristromatic, about 125 μm thick with epidermal cells 25 μm tall and medullary cells 75 μm tall with lenticular thickenings. Sporangia 55-60 μm in diameter, singly pedicellate, scattered along middle portion of the upper surface of thallus. Involucrium absent.

**Remarks:** The thin, greenish iridescent and striated blades that form densely imbricated, closely adherent mats on coral debris and hard surfaces are characteristic of this species. Common, epilithic or epiphytic, often mixed with turfs in both intertidal and subtidal habitats.


Thallus to 25 mm high, yellowish brown, composed of dichotomously branched axes 1-2 mm wide. Medulla unlayered, composed of large cells 50-200 μm high. Curved, hook-like falcate side branchlets to 1 mm long commonly occur on the main axes, and are the result of an asymmetric division of the apical cell. Sporangia non-industate, on a single stalk cell, occurring singly scattered on both surfaces. Branch tips are truncate, with a pair of prominent apical cells.

**Remarks:** Grows as entangled masses on the exposed fringing reef, associated with *Sargassum* beds (Taharaa, Tahiti). This characteristic species with hooked branchlets is distinctive within the genus.

**Genus Lobophora J. Agardh**


**Basionym:** *Dictyota variegata* Lamouroux, 1809: 331 (type locality: Antilles).


Thallus composed of flabellate, deltoid to ovoid, loosely to strongly decumbent blades (Fig. 24), to 10.5 cm high, 9.5 mm broad and 125 μm thick. In the cooler southern French Polynesian waters (Rapa, Marotiri) it usually assumes a stipitate habit (Fig. 26), with multiple fan-like blades arising from a suposte holdfast. Colour yellowish-brown. The blades are irregularly lacerate, with smooth straight edges and faint, parallel lines running perpendicular to the growing edge. Internal structure cellular, with a central row of rectangular cells about 25 × 50 μm surrounded on both sides by two layer of smaller, cuboid to rectangular cells 12-25 μm in diameter (Fig. 25). Triangular to ovate sori of indusiate sporogaria are scattered on both surfaces of the blade.

**Remarks:** Usually found on rocks or coralline surfaces, from the surface to 70 meters deep. The decumbent form is a common feature of the lagoon flora in the atolls of the Tuamotu, where it attains large sizes (Tahiti, Tuamotu). Very common in the southern Australs (Rapa, Marotiri, McDonald) where it forms with the *Sargassum* and *Dictyota* spp a dominant cover in many habitats. In the latter localities, the dominant form of the species assumes a stipitate, erect habit
(Fig. 26) which is otherwise anatomically identical with the decumbent form. These two distinct morphological forms of the species seem to be related to the depth and degree of exposure of the habitat (Lord Howe Island: Allender & Kraft, 1983: 82). According to the description in Setchell (1926) Aglaozonia pacifica from Tahiti would be conspecific with Lobophora variegata, but this could not be ascertained since the type specimen is apparently misplaced in UC (P. C. Silva, pers. com.). The synonymy of Zonaria obscura Dickie was given by N’Yeurt & Payri (in prep.).

Genus **Padina** Adanson

**Key to the French Polynesian species of Padina**

1. Thallus 2-cells thick; sporangia non-indusiate .......................... 2
2. Thallus 3-cells thick; sporangia indusiate .......................... *P. pavonica*

1. Thallus inferior surface lightly to moderately calcified, superior surface dull brownish yellow, creeping stage present, usually intertidal  .... *P. boryana*
2. Thallus inferior surface bright white, moderately to heavily calcified, superior surface bright yellow, creeping stage absent, exclusively subtidal ........................................... *P. melemele*


Thallus flabelliform, to 5 cm high, entire to deeply incised, basally attached by rhizoids. Colour light brownish yellow, hidden by a light coat of whitish calcium carbonate on inferior surface. Apical margin revolute and inrolled to the inferior or inner surface; blade 2-cells thick. Superior surface of thallus with
concentric rows of fine hairs alternating with rows of non-indusiate unilocular sporangia. Slender, terete to compressed, 'Dictyerpa or Vaughaniella' creeping form variously abundant at the base of the thallus (Fig. 27). The tortuous taxonomy of this species is discussed in Silva et al. (1996: 603).

**Remarks:** The commonest Padina species in the Society Islands, present throughout the year, on coral rubble in shallow waters of the lagoon (Tahiti, Moorea) and fringing reefs. Absent from the southern Austral islands (e.g. Rapa). The associated, terete (or filamentous) creeping form of gametophytic or sporophytic plants is diagnostic of the species, and is so morphologically different from the flabellate form that it was once described as a separate genus and species (Vaughaniella ripicola, Børjesen 1950). The connection between Vaughaniella and Padina was first made by Cribb (1951). A similar confusion arose with Dilophus radicans Okamura (1916) from the Caroline Islands in the tropical North Pacific; Fan (1953) showed that it was also the prostrate juvenile form of Padina boryana. In some instances, especially after periods of heavy swells or hurricanes, the flabellate forms of Padina are ripped off the reef and only the creeping form (if any) remains, a situation which might have confused past collectors. Farrant & King (1989) report indusiate sori in Australian plants referred to as Padina tenuis, but indusia were not seen in French Polynesian plants.


(Figs 28-29)


Thallus fan-shaped and to 7 cm across, distromatic, 40-60 μm thick. Superior surface (Fig. 28) bright yellow; inferior or inner surface (Fig. 29) brilliant white and smooth, moderately to heavily calcified. Blade usually entire, rarely incised. Sporangia not seen in French Polynesian plants, but reported as non-indusiate, on inferior surface, with hair rows on either side for Hawaiian material (Abbott 1996), and as embedded in calcareous deposits for New Caledonian plants (CEP, pers. obs.). Creeping stage not present.

**Remarks:** Growing exclusively subtidally, on coral rubble, 10-50 m depth at Rapa Island, where it represents the only species of its genus. This deepwater species of Padina is characterised by a bright yellow to orange superior surface and a bright white calcified inferior or inner surface (surface towards which margin is curled; see Wynne 1998: 273). It is also reported from Fiji (N'Yeurt, unpubl.) and New Caledonia (Payri, unpubl.). Padina melemele may thus be quite widespread in the tropical Pacific, but undercollected because of its inconspicuous subtidal habitat. Interestingly, it has yet to be found north of Rapa Island in French Polynesia.
Figs 27-38. 27. *Padina boryana* (UPF 197), habit, showing characteristic *Dictyerp* creeping stage (arrowhead) (Scale = 5 mm). 28. *Padina melemele* (UPF 1979), Habit, showing bright-yellow superior surface and non-laciniate blades (Scale = 5 mm). 29. *Padina melemele* (UPF 2188), detail of bright white calcified inferior surface of blade (Scale = 3 mm). 30. *Padina pavonica* (UPF 700), habit of deeply laciniate, tristromatic thallus (Scale = 5 mm). 31. *Spatoglossum asperum* (UPF 208), habit of large foliose thallus from shallow water (Scale = 10 mm). 32. *Spatoglossum asperum* (UPF 209), habit of strap-shaped thallus from deeper water (Scale = 5 mm). 33. *Spatoglossum asperum* (In Herb. UPF), cross-section of shallow-water thallus from Tahiti Island (Scale = 30 μm). 34. *Stypopodium australasicum* (UPF 1837), habit of thallus (Scale = 5 mm). 35. *Stypopodium australasicum* (UPF 1848), habit of cleft thallus (Scale = 5 mm). 36. *Stypopodium australasicum* (UPF 1836), cross-section of thallus showing 3-4 layers of large irregularly tiered rectangular cells (Scale = 40 μm). 37. *Chnoospora implexa* (UPF 914), habit of densely dichotomous, entangled thallus (Scale = 5 mm). 38. *Chnoospora implexa* (UPF 747), cross-section of thallus, showing hair pit (arrowhead) (Scale = 50 μm).

**Basionym:** *Fucus pavonicus* Linnaeus, 1753: 1162 (type locality: “In Mari Europae australis”).

**Synonym:** *Padina pavonia* Lamouroux, 1816: 304. Morocco: Gayral, 1958: 230, 231 pl. 34; Sri Lanka: Durairatnam, 1961: 36, pl. 26 fig. 2; Lord Howe Island: Allender & Kraft, 1983: 84, fig. 6F.


Fronds dark brown, 76-82 µm thick, tristromatic but sometimes tetrasromatic in basal portions; lightly calcified. Outer cells subquadrate, 30-32 µm long and 34-36 µm high, smaller than cells of two lower layers, which are rectangular and measure 62-69 µm long and 21-23 µm high. Sporangia persistently indusiate, on either side of hair bands; hair bands alternate on upper and lower surface of thallus. 

**Remarks:** Growing on the fringing reef flats, in tide pools. Also found in turbid, calm waters of estuaries and bays, where it assumes a larger, heavily lacerated habit and is usually covered with diatoms (Tahiti). The iridescent, hair-fringed margins of the plant are quite noticeable in the field. It also feels coarser, and is usually darker in colour, than *P. boryana*.

Genus *Spatoglossum* Kützing


**Misapplied name:** *Spatoglossum solieri* (Chauvin ex Montagne) Kützing. French Polynesia: Payri *et al*., 2000: 140.


Thallus to 20 cm high, yellowish-brown, composed of oovoid to elongate, rough, irregularly dichotomous blades to 9-20 (25) cm long and 3-8 (9) cm wide, and 150 µm thick (Figs 31-32). The living blades are leathery in texture, with broadly rounded ends and are more or less irregularly perforated with holes to 6 mm in diameter. Blade margins with numerous conspicuous marginal teeth, which can become eroded in older plants. Internal structure composed of 3 to
4 layers of irregularly quadrat to rectangular cells 68-128 × 48-88 μm (Fig. 33). Blade margins with aggregations of relatively smaller cells. Sporangia dark brown, ovoid, 72-92 × 60-88 μm, in a lateral-basal position, with a small stalk cell, not protruding from the blade surface. Does not adhere well to paper on drying.

Remarks: Commonly found at the base of coral heads in the lagoon 0.5-2 m depth, or forming extensive beds at depths of 15 to 20 meters on the outer slope (Tahiti). Older plants in calm waters can attain large sizes and are heavily epiphytised by crustose coralline algae (e.g., Pneophyllum spp., Hydrolithon farinosum) and turf such as Hinckia mitccllliae, Ceramium spp., Heterosiphonia spp. The Mediterranean species S. solieri differs from S. asperum in its entire, never denticulate margins and smaller (22-76 × 18-94 μm) and more regularly arranged medullary cells (J. R. Lluch, pers. com.). The Central and Western Pacific species S. macrodontum J. Agardh (Allender & Kraft, 1983: 100, figs 15, 16; Farrant & King, 1989; Abbott & Huisman, 2004: 222, fig. 8SA-D) differs from S. asperum by the presence of deeply dentate margins, and narrower thallus branches 0.3-1 (2.5) cm wide. The French Polynesian plants are in excellent morphological agreement with Mauritian material of S. asperum described and illustrated in Börjesen, 1941: 48, pl. I, although reproductive information for that species is lacking (J.R. Lluch, pers. com.). Spatoglossum plants from New Caledonia are also similar to the French Polynesian species (pers. obs.). The genus is in need of revision as there are over 19 species described worldwide (Tanaka, 1992).

Genus Stypopodium Kützing


Thallus 20-80 mm high, composed of palmate segments to 15 mm wide, or of flabellate fronds 30-70 mm wide, attached to the substratum via a single holdfast (Figs 34-35). Colour yellow-brown, sometimes with greenish-blue iridescence, becoming dark brown on drying, with prominent concentric hair lines irregularly separated by 4-6 mm. Blade margins usually smooth, but frequently lacerate and with small lenticular perforations throughout the thallus. Thallus 181-272 μm and 4-6 cells thick, in upper regions with 2-3 rows of clear rectangular
medullary cells 41-82 µm long and 40-50 µm wide, and in basal regions with 4 rows of medullary cells mostly about 80 by 50 µm (Fig. 36). Epidermal cells small and densely pigmented, 18-45 µm long and 18-23 µm wide. Sporangia discrete, spherical and non-indusiate, 68-90 µm in diameter, borne atop 2 stalk cells resulting from the division into two tiers of the epidermal cell below.

**Remarks:** Restricted in French Polynesia to the southern Austral islands (Rapa, Marotiri) where it can form large dominant covers. There are three species of *Stypodium* commonly reported from the Indo-Pacific, which are (in decreasing order of frequency): *S. zonale* (Lamouroux) Papenfuss 1940: 205 (type locality Dominican Republic), *S. flabelliforme* Weber-van Bosse 1913: 176 (syntype localities Indonesia, Philippines) and *S. australasicum* (Zanardini) Allender et Kraft 1983: 94 (type locality Lord Howe Island, South Pacific). A fourth species, *S. hawaiiensis* (Doty et Newhouse) Abbott 1977: 6 (type locality Hawaii) is likely conspecific with *S. flabelliforme* (Abbott & Huisman, 2004: 224; O. De Clerck, pers. com.). The distinction between *S. zonale* and *S. australasicum* seems to be based on vague and variable characters (Mayhoub & Billard, 1991). Coppejans *et al.* (1995a) reported *Stypodium zonale* from Papua New Guinea, seeing no difference between the Pacific plants and the Indian Ocean *S. zonale* they were familiar with (O. De Clerck, pers. com.). The French Polynesian plants are identical to those reported from Lord Howe Island (Allender & Kraft, 1983). *Stypodium flabelliforme* differs from *S. australasicum* mainly by the absence of a stipulate stipe, the presence of marginal rhizoids, and a smaller thallus with overlapping blades (Allender & Kraft, 1983). A specimen of *S. australasicum* has been identified by us from Pitcairn Island in the south-eastern Pacific.

Order **Dictyosiphonales**
Family **Chnoosporaceae**
Genus **Chnoospora** J. Agardh

**Key to the French Polynesian species of Chnoospora**

1. Thallus erect, attached and laxly dichotomous, growing in exposed habitats . . .
   1. Thallus in entangled, unattached masses, densely dichotomous, growing in calm habitats . . .


Thallus composed of terete to compressed axes, forming extensive compact to lax yellow-brown unattached masses, up to 30 cm in diameter, wiry. Branching divaricately dichotomous, with branches 0.5-1 mm in diameter. Forking distant below, and becoming denser above (up to the sixth order), axes slightly
broadened at dichotomies (Fig. 37). In cross-section, subterete to oval, with a medulla of irregularly ovoid to subrectangular cells 42-100 μm in diameter, and a central region of small circular cells with thickened cell walls (Fig. 38). Life history heteromorph and diphasic, alternating between an erect gametophyte and a discoid sporophyte.

**Remarks:** Found growing entangled with *Sargassum* spp in the lagoon of high islands. This seasonal species is present mostly between September and December, after the cool season and at the onset of the warmer season (Payri, 1987). *Chnoospora implexa* favours calm, lagoon conditions, unlike the related species *C. minima*, which is found in exposed habitats. A direct-type life history has been shown to sometimes occur in the culture of sexual strains of *C. implexa* (Kogame, 2001).


**Basionym:** *Fucus minima* Hering, 1841: 92 (type locality: “Port Natal” (Durban), South Africa).


Plants to 40 mm tall, dull brown in colour, with main axis repeatedly and fastigiately dichotomously branched. Branches 0.5-1 mm broad, broadened and flattened at points of division. Cryptoblasts 9 mm broad and up to 53 mm long present on older branches. Attached to the substratum by a small discoid holdfast.

**Remarks:** Found on the reef crest of the high islands, in exposed locations; typically occurring as clumps on the wave-washed rocks or hidden within red algal mats. Usually associated with the filamentous brown alga *Asteronema brevichiatalatum*. This is an edible species, being consumed in French Polynesia in the Marquesas (Conte & Payri, 2002).

Order *Scytosiphonales*

Family *Scytosiphonaceae*

Genus *Colpomenia* (Endlicher) Derbès et Solier

Figs 39-50. 39. Chnoospora minima (UPF 156), habit of laxly dichotomous, erect thallus (Scale = 5 mm). 40. Colpomenia sinuosa (UPF 2367), habit of unattached, hollow thallus (Scale = 5 mm). 41. Colpomenia sinuosa (UPF 2684), cross-section of thallus (Scale = 50 μm). 42. Hydroclathrus clathratus (UPF 2513), habit of reticulate thallus (Scale = 5 mm). 43. Hydroclathrus clathratus (UPF RPS 192), cross-section of thallus, showing hair pit with phaeophycean hairs (arrowhead) (Scale = 50 μm). 44. Hydroclathrus tumulis (UPF 2065), habit of pressed thallus (Scale = 5 mm). 45. Hydroclathrus tumulis (UPF 2065), detail of sparse perforations (Scale = 3 mm). 46. Hydroclathrus tumulis (UPF 2065), angular plurangular sori (s) adjacent to hair primordia (h) (Scale = 20 μm). 47. Rosenvingea intricata (UPF 2082), habit of pressed thallus (Scale = 3 mm). 48. Sargassum cf. S. echinocarpum (UPF 780), habit of pressed thallus (Scale = 10 mm). 49. Sargassum cf. S. echinocarpum (UPF 1981), habit of freshly-collected stunted thallus (Scale = 5 mm). 50. Sargassum cf. S. echinocarpum (UPF 780), detail of large air vesicle (Scale = 3 mm).
French Polynesian brown algae


(Figs 40-41)

**Basionym:** Ulva sinuosa Mertens ex Roth, 1806: 327, pl. XI (type locality: near Cádiz, Spain).


Thallus 10-30 cm in diameter, yellow to golden-brown, hollow, of irregularly globular or convoluted shape (Fig. 40), texture firm but brittle; epilithic or epiphytic and sessile. Sometimes perforate, although never reticulate. Internal structure consisting of a surface layer of pigmented cuboid cells 5.5-6 μm across, and 4-6 layers of progressively larger subcortical and clear medullary cells 50-215 μm in diameter (Fig. 41). Phaeophycean hairs 31-43 μm long commonly occur in scattered pits on the surface of the thallus. Pluriocular reproductive organs are usually uniseriate, and occur in punctuate surface sori around hair groups; clavate unicellular paraphyses accompany the loculi.

**Remarks:** A seasonal species predominantly abundant during the cooler months. Growing on the reef flats and in the lagoon, often epiphytic on other brown algae such as Turbinaria. Found on both high islands and atolls, as far south as Rapa in the Austral Islands. Can form very large unattached masses to 30 cm in diameter in the lagoons following destructive heating up of the stagnant water mass (such as that which occurred in Bora Bora in 2002, pers. obs.)

Genus Hydroclathrus Bory de Saint-Vincent

**Key to the French Polynesian species of Hydroclathrus**

1. Plant netlike; perforations numerous and close together (< 2 mm), phaeophycean hairs born in depression; sporangial sori extensively spread and irregular, not angular. .......................... **H. clathratus**

1. Plant membranous, not netlike, with large and small perforations separated by wide membranous areas (> 2 mm); phaeophycean hairs not arising in depressions; sporangial sori discrete, often with angular arrangement ........

.............................................................. **H. tumulis**


(Figs 42-43)

**Basionym:** Encoelium clathratum C. Agardh, 1823 (1822-1823): 412 (type locality Belle-Île, France according to Womersley, 1987: 300.)
**Heterotypic synonym:** Hydroclathrus cancellatus Bory de Saint-Vincent, 1825: 419. Easter Island: Børgersen, 1924: 263.


Thallus forming entangled masses to 15 cm across, dark brown, consisting of an expanded, torn and irregularly lobed net-like membrane with abundant ovoid to spherical holes 3-11 mm in diameter (Fig. 42). Attachment vague and diffuse, by means of rhizoids. Medulla 3-5 layered, of large clear cells 90-135 μm in diameter and cortex 1-2 cell thick, of isodiametric pigmented cells 6-10 μm in diameter. Phaeophycean hairs 5-8 cell long, abundant in depressions on surface of thallus (Fig. 43). Plurilocular reproductive organs are uni- or biseriate, in surface sori, without accompanying paraphyses.

**Remarks:** A seasonal species commonly found in the lagoon of high islands, either loosely attached to coral heads or unattached in balls on the bottom (Tsuda, 1974; Payri, 1987); also occurs on the reef crest of high islands and atolls. It sometimes can be confused with perforate thalli of Colpomenia sinuosa, but the latter are thinner and lighter in colour, and rarely become clathrate as Hydroclathrus. However, in some instances there appears to be a continuum of morphotypes between non-clathrate “Colpomenia-like” and clathrate “Hydroclathrus-like” forms, which raises questions as to the generic affinities of the material; the only criteria to differentiate Colpomenia from Hydroclathrus in that instance being the presence (in the former) or absence (in the latter) of paraphyses among the reproductive sori.


(Figs 44-46)


Thallus forming slimy, membranous light brown sheets 25 to 90 mm in diameter at widest and 110 to 250 μm thick; margins curled or folded (Fig. 44). Perforations rare or sometimes absent, 2 to 20 mm in diameter, separated from each other by membranous areas 2.5 to 30 mm wide (Fig. 45). Phaeophycean hairs occurring singly or up to 6 together, not borne in depressions. Internal structure composed of a medulla of 2-4 clear, ovoid cells to 250 μm in diameter, surrounded by small, usually papillate pigmented cortical cells 8-10 × 10-14 μm. Plurangular sori adjacent to hair primordia, discrete with angular outlines, 40-250 × 30-200 μm, with loosely aggregated plurangia in palisade layers (Fig. 46).
**Remarks:** Growing together with *Colpomenia sinuosa*, -15 to -52 m depth. In French Polynesia, to date only distributed in the cooler waters of Rapa, Australs, where it could be mistaken for perforate thalli of *Colpomenia sinuosa*. However, the sharply angular plurangia sori of *H. tumulis* distinguishes it from the discrete, circular sori of *Colpomenia*. The angular plurangular sori, widely separated perforations and papillate cortical cells separate *H. tumulis* from *H. clathratus*. In the field, however, sterile material of all three species can look very similar and are quite difficult to distinguish.

**Genus Rosenvingea Børgeesen**


**Basionym:** *Asperococcus intricatus* J. Agardh, 1847: 7 (type locality: Veracruz, Mexico).


Thallus forming soft golden brown entangled cushions 3-10 cm in diameter, with hollow branches 2-5 mm in diameter. Branching wide angled, irregular to irregularly dichotomous, with tapered subacute to truncated apices. Medulla of large irregularly shaped clear cells 22-71 μm in diameter. Cortex single-layered, with subrectangular to cuboid pigmented cells 7-11 μm in diameter and 8-15 μm high.

**Remarks:** forming loose unattached balls on the lagoon floor of high islands and atolls. This is a seasonal species, usually abundant in May to November.

**Order Fucales**

**Family Sargassaceae**

**Genus Sargassum C. Agardh**

Setchell (1926) credits four species of *Sargassum* to French Polynesia, but so far only two of these (*S. mangarevense* and *S. sociale*) have been confirmed on the basis of molecular taxonomy (Stiger *et al.*, 2000). A further species has been recorded for French Polynesia since Setchell’s publication, and several others are in the process of molecular investigation (Mattio & Payri, pers. com.).

**Key to the French Polynesian species of Sargassum**

1. Leaves thick and coarse, spines numerous and in a double row. ............... 
   
   1. Leaves thinner, spines absent to less conspicuous and in a single row .... 2

   2. Vesicles with filiform extension, pedicel of vesicle often broadly foliaceous, cryptostomata relatively large and few, confined to either side of the leaf midrib. .................. *S. sociale*

   2. Vesicles lacking filiform extension, pedicel terete to flattened but not especially foliaceous, cryptostomata small and numerous, randomly distributed throughout leaf .................. *S. mangarevense*
(Figs 48-51)


Thallus to 30 cm high, with a clearly apparent and smooth main axis 1-1.5 mm in diameter; attached to the substratum via a single discoid holdfast (Figs 48-49). Leaves 4-6 mm wide and 17-40 mm long, coriaceous, ovate, with numerous marginal spines often in a double-row (Fig. 51). Cryptostomata relatively large, randomly distributed about leaf. Air vesicles (Fig. 50) to 5 mm in diameter, spherical on a terete pedicle, without filiform extension. Plants androgynous; cymose receptacles 2-3 mm long, with spiny margins.

**Remarks:** This species usually grows close to the shoreline, and can be readily distinguished in the field by its coriaceous oval leaves with double-rows of marginal teeth. In French Polynesia, it is so far only reported from the Gambiers and the Australs groups, and apparently absent from the Society group; it was hence not mentioned by Setchell (1926). This species, along with others, is the subject of ongoing molecular investigations (Mattio & Payri, pers. com.).

(Figs 52-54)

**Basionym:** *Sargassum vulgare* var. *mangarevense* Grunow, 1916: 44 (type locality: Mangareva Island, Gambier archipelago, French Polynesia).


Thallus to 20 cm high, irregularly and densely branched (Fig. 52). Lateral branches bearing numerous leaf like, lanceolate blades with a smooth or serrated margin to 30 mm long and 6 mm wide. Upper surface of the blades spotted by numerous cryptostomata randomly distributed about the midrib (Fig. 54). Vesicles shortly pedicellate, spherical to oblong to 4-6 mm wide, lacking leaf like projections and generally non foliose below (Fig. 53). Branches growing from a stipe to 2 mm wide, naked below, arising from a discoid holdfast. Plants monoecious; fertile receptacles elongate, present all the year round.
Figs 51-59. **51. Sargassum cf. S. echinocarpum** (UPF 780), detail of leaves, showing randomly distributed cryptostomata and double row of marginal teeth (arrowhead) (Scale = 3 mm). **52. Sargassum mangarevense** (UPF 206), habit of pressed thallus (Scale = 15 mm). **53. Sargassum mangarevense** (UPF 206), detail of air vesicles, showing foliose pedicel (arrowhead) (Scale = 3 mm). **54. Sargassum mangarevense** (UPF 206), detail of leaf, showing randomly distributed cryptostomata (Scale = 2 mm). **55. Sargassum sociale** (UPF 2679), habit of pressed thallus (Scale = 15 mm). **56. Sargassum sociale** (UPF 2679), detail of air vesicles, showing non-foliose pedicel and filiform extension (arrowhead) (Scale = 2 mm). **57. Sargassum sociale** (UPF 2679), detail of leaves, showing cryptostomata confined to either side of midrib (Scale = 2 mm). **58. Turbinaria ornata** (In Herb. UPF), habit of freshly-collected thallus, showing stilt-like haptera and obpyramidal leaves atop terete axis (Scale = 10 mm). **59. Turbinaria ornata** (In Herb. UPF), detail of leaves, showing second row of inwardly-directed teeth (arrowhead) (Scale = 5 mm).
Remarks: Common in the lagoon, growing in patches on coral heads (Tahiti, Moorea). Setchell (1926) noted the absence of foliose pedicels in the vesicles of *S. mangarevense*, however these were observed in our specimens (Fig. 53). The larger diameter, smooth basal leaves and randomly distributed cryptostomata are characteristic for this species.

*Sargassum sociale* (Grunow) Setchell, 1926: 95, pl. 15 figs 3-4. French Polynesia: Payri & N’Yeurt, 1997: 878. (Figs 55-57)

**Basionym:** *Sargassum vulgar var. socialis* Grunow, 1916: 44 (type locality: Tahiti).


Thallus to 25 cm tall, with branches up to 8 cm long, attached to the substratum via a single holdfast (Fig. 55). Leaves sharply toothed, acute or obtuse, 1-4 cm long (Fig. 57). Cryptostomata sparse, confined to double rows either side of the midrib. Vesicles pedicellate, often foliaceous, toothed with cryptostomata present, and with characteristic filiform extensions (Fig. 56). Plants monoecious; receptacles cymose, to 4 mm long.

**Remarks:** An intertidal species, restricted to the outer part of the barrier reef, while *S. mangarevense* grows throughout the lagoon. Setchell (1926) separated this species on the basis of its more elongate, sharply toothed leaves with cryptostomata in double rows on either side of the midrib, features which were confirmed in our specimens, along with common filiform extensions of the vesicles. However, the foliaceous nature of the vesicle pedicel was found to be a highly variable character. It is clearly apparent in some specimens (e.g. UC 261347) but not so clear in others. The same applies for the distribution in double rows of cryptostomata, which in some plants is not so apparent.

Genus *Turbinaria* Lamouroux


**Basionym:** *Fucus turbinatus* Linnaeus var. *ornata* Turner, 1807-1808: 50-53, pl. 24, figs c, d (type locality unknown).

**Misapplied name:** *Turbinaria condensata* Sonder in Kützing, 1860: 25, pl. 69 fig. II (type locality: China Sea). French Polynesia: Taylor, 1973: 38.

French Polynesian brown algae


Plants light brown to yellow, to 3-10 cm tall and 5 cm broad, coarse and firm, with monopodial axes attached to the substratum by stilt-like haptera up to 2 mm in diameter and 25 mm long (Fig. 58). Axes radially branched, with laterals generally concave, 1-2 cm in diameter, with terete stalks for about half their length, terminally distended in a rounded to obpyramidal manner with obtuse ridges; a large air vesicle usually occupying the central portion; intramarginal teeth up to 3 mm high present (Fig. 59). Up to 13 marginal crown teeth on periphery of leaves, and up to 6 often paired erect teeth arranged at about 120° angle over the peripheral surface of the blades. Receptacles short and densely branched, adaxial on stalks of laterals.

**Remarks:** Commonly found growing in the lagoons and on the reefs. The presence of intramarginal teeth currently distinguishes *T. ornata* from superficially similar *T. conoides*, which is so far not reported east of the Cook Islands in the South Pacific (Chapman, 1977, N’Yeurt & Payri, 2004b). Some of the Polynesian plants are stocky and no more than 4 cm high, showing the environmentally-induced form of dwarfism in exposed habitats, described by Payri (1984) and also reported from Oman (Wynne, 2002: 285), Guam (Taylor, 1964) and French Polynesia (Taylor, 1973). In calm lagoon habitats of French Polynesia, the typical form of this species has a more lax and less robust habit, individual axes reaching up to 15 cm and at times once or twice dichotomously divided near the base (Payri, 1984). Together with *Sargassum* spp, detached thalli of *T. ornata* have the tendency to form large drifting rafts on the ocean surface, which can travel between islands and retain reproductive potential (French Polynesia: Payri et al., 2000: 148, photo with caption). In French Polynesia, *T. ornata* has become invasive in recent years, spreading to atolls of the Tuamotu and Australs and disrupting the natural ecological balance of the habitats of these islands (Stiger & Payri, 1999).

**DISCUSSION**

The distribution of the species among the five main archipelagoes of French Polynesia (Tab. 1), shows that a few species are ubiquitous and occur in almost all groups, such as *Colpomenia sinuosa* and *Lobophora variegata*. On the other hand, *Dictyopteris repens* and *Dictyota hamifera* have been only recorded from Society and Marquesas, and 20% of the species are apparently specific to the Australs, such as *Cladosiphon novae-caledoniae*, *Cutleria mollis*, *C. irregularis*, *Hydroclathrus humidis*, *Padina melemele* and *Stypodium australasicum* and five species are recorded from the island of Rapa. These distribution patterns could be explained by temperature barriers (which prevent cooler water, southerly species from implanting in warmer localities to the north) and other as yet unstudied ecological factors, perhaps linked to the availability of certain specific habitats. The occurrence of only two species of Phaeophyceae in the Marquesas is likely an artefact of under sampling in that phycologically little-known archipelago, rather than a true representation of distribution patterns. If the possibilities of comparing are hence limited, the data (Tab. 1) indicate that the Society and Australs are the richest archipelagoes, which may reflect the larger variety of
Table 1. Distribution of species of Phaeophyceae among the various archipelagos and affinities to Pacific and Indo-Pacific regions.

<table>
<thead>
<tr>
<th>Archipelagos</th>
<th>Australs</th>
<th>Gambier</th>
<th>Marquesas</th>
<th>Society</th>
<th>Tuamotu</th>
<th>Pacific species</th>
<th>Indo-Pacific species</th>
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<tr>
<td>Colpomenia sinuosa</td>
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<td>+</td>
<td>+</td>
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<tr>
<td>Cutleria irregularis</td>
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<td>Cutleria mollis*</td>
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<td>Dictyopteris repens</td>
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<td>Dictyota aquiloba*</td>
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<td>Dictyota friabilis</td>
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<td>Lobophora variegata</td>
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<td>Sargassum sociale</td>
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<td>Spatoglossoas asperum</td>
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<td>Sphacelaria rigidula</td>
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<td>Stypopodium australasicum*</td>
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<tr>
<td>Turbinaria ornata</td>
<td>+</td>
<td>11</td>
<td>2</td>
<td>21</td>
<td>6</td>
<td>31(64.5%)</td>
<td>20(35.5%)</td>
</tr>
</tbody>
</table>

* Species present only on Rapa island.
### French Polynesian brown algae

Table 2. Number and percentages of French Polynesian brown algal species in common with several tropical and subtropical-temperate localities.

<table>
<thead>
<tr>
<th>Localities</th>
<th>Number of species shared with FP</th>
<th>%</th>
<th>Sorensen index</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guam, Pohnpei, Ant atoll and Micronesia</td>
<td>21</td>
<td>70</td>
<td>0.33</td>
<td>Lobban &amp; Tsuda, 2003; Hodgson &amp; McDermid, 2000</td>
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<tr>
<td>Fiji and Rotuma</td>
<td>20</td>
<td>67</td>
<td>0.34</td>
<td>N'Yeurt et al., 1996; Littler &amp; Littler, 2003; South &amp; Skelton, 2003</td>
</tr>
<tr>
<td>Hawaii</td>
<td>18</td>
<td>60</td>
<td>0.28</td>
<td>Abbott &amp; Huisman, 2004</td>
</tr>
<tr>
<td>Rarotonga and Cook Islands</td>
<td>18</td>
<td>60</td>
<td>0.40</td>
<td>Chapman, 1977; N'Yeurt &amp; Payri, 2004</td>
</tr>
<tr>
<td>Samoa</td>
<td>18</td>
<td>60</td>
<td>0.33</td>
<td>Skelton &amp; South, 1999, 2002; Littler &amp; Littler, 2003</td>
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<tr>
<td>Lord Howe Island</td>
<td>15</td>
<td>50</td>
<td>0.25</td>
<td>Millar &amp; Kraft, 1994</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>11</td>
<td>37</td>
<td>0.27</td>
<td>Womersley &amp; Bailey, 1970; Littler &amp; Littler, 2003</td>
</tr>
<tr>
<td>Kermadec</td>
<td>9</td>
<td>30</td>
<td>0.20</td>
<td>Nelson &amp; Adams, 1984</td>
</tr>
<tr>
<td>Norfolk Island</td>
<td>8</td>
<td>27</td>
<td>0.18</td>
<td>Millar, (1999)</td>
</tr>
</tbody>
</table>

Benthic habitats and ecological environments. The Australs's high richness and originality may be due to their geographic extension over the Tropic of Capricorn, and the southernmost position (27°S) of Rapa and Marotiri Islands close to cooler waters (19-22°C). The Rapa flora appears particularly interesting, with six species only recorded in French Polynesia from this locality (Tab. 1), including species such as *Cutleria irregularis* and *Hydroclathrus tumilis* recently described as Hawaiian endemics (Abbott & Huisman, 2003), or *Padina melemele* and *Sargassum* cf. *S. echinocarpum* which are in contrast, more widely distributed in the tropical Pacific. Another two species, *Cutleria mollis* and *Stypopodium australasicum*, are known from temperate South Pacific islands such as Lord Howe Island, Norfolk and Kermadec. These unexpected species are indicative of a sort of continuum in the dispersal of species within the temperate South Pacific region, and it is not surprising that temperate species can establish themselves in the southern Australs islands. The record of *Cladosiphon novae-caledoniae* considerably extends the eastern distribution of this species in relation to its type locality. On the other hand, the absence from other areas of French Polynesia, and in particular from the Society group where few habitats remain unexplored, of *Padina melemele*, a species widely distributed in the Western and Central Pacific, remains a mystery.

Conversely, the case of the invasive brown alga *Turbinaria ornata* is of particular interest, since that species has been gradually propagating to atolls of the Tuamotu Group (Stiger & Payri, 1999), but has not yet reached the Gambier or the Marquesas, which are at opposite extremes of the presumed centre of distribution (Society). In the Australs, *T. ornata* has reached as far south as Raivavae, but not as yet the cooler waters of Rapa. The Sargassaceae, which are
widely distributed in the lagoons of high islands in the Society, Gambier and Austral groups are totally absent in the Marquesas and Tuamotu. However, current global warming trends and increasing sea temperatures, if left unchecked, could change that picture, with the possible eradication of Polynesian cool-temperate brown algal beds (e.g. *Stypopodium australasicum*, stiped *Lobophora variegata*) and the introduction of such undesirable invasive species as *T. ornata* in Rapa waters, with consequential negative effects on local fish populations associated with those algal beds.

At the Indo-Pacific scale, the largest number of the French Polynesian Phaeophyceae (64.5%) is found throughout the Pacific, while the remaining 35.5% belong to the Indo-Pacific biogeographic province, which contains species known from both Pacific and Indian Oceans. Comparison of the French Polynesian flora with phycologically better-known Pacific regions (Tab. 2) shows that most of the species are typical of those found in the Central Pacific. The greatest number of species is shared with the Micronesia and Fiji groups (70 and 66% respectively; Tab. 2) which may be due to a comparable combined high island — atoll environments and habitats in these regions. However, the degree of similarity calculated using Sorensen’s Index (Legendre & Legendre, 1992) indicates that the brown algal flora of French Polynesia is more similar to its nearest neighbouring archipelago the Cook Islands, than to the more distant group of islands. Despite the fact that the species of Phaeophyceae known from French Polynesian have increased, this region remains less rich than the areas located in the Western Pacific, reflecting the west-to-east decrease of richness well documented for corals by Veron (1995) and other faunal groups.

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algae of the Samoan Archipelago. *The university of the South Pacific marine
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the Fiji Islands, South Pacific. *Australian systematic botany* 16: 699-758.

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(Dictyotales, Phaeophyceae) from Japan. *The Korean journal of phycology* 7:
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the southwestern Islands of Japan. *Memoirs of the faculty of fisheries, Kagoshima


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