

# A Preliminary Illustrated Field Guide to The Common Marine Algae of the Cook Islands (Rarotonga and Aitutaki)

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## CONTENTS

Seaweeds: what are they? .....	3
Where are seaweeds found? .....	5
Which seaweeds are found where? .....	6
History of seaweed collecting in the Cook Islands .....	8
Biogeographical range of Cook Islands seaweeds .....	8
Geography of the Cook Islands .....	9
Descriptions of the common seaweeds of the Cook Islands .....	12
Division Cyanophyta (Blue-Green algae) .....	12
Division Chlorophyta (Green algae) .....	14
Division Phaeophyta (Brown algae).....	33
Division Rhodophyta (Red algae) .....	43
Uses of seaweeds .....	60
Collection, preservation and processing of marine algae .....	61
Acknowledgments .....	63
Glossary .....	64
References .....	72
Taxonomic Index .....	73

## Seaweeds: what are they?

Seaweeds or marine algae comprise a grouping of very diverse photosynthetic organisms whose relatively simple vegetative structure is called “thallus”. They have been traditionally set apart from higher plants, whose more complex level of organisation is differentiated as stems, leaves and roots, through which run sap-carrying conductive tissues.

Algae are autotrophic organisms, which are able to manufacture their own organic molecules from elements containing carbon and nitrogen. Their energy is obtained directly from sunlight, which is trapped by the pigment chlorophyll during the process of photosynthesis. Water and mineral nutrients are directly taken from their environment through their cell surfaces.

While seaweeds are an essential part of the marine ecosystem, they are mostly overlooked as they are overshadowed by their more conspicuous neighbours such as corals, fishes and molluscs. Nevertheless, they occupy the bottom of the food chain and are direct food for a large number of marine organisms, and also for humans in many parts of the world. A host of useful products are also extracted from marine algae, with applications ranging from cosmetics to medicine and the food industry.

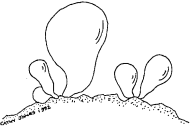


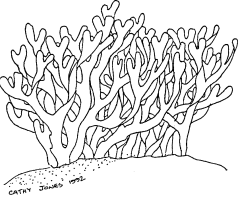


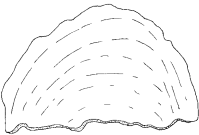
Disruptions in seaweed growth patterns caused by unnatural sources such as pollution and deliberate introduction can have quite harmful consequences on the marine ecosystem. For instance, in the Mediterranean sea, the tropical green alga *Caulerpa taxifolia* has in recent years become a pest, as it clogs waterways and displaces other marine organisms after having escaped from an aquarium in Monaco. In the Cook Islands, fluctuations in the numbers of the *patito* or sea hare (*Stylocheilus longicauda*) has been linked to the disappearance and reappearance of the blue-green alga *Lyngbya majuscula*, on which it primarily feeds. These fluctuations have been also linked to blooms in the green alga *Boodlea kaeneana*, which could be caused by an increase in organic nitrates flushed into the lagoon (for instance from piggeries) or an increase in global seawater temperatures caused by climatic factors such as the greenhouse effect and El Niño.

It is hence important to recognise seaweeds in their natural environment, and realise their major role in the balance and well-being of the coral reef community, on whose biodiversity and health the livelihood of many island communities such as the Cook Islands closely depends.

## Algal growth forms

The size and shape of algae varies greatly and is a result of varied modes of growth and anatomical organisation. Nevertheless, we find shapes common to the different taxonomic groups and which can be broadly classified into morphological categories (Table I).

**Table I. The various growth forms assumed by seaweeds**

<p><b>Vesicular forms</b></p> 	<p>These algae have hollow, sac-like or ball-like thalli filled with fluid. In some species, cells can attain large sizes (over 5 cm; <i>Valonia</i>, <i>Ventricaria</i>).</p>
<p><b>Filamentous forms</b></p> 	<p>These algae have filamentous which can have internal cross-walls, remain simple (<i>Chaetomorpha</i>) or become branched (<i>Cladophora</i>, <i>Griffithsia</i>, <i>Polysiphonia</i>, <i>Ceramium</i>). Filamentous axes may also lack internal cross-walls and form more or less branched siphons (<i>Bryopsis</i>).</p>
<p><b>Hollow or mucilaginous forms</b></p> 	<p>These multicellular algae have either a hollow tubular (<i>Enteromorpha</i>, <i>Rosenvingea</i>) or more or less contorted spherical thallus (<i>Colpomenia</i>, <i>Hydroclathrus</i>), bearing internal cross-walls or internal filaments bathed in a mucilaginous substance (<i>Platoma</i>).</p>
<p><b>Leafy and membranaceous forms</b></p> 	<p>These seaweeds are all characterised by having a very thin, often translucent thallus which one to a few cells thick and is not or weakly corticated. The surface is uniform (<i>Dictyota</i>, <i>Ulva</i>) or bears fine veins or midribs (<i>Dictyopteris</i>, <i>Melanamansia</i>). Texture is supple but delicate.</p>
<p><b>Erect coriaceous or encrusting forms</b></p> 	<p>Algae in this group form erect thalli with intricate branching and coriaceous texture (<i>Turbinaria</i>, <i>Sargassum</i>, <i>Gelidium</i>) or thick corticated blades (<i>Padina</i>, <i>Lobophora</i>, <i>Peyssonnelia</i>).</p>
<p><b>Erect calcified and articulated forms</b></p> 	<p>Calcified algae with articulated thalli are composed of a regular succession of calcified segments (articles) and supple segments (articulations) imparting a robust but flexible structure to the whole thallus (<i>Amphiroa</i>, <i>Galaxaura</i>, <i>Halimeda</i>).</p>
<p><b>Calcified encrusting forms</b></p> 	<p>In this group, calcification is very important, giving the thallus a stony aspect. Thalli can be encrusting and firmly adhering to the substratum (<i>Hydrolithon</i>), lamellate (<i>Mesophyllum</i>) or branched (<i>Lithophyllum</i>, <i>Neogolithon</i>).</p>

## Where are seaweeds found?

The marine flora of the Cook Islands is essentially one of lagoons and coral reefs, distributed in high islands (such as Rarotonga), low-lying atolls (such as Manihiki) or intermediate low / high islands such as Aitutaki. Because of the low extent of estuaries, the shoreline does not include mangroves and the algal flora usually associated with mangrove roots. Similarly, seagrasses (flowering marine plants) that are common in most tropical areas, are to date unknown in the Cook Islands. The major habitats or places where algae are found can be classified as follows:

### The high islands (e.g. Rarotonga)

Coral reefs in Polynesia encircle high volcanic islands, and make up the calcareous ring of atolls with an extensive lagoon (Figure 1). The reef complex of high islands is usually submerged, and the generally sandy shore is sometimes enclosed by a fringing reef where coral formations remain modest. Beyond this, and up to the ocean, extends the barrier reef, a compact formation rich in coral bommies that protects a lagoon with calm waters. On the reef front where the ocean waves break, begins the external reef slope which bears numerous perpendicular spurs and grooves over the first ten metres depth. Generally the slope ends at about 45 metres depth, where a sandy plains extends to about 100 metres depth, after which a vertical wall several thousands metres deep drops off to the abysses. On the oceanic side of the barrier reef, important coral growths exist which make up the richest and most complex habitat on the reef, where thousands of species flourish.

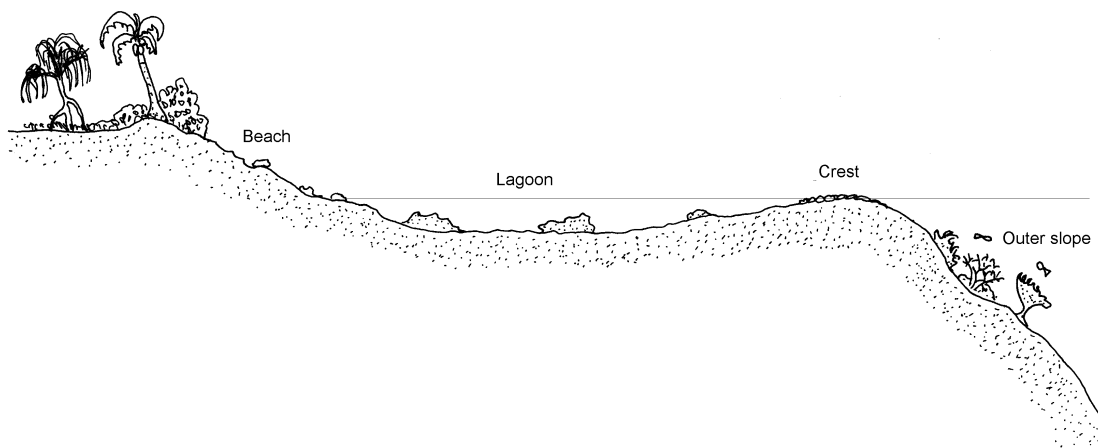


Figure 1. Profile of a typical high-island reef system

### The atolls and atoll-like islands (e.g. Manihiki, Aitutaki)

The product of the long evolution of an ancient volcanic high island, the atoll is a totally calcareous complex. A coral ring encircles a lagoon whose size and depth vary from a few kilometres to several tens of kilometres long and from a few decimetres to over forty metres depth. The lagoon is an area of accumulation for coralline sediments, where

coralline growths are more or less abundant and range from modestly sized coral bommies to imposing pinnacles rising from the lagoon floor all the way to the surface. The elevated part of the atoll crown makes up the wooded terrestrial area or “ motu ”. It is generally cut by shallow channels and passes, the latter veritable breaks in the crown that allows the lagoon to communicate with the open ocean. The external border of the crown is a flat of variable width and depth, whose margin makes up the algal ridge. In some atolls, the crown is devoid of motus on part of its perimeter, and is then a large flat which is regularly submerged. The oceanic side is a slope of variable angle but generally more abrupt than those of high islands.

## **Which seaweeds are found where?**

### **The flora of fringing reefs**

In shallow, calm fringing areas where sediment accumulations are predominant, green and brown algae are most abundant with the most characteristic species being *Caulerpa cupressoides*, *Chlorodesmis fastigiata*, *Halimeda incrassata*, *Neomeris vanbosseae*, *Ventricaria ventricosa* and *Boodlea kaneana* for the greens, and *Padina boryana* and *Dictyota bartayresiana* for the browns. Common red algae include *Galaxaura* spp. and *Laurencia* spp. When water depth and movement are more important, hard substrata (coral colonies and rubble) are more numerous and ubiquitous species such as *Turbinaria ornata* and *Sargassum mangarevense* thrive. In very exposed places (e.g. Ngatangia, makatea shoreline), the marine scenery is generally rocky or limited to small shelves below the border road. The violent wave action increases sea spray and enables the rise of certain species notably the two brown algae *Chnoospora minima* and *Hincksia breviarticulata*. On this type of shelf we generally find the flora of external reef shelves described later, confined to a few square meters owing to the intensity of the hydrodynamic factors such as wave action.

### **The flora of the barrier reef**

On barrier reefs, coral bommies (Figure 2) are generally dominant, between which are spread out well sorted-out sediments. The pavement of the lagoon floor is visible in areas of strong hydrodynamism. Water level rarely exceeds 2.5 m. The flora is essentially one of hard substrata, and species exist in close link with the coral colonies, resulting in a mosaic pattern of species distribution. The summit of coral bommies skimming the water surface are generally colonised by the large brown algae *Turbinaria ornata* and *Sargassum mangarevense*, that form an elevated layer under which grow species such as *Melanamansia glomerata*, and Corallinales. In areas where grazing by herbivores is more important, the bommies are covered by a fine tuft where a great number of discrete species belonging to the Ceramiaceae and Rhodomelaceae intermingle. Finally, in areas where hydrodynamism is more important, the encrusting coralline algae form pinkish, yellowish and bluish blotches on the upper parts of the substratum.

At the base of bommies, it is common to see large bunches of brown algae such as *Dictyota bartayresiana*, intermingled to the spread-out thalli of *Halimeda opuntia* and tufts of the red algae *Galaxaura fasciculata* and *G. filamentosa*. Most crevices are colonised by

*Ventricaria ventricosa*, *Valonia fastigiata*, and *Dictyosphaeria spp.* Finally, where direct sunlight does not reach, live a range of encrusting coralline algae whose pink, violet and purple hues mingle with the soft green colours of *Halimeda discoidea*, *H. minima* and *Caulerpa taxifolia*

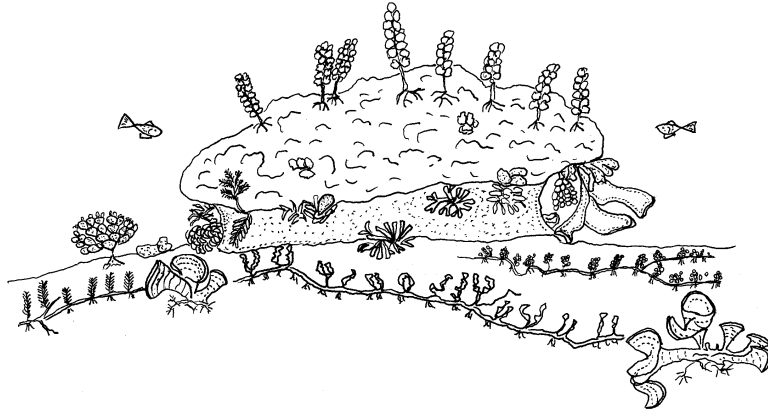


Figure 2. A typical coral bommie, with distinctive *Turbinaria ornata* growth on the top

### **The flora of the outer reef flats**

It is probably the richest and most diversified flora of the reef complex. On high islands, it is represented by a belt of the brown algae *Turbinaria ornata* and *Sargassum mangarevense*. We find in particular the erect and stiff tufts of *Laurencia flexilis*, to which is attached the little bright green balls of *Chlorodesmis fastigiata*, or the light pink hemispherical cushions of the articulated Corallinaceae *Amphiroa fragilissima*. It is here that the encrusting calcified algae form the most important growths, with notably *Hydrolithon spp.* However, it is on the reef flats of atolls that Corallinaceae formations are the most exuberant. They form a compact pad of a beautiful brick-red colour, and in very exposed places even construct spectacular corbellings several tens of centimetres thick. The dominant species is *Hydrolithon onkodes* with a rather smooth texture. On atolls, large brown algae are absent and the fleshy species are limited to yellowish-brown rosettes of *Lobophora variegata* and some *Turbinaria ornata*.

### **The flora of the lagoons of atolls**

The sandy bottoms of the lagoons are often in deeper parts, covered with a mucous film rich in bacteria or of a carpet of Cyanobacteria where mingle tufts of filamentous red algae such as *Polysiphonia*, *Ceramium*. The hard substrata are always much richer in various green algae such as *Caulerpa* and *Halimeda*. Bommies in the lagoon offer a habitat for green genera such as *Cladophoropsis luxurians* and very large *Dictyosphaeria cavernosa*.

## **The flora of the outer reef slope**

It extends beyond 10 meters depth. The red algae are most abundant and diversified. It is the privileged area of encrusting coralline algae (mainly in the atolls), but also of elegant and fleshy forms such as *Platoma* and *Asparagopsis*.

## **History of seaweed collecting in the Cook Islands**

The first reports of marine algae from the Cook Islands were by Dickie (1877), listing 21 species from Mangaia and Cranwell (1933), listing 4 species from Manihiki. Later, Chapman (1977), listed some 24 species (1 Cyanophyta, 8 Chlorophyta, 9 Phaeophyta, 6 Rhodophyta), based on collections by himself and Dr W. Ballantine from Rarotonga. Unpublished collections by Parks (1929) and L. Ford (1933) are mentioned in MacRaild (1978), and these are most probably housed in UC. MacRaild (1978) discussed some biogeographic implications of algae distribution in the Cook Islands, notably on *Sargassum* and *Ulva* which he did not find in Rarotonga but which were reported by Chapman (1977) and in the present study, thus confirming that these species may be seasonal or opportunistic in nature. Although he mentioned some 47 species from the Cook Islands in his 1978 paper, MacRaild did not provide a checklist for comparison and the whereabouts of these records is currently unknown

An expedition to Suvarrow Atoll in the northern Cook Islands in 1998, to conduct an environmental impact assessment for a pearl farming proposal, also collected a number of seaweed samples. These have been sent to Professor I. A. Abbot in Hawaii for identification (Miles Anderson, pers. comm.). No list has yet been received in the Cook Islands.

The present survey was conducted by Dr. Antoine D. R. N'Yeurt, assisted by Mr. Kelvin Passfield from January 27 to February 5, 1999. It came about after several random samples were sent by Passfield to N'Yeurt in Fiji for identification. This led to a proposal being submitted to WWF Cook Islands partnership programme for a small grant to allow N'Yeurt to stopover en route to French Polynesia to conduct a 3 week survey of Cook Islands seaweeds. Twenty three days were spent on Rarotonga, with a further 2 days spent on Aitutaki.

Much yet remains to be done in the way of investigating the marine algal flora of the Cook Islands. In particular, the Northern Group needs to be thoroughly investigated, with comprehensive checklists written. The higher latitude of these islands should favour a different, more equatorial algal composition than the cooler localities to the south. It is hoped that further research in future will increase our knowledge of the algal flora of this very interesting and still mostly unspoiled part of the South Pacific.

## **Biogeographical range of Cook Islands seaweeds**

For all species encountered in this survey, the biogeographical range is Indo-Pacific, ie. they occur throughout the islands of the south and north tropical Pacific, and Indian oceans. No endemic species have yet been identified, but these could possibly come to light once more investigations are done in little-known areas of the group.



## Geography of the Cook Islands

The Cook Islands (Figures 3-5) comprise 15 islands, located between 9° and 23° S latitude and 156° and 167° W longitude. The total EEZ for the country is nearly 2 million square kilometres. The islands are geographically divided by the 15<sup>th</sup> parallel into a northern group and a southern group. The more populous southern group consists of Rarotonga (Figure 4), a high volcanic island, four raised makatea islands, (Mangaia, Mitiaro, Mauke, and Atiu); one almost atoll, Aitutaki (Figure 5), one atoll, Palmerston, and two smaller uninhabited islands, the sand cay of Takutea and the atoll of Manuae. The Northern group consists of four inhabited atolls, Manihiki, Rakahanga, Penryhn (or Tongareva), and Pukapuka, one uninhabited atoll, Suwarrow, and one inhabited sand cay, Nassau. Table II gives a summary of each of the islands, which are represented on the map in Figure 3.

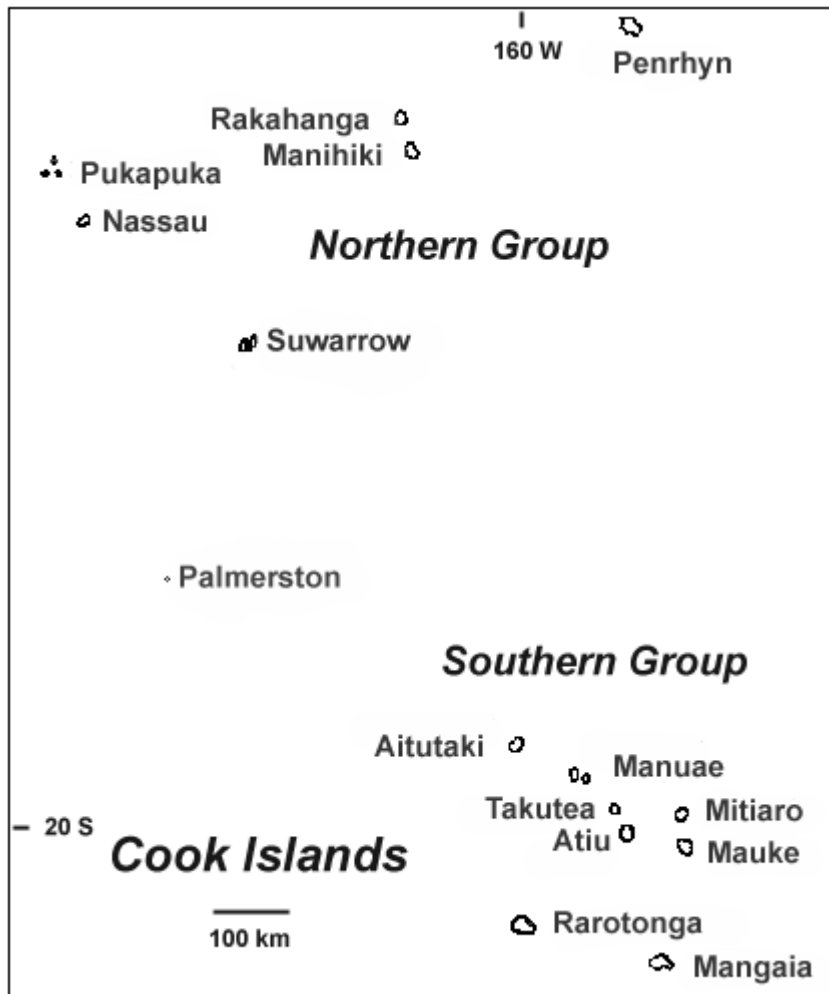


Figure 3. Map of the Cook Islands

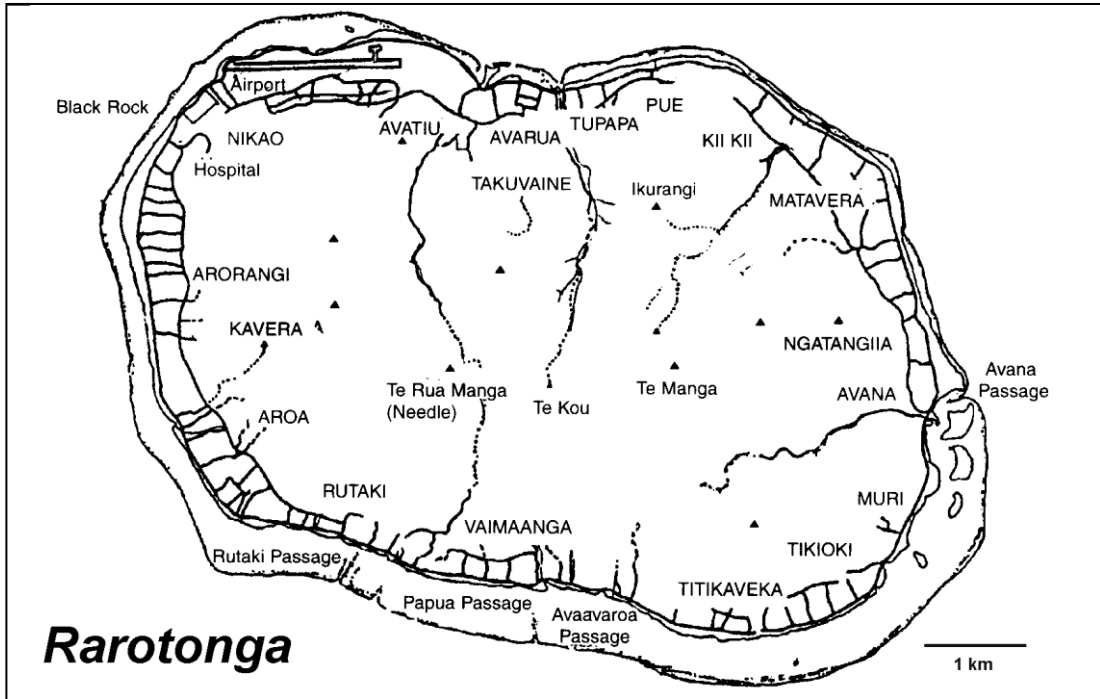


Figure 4. Map of Rarotonga, the main island of the Cook Group

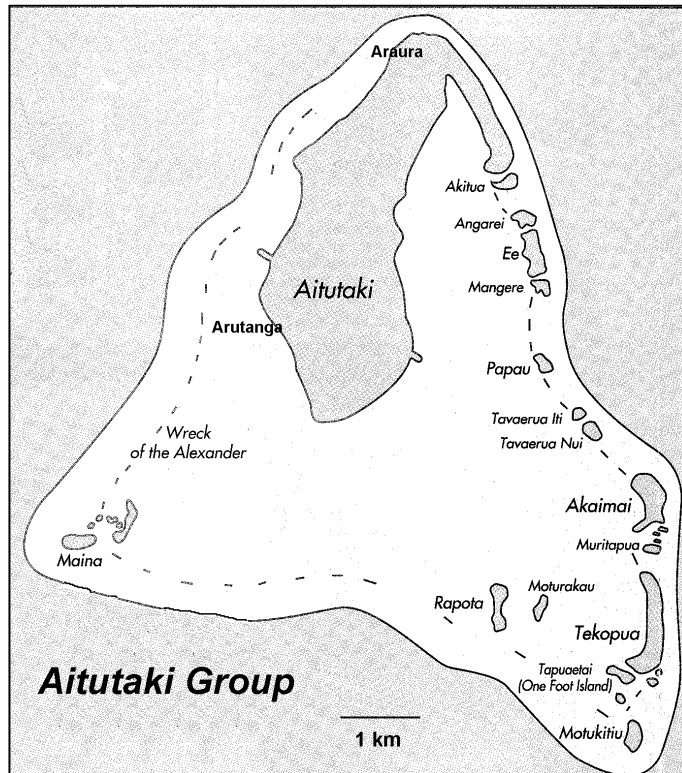


Figure 5. Map of Aitutaki Group

**Table II. Selected statistics on each of the Cook Islands**

Island	Type	Location	Population	Distance (km) from Rarotonga	Land area (ha)	Highest point (m)	Lagoon size (sq. km.) & reef length (km)	Maximum depth
<i>Southern</i>								
Mangaia	raised coral (makatea)	22.00° S 158.00° W	1100	175	5180	169	fringing reef, 27 km.	< 3m
Rarotonga	high island, volcanic	21.00° S 159.75° W	9,000	0	6718	652	fringing reef, 34 km.	< 5m
Atiu	makatea	20.00° S 158.00° W	960	185	2693	72	fringing reef, 22 km.	< 3m
Mauke	makatea	20.00° S 157.50° W	650	240	1842	29	fringing reef, 18 km.	< 3m
Mitiaro	makatea	20.00° S 157.00° W	320	230	2228	15	fringing reef, 19 km.	< 3m
Aitutaki	almost-atoll	19.00° S 159.75° W	2332	225	1805	124	40 sq. km., 45 km.	< 10m
Manuae	atoll	19.25° S 159.00° W	0	200	617	10	4 sq. km., 17 km.	< 10m
Takutea	sand cay	19.75° S 158.25° W	0	190	122	5	fringing reef, 6 km.	< 2m
Palmerston	atoll	18.00° S 163.00° W	49	430	202	5	35 sq. km., 36 km.	< 40m
<i>Northern</i>								
Suvarrow	atoll	13.25° S 163.00° W	4	820	40	5	100 sq. km., 57 km.	< 50 m
Nassau	sand cay	11.50° S 165.50° W	100	1075	121	9	fringing reef, 7 km.	< 3m
Pukapuka	Atoll	11.00° S 166.00° W	780	1145	506	5	7 sq. km., 40 km.	< 50m (?)
Manihiki	atoll	10.50° S 161.00° W	662	1040	544	5	40 sq. km., 32 km.	< 50m
Rakahanga	atoll	10.00° S 161.00° W	249	1080	390	5	2 sq. km., 14 km.	< 20m (?)
Tongareva	atoll	9.00° S 158.00° W	600	1180	985	5	180 sq. km., 60 km.	< 50m

Sources: Wood and Hay, 1970; measurements from navigational charts and maps; Cook Islands Statistical Bulletin 1996 (Courtesy K. Passfield)

## DESCRIPTIONS OF THE COMMON SEAWEEDS OF THE COOK ISLANDS

(This section follows a taxonomic classification system as adopted in Silva *et al.* 1996)

For each of the 58 common species, a brief description and diagnostic illustration is given. Also, whenever possible distribution and the common and / or local Maori names are included, together with herbarium accession numbers where known. Some specimens collected in 1992 and illustrated by Cathy Jones are housed at Waikato University, New Zealand (WAIK) while those collected during the present study are housed at the Phycological Herbarium, South Pacific Regional Herbarium in Suva, Fiji (USP).

### Division **CYANOPHYTA**

#### **Blue-green algae (Cyanobacteria)**

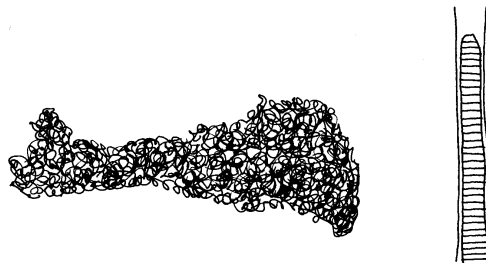
Blue-green algae or Cyanobacteria differ fundamentally from other groups of algae, since they arguably belong to the world of bacteria. They belong to the most ancient forms of life on Earth. During the Precambrian (about 1.5 billion years ago), they built-up rocky formations called stromatoliths, either by the precipitation of calcium or the trapping of sediments. Despite their very ancient origin we should not consider them as a relic group, on the contrary even though being discrete, they occupy all types of habitats, even those inaccessible to other organisms. Despite an apparent simplicity in the organisation of forms, the taxonomic identification of Cyanobacteria currently remains difficult and delicate. Hence, in the context of this work, this group will be illustrated only by a few very common examples, without going into detailed taxonomic descriptions.

#### Order **Nostocales (= Oscillatoriales)**

#### Family **Oscillatoriaceae**

#### Genus **Lyngbya** C. Agardh

#### **Lyngbya majuscula** (Dillwyn) Harvey



This species forms blackish clumps of intertwined, fuzzy filaments to 30 cm long. It favours shallow sandy bottoms, where it attaches itself to rubble or algae. It can be locally very abundant

during the warm season. This algae is known to produce biologically active compounds, and is a favourite food for the *patito* or long-tailed sea hare (*Stylocheilus longicauda*).

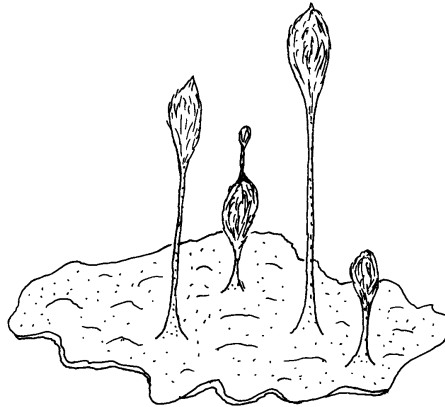
Cook Islands Distribution:

Ubiquitous, growing in the lagoon, attached to rocks, coral pieces and also within interstices in coral rubble.

Rarotonga: Titikavena, Avana, Muri Lagoon.

Genus **Schizothrix** Kützing

**Schizothrix calcicola** (C. Agardh) Gomont



This species forms reddish-brown blotches or mats on sandy or coralline substrata. Very often, are seen trapped gas bubbles (oxygen produced by the Cyanobacteria) forming characteristic columns several tens of centimetres high.

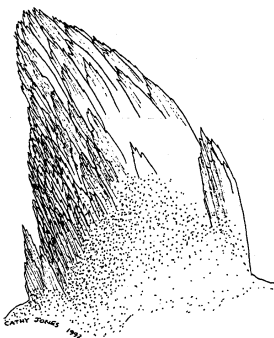
Cook Islands Distribution:

Ubiquitous in lagoon and reef environments growing as slippery sheets covering rocks and sandy bottoms.

Rarotonga: Titikavena, Poara, Avana, Nikao; Aitutaki: Araura

Genus **Symploca** Kützing

**Symploca hydroides** (Harvey) Kützing



Forms isolated dark brown to yellowish tufts a few centimetres in diameter. Colonies have a firm consistency, and have their summit pointed into characteristic sawtooth.

Cook Islands Distribution:

Ubiquitous in lagoon and reef environments (Rarotonga, Aitutaki), growing as erect tufts, and also found on dead coral to depths of 20 metres on the outer reef slope.

## Division **CHLOROPHYTA**

### **Chlorophyta or Green Algae**

Chlorophyta are algae whose thallus is typically green in colour due to chlorophyll *a* and *b* pigments that are dominant in the chloroplasts. However, prolonged exposure to strong light intensity leads to the synthesis of photoprotecting pigments (carotenoids) that impart to the thalli orange to yellowish colours. We find the cosmopolitan *Ulva* and *Enteromorpha* species abundant in calm waters with variable salinity that are occasionally over-charged in nutrients. However, *Ulva* blooms remain modest on our reefs compared to the “green tides” that it creates in several areas of the world. In the Cook Islands, the seaweed *Boodlea kaeneana* can on certain reefs and in the lagoons bloom in spectacular fashion during the southern summer. An overcharge in nutrients linked to sewage effluents in addition to strong sunlight is the most probable hypothesis to explain these blooms. The most diversified Chlorophyta of the Cook Islands are *Caulerpa* and *Halimeda*. *Caulerpa* species can be found either on hard substrata, or on sand. The presence of long creeping stolons (up to one metre in length) contributes locally to the retainment of sediments at the bottom of atoll lagoons. This group has the peculiarity to contain one of the algal species still consumed by in the Cook Islands : *Caulerpa racemosa*, called “rimu kai” in Maori.

#### **Key to the common genera of Cook Islands Chlorophyta (Green Algae)**

- 1. Thallus calcified or joined together by calcification ..... 2
- 1. Thallus totally uncalcified ..... 3
  - 2. Thallus unsegmented; cylindrical ..... **Neomeris**
  - 2. Thallus segmented; segments flattened ..... **Halimeda**
- 3. Thallus sac-like, unicellular ..... **Ventricaria**
- 3. Thallus multicellular or filamentous ..... 4
  - 4. Thallus filamentous, bubble-like, leather-like, feather-like or grape-like ..... 6
  - 4. Thallus net-like, or sheet-like ..... 5
- 5. Thallus forming crispy masses of entangled net-like filaments, never in sheets .... **Boodlea**
- 5. Thallus forming a two-layered sheet, not crispy or in masses ..... **Ulva**

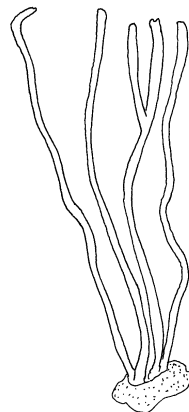
- 6. Filaments regularly septate, fleecy, segments rectangular ..... **Rhizoclonium**
- 6. Filaments non-septate or irregularly septate, not fleecy ..... 7
- 7. Filaments dichotomously branched, in tufts ..... **Chlorodesmis**
- 7. Filaments not dichotomously branched, not in tufts ..... 8
  - 8. Thallus differentiated into terminal inflated utricles or peltate discs ..... 10
  - 8. Thallus not differentiated into terminal utricles or peltate discs ..... 9
- 9. Thallus a solid or hollow mass of closely-adhering, hexagonal cells ..... **Dictyosphaeria**
- 9. Thallus filamentous or bubble like ..... 11
  - 10. Thallus spongy, terminal utricles closely adhering to each other, never peltate .  
..... **Codium**
  - 10. Thallus not spongy, terminal utricles grape-like or peltate, not adherent .....  
..... **Caulerpa**
- 11. Thallus cylindrical or slightly flattened, never adherent, tufted or plumose ..... 12
- 11. Thallus composed of irregularly shaped, loosely adherent vesicles, not tufted .... **Valonia**
  - 12. Filaments with cross-walls at base of segments and / or branches ..... 13
  - 12. Filaments lacking cross-walls ..... **Enteromorpha**
- 13. Lateral branches lacking basal cross walls ..... **Cladophoropsis**
- 13. Lateral branches with basal cross wall ..... **Cladophora**

Order **Ulvales**

Family **Ulvaceae**

Genus **Enteromorpha** Link

**Enteromorpha flexuosa** (Wulfen) J. Agardh





Plants light-green and fleecy, sparsely branched; 150-155 µm in diameter, up to 20 cm long, forming loose tufts attached to rocks and pebbles via a small basal holdfast. Lateral branches often monofilamentous, 25-30 µm in diameter.

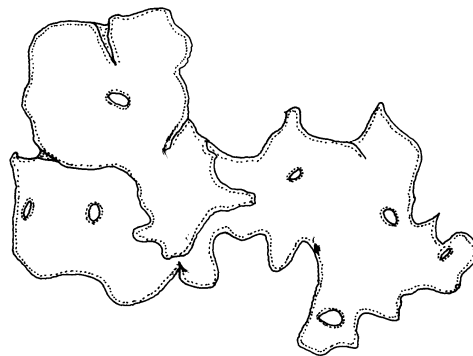
Cook Islands Distribution:

Relatively uncommon, growing on rocks and pebbles in the calm waters of the lagoon This algae is often used as a bioindicator species of nutrient-rich habitats. It is a potentially edible species, but one needs to be careful if the seaweed grows in polluted areas subject to domestic and industrial effluents.

Rarotonga: Rarotongan Hotel; Aitutaki: Araura.

Genus **Ulva** Linnaeus

**Ulva lactuca** Linnaeus



Plant light to dark-green, to 10 cm broad, flat and simple, membranous and irregularly lacerate with small holes; attached by a small rhizoidal holdfast. Blade two-cell thick.

Cook Islands Distribution:

Growing in pools with *Sargassum* spp. This genus is often used as a bioindicator of nutrient-rich habitats.

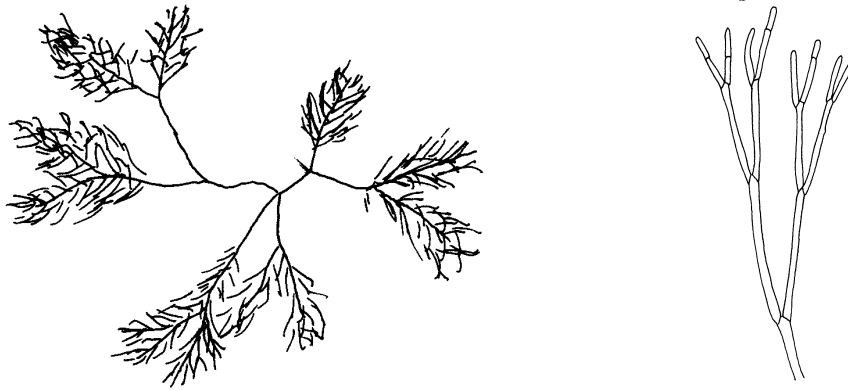
Rarotonga: Ngatangia.

Order **Cladophorales**

Family **Cladophoraceae**

Genus **Cladophora** Kützing

**Cladophora coelothrix** Kützing



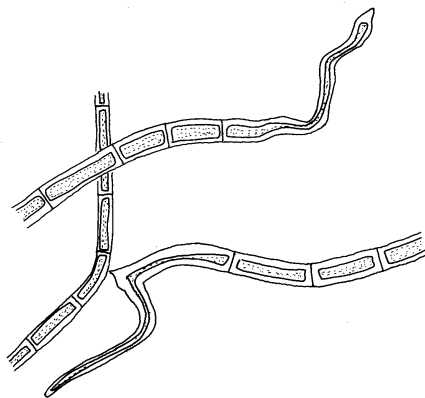
Plants light to dark green, forming somewhat stiff, fasciculate clumps 3-4 cm high. Axes cylindrical and dichotomously branched, in radiating pompoms.

Cook Islands Distribution:

Ngatangiia, Rarotonga , in front of school beyond the reef, 25 metres depth on coral.

Genus **Rhizoclonium** Kützing

**Rhizoclonium africanum** Kützing



Thallus light green and filamentous to 10 cm long, forming entangled fleecy masses composed of filaments 45-82  $\mu\text{m}$  in diameter. Individual cells rectangular, with thick cell walls.

Cook Islands Distribution:

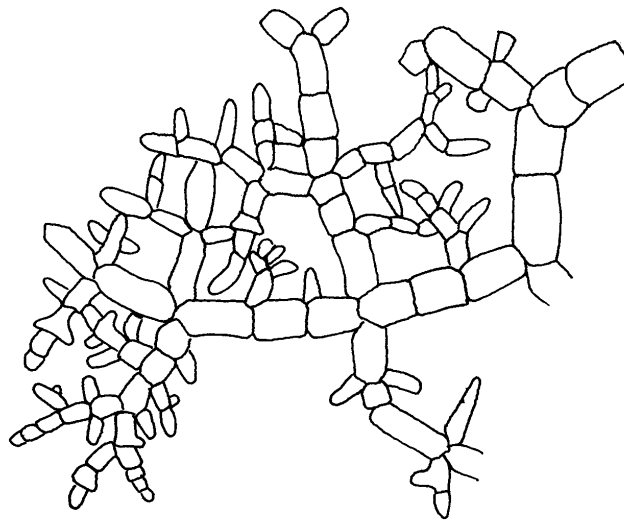
Arutanga, Aitutaki: growing on boat anchoring ropes in the harbour.

Order **Siphonocladales**

Family **Siphonocladaceae**

Genus **Boodlea** Murray et De Toni

**Boodlea kaeneana** Brand



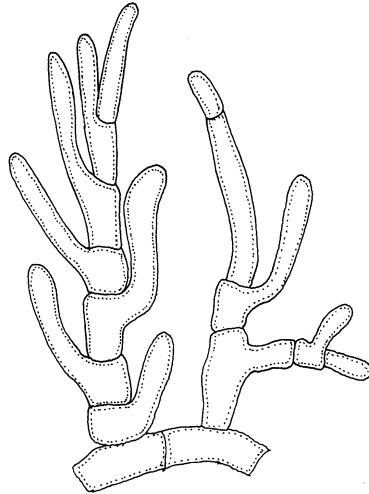
Thallus shiny yellowish green, forming crisp, spongy unattached masses to 13 cm in diameter. Branching of the individual filaments is irregularly single or double, with frequent secondary attachments between branches via crenellated sucker-like pads at the tips of branchlets.

Cook Islands Distribution:

Rarotonga, Aitutaki: common on all fringing reefs, nesting between coral. In Muri and Titikavena lagoons (Rarotonga), this species recently formed great masses 10-20 cm thick completely covering the lagoon floor in places. As this appears to be a seasonal or periodic event, the causes could be linked to changes in water temperature owing to warmer than usual weather, and / or an increase in levels of organic nutrients in the lagoon, perhaps due to sewage effluents from domestic sources or piggeries.

Genus **Cladophoropsis** Børgesen

**Cladophoropsis luxurians** Gilbert



Thallus dark-green, up to 3 cm tall and forming small, tough mats. Branching sparse to profuse and irregular, filaments 400-450  $\mu\text{m}$  in diameter, turgid, with lateral branchlets secundly or irregularly issued from distal or proximal ends of mother cells, often curving downwards with frequent formation of secondary holdfasts from the tips of filaments. Cross-wall formed between branches; lateral branches without basal cross-walls but arising beneath a cross-wall of the supporting filament.

Cook Islands Distribution:

Clam nursery, Aitutaki: forming mats on coral bommies in the lagoon. This species is characteristically found in atoll habitats.

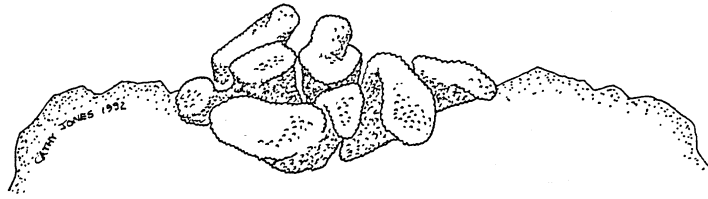
Family **Valoniaceae**

Genus **Dictyosphaeria** Decaisne ex Endlicher

**Key to the common Cook Island species of *Dictyosphaeria***

- 1. Thallus solid throughout, flattened ..... *D. australis*
- 1. Thallus hollow, convoluted ..... *D. cavernosa*

### **Dictyosphaeria australis** Setchell



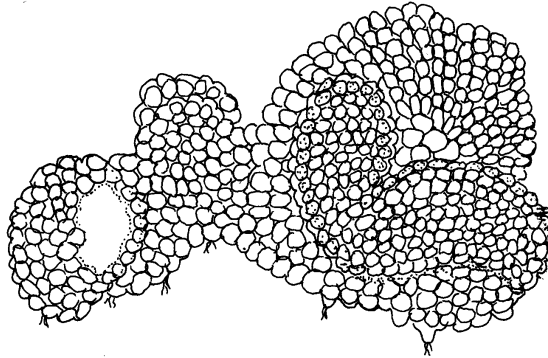
Thallus to 4 cm in diameter, shiny dark green, sessile and cartilaginous, with angular or polygonal cells clearly seen with the naked eye. Internal structure solid throughout. Attached to the substratum via sparse basal rhizoids.

Cook Islands Distribution:

Growing appressed to rocks and coral in the lagoon.

Rarotonga: Nikao, Poara, Titikavena.

### **Dictyosphaeria cavernosa** (Forsskål) Børgesen



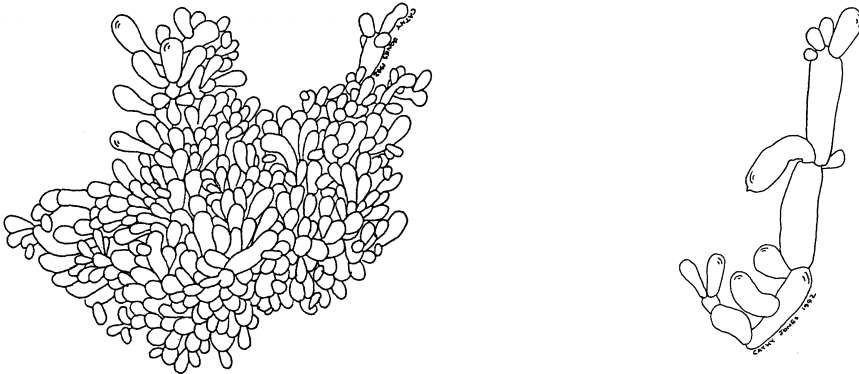
Thallus 8-13 cm in diameter; shiny light green, sessile, sometimes spherical and often irregularly lobed. Internal structure hollow, the walls one-cell thick, with angular or polygonal cells clearly seen with the naked eye. Intracellular spines absent. Thallus lightly attached to substratum via small rhizoids.

Cook Islands distribution:

Growing on coral bommies in the lagoon. Rarotonga: Titikavena; Aitutaki: Araura, clam nursery.

### Genus **Valonia** C. Agardh

**Valonia fastigiata** Harvey ex J. Agardh



Thallus shiny dark olive green, forming erect clumps or cushions to 3 cm high and 10 cm across. Individual vesicles elongate-ovoid, hollow, irregularly branched, to 10 mm long and 5 mm wide, loosely attached to each other.

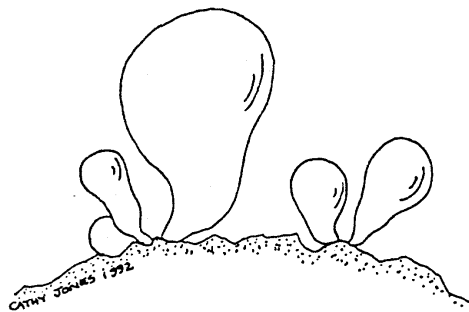
Cook Islands distribution:

Growing on coral boulders in lagoon.  
Rarotonga: Rutaki (9 July 1992: WAIK 14319).

Genus **Ventricaria** Olsen et West

**Ventricaria ventricosa** (J. Agardh) Olsen et West

Common name: sailor's eyeball



Thallus to 5 cm in height, shiny dark green, consisting of a thin-walled, fluid-filled subspherical, spherical or pyriform vesicle. The algae represents a single cell. Attached to the substratum via minute basal rhizoids. The cell does not rupture if the cell wall is punctured.

Cook Islands distribution:

Growing on the reef flat, among coral debris.

Rarotonga: Rutaki (9 July 1992: WAIK 14321), Titikavena (27 January 1999), Poara (29 January 1999), Avana (30 January 1999); Aitutaki: Araura lagoon (3 February 1999).

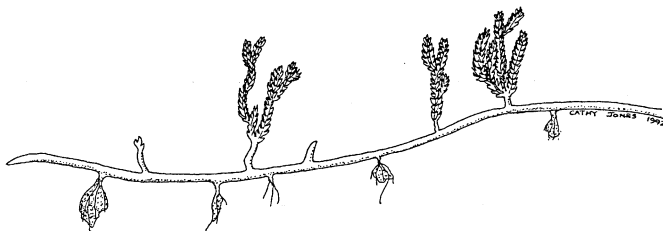
Family **Caulerpaceae**

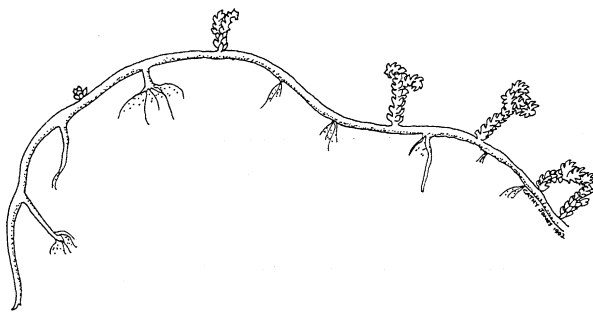
Genus **Caulerpa** Lamouroux

**Key to the common Cook Islands species of *Caulerpa***

- 1. Plants with grape-like clusters of branchlets, not flattened or peltate ..... *C. racemosa*
- 1. Plants with flattened, cylindrical or disc-like branchlets ..... 2
  - 2. Branchlets thin and disc-like ..... *C. peltata*
  - 2. Branchlets flattened or cylindrical, not disc-like ..... 3
- 3. Branchlets cylindrical, with ramulli in rows of three or five ..... *C. cupressoides*
- 3. Branchlets flattened, feather-like or with serrated edges ..... 4
  - 4. Branchlets strap-like, with serrated edges, twisted or linear ..... *C. serrulata*
  - 4. Branchlets feather-like, with oppositely arranged ramulli ..... 5
- 5. Secondary branchlets to 0.2 mm in diameter, upwardly curved, not basally constricted .....  
..... *C. sertularioides*
- 5. Secondary branchlets to 1 mm in diameter, not upwardly curved, basally constricted .....  
..... *C. taxifolia*

***Caulerpa cupressoides* (Vahl) C. Agardh**



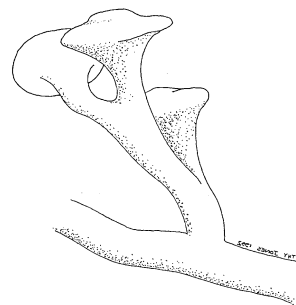
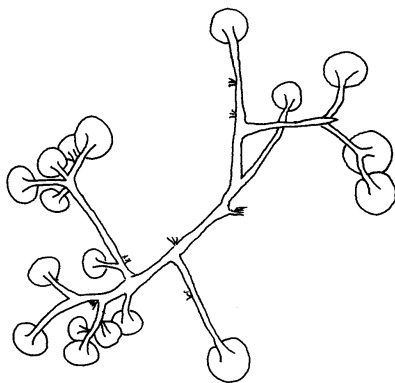


Thallus to 5 cm tall, forming dense aggregations, with a smooth spreading stolon up to 30 cm long and 3 mm in diameter, anchored by numerous rhizoid-bearing branches spaced at close (0.5-1 cm) intervals. Erect axes to 2 mm wide, often strongly forked with sub-dichotomous branching. Secondary branchlets oppositely pinnate and compressed, with upward curving tendency, tapering to a sharp point at the tip, and generally twice as long as the diameter of the supporting axis. The branchlets usually arranged in ranks of threes, sometimes two or up to five.

Cook Islands distribution:

Growing in small pools on the reef rim, inland edge and creeping on algal carpets on the reef flat. Rarotonga: Matavera (3 July 1992: WAIK 14310), Titikavena (27 January 1999), Poara (29 January 1999), Avana.

### ***Caulerpa peltata* Lamouroux**



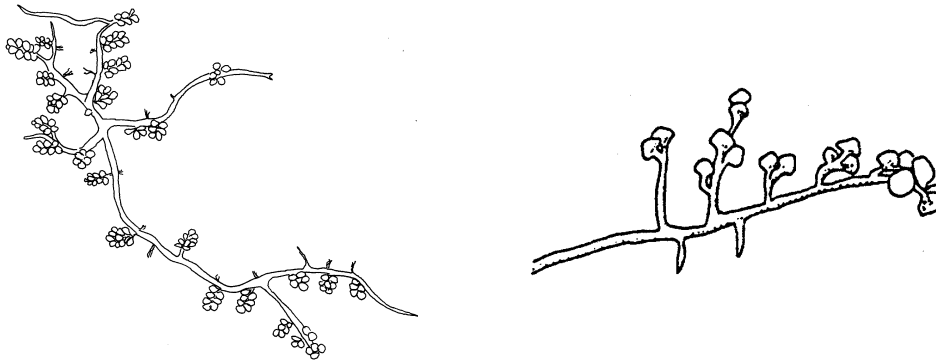
Plants small and delicate, with a creeping stolon to 1 mm in diameter, occasionally forming clumps 5-10 cm across of densely intermingled plants, each about 8 cm long and sparingly provided with short rhizoids. Spreading stolon bearing short cylindrical erect branchlets 1-1.5 cm long at 2-3 mm intervals, these producing thin peltate to subpeltate discs 3-5 mm in diameter either singly at the end, or several discs axially arranged around the main branches.

Cook Islands distribution:



Growing creeping on coral debris or within algal carpets, on the reef flat and reef crest. Rarotonga: Rutaki (9 July 1992: WAIK 14322), Titikavena, Poara; Aitutaki: clam nursery, Arutanga.

**Caulerpa racemosa** (Forsskål) J. Agardh



Thallus light green, up to 15 cm long, with a creeping stolon to 3 mm in diameter and ventral branchlets beset with rhizoids. Erect axes up to 3 cm long, bearing up to 15 radially disposed secondary branchlets with toadstool-shaped or globular, inflated ends 2-4 mm in diameter.

Cook Islands distribution:

Common on the reef flat, growing on coral bommies, sponges and soft corals in shallow waters. This alga is edible, being eaten as a salad in the Cook islands and by many Pacific islanders. Rarotonga: Titikavena, Ngatangia, Rutaki. Aitutaki: Araura.

There are several varieties of this species, which some taxonomists recognise and others prefer to group together as *C. racemosa*. In the Cook Islands, however, the following variety is consistently identifiable and so merits description:

**Caulerpa racemosa** (Forsskål) J. Agardh var. **uvifera** (Turner) J. Agardh

Common name: sea grapes

Maori name: *Rimu kai*



Plants forming light to dark-green clumps up to 15 cm in diameter, composed of numerous small spreading stolons with relatively short (1-1.5 cm) assimilators densely beset with grape-like imbricate ramelli up to 1.5 mm diameter, disposed radially around the foliar axis. Ramelli club to trumpet shaped, with a semi-hemispherical and somewhat flattened end borne on a distinct stalk up to 2.3 mm long. This dense arrangement of small ramelli imparts a distinctive grape-like appearance to the clusters of plants.

Cook Islands distribution:

Growing in patches on the reef crest, creeping on algal carpets or soft coral, in crevices and tide pools on the reef rim. This variety is the preferred one for human consumption, because of its less fibrous texture and milder taste. In other parts of the Pacific such as Fiji, this variety is cultured in cages for export to Asian markets. Rarotonga: Titikavena.

***Caulerpa serrulata* (Forsskål) J. Agardh**

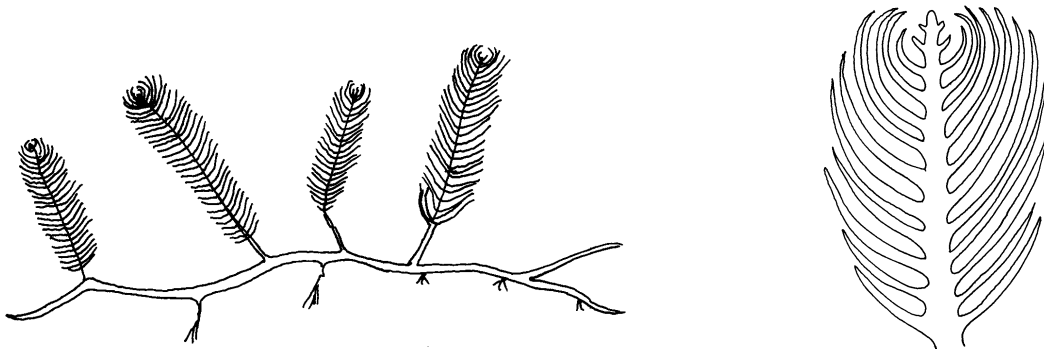


Thallus light to dark green, with a creeping stolon up to 20 cm long and 2 mm wide, bearing flattened to compressed, serrated erect branches up to 7 cm tall at 1-4 cm intervals along the spreading stolon. The erect branches are several times dichotomously or irregularly branched, terete below up to point of dichotomy, the rest compressed (1-2 mm broad) with moderate to strong twisting and serrated margins; the serrations more pronounced on the outwardly facing edge of the twist.

Cook Islands distribution:

Growing in tide pools or creeping on coral in the lagoon and close to the beach. More sheltered, shallow-water plants are distinctly more twisted than those growing in deeper water. Rutaki (4, 11 July 1992, WAIK 14312, 14318), Titikavena; Aitutaki: Araura, Arutanga clam nursery.

***Caulerpa sertularioides* (S. G. Gmelin) Howe**

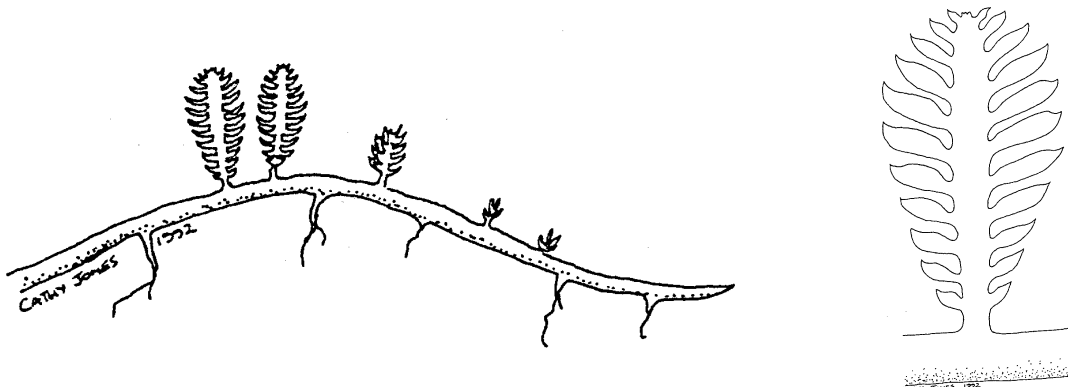


Thallus to 6 cm tall, with terete stolons 0.25-1.0 mm in diameter, bearing sparse erect branches which are simple or occasionally dichotomously divided, naked or branched at the base and bearing plumose, pinnate, undivided branchlets; branchlets cylindrical throughout, not constricted at the base, to 8 mm long and 200 µm in diameter, upcurved, with pointed tips.

Cook Islands distribution:

Creeping on sandy surfaces, in shallow passage. Aitutaki (3 February 1999): Ootu Passage, Akitua (under bridge leading to Aitutaki Lagoon Resort Hotel).

***Caulerpa taxifolia* (Vahl) C. Agardh**



Thallus to 45 mm tall, yellowish-green, composed of a creeping stolon to 25 cm long and 1 mm in diameter, bearing erect, plumose branches at relatively wide intervals. Erect branches to 8 mm wide, bearing pairs of opposite branchlets to 4 mm long and 1 mm in diameter which are compressed, basally constricted, with tapered, upwardly curved tips.

Cook Islands distribution:

Growing on the base of coral boulders in the lagoon.

Rarotonga: Titikavena (13 July 1992: WAIK 14329; 27 January 1999: USP).

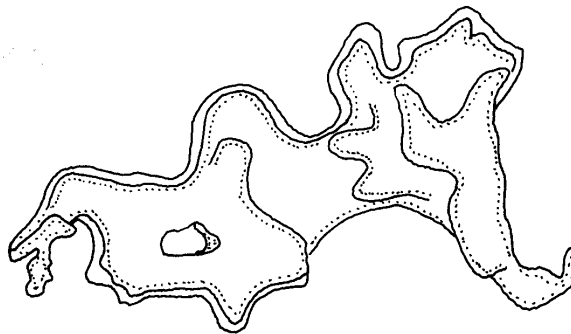
### Family **Codiaceae**

#### Genus **Codium** Stackhouse

#### **Key to the common Cook Islands species of *Codium***

- 1. Plants flattened, leather-like and convoluted ..... *C. arabicum*
- 1. Plants cylindrical, dichotomously branched ..... *C. geppiorum*

#### ***Codium arabicum* Kützing**



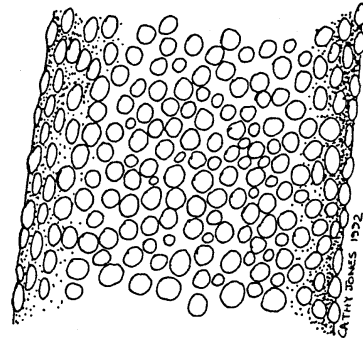
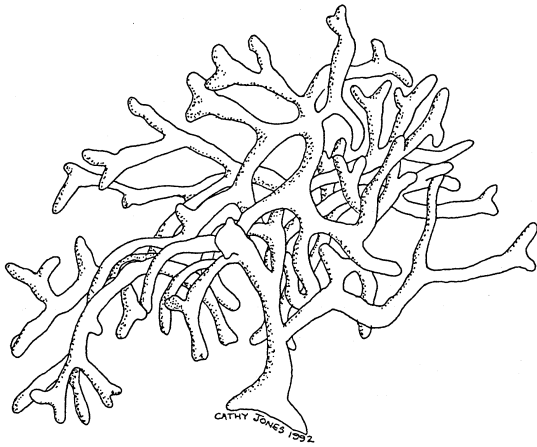
Thallus dark green and rubbery, flattened, up to 15 cm broad and 1 cm thick; adhering strongly to the substratum, assuming a leathery, convoluted habit. Internally, composed of medullary filaments 17-23  $\mu\text{m}$  in diameter; with clavate to pyriform peripheral utricles 58-88  $\mu\text{m}$  broad and 380-500  $\mu\text{m}$  long, with rounded ends.

Cook Islands distribution:

Growing on rocks and coral rubble on the reef flat. In some parts of the Pacific, this alga was formerly used when dried to scour cooking utensils.

Rarotonga: Avana (30 January 1999).

**Codium geppiorum** O. C. Schmidt



Thallus dark-green, profusely branched, with slightly furry, terete and imbricating axes arching downwards; attached at various points to the substratum. Branching irregularly dichotomous, axes 2-3 mm in diameter and up to 8 cm long. Internally, composed of medullary filaments 35-41  $\mu\text{m}$  in diameter, with obovoid, cylindrical to subspherical peripheral utricles 140-235  $\mu\text{m}$  broad and 382-500  $\mu\text{m}$  long, with rounded apices and occasional hairs up to 29  $\mu\text{m}$  in diameter arising from the apical zone.

Cook Islands distribution:

Growing attached to boulders, coral or other seaweeds, on the fringing and barrier reef. This is an edible species, being a favourite dish, eaten raw as a salad or cooked in coconut milk, in several Pacific Islands (e.g. Fiji, Rotuma).

Rarotonga: Muri lagoon (6 July 1992: WAIK 14315), Avana (30 January 1999), Nikao (2 February 1999); Aitutaki: Araura (3 February 1999).

Family **Halimedaceae**

Genus **Halimeda** Lamouroux

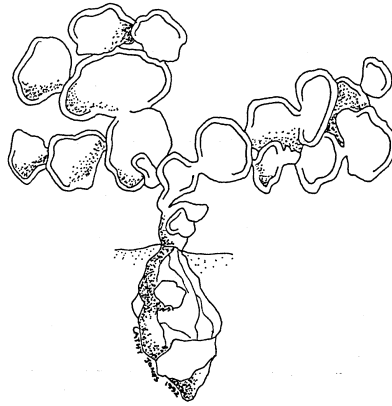
Maori name: *rimu kirikiri*

**Key to the common Cook Islands species of *Halimeda***

- 1. Segments ribbed, kidney-shaped, calcification heavy ..... 2
- 1. Segments discoid, not ribbed, calcification light ..... *H. discoidea*
- 2. Plant growing in clumps, multiple rhizoidal holdfasts present ..... *H. opuntia*

2. Plant solitary, with a single, bulbous holdfast anchored in sand ..... *H. incrassata*

**Halimeda discoidea** Decaisne



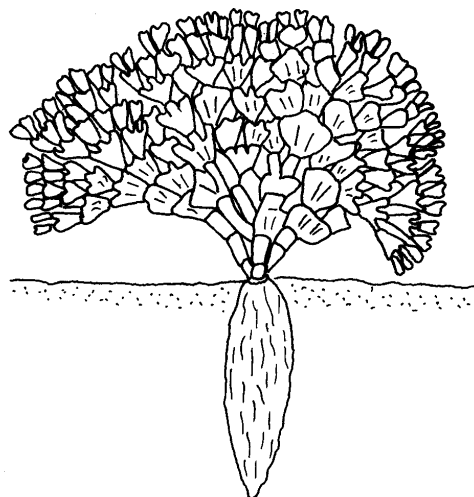
Thallus to 10 cm tall and lightly calcified, dark green to cream in colour with thickened, somewhat convoluted outer margins. A single short stalk-like segment is present at the base of the plant, which is anchored by a bulbous mass of sediment-filled rhizoids. Segments large (up to 20 mm broad and 15 mm high) and in a single plane, mostly branching dichotomously. Internally, composed of peripheral utricles which are hexagonal in surface view, between 42-43  $\mu\text{m}$  in diameter. Secondary utricles up to 128  $\mu\text{m}$  in diameter, distinctly inflated, supporting up to five primary utricles. Cortex generally two-layered.

Cook Islands distribution:

A common alga, growing on the inner reef flat.

Rarotonga: Matavera (28 June 1992, WAIK 14304), Titikavena, Poara, Avana.

**Halimeda incrassata** (Ellis) Lamouroux



Thallus to 10 cm tall, with a distinct bulbous holdfast up to 3 cm long and 1.5 cm wide. Branching fan-shaped (polychitinous) from a basal segment about 1 cm broad and 5 mm high; upper segments 2-4 mm wide and 3-6 mm tall, cuneate to trilobed, sometimes cylindrical; not distinctly ribbed. Cortex 2-3 layered, primary utricles hexagonal in surface view, 40-50  $\mu\text{m}$  in diameter, remaining loosely attached following decalcification. Tertiary utricles 64-71  $\mu\text{m}$  in diameter, dichotomously branched, bearing a pair of secondary utricles 36-43  $\mu\text{m}$  in diameter, in turn bearing 2-3 primary utricles each.

Cook Islands distribution:

Growing in sandy places on the reef flat.

Rarotonga: Nikao.

### ***Halimeda opuntia* (Linnaeus) Lamouroux**



Thallus dark green fading to cream underneath the main mass of the plant, forming dense or lax bushy clumps to 30 cm in diameter and 6 cm high with multiple rhizoidal attachment points. Branching dense and irregular to opposite, in many planes. Segments 10 mm broad to 5 mm high, kidney-shaped, ribbed and trilobed at base of plant. Basal segments often bleached white. Internally, composed of cortical utricles 10 to 12  $\mu\text{m}$  in diameter, small, rounded and slightly adhering in surface view following decalcification. Secondary utricles slender and fork-shaped, arising as dichotomies of the medullary filaments.

Cook Islands distribution:

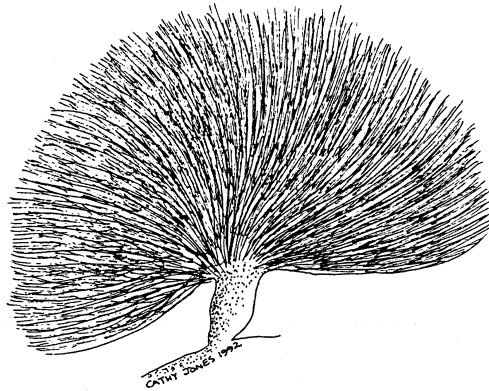
A common alga found in pools on the reef rim and on the reef flat.

Rarotonga: Titikavena, Poara, Avana, Nikao; Aitutaki: Araura.

Genus **Chlorodesmis** Harvey et Bailey

**Chlorodesmis fastigiata** (C. Agardh) Ducker

Maori name: *Rimu matie*



Thallus up to 3 cm high, consisting of bright green, strong-smelling cushions or tufts of free filaments, with a short basal spongy filamentous holdfast. Filaments cylindrical with rounded tips, 60-100  $\mu\text{m}$  in diameter, distally dichotomously to trichotomously branched with unequal constrictions above dichotomies.

Cook Islands distribution:

Growing on the outer reef and reef crest, in tide pools.

Rarotonga: Titikavena, Poara, Avana, Nikao.

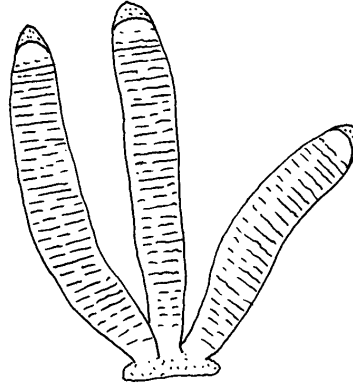
Order **Dasycladales**

Family **Dasycladaceae**

Genus **Neomeris** Lamouroux



***Neomeris vanbosseae* Howe**



Thallus cylindrical and erect, up to 20 mm tall and 4 mm in diameter, in a broad, 120-130° curve. Basal portion whitish and moderately calcified, upper portion light to dark green with hairlike whorls of radial branchlets at the tip, which is characteristically uncalcified.

Cook Islands distribution:

Growing in clumps in pools on the inner reef flat.

Rarotonga: Poara; Aitutaki: Araura.

## Division PHAEOPHYTA

### Phaeophyta or Brown Algae

The colour of Phaeophyta or brown algae is due to the abundance of the brown pigments fucoxanthin that mask chlorophyll *a* and *c*. They are an exclusively marine group, showing a great morphological diversity, from relatively simple filamentous forms (*Hincksia*) to the large brown algae (*Turbinaria*, *Sargassum*) whose complex morphology approaches the leafy stems of higher plants. In the Cook islands, on the reefs of high islands, the two genera *Sargassum* and *Turbinaria* form perennial populations that have an impact on the plant scenery in the upper parts of the reef complex. Furthermore, they make up the main part of the drift torn off the reefs by the swell, and commonly form floating rafts that drift across the ocean.

#### Key to the common genera of Cook Islands Phaeophyta (Brown Algae)

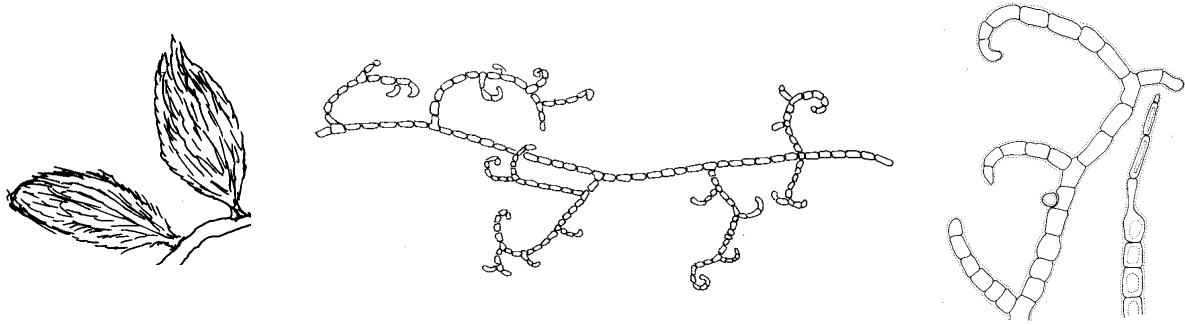
1. Thallus crustose ..... **Lobophora**
1. Thallus not crustose ..... 2
  2. Thallus filamentous, in brownish-yellow tufts ..... **Hincksia**
  2. Thallus not filamentous ..... 3
3. Thallus branched in one plane only ..... 4
3. Thallus branched in more than one plane ..... 6
  4. Thallus fan-shaped; lightly to moderately calcified on lower surface; margin inrolled; branching not dichotomous ..... **Padina**
  4. Thallus not fan-shaped or calcified; margin not inrolled; branching dichotomous ..... 5
5. Branches without midrib ..... **Dictyota**
5. Branches with midrib ..... **Dictyopteris**
  6. Thallus with leaf-like or toadstool-shaped , serrated branchlets ..... 8
  6. Thallus with cylindrical, smooth branchlets ..... 7
7. Branches soft and hollow ..... **Rosenvingea**
7. Branches tough and solid ..... **Chnoospora**
  8. Ultimate branchlets leaf-like, not obconical ..... **Sargassum**
  8. Ultimate branchlets obconical, toadstool-shaped ..... **Turbinaria**

Order **Ectocarpales**

Family **Ectocarpaceae**

Genus **Hincksia** J. E. Gray

**Hincksia breviarticulata** (J. Agardh) P. C. Silva



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 mm thick, composed of rectangular cells about up to 25 x 50 mm. Secondary hook-like branchlets up to 800 mm long and 25 mm broad, arising at 85-90° to main filaments and spaced at 500-700 mm intervals.

**COOK ISLANDS DISTRIBUTION**

Growing on rocks, or epiphytic on other algae (such as *Laurencia flexilis*) in exposed, wave-beaten sites on the fringing reef and coastal makatea.

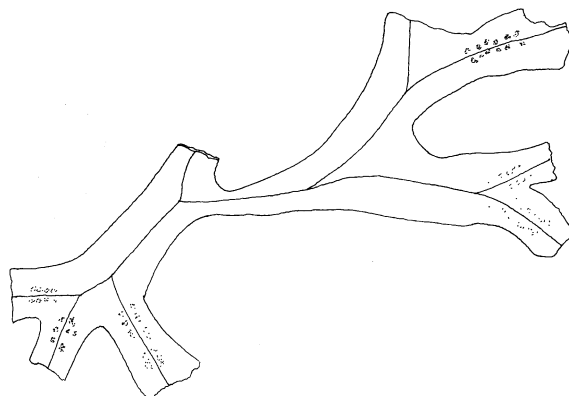
Rarotonga: Ngatangia (13 February 1999).

Order **Dictyotales**

Family **Dictyotaceae**

Genus **Dictyopteris** Lamouroux

**Dictyopteris repens** (Okamura) Børgesen



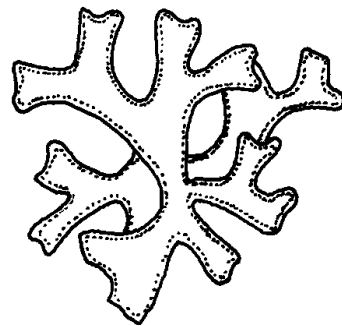
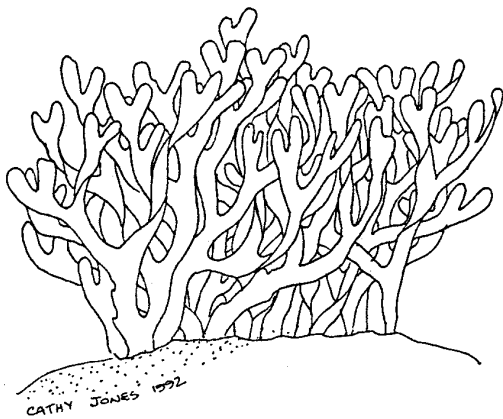
Thallus ribbon-like, up to 3 cm long, light brown; branching dichotomous with blades 1-3 mm broad; blade two-cell thick with a prominent midrib 4-8 cells thick throughout.

#### COOK ISLANDS DISTRIBUTION

Common, found growing on larger seaweeds on the reef flat and in the lagoon.  
Rarotonga: Titikavena.

#### Genus **Dictyota** Lamouroux

#### **Dictyota bartayresiana** Lamouroux



Thallus ribbon-like, to 45 mm high, brownish-orange, 2-5 mm wide, with relatively tough flattened, complanate axes dichotomously branched at an angle of 70-80°. Branch tips are blunt and rounded. Small proliferations 0.5-1 mm long sometimes occur on thallus margins.

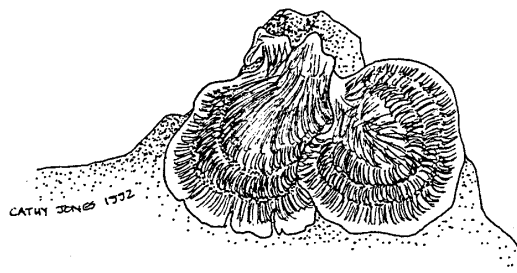
#### COOK ISLANDS DISTRIBUTION

Commonly found growing in clumps at the base of coral bommies in the lagoon, or epiphytic on other seaweeds.

Rarotonga: Rutaki (12 July 1992, WAIK 14326), Titikavena, Poara, Avana, Nikao.  
Aitutaki: Araura.

#### Genus **Lobophora** J. Agardh

#### **Lobophora variegata** (Lamouroux) Womersley



Thallus composed of flabellate, deltoid to ovoid, loosely to strongly encrusting blades, 3 to 6 cm high, 2 to 3 cm broad and 125 µm thick. Colour dark to pale 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 x 50 µm surrounded on both sides by two layer of smaller, cuboid to rectangular cells 12-25 µm in diameter.

#### COOK ISLANDS DISTRIBUTION

Growing loosely fixed as crusts to coral boulders and algae, sometimes on wave-splashed rocks on the beach. In Aitutaki, the plants are typical of the atoll variety, ie. larger and more pale in colour.

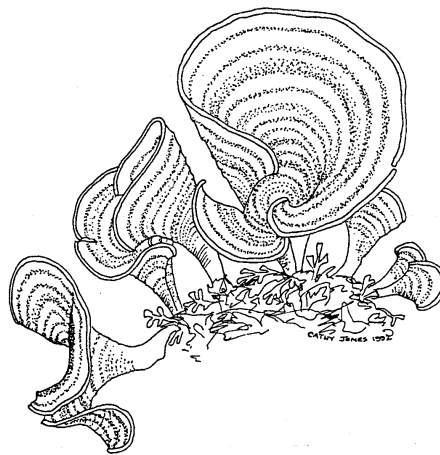
Rarotonga: Titikavena, Poara, Avana; Aitutaki: clam nursery, Arutanga.

#### Genus **Padina** Adanson

#### **Padina boryana** Thivy

Common name: fan-leaf seaweed

Maori name: *Rimu ta'iri'iri*



Thallus fan-like, 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. Apical margin revolute and inrolled to the upper surface; blade 2 cells thick. Upper surface of thallus with concentric rows of fine hairs alternating with rows of non-indusiate (lacking a covering layer) unilocular sporangia. Slender, terete to compressed, 'Vaughaniella' gametophyte stage abundant at the base of the thallus.

#### COOK ISLANDS DISTRIBUTION

Growing in sheltered sandy places, close to the beach or in tide pools, or on coral bommies in the lagoon.

Rarotonga: Matavera (24 June 1992, WAIK 14302), Titikavena, Poara, Avana.

Order **Dictyosiphonales**

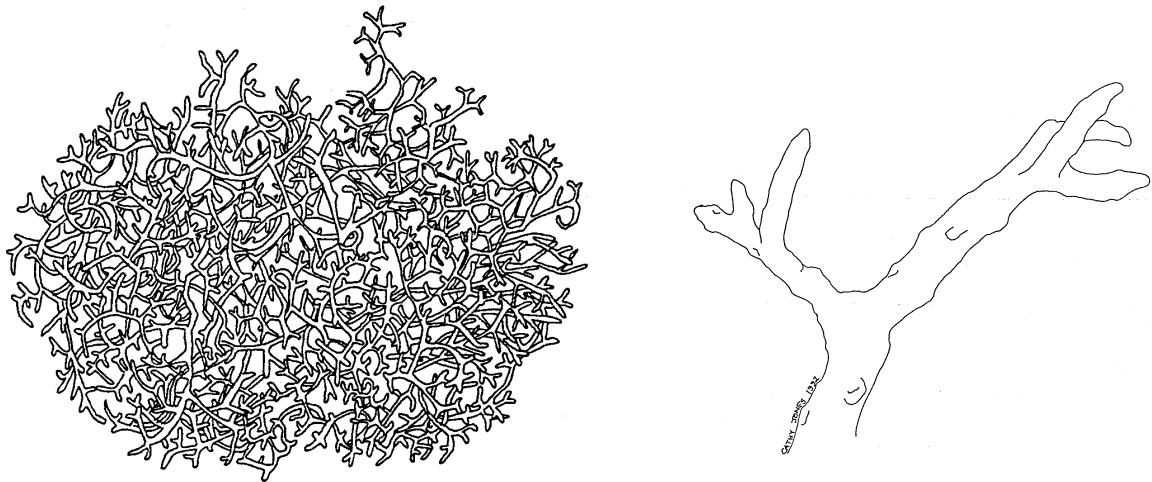
Family **Chnoosporaceae**

Genus **Chnoospora** J. Agardh

**Key to the species of *Chnoospora* in the Cook islands**

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

***Chnoospora implexa* J. Agardh**

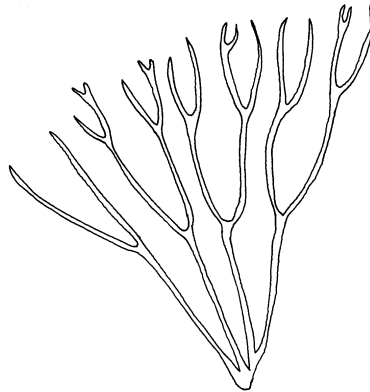


Thallus forming extensive, wiry, compact to lax yellow-brown unattached rubbery masses, up to 30 cm in diameter. Branching divaricately dichotomous, with branches 0.5-1 mm in diameter, terete to compressed. Forking distant below, and becoming denser above (up to the sixth order), axes slightly broadened at dichotomies.

**COOK ISLANDS DISTRIBUTION**

Forms compact unattached lumps on the lagoon floor. This species is seasonal, with peaks of growth yet to be determined in the Cook Islands. Rarotonga: Titikavena (9 November 1992, WAIK)

**Chnoospora minima** (Hering) Papenfuss



Thallus to 13 cm high, dull dark brown, composed of erect, compressed dichotomously branched axes 0.5-1 mm in diameter attached to the substratum via a small discoid holdfast. The axes are characteristically flattened at the point of branch dichotomies, and the branch tips are pointed and usually bifurcate.

**COOK ISLANDS DISTRIBUTION**

Found growing in clumps, on rocks in very exposed reef and makatea areas, together with *Chnoospora minima*.

Rarotonga: Ngatangia.

**Order Scytosiphonales**

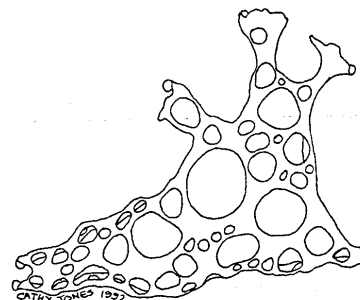
**Family Scytosiphonaceae**

**Genus Hydroclathrus** Bory

**Hydroclathrus clathratus** (C. Agardh) Howe

Common name: open-sponge seaweed

Maori name: *Rimu oma*



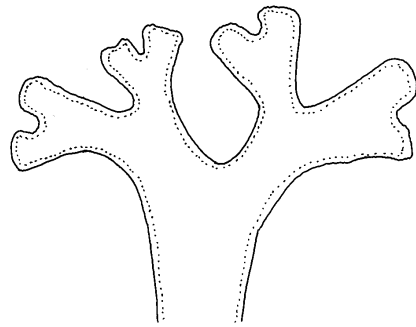
Thallus forming entangled masses to 15 cm across, dark brown, consisting of an expanded, torn and irregularly lobed net-like or sponge-like membrane, with abundant ovoid to spherical holes 3-11 mm in diameter. Attachment vague and diffuse, by means of rhizoids.

#### COOK ISLANDS DISTRIBUTION

Found growing loosely attached to rocks or coral in the lagoon or on the reef crest.  
Rarotonga: Matavera (27 June 1992, WAIK 14301), Muri, Poara.

Genus **Roseningea** Børgesen

**Roseningea intricata** (J. Agardh) Børgesen



Thallus forming strong-smelling, golden brown cushions 5-20 cm across, composed of soft, translucent hollow tubular branches 2-5 mm in diameter. Branching irregular dichotomous, at wide angles, with tapered pointed to truncated tips.

#### COOK ISLANDS DISTRIBUTION

Growing on coral boulders and epiphytic on other algae in the lagoon.  
Rarotonga: ?Muri (12 July 1992, WAIK 14327).



Family **Sargassaceae**

Genus **Sargassum** C. Agardh

**Sargassum mangarevense** (Grunow) Setchell

Maori name: *Rimu akau*



Thallus to 20 cm high, irregularly and densely branched. Stems round, lacking teeth. 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 hair pits (cryptostomata). Air bladders when present on short stalk, spherical to oblong to 4-6 mm wide, often with a leaf-like projection at the tip. Branches growing from a stipe to 2 mm wide, naked below, with several arising from a discoid holdfast. Fertile receptacles present at the base of branches.

**COOK ISLANDS DISTRIBUTION** Growing on the outer edge of the reef rim, and in pools in very exposed parts of the fringing reef or makatea.

Rarotonga: Matavera (1 July 1992, WAIK 14308), Ngatangia, Titikavena, Poara, Avana, Nikao.

**Sargassum sp.**



Plants to 15 cm high, with ovoid, tough, thick, serrated leaves, with prominent spiny gas bladders and receptacles at base of branches. Stem thick and clearly visible, distinctly alternately branched. Basal holdfast single.

**COOK ISLANDS DISTRIBUTION**

Growing in wave-washed areas on the reef. This species is distinguishable from *S. mangarevense* by its more stocky appearance and shorter, thicker leaves, and also the fact that a single stem arises per holdfast. The taxonomic identification of this plant is under investigation, as it could represent a new species.

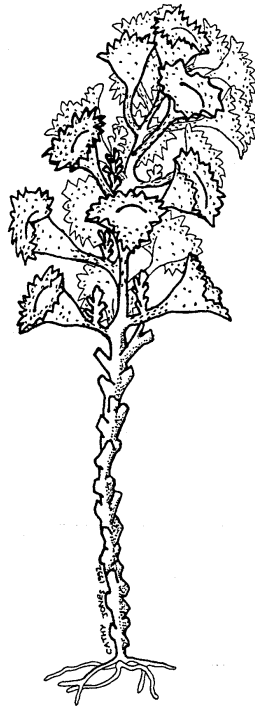
Rarotonga: Matavera (29 June 1992, WAIK 14307), Nikao.

Genus **Turbinaria** Lamouroux

**Turbinaria ornata** (Turner) J. Agardh

Common name: spine-leaf seaweed

Maori name: *Rimu taratara*



Thallus light brown to yellow, stiff and erect with distinctive angular turban-like blades, up to 15 cm tall and 5.5 cm broad. Lateral branchlets generally concave on the top, 1-2 cm wide, with terete stalks for about half their length, terminally distended in a rounded to obpyramidal manner with obtuse ridges; a large vesicle usually occupying the central portion. Up to 13 marginal crown teeth of 3 mm high, on periphery of the top of the leaves, and up to 6 often paired erect teeth arranged at about 120° angle over the peripheral surface of the blades. Up to 18 leaves per plant; principal axes moderately branched, to 3 mm wide. Thallus attached to the substratum by stilt-like haptera up to 2 mm in diameter and 25 mm long.

#### COOK ISLANDS DISTRIBUTION

Growing on the reef crest or rim, together with *Sargassum* spp. Plants can also be found on the top of coral bommies, with their tips just skimming the surface of the water. Plants of sheltered areas are typically longer and more lax than those of the reef crest, which are somewhat stocky and dwarfed.

Rarotonga: present on all reefs. Aitutaki: Araura, Arutanga.

## Division RHODOPHYTA

### Rhodophyta or Red Algae

Rhodophyta, as their name suggests, are the red algae. They are by far the more numerous in tropical regions, and represent a very morphologically diversified group. Except for some rare unicellular species, morphologies vary from simple and delicate filaments (*Griffithsia*) to thick leafy blades several tens of centimetres long (*Meristotheca*), or at the extreme stony forms (*Lithophyllum*).

They show a particular originality with their dominant red (phycoerythrins) and blue (phycocyanins) pigments that mask chlorophyll *a* and *b*. The relative proportions between the different pigments, in conjunction with the shape of the thallus, result in a range of all imaginable colours from dark brown to light pink, purple reds and orange tints. Furthermore, within a single species colour varies according to the exposure to light and often individuals that grow in strong light intensity show washed-off colours where yellow or orange dominate due to the strong concentration of carotenoid pigments. Some groups of red algae are among the deepest known marine plants discovered, growing as deep as 200 metres.

Many species are rich in phycocolloids, which are used in industry to manufacture a variety of chemical compounds used in everyday things like ice cream and lipstick, while several species are edible (*Gracilaria*, *Hypnea*, *Meristotheca*).

In the Cook Islands, this group is represented by mostly subtidal species, although several common red algae such as *Galaxaura* and *Gelidiopsis* are found in the lagoon and on the reef flats. An essentially overlooked section of the red algae are the encrusting corallines, which form pinkish to red or purple paint-like coverings on rocks and coral, and are an essential part of the reef complex owing to their role in cementing together and consolidating the otherwise fragile coral lattice. Coralline algal ridges on the reef crest are also very important as wave breakers, taking and dissipating much of the impact of the large waves that could otherwise swamp low-lying atolls.

### Key to the common genera of Cook Islands Rhodophyta (Red algae)

- 1. Thallus internally calcified ..... 2
- 1. Thallus internally uncalcified ..... 7
  - 2. Thallus segmented ..... 3
  - 2. Thallus unsegmented ..... 5
- 3. Thallus calcified at segment joints ..... **Galaxaura** (in part)
- 3. Thallus uncalcified at segment joints ..... 4
  - 4. Thallus to 1 cm high, always cylindrical, forming dense cushions ..... **Jania**

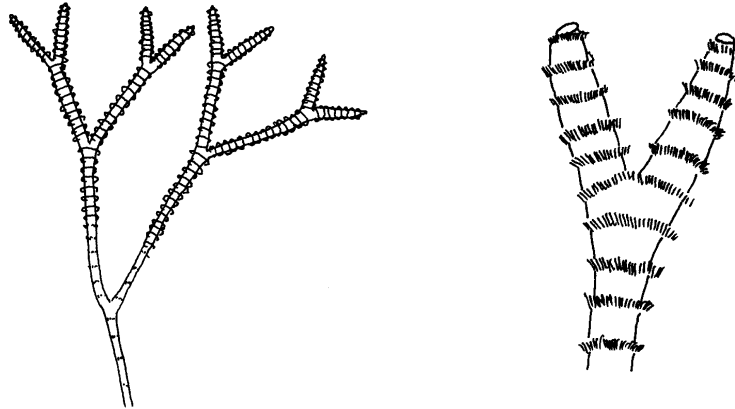
4. Thallus 4-5 cm high, flattened or cylindrical, in lax, brittle clumps .....	<b>Amphiroa</b>
5. Thallus stone-like, or furry, without rings of hairs around branches .....	7
5. Thallus not stone-like, with rings of verticillate hairs around branches.....	<b>Actinotrichia</b>
6. Branches furry, not stone-like .....	<b>Galaxaura</b> (in part)
6. Branches smooth and stone-like .....	<b>Lithophyllum</b>
7. Thallus crustose, with basal external calcification .....	<b>Peyssonnelia</b>
7. Thallus not crustose and lacking calcification .....	8
8. Thallus consisting of a single row of cells .....	<b>Griffithsia</b>
8. Thallus consisting of more than one row of cells .....	9
9. Inner structure filamentous or semi- filamentous .....	10
9. Inner structure cellular, or cellular with sparse hyphae .....	21
10. Thallus procumbent, with multiple attachment points .....	<b>Meristotheca</b>
10. Thallus erect, with a single basal holdfast .....	11
12. Thallus segmented and hollow, consisting of vesicles .....	<b>Chamaebotrys</b>
12. Thallus solid throughout, cylindrical at least basally, and unsegmented .....	13
14. Thallus forming rosettes, differentiated into a rigid naked stem and leaf-like ultimate branchlets with a midrib and inrolled tips .....	<b>Amansia</b>
14. Thallus not forming rosettes, and not differentiated into a rigid stem and leaf-like ultimate branchlets with inrolled tips .....	15
15. Thallus plumose .....	16
15. Thallus not plumose .....	17
16. Thallus to 10 cm high, with a naked creeping stolon .....	<b>Asparagopsis</b>
16. Thallus to 1 cm high, lacking a creeping stolon .....	<b>Wrangelia</b>
17. Thallus unbranched in lower portions but irregularly branched above; side branchlets short and truncate, alternately to radially arranged .....	<b>Laurencia</b>
17. Thallus not as above .....	18
18. Thallus greenish-yellow, tough and wiry with oppositely-branched axes, forming decumbent clumps on the reef crest .....	<b>Gelidiella</b> (in part)
18. Thallus not decumbent or not as above .....	19
19. Thallus wiry and flexible; axes cylindrical or compressed and distally palmate; tetrasporangia in terminal bulb-like swellings .....	<b>Gelidiopsis</b>
19. Branches cylindrical or flattened; always arcuate; proliferous side branchlets sometimes present; tetrasporangia zonate and occurring in saddle-shaped sori on the underside of branchlets.....	<b>Hypnea</b>

Order **Nemaliales**

Family **Galaxauraceae**

Genus **Actinotrichia** Decaisne

**Actinotrichia fragilis** (Forsskål) Børgesen



Thallus bushy, to 6 cm high, reddish orange, relatively stiff and composed of cylindrical, dichotomously branched axes with characteristic rings of verticillate filaments or hairs regularly spaced on the surface. Lightly calcified.

**COOK ISLANDS DISTRIBUTION**

Growing as stiff clumps on the reef flat and on coral bommies in the lagoon.  
Rarotonga: Titikavena, Poara; Aitutaki: Araura.

Genus **Galaxaura** Lamouroux

**Key to the common Cook Islands species of *Galaxaura***

- 1. Thallus flattened ..... *G. marginata*
- 1. Thallus cylindrical..... 2
  - 2. Branches furry, with hair-like filaments, lacking annulations .....3
  - 2. Branches smooth, glabrous, with distinct annulations near tips ..... *G. rugosa*
- 3. Branches sparsely covered with filaments which are both long and short .....*G. fasciculata*
- 3. Branches densely covered with filaments of uniform length ..... *G. filamentosa*

### ***Galaxaura fasciculata* Kjellman**

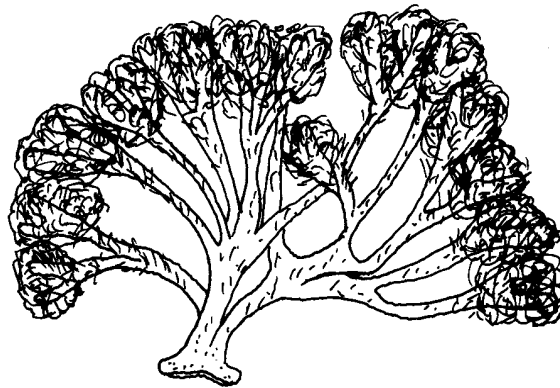


Thallus to 8 cm high, forming stiff compact clumps. Main axes to 2 mm wide, cylindrical and dichotomously branched, whitish and moderately calcified. The branches are covered sparsely with reddish-brown filaments which appear both long and short under the microscope.

Cook Islands distribution:

Commonly found growing on coral bommies in the lagoon and on the reef flat.  
Rarotonga: Titikavena, Poara, Avana, Nikao; Aitutaki: Araura.

### ***Galaxaura filamentosa* Chou**



Thallus to 3 cm high, reddish white, forming hairy clumps with cylindrical, dichotomous pom-pom-like branches 2-4 mm in diameter densely covered with filaments of uniform length. Plant lightly calcified.

#### **COOK ISLANDS DISTRIBUTION**

Growing in isolated clumps, on the reef flat.  
Rarotonga: Nikao.

**Galaxaura marginata** (Ellis et Solander) Lamouroux



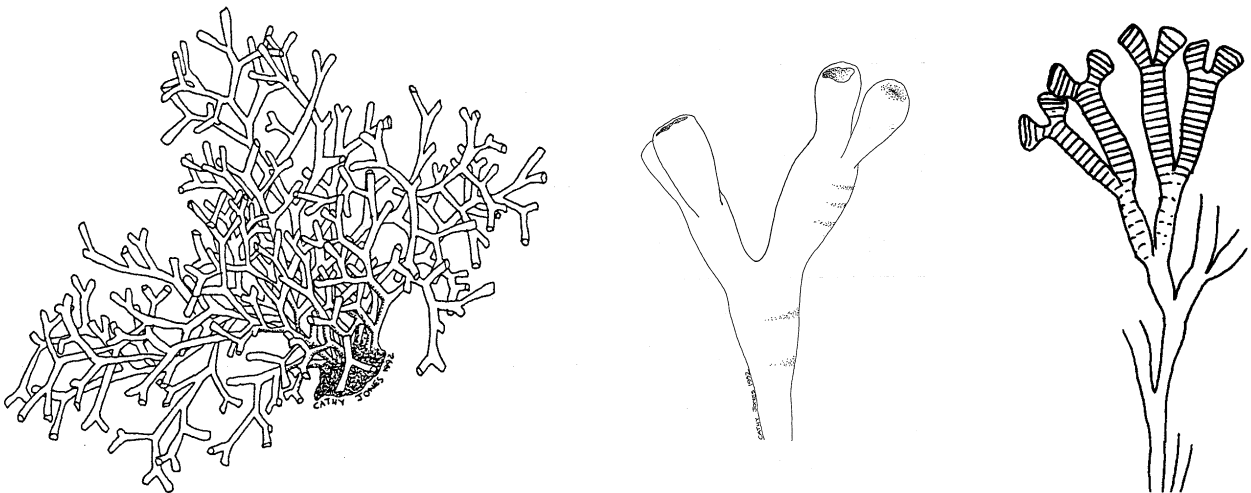
Thallus to 8 cm high, flattened and dichotomously branched. Lightly calcified. Branches 1-2.5 mm wide, with slightly thickened margins and obtuse bifurcate tips. Raised needle-like microscopic cells are sometimes present on marginal portions of the blade.

**COOK ISLANDS DISTRIBUTION**

Growing on coral bommies, in the lagoon and reef flat.

Rarotonga: Nikao. Aitutaki: Araura.

**Galaxaura rugosa** (Ellis et Solander) Lamouroux



Thallus to 5 cm high, yellow-orange to purple-pink, composed of soft, hollow, cylindrical densely subdichotomously branched axes 0.7-1 mm in diameter, with truncate obtuse pitted



branch tips. Characteristic rings or annulations are present on upper parts of the branches, near the tips. No hairs are present on upper branches.

#### COOK ISLANDS DISTRIBUTION

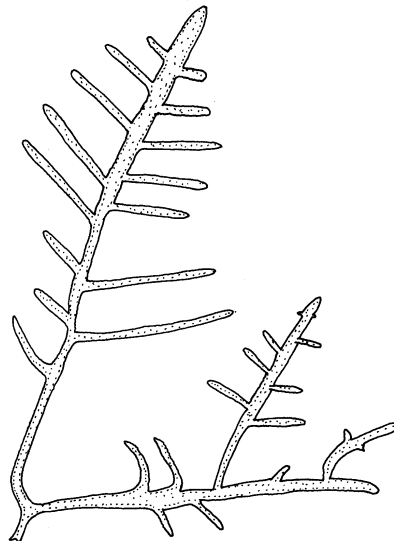
Common on the inner and outer reef flat and on coral bommies in the lagoon.  
Rarotonga: Matavera (1 July 1992: WAIK 14309), Titikavena, Poara, Avana, Nikao.

#### Order **Gelidiales**

#### Family **Gelidiaceae**

#### Genus **Gelidiella** Feldmann et Hamel

#### **Gelidiella acerosa** (Forsskål) Feldmann et Hamel



Thallus greenish-yellow, forming tough, wiry decumbent clumps to 10 cm across, composed of oppositely-branched axes 0.5-1 mm in diameter. Internal structure cellular.

#### COOK ISLANDS DISTRIBUTION

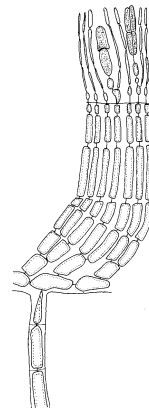
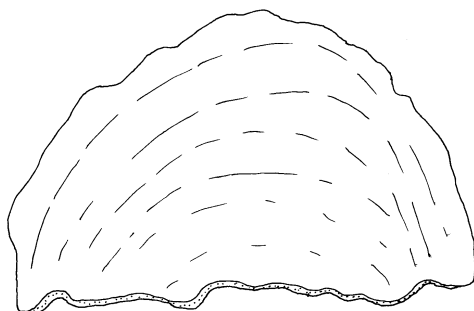
Found growing on coral bommies in the lagoon, and as a turf on the reef rim, in exposed areas.  
Aitutaki: Araura.

#### Order **Cryptonemiales**

#### Family **Peyssonneliaceae**

Genus **Peyssonnelia** Decaisne

**Peyssonnelia bornetii** Boudouresque et Denizot



Thallus forming brittle and rigid dark brownish red crusts, with distinct concentric lines on upper surface; lower surface whitish and heavily calcified, 5-8 cm across and up to 600  $\mu\text{m}$  thick (including hypobasal calcification); edges not curling upwards when dry. Internal structure cellular, with 6-7 layers of uncalcified, regularly arranged rectangular to elongate cells. Basal rhizoids multicellular, 8-10  $\mu\text{m}$  in diameter, lightly septate and abundant.

**COOK ISLANDS DISTRIBUTION**

Growing appressed to coral debris in the lagoon.  
Rarotonga: Titikavena.

Order **Corallinales**

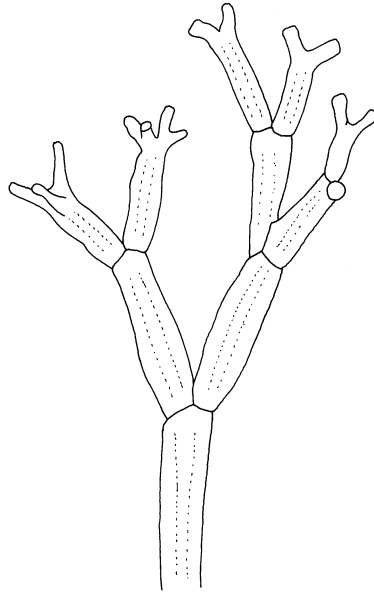
Family **Corallinaceae**

Genus **Amphiroa** Lamouroux

**Key to the common species of Cook Islands *Amphiroa***

- 1. Branches cylindrical ..... *A. fragilissima*
- 1. Branches flattened, with more or less pronounced wings ..... *A. foliacea*

***Amphiroa foliacea* Lamouroux**

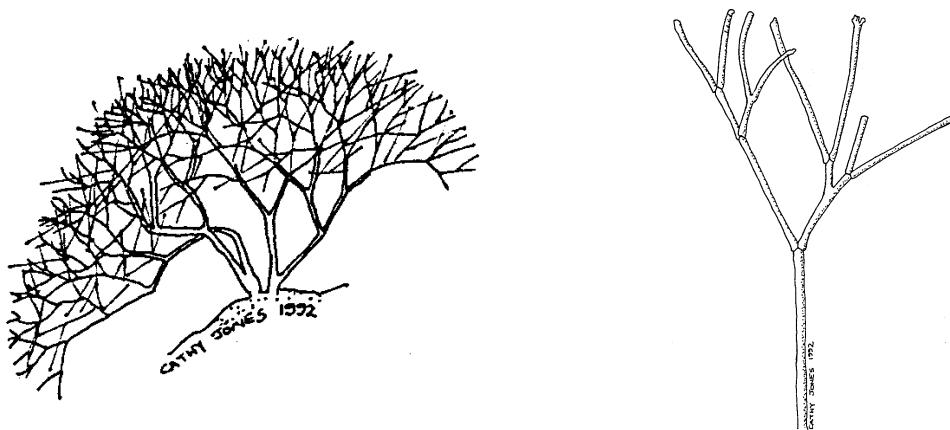


Thallus to 35 mm high, purple-pink, forming loose, clumps of flattened or wing-like , heavily calcified irregularly dichotomously branched axes. Branches segmented, 2-4 mm long and 1-2 mm in diameter, with the edges so flattened as to give a keeled, raised appearance to the middle section.

**COOK ISLANDS DISTRIBUTION**

Growing on coral bommies in the lagoon.  
Aitutaki: Araura.

***Amphiroa fragilissima* (Linnaeus) Lamouroux**



Plant forming pale-pink, erect brittle clumps to 5 cm high, heavily calcified and solid throughout. Branches segmented and cylindrical, Y-shaped and dichotomously branched,

segments 1-4 mm long and 0.3-0.5 mm in diameter. Faint pink rings are visible near the tips of younger branches.

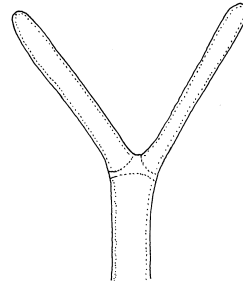
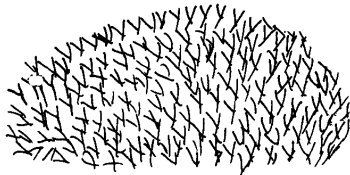
#### COOK ISLANDS DISTRIBUTION

Growing on *Halimeda* and coral rubble in the lagoon and on the reef flat.

Rarotonga: Rutaki (11 July 1992: WAIK 14324), Titikavena, Nikao, Ngatangiia. Aitutaki: Araura.

#### Genus **Jania** Lamouroux

#### **Jania adhaerens** Lamouroux



Plants forming cushions up to 10 mm high, with individual plants branching in Y-fashion at angles of more than 45°. Branches 190-200 µm in diameter, the segments 3-5 diameters long with articulations at the base of each branch and often between forkings. Apex of branches conical, rounded to acute.

#### COOK ISLANDS DISTRIBUTION

Common on most reefs, forming clumps on the reef flat and reef crest. These clumps are microhabitats for a number of smaller algal species and other organisms.

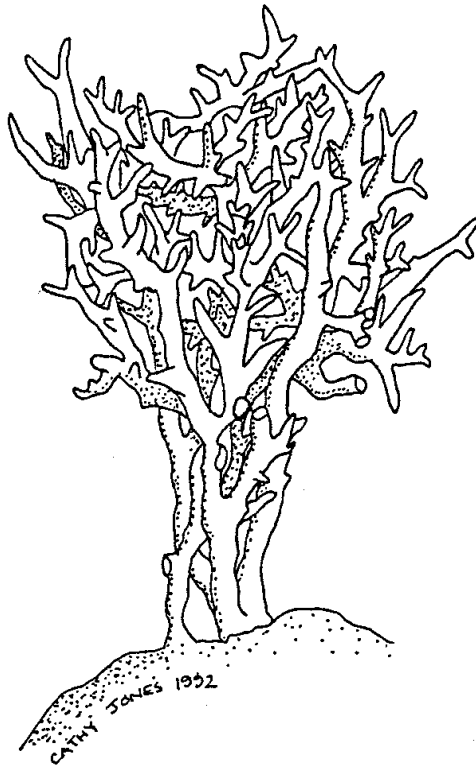
Rarotonga: Titikavena, Poara, Avana.

#### Family **Mastophoroideae**

#### Family **Lithophylloideae**

#### Genus **Lithophyllum** Philippi

**Lithophyllum sp**



Plant to 6 cm high, forming hard, stony and spiky clumps or unattached balls. Colour is pale pink at the tips, becoming deep salmon pink further down and grayish towards the base. Unattached specimens are often bleached white to cream. The main axes are cylindrical, 2-3 mm wide and irregularly branched, with pointed to blunt tips.

**COOK ISLANDS DISTRIBUTION**

Commonly found in the lagoon, either attached to coralline surfaces or as unattached balls on the lagoon floor.

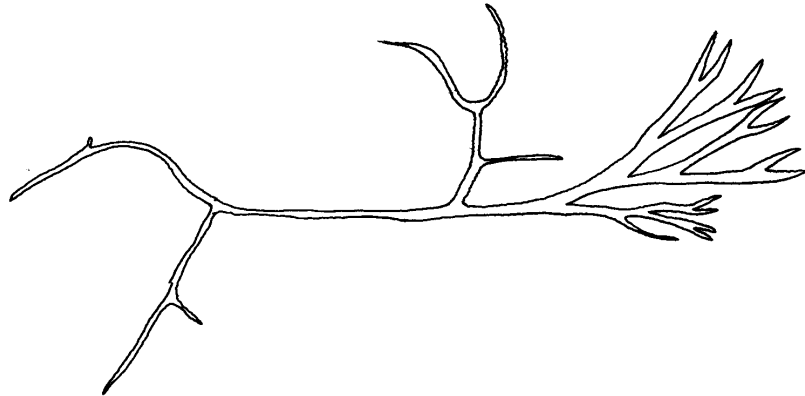
Rarotonga: Rutaki (12 July 1992, WAIK 14325), Muri, Titikavena, Poara.

**Order Gigartinales**

**Family Gracilariaceae**

**Genus Gelidiopsis Schmitz**

**Gelidiopsis repens** (Kützing) Weber-van Bosse



Thallus to 40 mm high, deep reddish-maroon, wiry and flexible. Axes ligulate, compressed below and distally flattened; dichotomously branched and palmate above. Branch tips usually forked and sharp. Internal structure is cellular, not filamentous.

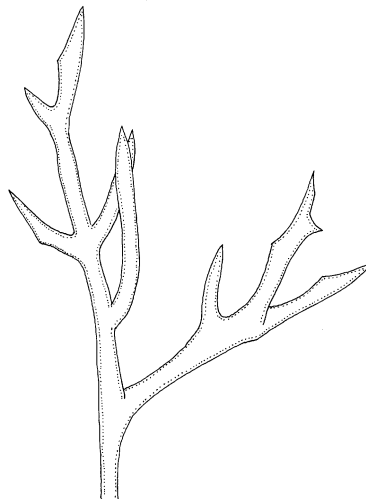
**COOK ISLANDS DISTRIBUTION**

A common alga growing on coral bommies and in the algal turf on the reef flat and rim.  
Rarotonga: Titikavena, Poara, Nikao.

**Family Hypneaceae**

**Genus Hypnea** Lamouroux

**Hypnea saidana** Holmes



Thallus to 40 mm high, yellowish-red and cartilaginous, composed of strongly compressed to flattened, arcuate axes 1-2 mm wide and branched in a single plane. Branches often entangled and fused with each other, and having short, secondary branchlets mostly one side (second) or on opposite sides at different levels (alternate) giving a spiky appearance to the thallus.

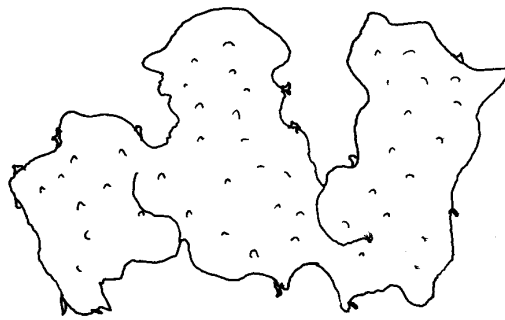
#### COOK ISLANDS DISTRIBUTION

Growing in clumps, on the sides of coral bommies in the lagoon.  
Rarotonga: Titikavena, Ngatangia. Aitutaki: Araura.

#### Family **Solieriaceae**

Genus **Meristotheca** J. Agardh

**Meristotheca procumbens** P. Gabrielson et Kraft



Thallus deep-pink to dark red, forming cartilaginous, smooth and flattened blades 6 to 12 cm across, turgid, with a decumbent habit. Plants are irregularly branched or lobed, with an iridescent sheen on the upper surface. The edges are often ruffled, with multiple haptera or attachment pads issued from the margins and underside of the thallus. Internal structure loosely filamentous, with characteristic stellate cells close to the surface.

#### COOK ISLANDS DISTRIBUTION

Found growing in subtidal habitats, attached to coral. May also be found in exposed areas of the reef flat, in interstices and below *Sargassum* cover. In other parts of the Pacific (e.g. Rotuma), this species is commonly eaten raw or cooked.

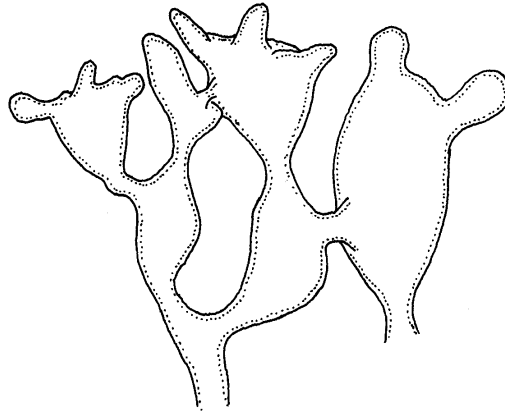
Rarotonga: Ngatangia, in front of school, -12 metres on the reef slope.

#### Order **Rhodymeniales**

Family **Rhodymeniaceae**

Genus **Chamaeobotrys** Huisman

**Chamaeobotrys boergesenii** (Weber-van Bosse) Huisman



Thallus to 30 mm high, deep-red and turgid, composed of hollow dichotomously branched vesicles 3-5 mm high which are often laterally fused with each other.

**COOK ISLANDS DISTRIBUTION**

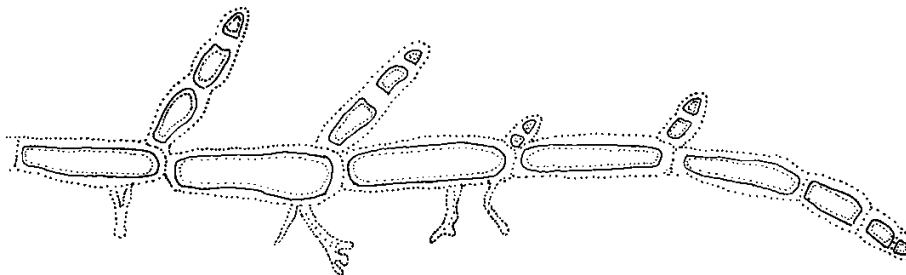
Growing attached to coral and other surfaces in relatively shallow subtidal habitats.  
Rarotonga: Arorangi (26 January 1999), -12 metres depth on coral.

Order **Ceramiales**

Family **Ceramiaceae**

Genus **Griffithsia** C. Agardh

**Griffithsia subcylindrica** Okamura



Thallus light purple to red, up to 10 mm long; and 160-300  $\mu\text{m}$  in diameter, composed of ellipsoidal to subcylindrical cells, about 70x170  $\mu\text{m}$  in middle of thallus. Branching irregularly lateral. Basal rhizoidal filaments up to 50 mm in diameter, spaced at 50-170  $\mu\text{m}$  intervals. Forms soft clumps.

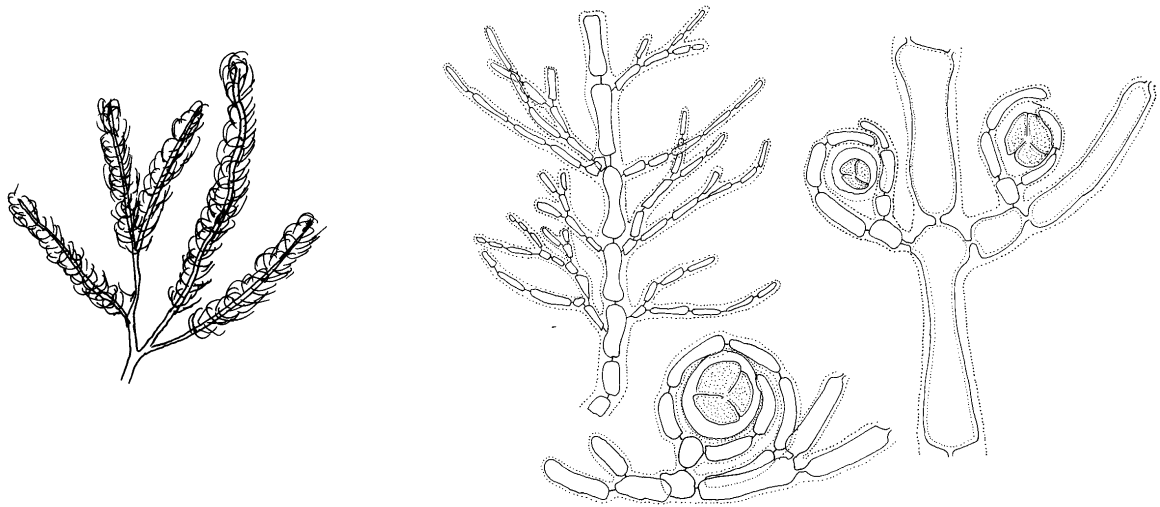


COOK ISLANDS DISTRIBUTION

Growing on the sides of coral bommies in the lagoon.  
Rarotonga: Matavera, Titikavena.

Genus **Wrangelia** C. Agardh

**Wrangelia argus** (Montagne) Montagne



Plants in turf-like colonies, purple red with a slight iridescence; 5-7 mm high and 1.5-1.8 mm broad, plumosely branched in two indistinct ranks. Main axis 41-58  $\mu$ m in diameter, uncorticated with determinate lateral branchlets 17-24  $\mu$ m in diameter terminating in attenuate cells. Tetrasporangia 55-60  $\mu$ m in diameter, surrounded by short-celled involucre filaments.

COOK ISLANDS DISTRIBUTION

Growing as a turf on the reef rim, along with *Laurencia*.  
Rarotonga: Nikao.

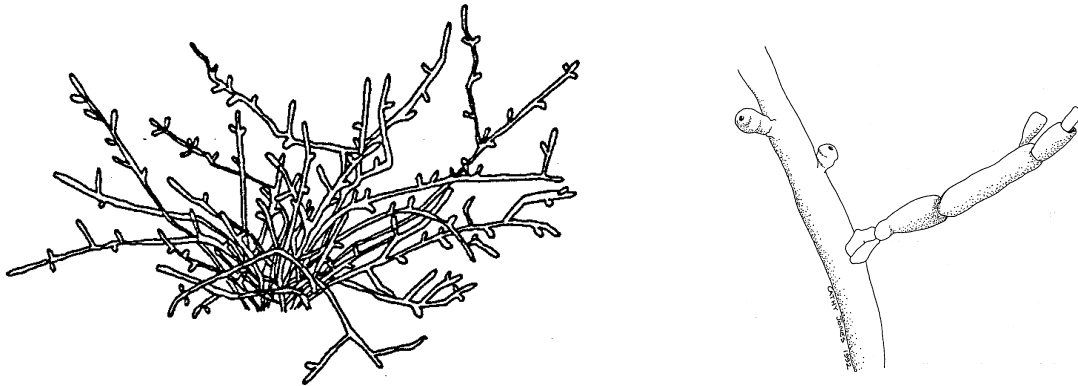
Family **Rhodomelaceae**

Genus **Laurencia** Lamouroux

**Key to the common species of Cook Islands *Laurencia***

- 1. Thallus deep red, to 2.5 cm high, branch tips with groove-like slit ..... *L. succisa*
- 1. Thallus purplish-brown, to 8 cm high, branch tips lacking slit-like groove ..... *L. flexilis*

**Laurencia flexilis** Setchell



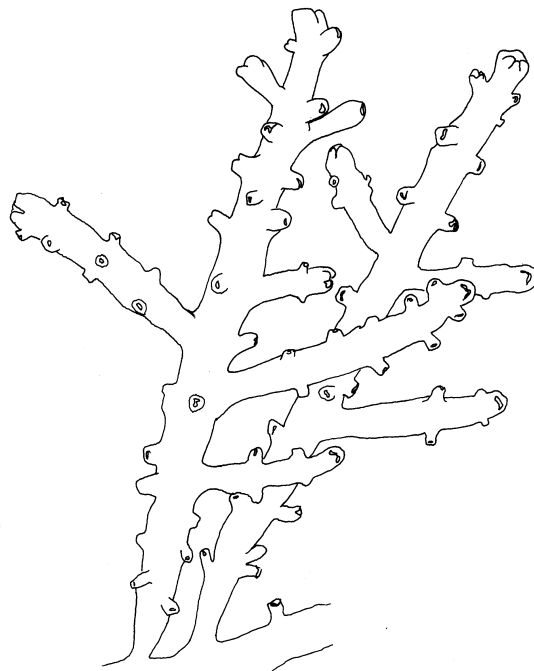
Thallus to 8 cm high and 2-3 mm in diameter, dark purplish brown, forming cartilaginous but flexible clumps. The main axes are erect, cylindrical and unbranched in lower portions but irregularly branched above, with short truncate side branchlets 0.5-1 mm long arranged in irregularly alternate to radial fashion around the distal portions of the axes.

**COOK ISLANDS DISTRIBUTION**

Found growing on shells, rocks and other hard surfaces in the upper littoral and on the reef rim, and in exposed wave-washed areas of the coastline.

Rarotonga: Rarotongan Hotel, Titikavena, Ngatangia. Aitutaki: Araura.

**Laurencia succisa** Cribb



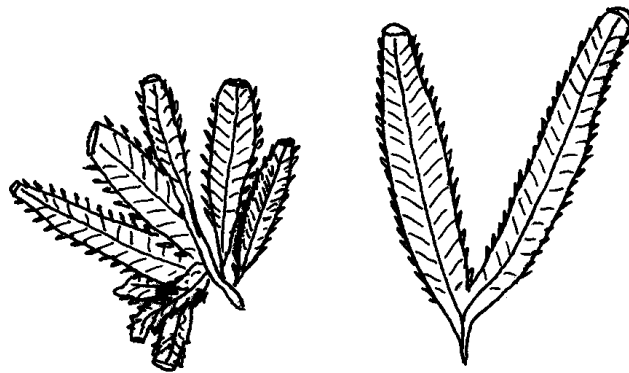
Thallus 10-25 mm high, deep red, decumbent to erect, composed of rigid, compressed axes 3-4 mm in diameter. Axes with broad tips and curved slit-like distal grooves, bearing frequent, short and simple, distichous, mostly cylindrical ultimate branchlets.

#### COOK ISLANDS DISTRIBUTION

Growing in clumps on coral, on the reef flat and on other algae.  
Rarotonga: Titikavena.

#### Genus *Amansia*

#### *Amansia* sp.



Thallus to 10 cm across, forming deep-red leafy rosettes. The individual blades are crisped and lanceolate, up to 35 mm long and 6 mm wide, with serrated edges, a distinct midrib and characteristically inrolled tips. Main axis is irregularly branched, stem-like and rigid in basal portions, to 0.8 mm in diameter. Internal structure cellular, with a central axial cell surrounded by five pericentral cells. Tetrasporangia occur in curved, trichotomously branched stichidia to 340  $\mu$ m long borne marginally on the blades.

#### COOK ISLANDS DISTRIBUTION

Rarotonga: Ngatangia (9 July 1999).  
(Formerly known as *Amansia glomerata*, this species is currently under taxonomic revision)

## Uses of Seaweeds

Seaweeds have been used by humans for a very long time, mainly as food and as a source of chemical substances in industry. In Japan, some 21 species of seaweeds are used daily as food, whereas 9 species are commonly eaten in Fiji (South 1993 ; N'Yeurt 1995). In the phycocolloid industry, polysaccharides are particularly sought. These fall into three categories: alginates (derivatives of alginic acid), agars and carrageenans. The first is extracted solely from brown seaweeds whilst the last two are extracted only from red seaweeds. There are a number of artificial products reputed to be suitable replacements for polysaccharides but none have the exact gelling and viscosity properties of those extracted from seaweeds and it is very unlikely that seaweeds will be replaced as the source of these polysaccharides in the near future (Guiry 1997). Alginates from brown seaweeds of the orders Laminariales and Fucales are mainly used in medical dressings, for polishing in the textile industry, and as a stabilizing agent in ice cream. Agar from the red seaweeds *Pterocladia* and *Gelidium* is mainly used as a solid microbiological culture substrate, and in the food industry. Carrageenans are mainly derived from the red seaweed *Chondrus*, to give a gel with special properties much sought after in industry. A further possible use of seaweeds is in making bookmarks, when particularly pleasing specimens are pressed on paper and laminated.

In the Western Pacific and in particular the Fiji Islands in Melanesia, at least nine species of marine algae are commonly used as food. The green algae *Caulerpa racemosa* ('nama'), *Codium geppiorum* ('sagati') and *Enteromorpha intestinalis* are eaten raw as a seasoned salad, while the red seaweeds *Hypnea pannosa* ('lumicevata'), *Gracilaria* sp. ('lumiwawa'), *Solieria robusta* ('lumitamana'), *Acanthophora spicifera* ('lumikava') and *Meristotheca procumbens* ('lum mi'a') are eaten cooked in coconut milk with condiments added to make use of their gelling properties. Species of the brown seaweed *Sargassum* are used when dried as a decoration for traditional dance outfits in Rotuma Island, while the dry green algae *Codium arabicum* was formerly used as an abrasive to scour pots and pans.

In Polynesia, Abbott (1991) reports several species eaten in Hawaii, including the red algae *Halymenia floresia* and *Asparagopsis taxiformis*. In the Cook Islands *Caulerpa racemosa* ('rimu') is favored as a salad, while in French Polynesia *Caulerpa racemosa* and *Caulerpa bikinensis* are eaten as a salad in the Austral islands. Setchell (1926) reports *Ulva lactuca* ('rimu miti') being formerly eaten in Tahiti.

Many species of seaweeds are cultured commercially, especially *Kappaphycus* and *Caulerpa racemosa* in the South Pacific. To date no aquaculture of seaweeds has been carried out in the Cook Islands, but it is a possibility to be looked into in the future, as there are many islands which are doubtless suitable for seaweed farming. The main factors possibly hindering such developments will be the economic viability of the ventures, especially shipping costs to the markets which are mostly located in Asia.

## **Collection, preservation and processing of marine algae**

The collection of marine algae in the field and the subsequent preservation and creation of a reference herbarium can be a rewarding experience for the marine life enthusiast. It is also a very good way to illustrate the marine plant biodiversity in a particular locality.

### **Collection**

Collecting of marine algae can either be done by reef walking, snorkelling or SCUBA diving. On many tropical reefs, a casual walk on the fringing or barrier reef should yield a fair number of common species which can be collected for further identification. More thorough searches in the lagoon and outside the reef by SCUBA will yield many more species, some of them rare or possibly new to science. Plants should be as far as possible collected whole with their holdfasts (if any) intact, and immediately placed in plastic bags or containers with an amount of seawater to keep the algae fresh until the preservation stage. Labels on waterproof paper can be added in the bag, on which are written in pencil information on the collecting site, date, habitat, and collector. Encrusting or coralline algae can be pried out with a knife, or small pieces broken off with a geological hammer. While collecting, care should be taken not to disturb the natural habitat, especially while SCUBA diving on coral reefs. Damage to corals by breaking them or by careless use of fins should be avoided. Over-collecting should also be avoided, and only representative samples taken of each species. For very rare or fragile algae, an option to be considered is only photographing the specimen in its natural habitat, which is a non-destructive data collecting method.

### **Preservation**

For fleshy macroalgae, 3-5% formalin (made from 37% commercial formaldehyde solution diluted in seawater, with a little sodium bicarbonate added to reduce acidity) is a good fixative. Care should be taken to avoid contact of this solution with the skin and breathing its vapours, as it is a potential carcinogen. The samples can be roughly sorted out in taxa in the field, then soaked in the formalin-seawater solution overnight to a few days away from light (which has a tendency to bleach the fixed algae).

### **Processing**

Once fixed, seaweeds can be pressed as herbarium specimens for permanent record. For this purpose, a simple algal press can be constructed from available materials. The seaweeds are taken out of their storage containers and briefly rinsed in fresh water, then floated-out in a tray filled with tap water. Suitable pieces of white card stock (on which collecting data was previously inscribed with pencil) are laid under the floating algae, and the whole gently lifted at an angle of 30-45 degrees to drain excess water. While still wet, the specimen can then be esthetically arranged with forceps or paintbrushes on the card, until the desired effect is given. For rare or unidentified algae, small pieces of thallus can be cut off and stored in small vials with 3-5% formalin-seawater for later microscopic investigation. The seaweed laid out on the cards are placed on a few sheets of blotting

paper or newsprint, and covered with a piece of cheesecloth or thin synthetic curtain material (to avoid sticking) and another layer of blotters or newsprint placed on top. This is then sandwiched between pieces of heavy corrugated cardboard or corrugated metal sheets, and repeated as needed depending on the number of specimens. The whole plant press is then strongly strapped together, or heavy objects placed on top such as books. It is then placed in a warm and dry, possibly windy place. A fan can be used to force air across the press to speeden drying. Blotters should be changed about two hours after the first application, then at least twice a day after until the specimens are dry to the touch. Coralline algae can be soaked for several days in a solution of about 40% glycerin in 3% buffered formalin-seawater before being air-dried and stored in labeled lightproof boxes. More delicate microscopic species should be processed as microscope slides, stained in 1% aniline or cotton blue (with a drop of 10% HCL added as a fixative) and mounted in 50% glycerin or clear corn syrup. Once dry, the seaweed (if on card) are placed on A3 sheets of white card with a label (Figure 6) containing the scientific name, authority, collecting date and locality and habitat information in the right-bottom corner. Slides can be labeled and stored in slide cabinets, taking care to seal the coverslips with nail varnish to prevent dessication.

<b>South Pacific Regional Herbarium</b> <b>Phycological Herbarium</b>	
<b>MARINE ALGAE OF THE COOK ISLANDS</b>	
<hr/>	
Locality _____	Habitat _____
Date __ / __ / __	Collector _____ Det _____

Figure 6. A typical herbarium label

## **Acknowledgments**

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## Glossary to common scientific terms relating to algae

(Adapted from Hine, 1977)

### A

**Adherent:** Attached more or less firmly.

**Adjacent:** situated close.

**Air bladders:** gas-filled vesicles. Common in Fucales (Phaeophyta).

**Alga** (plural, algae): a photosynthetic plant that reproduces by spores; lacking true stem, leaves, roots, flowers and seeds.

**Alternately branched:** branches occur on opposite sides of the axis at different levels.

**Angular:** with divergent parts.

**Annular:** ring-like

**Apex:** growing tip, top of the axis.

**Apical:** at or near the apex (e.g. apical cell).

**Arcuate:** curved like a bow. Crescent-shaped.

**Articulated:** having a series of calcified segments separated by flexible uncalcified joints.  
See *Halimeda* (Chlorophyta) or Corallinales (Rhodophyta).

**Assimilatory cell:** photosynthetic cell borne on the surface of the plant.

**Atoll:** ring-shaped reef, surrounded by ocean, enclosing a lagoon with no central high island.

**Author:** person who described a given species, whose name appears after the Latin epithets (scientific name) of an organism.

**Attenuated:** narrowing towards the end.

**Auricular:** shaped like an ear.

**Axial:** around or along an axis. Pertaining to the primary filament. Located in the centre.

**Axis** (plural, axes): main branch; central part of development of the plant, around which the branches are borne.

### B

**Barrier reef:** a reef that is separated from the land by a lagoon.

**Basal:** nearest the point of attachment.

**Benthic:** referring to the attached plant forms of marine and aquatic environment.

**Bifurcate:** divided into two parts; forked.

**Blade:** the foliar portion of the alga, generally flattened and expanded.

**Bleached:** of a lighter colour than is usual.

**Blunt:** ending in a rounded form.

**Branchlet:** any small or secondary branch. Smaller axes emanating from a main axis or larger branch.

**Bulbous:** bulb-like, with a swollen end.



## C

**Calcareous** (calcified): impregnated with calcium carbonate, mineralised from the surrounding water.

**Carposporangia**: single-celled structures produced by the cystocarp, which germinate into the tetrasporophyte generation.

**Cartilaginous**: fleshy but firm. Not easily compressed.

**Clavate**: club-shaped.

**Complanate**: flattened

**Compressed**: flattened

**Concentric**: zones that parallel the margin of a blade, with a common centre (see *Padina*).

**Conceptacle**: a cavity containing reproductive organs and opening to the surface.

**Conical**: shaped like a cone.

**Constricted**: transversely narrowed or contracted. Narrow in certain place.

**Contiguous**: parts of a plant that are in contact.

**Convex**: a surface curving outwards

**Coralline**: with the structure composed of calcium carbonate. See Corallinaceae.

**Corona**: small crown of rudimentary branchlets (see *Polyphysa*)

**Cortex**: outer layer of tissue, lying beneath the epidermis and always outside the medulla.

**Cortical**: belonging to the cortex.

**Corticated**: with a cortex.

**Cortication**: the secondarily formed outer covering of part or of all of an algal thallus.

**Creeping**: growing along the substrata and attaching at intervals along its entire length.

**Crenulate** (Crenellate): with minute rounded teeth.

**Crisped**: crinkled or curled.

**Cruciate**: divided into two planes at right angles. Cross shaped planes of division separating tetraspores.

**Crustose**: crust-like in habit.

**Cuneate**: wedge-shaped. Triangular with the acute angle downward.

**Cystocarp**: swollen reproductive structure on female Rhodophyta, producing carposporangia. It represents the minute, parasitic carposporophyte generation in the red algal life cycle.

## D

**Decalcification**: process of dissolving the calcium carbonate matrix (as with dilute Hydrochloric acid) of a calcareous alga to examine the cellular structure.

**Decumbent**: creeping, loosely following the substratum, but with the apex or margin ascending.

**Delicate**: fine

**Dense**: crowded together.

**Dentate**: with teeth pointed outward.

**Diaphragm**: a cellular partition across a hollow thallus (as in *Champia*, Rhodophyta).

**Dichotomous** (dichotomously branched): divided or forked into two equal parts. Branched by repeated forkings.

**Discoïd** (disc-like): resembling a disc. Flat and circular.

**Distal**: opposite of basal. At the free end

**Distichous**: arranged in two vertical rows or ranks, along the opposite sides of an axis or branch.

**Divaricate**: forked at a widely diverging angle.

**Dorsal**: the upper surface of a prostrate plant. Relating to the outer surface of a plant.

**Dorsiventral**: with distinct dorsal and ventral surfaces.

## E

**Elongate**: long and narrow.

**Entire**: having a smooth margin, not toothed, notched or divided.

**Epilithic**: growing attached to a rock or hard substrata.

**Epiphytic**: growing attached to a plant, not parasitic.

**Erect**: of vertical growth.

## F

**Fertile**: bearing organs of reproduction.

**Fibrous**: composed of coarse, threadlike fibres.

**Filament**: slender threadlike row of cells attached end to end.

**Flabellate**: like an expanded fan; blade-like (see *Avrainvillea*, *Padina*).

**Flaccid**: soft and pliable. Not firm or turgid.

**Fleshy**: soft, smooth. Not slimy or mucilaginous.

**Flexuous**: not firm or rigid, pliable.

**Foliar**: belonging to leaves, or leaf-like organs.

**Forcipate**: forked and incurved like pincers.

**Forked**: divided into branches, usually in pairs.

**Free** (Freely): unattached, not attached laterally.

**Fringing reef**: a reef running parallel to, and attached to the shoreline or an island or land mass that is not separated by a lagoon.

**FronD**: blade or leaf-like structure of an alga.

**Fusiform**: swollen in the middle and tapering toward each end.

## G

**Gametophyte**: a plant which is genetically constituted to produce gametes.

**Gelatinous**: of jelly-like consistency ; a certain degree of firmness is implied.

**Genus** (plural Genera): the smallest natural or related grouping of plants containing distinct species. First Latin name of a scientific name.

**Glabrous**: having a smooth surface; lacking any hair.

**Globose**: nearly spherical in form.

## H

**Habit:** general aspect of a plant or its mode of growth.

**Habitat:** the place where an organism is typically found.

**Haptera:** a branched organ of attachment.

**Hirsute:** covered with rather rough or coarse hairs.

**Holdfast:** root-like or disc-like structure that attaches an alga to the substratum.

## I

**Indusiate:** with a membrane (indusium) covering superficial reproductive structures (see *Padina pavonica*).

**Inflated:** swollen.

**Intercalary:** between the apex and the base; between two nodes.

**Intergenicular:** belonging to the calcified segments between uncalcified articulations in certain red (Corallinaceae) and green algae (*Halimeda*).

**Interstice:** a space between two bodies.

**Intertidal:** occurring between high and low tides marks.

**Iridescent:** glowing or shining, reflecting an interplay of rainbow-like colours.

**Irregular:** (branching) not of the same type throughout; (cells) of varying shapes and dimensions.

**Isodiametric:** having equal diameters.

## J

**Joint:** the junction between segments or end walls between contiguous cells in filament (often termed node). See *Amphiroa*.

## K

**Keeled:** having a lengthwise ridge, like the keel of a boat. See *Amphiroa foliacea*.

## L

**Lacerate:** appearing as if torn or irregularly cleft.

**Lagoon:** a relatively deep (5-30 m) protected area behind a reef front; the area separated from the sea by a barrier reef ; the central portion of an atoll.

**Lanceolate:** lance-shape. Much longer than broad, broadest at the base and tapering toward the apex.

**Lateral:** on, or at the side.

**Lax:** loose. Distant.

**Lenticular** (thickening): shaped like a thick convex lens (see *Laurencia*).

**Ligulate:** strap-shaped.

**Lobed:** having large, rounded divisions of the margin.

**Long:** measure of the longest axis.

**Lubricous:** smooth. Slippery. Slick.

## M

**Mamillate:** provided with small protuberances or projections.

**Marginal:** at the edge of the margin.

**Medulla:** central core of cells or filaments which is surrounded by the cortex.

**Membranous:** thin, delicate and translucent.

**Microscopic:** unable to be reliably observed without the aid of a microscope.

**Midrib:** the central raised and vein-like structure of a blade.

**Minute:** very small.

**Monosiphonous:** with a single row of cells, as opposed to polysiphonous.

**Mucronate:** furnished with an abrupt sharp point, sometimes slightly curved.

## N

**Nodal:** at, on, or in a node of an axis.

**Node:** the point or area of an axis where branching or leafing occurs. The joint, either uncalcified as in *Halimeda* or *Amphiroa* or swollen and corticated as in *Ceramium*.

## O

**Oblong:** longer than broader.

**Obovate:** rather egg-shaped, but broader at the distal end.

**Obtuse:** blunt or rounded at the end.

**Opposite:** type of branching in which there are two pinnules or branchlets at a node, usually placed 180 degrees apart.

**Order:** a category of taxonomic classification ranking above family and below class (ending in ales).

**Oval:** an elongated figure with convex margins, rounded equally at the ends.

**Ovate:** oval in outline.

**Ovoid:** shaped like a hen's egg.

## P

**Palmate:** radiating from a point in a finger-like fashion.

**Peltate:** a foliar organ with its stalk attaching somewhere near the centre, and away from the margin. Parasol-shaped.

**Pericentral cell:** cells surrounding the centre (central axial cell + pericentral cells = three-dimensional polysiphonous branch).

**Pinnate:** furnished with distichous branchlets, arranged like the plumes of a feather.

**Pinnule:** a secondary leaflet of a pinnately compound leaf.

**Plumose:** feather-like.

**Plurilocular:** with several chambers.

**Polygonal:** with many angles.

**Polysiphonous:** having several coherent longitudinal rows of cells surrounding a central axis.

**Proliferation:** new part developed on a blade by vegetative cell division.

**Propagule:** a vegetative structure having the potential to develop into a new plant when detached from its parent.

**Prostrate:** lying flat on the substratum.

**Pseudodichotomous:** appearing dichotomous ; almost, or not quite, dividing into two equal parts.

**Pseudopericentral cell:** a single cell issued from a pericentral cell, above, but not attached to, the axial cell (see *Melanamansia*).

**Pyriform:** pear-shaped, with the broad end toward the base.

## R

**Ramuli:** a small secondary branchlet.

**Receptacle:** an enlarged or swollen reproductive body.

**Rectangular:** having right angles and parallel sides.

**Reef crest:** the shallowest part of a reef where the highest wave energy is released, usually an intertidal or upper subtidal area.

**Reef flat:** the uniformly shallow, protected area behind the reef crest.

**Reniform:** bean- or kidney--shaped.

**Reticulate:** appearing as a network of veins. Arranged in a network.

**Rhizoid:** root-like cell extension or cellular filament serving as an attachment organ.

**Rhizoidal:** root-like.

**Ribbed:** with pronounced and prominent veins, as on some *Halimeda* segment.

**Ruffled:** with a pronounced wavy margin.

**Rugose:** rough in texture, not smooth to the touch.

## S

**Sediment:** particulate matter (sand, mud, gravel) that has deposited on the bottom.

**Segmented:** divided into sections, as by joints or articulations.

**Serrate:** having saw-like notches or teeth along the edges.

**Sessile:** attached directly to the axis or to the substratum. Not stalked.

**Siphonous:** composed of tubes with no cross-walls.

**Sorus** (plural Sori): group of reproductive organs, in patches or as a single specialised structure.

**Species:** a group of closely related organisms that can interbreed to produce fertile offsprings ; the second word in a scientific name. Related species are grouped in a genus.

**Spermatangium** (plural Spermatangia): the male reproductive structure producing the male gametes (spermatia) in red algae.

**Spermatium** (plural Spermatia): the non-motile male gametes of red algae.

**Spore:** a single-celled reproductive body that can germinate into a new thallus.

**Stalked:** not sessile, with a pedicel (stalk).

**Stichidia:** a specialised swollen branch that produces tetrasporangia (see *Dasya*).

**Stipe:** the erect stem-like portion of a thallus.

**Stipitate:** briefly stalked.

**Stolon:** a horizontal stem connecting small upright fronds.

**Substratum:** the surface or object upon which or within which, an alga is growing.

**Sympodial:** a form of development wherein a branch continues to grow in the direction of the axis, and the axis continues to grow as a lateral branch, in a zigzag fashion.

## T

**Terete:** cylindrical, and circular in cross section.

**Terminal:** located at the tip or apex ;

**Tessellated:** marked as on a checkerboard.

**Tetrasporangia:** an oval or spherical structure containing four tetraspores. It can be cruciately divided (as in *Gracilaria*) or zonately divided (as in *Hypnea*).

**Thallus** (plural thalli): a non vascular plant body. Commonly used to refer to the plant body of any alga.

**Trichoblast:** a simple or branched, colourless, filament arising near the apex.

**Trichocyte:** hair-producing cell, often swollen and almost colourless (see Corallinaceae).

**Truncate:** flat at the top.

**Tuft:** small bunch of filaments or thalli.

**Turf:** a sparse to dense, short mat of short thalli.

**Turgid:** firm.

## U

**Umbilicate:** with a central navel-like depression.

**Unilateral** (branching): branching on one side only.

**Unilocular:** having one chamber; a sporangium with one cavity producing one to many spores.

**Uniseriate:** in a single row or as a single series of cells.

**Upright:** standing at a right angle to the substratum.

**Utricle:** a bladder-like siphon or swelling, usually in the outer layer of the thallus (as in *Codium*).

## V

**Vein:** linear thickened areas within a blade.

**Ventral:** belonging to the lower or underside ; opposite of dorsal.

**Verrucose:** covered with small knobs or wart-like projections or growths.

**Verticillate:** arranged in successive whorls or three or more parts per node.

**Vesicle:** a small cavity, small bladder like organ.

**Villous:** having a hairy, fur-like appearance.

## **W**

**Wide:** measure from side to side.

**Whorl:** a group of three or more similar organ, radiating from a node.

**Whorled:** surrounding an axis or branch in a ring.

## **Z**

**Zonate division:** cleaving of the thallus or of the tetrasporangium in parallel planes (see *Sarconema*, *Hypnea*).

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## Taxonomic Index

### A

<i>Actinotrichia fragilis</i> .....	45
<i>Amansia</i> .....	58
<i>Amphiroa foliaceae</i> .....	50
<i>Amphiroa fragilissima</i> .....	50

### B

<i>Boodlea kaeneana</i> .....	18
-------------------------------	----

### C

<i>Caulerpa cupressoides</i> .....	22
<i>Caulerpa peltata</i> .....	23
<i>Caulerpa racemosa</i> .....	24
<i>Caulerpa serrulata</i> .....	25
<i>Caulerpa sertularioides</i> .....	26
<i>Caulerpa taxifolia</i> .....	26
<i>Chamaebotrys boergesenii</i> .....	55
<i>Chlorodesmis fastigiata</i> .....	31
<i>Chnoospora implexa</i> .....	37
<i>Chnoospora minima</i> .....	38
<i>Cladophora coelothrix</i> .....	17
<i>Cladophoropsis luxurians</i> .....	19
<i>Codium arabicum</i> .....	27
<i>Codium geppiorum</i> .....	28

### D

<i>Dictyopteris repens</i> .....	34
<i>Dictyosphaeria australis</i> .....	20
<i>Dictyosphaeria cavernosa</i> .....	20
<i>Dictyota bartayresiana</i> .....	35

### E

<i>Enteromorpha flexuosa</i> .....	15
------------------------------------	----

### G

<i>Galaxaura fasciculata</i> .....	46
<i>Galaxaura filamentosa</i> .....	46
<i>Galaxaura marginata</i> .....	47
<i>Galaxaura rugosa</i> .....	47
<i>Gelidiella acerosa</i> .....	48
<i>Gelidiopsis repens</i> .....	53
<i>Griffithsia subcylindrica</i> .....	55

### H

<i>Halimeda discoidea</i> .....	29
<i>Halimeda incrassata</i> .....	29
<i>Halimeda opuntia</i> .....	30
<i>Hincksia breviarticulata</i> .....	34
<i>Hydroclathrus clathratus</i> .....	38
<i>Hypnea saidana</i> .....	53

### J

<i>Jania adhaerens</i> .....	51
------------------------------	----

### L

<i>Laurencia flexilis</i> .....	57
<i>Laurencia succisa</i> .....	57
<i>Lithophyllum</i> .....	52
<i>Lobophora variegata</i> .....	35
<i>Lyngbya majuscula</i> .....	12

### M

<i>Meristotheca procumbens</i> .....	54
--------------------------------------	----

### N

<i>Neomeris vanbosseae</i> .....	32
----------------------------------	----

**P**

*Padina boryana*.....36  
*Peyssonnelia bornetii*.....49

**R**

*Rhizoclonium africanum*.....17  
*Rosenvingea intricata*.....39

**S**

*Sargassum mangarevense*.....40  
*Sargassum sp.*.....41  
*Schizothrix calcicola*.....13  
*Symploca hydroides*.....13

**T**

*Turbinaria ornata*.....42

**U**

*Ulva lactuca*.....16

**V**

*Valonia fastigiata*.....21  
*Ventricaria ventricosa*.....21

**W**

*Wrangelia argus*.....56

## APPENDIX I

### Listing of common species encountered in major raui areas on Rarotonga, and at Aitutaki

#### Titikavena, Tikioki Raui (27 January 1999)

##### Brown algae:

*Dictyota bartayresiana* Lamouroux

*Dictyopteris repens* (Okamura) Børgesen

*Lobophora variegata* (Lamouroux) Womersley

*Padina boryana* Thivy

*Sargassum* sp. aff *S. mangarevense* (Grunow) Setchell, dominant in parts of reef crest with *T. ornata*

*Turbinaria ornata* (Turner) J. Agardh (dominant in parts of reef crest)

##### Green algae:

*Boodlea kaeneana* Brand, great masses on lagoon floor

*Caulerpa cupressoides* (Vahl) C. Agardh var. *mamillosa* (Montagne) Weber-van Bosse

*Caulerpa peltata* Lamouroux

*Caulerpa racemosa* (Forsskål) J. Agardh

*Caulerpa serrulata* (Forsskål) J. Agardh

*Caulerpa taxifolia* (Vahl) C. Agardh

*Chlorodesmis fastigiata* (C. Agardh) Ducker

*Cladophora* sp.

*Dictyosphaeria cavernosa* (Forsskål) Børgesen

*Dictyosphaeria versluysii* Weber-van Bosse

*Halimeda copiosa* Goreau et Graham

*Halimeda discoidea* Decaisne

*Halimeda opuntia* Linnaeus (Lamouroux)

*Valonia aegagropila* C. Agardh

*Ventricaria ventricosa* (J. Agardh) Olsen et West

##### Red algae:

*Actinotrichia fragilis* (Forsskål) Børgesen

*Amphiroa fragilissima* (Linnaeus) Lamouroux

*Galaxaura rugosa* (Ellis et Solander) Lamouroux

*Galaxaura fasciculata* Kjellman

*Hypnea saidana* Holmes

*Jania adherens* Lamouroux

*Laurencia succisa* Cribb

*Lithophyllum* sp.

*Peyssonnelia* sp.

##### Blue-Green algae:

*Lyngbya majuscula* (Dillwyn) Harvey

*Schizothrix calcicola* (C. Agardh) Gomont

*Symploca hydroides* (Harvey) Kützing

**Poara Raui fringing reef walk (29 January 1999)**

**Green algae**

*Boodlea kaeneana*  
*Caulerpa cupressoides* var. *mamillosa*  
*Caulerpa peltata*  
*Chlorodesmis fastigiata*  
*Dictyosphaeria ?australis* or *versluysii*  
*Halimeda opuntia*  
*Halimeda discoidea*  
*Neomeris vanbosseae*  
*Ventricaria ventricosa*

**Brown algae**

*Dictyota bartayresiana*  
*Hydroclathrus clathratus*, rare on reef crest  
*Lobophora variegata*  
*Padina tenuis*  
*Sargassum* sp. aff *S. mangarevense*, dominant in parts of reef crest with *T. ornata*  
*Turbinaria ornata* (dominant in parts of reef crest)

**Red algae**

*Actinotrichia fragilis*  
*Galaxaura rugosa*  
*Galaxaura subfructiculosa*  
*Jania*  
*Laurencia* “green” on reef crest, forming carpet  
*Lithophyllum ?mollucense* or *tamiense*  
*Tricleocarpa cylindrica*

**Blue-green algae**

*Schizothrix calcicola*  
*Symploca hydroides*

**Avana Raui (30 January 1999)**

## **Estuary and Lagoon**

### **Green algae**

*Boodlea kaeneana* on *Turbinaria*  
*Caulerpa cupressoides*  
*Cladophora* sp.  
*Codium geppiorum* masses on coral  
*Halimeda discoidea*  
*Halimeda opuntia*

### **Brown algae**

*Dictyota bartayresiana*  
*Lobophora variegata*  
*Padina australis*  
*Turbinaria ornata*

### **Red algae**

*Galaxaura rugosa*  
*Galaxaura subfructiculosa*  
*Jania adherens*

### **Blue-green algae**

*Anabaena torulosa*  
*Lyngbya majuscula* on *Turbinaria*  
*Schizothrix calcicola*  
*Symploca hydnoides*

## **Reef Flat**

### **Green algae**

*Codium arabicum*  
*Chlorodesmis fastigiata*  
*Ventricaria ventricosa* in *Gelidiopsis* carpet  
*Valonia aegagropila* in *Gelidiopsis* carpet

### **Red algae**

*Gelidiopsis intricata*

### **Reef crest**

### **Brown algae**

*Sargassum mangarevense*  
*Turbinaria ornata*

**Nikao Raii (2 February 1999)**

**Reef crest**

**Green algae**

*Boodlea kaeneana*  
*Chlorodesmis fastigiata*  
*Dictyosphaeria* cf. *D. australis*

**Brown algae**

*Dictyota* “banded”  
*Sargassum* sp.  
*Turbinaria ornata*

**Red algae**

*Amphiroa fragilissima*  
*Dasya* sp.  
*Laurencia* “green mat”

**Reef flat**

**Green algae**

*Codium gepiorum*  
*Dictyosphaeria cavernosa*  
*Halimeda incrassata*  
*Halimeda opuntia*  
*Valonia aegagropila*

**Brown algae**

*Lobophora variegata*

**Red algae**

*Galaxaura fastigiata*  
*Galaxaura filamentosa*  
*Galaxaura marginata*  
*Galaxaura rugosa*  
*Gelidiopsis intricata*  
*Hypnea* sp.  
*Lithophyllum mollucense*

**Blue-green algae**

*Anabaena torulosa*  
*Schizothrix calcicola* (*Phormidium* sp?)

**Ngatangiia point, high-energy habitat (makatea) (13 February 1999)**

**Green algae**

*Caulerpa racemosa*

*Ulva lactuca*

**Brown algae**

\**Chnoospora minima*

\**Hincksia breviarticulata*

*Sargassum* sp. cf. *S. mangarevense*

*Turbinaria ornata*

**Red algae**

*Amphiroa* sp.

*Hypnea* sp

*Laurencia* sp. cf. *L. flexilis*

*Laurencia* sp. cf. *L. parvipapillata*

**Aitutaki (03-04 February 1999)**

**Araura Hatchery lagoon**

**Green algae**

*Boodlea composita*

*Caulerpa racemosa*

*Caulerpa serrulata*

*Caulerpa sertularioides*

*Caulerpa taxifolia*

*Codium geppiorum*

*Dictyosphaeria cavernosa*

*Enteromorpha* (on beach)

*Halimeda opuntia*

*Neomeris vanbosseae*

*Rhipidosiphon javensis*

*Rhizoclonium samoense* (on MMR boat rope, harbour)

*Ventricaria ventricosa*

**Brown algae**

*Dictyota bartayresiana*

*Dictyota divaricata*

*Turbinaria ornata*

**Red algae**

*Actinotrichia fragilis*

*Amphiroa fragilissima*

*Amphiroa tribulus*  
*Ceramium* sp.  
*Champia parvula*  
*Galaxaura fastigiata*  
*Galaxaura marginata*  
*Gelidiella acerosa*  
*Hypnea nidulans*  
*Hypnea* "small  
*Lomentaria corallicola*  
Unknown red

### **Blue-green algae**

*Anabaena torulosa* (green cyano)  
*Schizothrix calcicola*  
*Symploca hydroides*

## **Clam nursery, lagoon 5 metres depth**

### **Green algae**

*Cladophoropsis luxurians*  
*Caulerpa peltata*  
*Caulerpa serrulata*  
*Dictyosphaeria cavernosa* "big variety  
*Pseudobryopsis* sp.

### **Brown algae**

*Lobophora variegata* "big leafy variety  
*Turbinaria ornata* "long stiped variety

### **Red algae**

*Gelidium pussilum*

### **Blue-green algae**

*Schizothrix calcicola*  
*Anabaena torulosa*