A TAXONOMIC STUDY OF SEAWEEDS OF NORTH SULAWESI, INDONESIA

by

TANIA THENU

B.Sc., Universitas Pattimura, Ambon, Indonesia, 1988

Dipl. Sc., Simon Fraser University, 1993

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

(Department of Botany)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

November 1997

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of BOTANY

The University of British Columbia
Vancouver, Canada

Date DEC. 10, 1997

DE-6 (2/88)

Abstract

Biodiversity has become a world issue recognized not only by conservationists but also by politicians and other concerned people. The increased interest in biodiversity has generated a need for more information on species occurrence and distribution, and thus taxonomic information has again become essential. The chance of conserving any biological resource is improved if such a resource is fully identified and named. As basic information, taxonomy provides classification, nomenclature, description and identification aids. This can lead to more effective communication about conservation problems and effective action on how to solve such problems. Above all, species identification is a fundamental prerequisite for most biological studies.

Indonesia, the world's largest archipelago, is renowned for its biodiversity. Differences in its geological origin have resulted in a diverse and distinct fauna and flora in different regions. Ecologically, it is more diverse, complex and, in most parts, unknown, than perhaps any other part of the world. More than half of Indonesian territory is sea, and there are thousands of kilometers of coastline. Given the large shoreline, seaweeds are a common component of the marine biota. However, seaweeds of Indonesia as a whole have received little attention and even less is known about their possible biogeographic relationships.

This present study deals with seaweeds of North Sulawesi, Indonesia. The main objective of this study was to collect and identify seaweeds of North Sulawesi. The other objective was to place this current information into the context of what is known of the Indonesian seaweeds.

In this study, a total of 67 species within 37 genera of seaweeds have been recognized. This total consists of 29 taxa of Chlorophyta, 12 taxa of Phaeophyta and 26 taxa of noncoralline

Rhodophyta. This information is compared with those of the Siboga Expedition, the Danish Expedition, the Snellius-II Expedition and the Buginesia-III Project. Keys to the genera and/or species, description of each taxon, local distribution and the depth are also included along with some photographs of the habit of species.

TABLE OF CONTENTS

List of Tables

List of Figures

List of Plates

ACKNOWLEDGEMENTS

I am deeply indebted to Dr. Robert E. DeWreede for guidance, constructive criticisms and wonderful friendship that have been essential to the completion of this study.

I wish to thank Dr. P. Baas and Dr. W. F. Prud'homme van Reine from the Research Institute Rijksherbarium/Hortus Botanicus, Leiden University-The Netherlands for permitting me to work with numerous herbarium collections kept there. Dr. W. F. Prud'homme van Reine kindly supplied some French translations and spent some of his time out of his busy schedule for discussions on numerous taxonomic problems. I also would like to thank my committee members, Drs. G. Bradfield and P. G. Harrison, for providing valuable editorial assistance.

Many friends have encouraged me : Ricardo Scrosati, Andrea Sussmann, Russell Markel, Kristen Drewes-Milligan, Nick Grabovac, Len Dyck, Dale Marsden and Anita Gurak; also I appreciate the help of Carol-Ann Borden and Pak Gary Bradfield. My Canadian family, the Guraks of Port Moody, has welcomed me as their "adopted" daughter and sister. I thank you all for your friendship, love, care and encouragement that have warmed my heart in this cold part of the globe.

My whole overseas existence through my scientific journeys - at Simon Fraser University, Bamfield Marine Station, University of British Columbia and Rijksherbarium/Hortus Botanicus, Leiden University - would not have been possible but for the generous financial support provided by CIDA-Eastern Indonesia University Development Project to whom I extend my special thanks.

Finally, I want to address my countless thanks to my beloved far-away family for their ceaseless and consistent love, understanding, encouragement, patience and prayers.

With love, admiration and respect to my wonderful father,
Jacob Frans Thenu,
who always reminds me to put mind over matter

Chapter 1

INTRODUCTION

The increased interest in biodiversity among scientists and general public has generated a demand for more information on the occurrence and distribution of species. No one knows exactly, even to the nearest order of magnitude, how many species there are (Wilson, 1985). Taxonomy is essential and it provides the core reference system and knowledge-base on which all discussion of biodiversity hinges. In other words, it is the framework within which biodiversity is recognized and in which species diversity characterization occurs. It also plays an important role in conservation of biodiversity because the chance of conserving any biological resource is improved if such a resource is fully identified and named (May, 1990). As information, taxonomy provides classification, nomenclature, description, and identification aids (Bisby, 1984; Abbott *et al.*, 1985). This can lead to more effective communication about conservation problems and effective action on how to solve such problems. Above all, species identification is a fundamental prerequisite for most biological studies.

Indonesia is thought to have one of the world's highest biodiversities (Ministry of National Development Planning/National Development Planning Agency, 1993). Ecologically, it is more diverse, complex and, in most parts, unknown, than perhaps any other

part of the world. With its current population of over two hundred million people, Indonesia's economic development, which is people oriented, is directed towards improving welfare of the Indonesians. It is, therefore, not surprising that more intensive studies in Indonesia are focused on the areas of technology rather than taxonomy and ecology.

Activities such as logging, mining, shifting agriculture, other changing land uses, and over-exploitation of economically important species are common in Indonesia. As such activities continue to accelerate, natural and biological resources are continuously threatened. Most of Indonesia's biological resources are poorly studied and documented and the small amount of information that is available is not readily accessible either because it is written in languages other than bahasa Indonesia (Indonesian) and/or it is scattered among many sources within and outside Indonesia. Important contributing factors to the shortage of information are under-funding of inventory studies, taxonomic research and a general lack of trained Indonesian taxonomists. This has been a major constraint to effective conservation of biodiversity for decision-makers, planners and scientists in Indonesia.

The government of Indonesia has long recognized the situation outlined above and recently completed a biodiversity action plan for Indonesia (Ministry of National Development Planning/National Development Planning Agency, 1993) in which it provides a framework for biodiversity conservation for the 25 Year

Development Plan and outlines immediate and attainable priorities for conservation action. This Plan includes some policy and funding mechanisms to strengthen Indonesia's biodiversity management strategy. The realization of such a plan, however, is hampered by economic policy distortions that encourage rapid exploitation of biological resources rather than their sustainable use (*i.e.* the loss of forest will continue while timber remains a major export commodity). On the other hand, with increased awareness of how crucial such resources are and the urgent need for adequate ecological information, it is hoped that by providing adequate funding and staffing, and a balance between economic policy and conservation priority, this will facilitate realization of such plan.

Interest in Indonesian seaweeds has been focused on economically important species (Adnan *et al.*, 1987; Eisses, 1953; Firdausy and Tisdell, 1991; Luxton *et al.*, 1993; Soegiarto, 1978; Soegiarto *et al.*, 1990; Zaneveld, 1955) although their importance in the Indonesian economy is relatively low (Verheij and Prud'homme van Reine, 1993). The seaweeds are a common component of the marine biota. Some have been used in Indonesia and elsewhere for extraction of industrially useful chemicals (*e.g.*, carrageenans and agar), for food, and as a source of pharmaceutical products. However, the seaweeds of Indonesia as a whole have received little attention and even less is known about their possible biogeographical relationships.

The present study deals with the seaweeds of North Sulawesi, Indonesia, and its main objective was to collect and identify the seaweeds of North Sulawesi. A second objective was to place this new information into the context of what is known of the Indonesian algae.

Location and general description

Indonesia, the world's largest archipelago, straddles the equator for more than 8,500 kilometers and consists of more than 17,000 islands with five major islands namely Sumatra, Kalimantan, Java, Sulawesi, and Irian Jaya. Within the Indonesian archipelago itself, there are 30 smaller archipelagos that are grouped into four geographic entities: 1) the Greater Sundas including Sumatra, Java, Kalimantan and Sulawesi; 2) the Lesser Sundas including the islands stretching from Bali to Timor; 3) the Moluccas, a group of about a thousand islands including Ambon, Ternate, Tidore, Halmahera, Morotai, the Bandas, the Arus and the Tanimbars; and 4) Irian Jaya including the western portion of New Guinea and adjacent islands. Located between 6° N and 11° S, the Indonesian Archipelago lies between two continents - Asia and Australia - and between two oceans - the Pacific Ocean and the Indian Ocean. More than half of Indonesian territory is sea, and there are thousands of kilometers of coastline.

Biogeographically, the western islands of Indonesia are on the continental shelf of Asia, whereas to the east islands such as Irian

Jaya are on the Australian shelf. Other Indonesian islands are oceanic. These differences in geological origin have resulted in a diverse and distinct terrestrial fauna and flora in the different regions which have been documented and studied by, among others, Alfred Russell Wallace (Wallace, 1895). The island of Sulawesi, located in between Kalimantan and Irian Jaya, straddles the region that Wallace designated as a dividing line between continental Asian biota and biota of more eastern origin.

The mainland of Sulawesi covers a land area of 159,000 km^2. The distance between the most northerly Sulawesi island of Minggas (about 90 km south of Mindanao, The Philippines) and the most southerly island Satengar (north of Sumbawa) is 1,805 km. Sulawesi is divided into four provinces, North Sulawesi, Central Sulawesi, South-east Sulawesi and South Sulawesi; North Sulawesi covers only 13 % of the total area (Figure 1).

Because of its long, narrow peninsulas, Sulawesi has more coastline relative to its land area than other Indonesian islands. Most of its regions are within 50 km and never beyond 90 km from the sea. The coast of Sulawesi harbors various habitats such as mud flats, mangrove forests, seagrass meadows, coral reefs, and rocky and sandy beaches. The average temperature range of its coastal water is between 22.5° C and 25° C whereas the average salinity is between 15 *ppt* (after a long period of rain) and 50 *ppt* (particularly in some tide pools) (Whitten *et al.*, 1987).

The surface currents on which algae are largely dependent for dispersal run more or less anti-clockwise around Sulawesi during the north-westerly monsoon (November to April). From May to November, however, such patterns cannot be clearly seen. Throughout the year, the currents run southward on the Sulawesi side of Makassar Strait and eastward along the northern coast of North Sulawesi. In other words, the northern parts of Sulawesi receive currents from the north (*i.e.*, the Sulu Sea and the Philippines) and northwest (*i.e.*, the Pacific Ocean), whereas the southern parts receive the currents from the north and the east. The seaweeds in this present study were collected from seventeen sites around the tip of North Sulawesi and nearby islands (Figure 1).

Historical review of Indonesian algal taxonomy

Formal taxonomic descriptions of Indonesian seaweeds began with the Siboga Expedition, which collected throughout the Indonesian archipelago (1899-1900; Weber-van Bosse, 1913; 1921; 1923; 1928), the Danish Expedition to Kei Islands (1914-1916; Weber-van Bosse, 1926), the Snellius-II Expedition through some parts of eastern Indonesia (1984; Coppejans and Prud'homme van Reine, 1989a; 1989b; 1992), and the Buginesia-III Project in Spermonde Archipelago, SW Sulawesi (1988-1990; Verheij and Prud'homme van Reine, 1993). Among the areas visited during these expeditions, only the Spermonde Archipelago in southwest Sulawesi has been relatively well studied (Verheij and Prud'homme van Reine, 1993; Verheij and Erftemeijer, 1993; Verheij, 1994). Only the

Siboga Expedition visited North Sulawesi, and hence this research is the first taxonomic study done for this area for nearly 70 years. Detail of reference sites for the four previous expeditions can be obtained from Weber-van Bosse, 1913; 1921; 1923; 1928 (the Siboga Expedition), Weber-van Bosse, 1926 (the Danish Expedition), Coppejans and Prud'homme van Reine, 1989b (the Snellius-II Expedition), and Verheij and Prud'homme van Reine, 1993 (the Buginesia-III Project).

Many taxa reported by Weber-van Bosse from the Siboga and the Danish Expeditions are no longer considered as different species (Verheij and Prud'homme van Reine, 1993). For instance, Weber-van Bosse reported about 197 taxa of Chlorophyta and 411 taxa of noncoralline Rhodophyta during these expeditions whereas modern taxonomists accept only 131 and 210 taxa of each, respectively (Verheij and Prud'homme van Reine, 1993). These recent taxonomic revisions leave the total number of seaweed taxa recognized from the Siboga Expedition, the Danish Expedition, the Snellius-II Expedition, and the Buginesia-III project, at 148, 108, and 245 of Chlorophyta, Phaeophyta, and noncoralline Rhodophyta, respectively.

In this study, a total of 67 species within 37 genera of seaweeds have been recognized. This total consists of 29 taxa of Chlorophyta, 12 taxa of Phaeophyta, and 26 taxa of noncoralline Rhodophyta. Among them, *Padina japonica*, *Sargassum turbinarioides* (Phaeophyta), *Betaphycus gelatinum*, *Galaxaura filamentosa*, and *Laurencia flexilis* (Rhodophyta) are new records for Indonesia. The

results, including keys for the genera within the divisions and the species within a genus, are presented in Chapter 3 (Chlorophyta), Chapter 4 (Phaeophyta), and Chapter 5 (Rhodophyta). The results of my study are compared with previous documentation of Indonesian algae and are tabulated in Table 1 (Appendix A). Table 2 (Appendix B) presents the uses of some seaweeds collected during this study. Photographs of the habit of some taxa observed are presented in Appendix C.

Contribution of the taxonomic study of seaweeds from North Sulawesi

This study provides new knowledge of the seaweed flora in North Sulawesi. Such information is an important basis for biodiversity discussions and research, biogeographical studies and ecological research in Indonesia as well as globally. The dichotomous keys and herbarium specimens that are the products of this study will facilitate field identification for workers in Indonesia, and specifically in North Sulawesi. This study can serve as a baseline for management of marine conservation since information on seaweeds of Indonesia as a whole is scanty.

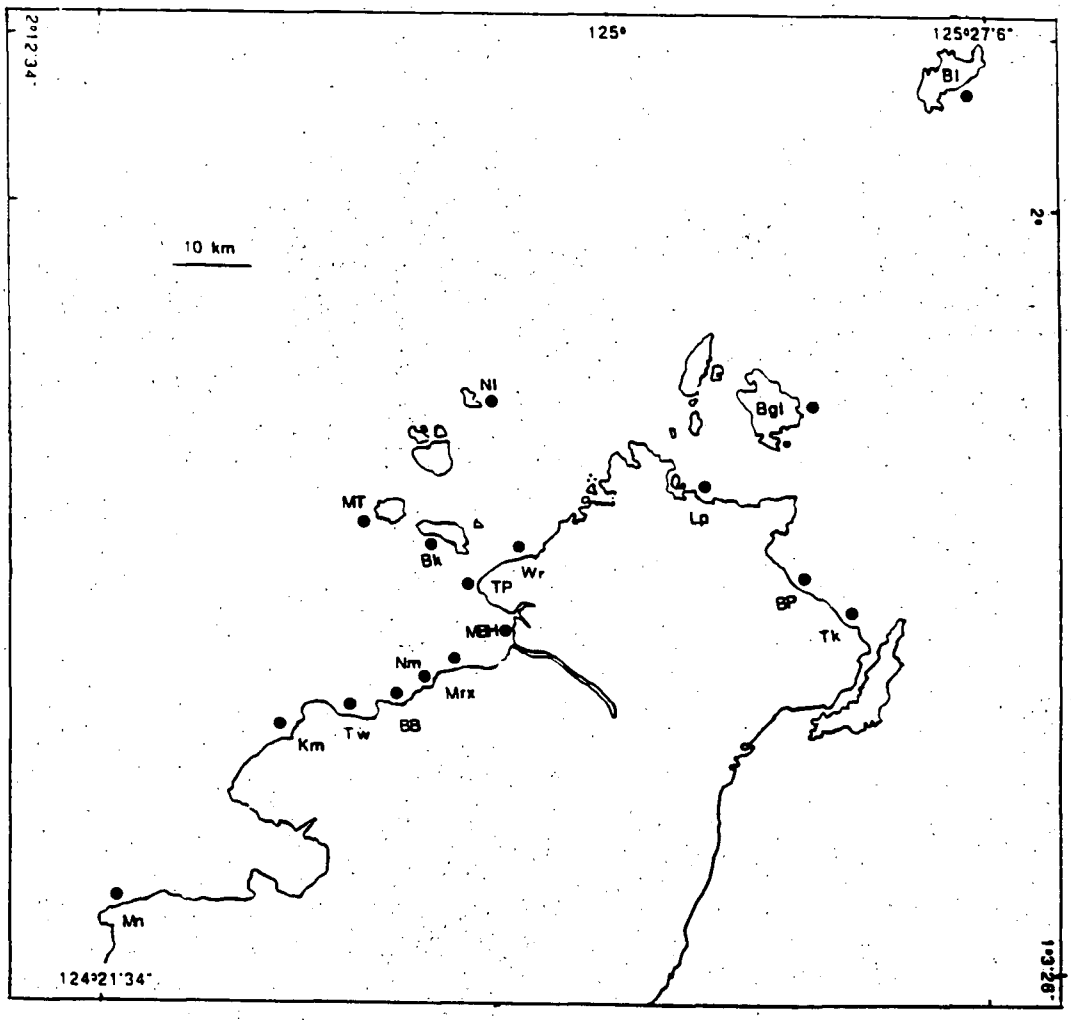


Fig. 1. Map of North Sulawesi, Indonesia, showing the collecting localities. Abbreviations used : Mn = Moniet; Km = Kumu; Tw = Tanawangko; MBH = Manado Beach Hotel; BB = Bulo Beach; Mrx = Murex; Nn = "an unnamed location about 0.5 km west of Murex"; TP = Tanjung Pisok; Wr = Wori; Bk = Bunaken; MT = Manado Tua; NI = Nain Island; Bl = Biaro Island; Bgl = Bangka Island; Lp = Likupang; BP = Batu Putih; and Tk = Tangkoko.

Chapter 2

MATERIALS AND METHODS

This taxonomic study of North Sulawesian seaweeds was based upon some three hundred algal specimens collected by Dr. R. E. DeWreede during the period of July 1993 to December 1994. Seventeen sites, all located on the tip of North Sulawesi and neighboring islands were visited. They are Moniet (NE Tanjung Moniet), Kumu, Tanawangko, Manado Beach Hotel, Bulo Beach (25 km south of Manado), Murex (Murex Diving Resort - 15 km south of Manado), an unnamed location 0.5 km west of Murex, Tanjung Pisok, Wori, Bunaken, Manado Tua, Nain Island, Biaro Island, Bangka Island, Likupang, Batu Putih, and Tangkoko (Figure 1).

Seaweed samples were collected from the intertidal and subtidal, the latter specimens taken by SCUBA diving. Most of the specimens were collected from both live and dead coral reefs. A Nikonos IVA camera was used to take *in situ* habit photographs of the specimens before they were dried as herbarium specimens. These specimens were press-dried shortly after collection and brought to the University of British Columbia, Vancouver, Canada for identification. The

location and the depth of each collection were recorded. Each depth was determined relative to the Lowest Normal Tide (LNT, Indonesian Chart Datum).

Taxonomic work involved extensive use of literature as documented in the next three Chapters. It also involved a great deal of microscope work and herbarium studies; the latter included bringing specimens to The Rijksherbarium Leiden, University of Leiden, The Netherlands, for identification and validation by using already identified specimens available there.

Identification was based primarily on the morphological and anatomical features of the specimens. Most anatomical studies were based upon hand-cut sections. Calcified seaweeds were decalcified in 1% HCl prior to hand-sectioning and 1% aqueous solution of aniline blue was used to stain all these materials. Sections were mounted in a 20% aqueous Karo (corn syrup) solution for 10 minutes followed by immersion in 50% aqueous Karo solution. Gradual infiltration of the tissue was accomplished by allowing preparations to air-dry after which 80% aqueous Karo solution was applied to make permanent slides. Slides were viewed under a Leitz Wetzlar light microscope.

The general systematic arrangement used in Chapters 3-5 follows that of Silva *et al.* (1987). Genera are listed

alphabetically under Family, and species alphabetically within genera. Authorities for genera and binomials are given in full. No taxon below the rank of species is included, with the exception for *Caulerpa* where ecad is used. Enumeration of species includes the most recent name, with author citation, year of publication of the name and the page in the original publication, and the synonyms. The description of a taxon includes general morphology (habit) and anatomical features used for species determination. Local distribution and the depth are listed following the description of species. World distribution presented here has been obtained through previous publications and through The Indian Ocean Catalog (Silva *et.al.*, 1996). Specimens examined are referred to Dr. R. E. DeWreede's collection number and are abbreviated as REDW - followed by original collection number. All collections are kept temporarily by the author until Universitas Pattimura, Ambon (Indonesia) has its own herbarium. Whenever possible, duplicates of the specimens will be deposited at the U.B.C. Herbarium.

Chapter 3

CHLOROPHYTA

Key to the genera of Chlorophyta from North Sulawesi :

1a. Frond calcified 2

1b. Frond not calcified 3

2a. Frond with fan-shaped blades or segments 4

2b. Frond of different shape 5

3a. Frond vesiculate (sac-like) 6

3b. Frond not vesiculate 7

4a. Calcified segments flat to cylindrical, discoid to reniform or cuneate, joined by narrow, not calcified internodes ..... *Halimeda*

4b. Frond fan-shaped, of intertwined filaments ..... *Udotea*

5a. Frond with successive whorls of glomerulous branchlets at intervals ..... *Tydemania*

5b. Frond radially symmetric at apex or along the entire length of the thallus 8

6a. Vesicle tough, spherical, thallus solitary ..... *Ventricaria*

6b. Vesicles soft and firm, of different shape 9

7a. Frond consisting of intricate filaments 10

7b. Frond not of interwoven filaments; having a well-developed horizontal stolon attached by rhizoids and bearing erect branches ..... *Caulerpa*

8a. Frond radially symmetric at the apex, tip an umbrella-like cap supported by a long, slender stipe .... *Acetabularia*

8b. Frond cylindrical, club-shaped, or spherical; central axis bearing whorls of determinate laterals 11

9a. Vesicular cells rounded and tightly packed in clusters forming solid or hollow thalli ..... *Dictyosphaeria*

9b. Vesicular cells elongated or cylindrical and branched .... *Valonia*

10a. Frond spongy, consisting of interwoven filaments differentiated into a loose medulla and a tightly packed cortex of utricles ..... *Codium*

10b. Frond otherwise 12

11a. Sporangia born singly at the tip of a lateral ..... *Neomeris*

11b. Sporangia many and born along the axis of lateral ... *Bornetella*

12a. Frond flabellate, thin; filaments anastomosing in a network forming monostromatic thallus ..... *Anadyomene*

12b. Frond flabellate, thick; consisting of entwined filaments not laterally attached ..... *Avrainvillea*

Order CAULERPALES

Family CAULERPACEAE

I *Caulerpa* Lamouroux

Key to species of *Caulerpa* from North Sulawesi :

1a. Branchlets either vesicle-like (spherical, clavate, or discoid) or peltate 2

1b. Branchlets filiform or strap-like 3

2a. Branchlets peltate (stalk-like lower portion abruptly expanded into a horizontally spread disciform structure) 4

2b. branchlets not peltate 5

3a. Branchlets in whorls; verticils conspicuous, well separated; branches rather long, supple, with 2-4 terminal mucron; stolon naked ..... *C. verticillata*

3b. Frond mostly spirally twisted; margin with laterally directed or slightly upwardly broadly attached 'continuous' mucronous teeth ..... *C. serrulata*

4a. Branchlets few; diameter of the disciform structures up to 3 mm ..... *C. racemosa* ecad *peltata-peltata*

4b. Branchlets numerous; diameter of disciform structures up to 8 mm ..... *C. racemosa* ecad *peltata-macrodisca*

5a. Vesicle-like branchlets with markedly constricted pedicel; branchlets very densely packed along the erect shoot (rachis) ..... *C. lentillifera*

5b. Vesicle-like branchlets without a constricted pedicel 6

6a. (Sub) sessile spherical branchlets either extremely rare or irregularly placed (to absent) or more frequent and (sub-) opposite; erect shoots frequently at least partly naked, rachis slightly to markedly compressed and irregularly constricted ..... *C. racemosa* ecad *lamouroxii*

6b. Branchlets irregularly placed, not compressed; rachis bearing shortly stipitate, pear shaped branchlets with a spherical upper part ..... *C. racemosa* ecad *racemosa*

Caulerpa lentillifera J Agardh (Plate 1: a)

Caulerpa lentillifera J. Agardh, 1837: 173; Weber-van Bosse, 1898: 380; Weber-van Bosse, 1913: 112-113; Coppejans and Meinesz, 1988: 184 -186; Coppejans and Beeckman, 1989: 383-384; Coppejans and Beeckman, 1990: 118; Coppejans, 1992: 395; Coppejans and Prud'homme van Reine, 1992b: 690-692.

Stolon terete, 1-2 mm in diameter; erect fronds generally simple, up to 3.5 cm tall, completely and densely covered by somewhat clavate ramuli/branchlets, up to 2 mm in diameter, and supported by markedly constricted pedicels.

Local distribution - Pulau Nain ; Depth : -3 m.

Distribution - Tropical Indian Ocean (Kenya), tropical western Pacific (Indonesia, eastern Australia).

Specimen examined - REDW-244

Caulerpa racemosa (Forsskål) J. Agardh

Fucus racemosus Forsskål, 1775 : 191

Caulerpa racemosa (Forsskål) J. Agardh, 1873: 35; Weber-van Bosse, 1898: 357-373; BØrgesen, 1907: 378-389; Weber-van Bosse, 1913: 104-110; Weber-van Bosse, 1926: 91-92; Lawson and John, 1987: 89; Coppejans and Meinesz, 1988: 191; Coppejans and Beeckman, 1989: 384-392; Coppejans and Beeckman, 1990: 119; Coppejans, 1992b: 397-403; Coppejans and Prud'homme van Reine, 1992: 693-70.

Fucus clavifer Turner, 1808: 126.

Caulerpa clavifera (Turner) C. Agardh, 1817: XXIII.

Fucus uvifer Turner, 1816: 81.

Caulerpa uvifera (Turner) C. Agardh, 1817: XXIII.

NOTE : *Caulerpa racemosa* is a very common species found in the tropical Indian Ocean and western Pacific (Australia, Indonesia, the Philippines) and is one of the algae with high plasticity that have been described with many varieties and forms. Often the same stolon may have upright shoots with very different morphologies. These variations have been reported to be caused by environmental

factors such as light, temperature, habitat, and depths (Peterson, 1972; Coppejans and Beeckman, 1989). Therefore, they should not be treated as genotypes but as ecological phenotypes or ecad (Peterson, 1972; Coppejans and Beeckman, 1989).

Caulerpa racemosa ecad *lamourouxii* [var. *lamourouxii* (Turner) Weber-van Bosse, 1898: 368].

Thallus characterized by the compressed fleshy rachis, up to 2.5 cm tall, with many to few generally (sub) opposite vesicle-like branchlets; erect shoots sometimes partly naked, slightly compressed and constricted or of irregular width; bladed erect shoot with smooth margin with the width up to 3 mm.

Local distribution - Kumu ; Depth : -2 m.
Distribution - Indonesia, Kenya.
Specimen examined - REDW-310.

Caulerpa racemosa ecad *macrodisca* [var. *macrodisca* (Decaisne) Weber-van Bosse, 1898: 376] (Plate 1: b)

Thallus stout; stolon up to 2 mm in diameter and fixed by well developed rhizoidal branches; erect fronds up to 6.5 cm tall; terete rachis bearing many irregularly placed peltate branchlets of up to 1 cm in length and discs of up to 0.8 mm in diameter.

Local distribution - Bunaken ; Depth : -12 m

Distribution - Indonesia

Specimen examined - REDW-258

Remark - Coppejans and Prud'homme van Reine (1992b: 696) and Verheij and Prud'homme van Reine (1993: 396) included this ecad in *C. racemosa* ecad *peltata-macrodisca*. For discussion, see Coppejans and Prud'homme van Reine (1992b: 696).

Caulerpa racemosa ecad *peltata* [var. *peltata* (Lamouroux) Eubank, 1946: 421].

Thallus characterized by a very thin stolon up to 1 mm in diameter; rachis up to 1 cm tall; peltate branchlets very few and generally born singly on the stolon; peltate discs up to 3 mm in diameter.

Local distribution - Murex ; Depth : -2 m.

Distribution - Indonesia, Kenya.

Specimens examined - REDW-143

Remark - Coppejans and Prud'homme van Reine (1992b: 696) and Verheij and Prud'homme van Reine (1993: 396) included this ecad in *C. racemosa* ecad *peltata - peltata.* For discussion, see Coppejans and Prud'homme van Reine (1992b: 696).

Caulerpa racemosa ecad *racemosa* (Plate 1: c)

Branchlets irregularly placed, not compressed, erect shoots 1-4 cm tall, bearing shortly stipitate, pear shaped branchlets with a spherical upper part 1-4 mm wide.

Local distribution - Tanawangko, Manado Tua, Pulau Nain ; Depth : 0 to -3 m.

Distribution - Tropical and subtropical Indian Ocean, tropical and subtropical Pacific.

Specimens examined - REDW-89 / -121 / -243.

Caulerpa serrulata (Forsskål) J. Agardh (Plate 1: d, e)

Caulerpa serullata (Forsskål) J. Agardh, 1837: 174; Eubank, 1946: 418; Taylor, 1950: 57; Dawson, 1954b: 393; Dawson, 1956: 38; Dawson, 1957: 105; Taylor, 1960: 145; Womersley and Bailey, 1970: 276; Tseng, 1983: 283; Silva *et al.*, 1987: 108; Coppejans and Meinesz, 1988: 191-192; Coppejans and Beeckman, 1990: 120-121; Coppejans and Prud'homme van Reine, 1992b: 701-704; Coppejans, 1992: 403-404; Verheij and Prud'homme van Reine, 1993: 397.

Fucus serullatus Forsskål, 1775, 1775: 189.

Caulerpa freycinetii C. Agardh, 1822: 446; Weber-van Bosse, 1898: 310; Weber-van Bosse, 1913: 102; Weber-van Bosse, 1926: 90; BØrgesen, 1932: 5.

Caulerpa hummii Diaz-Piferrer, 1969: 13.

Upright fronds strongly spirally twisted or somewhat curved, strap-shaped in one plane, up to 9 cm tall and 3 mm wide, dichotomously to subdichotomously branched; margin coarsely dentate, mucronate teeth broadly attached laterally or somewhat directed towards apex.

Local distribution - Tanawangko, Murex, Manado Beach Hotel, Bunaken , Kumu ; Depth : 0 to -2 m.

Distribution - Tropical Indian Ocean (Kenya), tropical western Pacific (Indonesia, the Philippines).

Specimens examined - REDW-88/ -142 / -177 / -257 / -308 / -338.

Remark - Most specimens of *C. serrulata* from North Sulawesi have strongly spirally twisted uprights. Only one specimen has uprights which are complanate and are curved and strap-shaped. The strongly spirally twisted uprights were usually shorter (up to 4 cm).

Caulerpa verticillata J. Agardh

Caulerpa verticillata J Agardh, 1847 : 6; Weber-van Bosse, 1898: 267; Weber-van Bosse, 1913: 96; Coppejans and Meinesz, 1988: 194; Coppejans and Beeckman, 1990: 124; Coppejans, 1992: 406; Coppejans and Prud'homme van Reine, 1992b: 708.

Thallus soft and slender, up to 3.5 cm tall, stolon and erect branches filiform; stolon up to 250 μm, naked and densely branched,

with numerous groups of rhizoids; upright branch dense, up to 250 μm at the base, simple or irregularly branched, naked at the base and bearing conspicuous verticils at intervals of 2-5 mm; verticils 60-80 μm in diameter at the base and tapering to 24-27 μm at the apices, dichotomously branched, up to 7 orders; apices with 2-4 mucrons.

Local distribution - Manado Tua ; Depth : 0 m.

Distribution - Tropical Indian Ocean, Indo-Pacific.

Specimens examined - REDW-133A/ -137A

Remark - *Caulerpa verticillata* was found either freely or entangled with *Gracilaria cononopifolia.*

Family CODIACEAE

II *Codium* Stackhouse

Key to species of *Codium* from North Sulawesi :

1a. Thallus amorphous ..... *C. arabicum*

1b. Thallus dichotomously to subdichotomously branched... *C. edule*

Codium arabicum Kützing (Plate 1: f)

Codium arabicum Kützing, 1856: 35; Trono, 1968: 190-191; Silva, 1952: 382 ; Egerod, 1974: 144-145; Silva *et al.*, 1987: 111; Coppejans and Prud'homme van Reine, 1992a: 174; Verheij and Prud'homme van Reine, 1993: 399.

Codium conoratum Setchell, 1926: 82.

Thallus dark green in color, spongy, amorphous; primary utricles with irregular shape, 276 to 297 μm broad and up to 550 μm long, apices smooth and rounded with 1 to 2 hair scars about 60 to 66 μm below the apex, wall 3 μm thick; secondary utricles arising from lower part of primary utricles, cylindrical to clavate, 48 to 84 μm broad and 300 to 336 μm long, apices blunt, no hair scars; medullary filament 12 to 21 μm broad.

Local distribution - Murex ; Depth : -2 m.

Distribution - Indo-Pacific (Indonesia, the Philippines), central western Pacific, Red Sea.

Specimen examined - REDW-140.

Codium edule Silva

Codium edule Silva, 1952: 392; Trono, 1968: 190; Trono and Ganzon-Fortes, 1980: 64; Silva *et al.*, 1987:112; Verheij and Prud'homme van Reine, 1993: 399.

Thallus green to dark green in color, spongy, branching dichotomous to subdichotomous with wide and somewhat rounded angles; branches terete, 2 to 3 mm in diameter; utricles club-shaped, cone-shaped, cylindrical, sometimes swollen just below apex, slightly tapering towards the base, 120 to 360 μm at broadest point and 444 to 732 μm long, wall 12 μm thick, apices blunt and smooth, 1 to 2 hair scars present at 30 to 60 μm below apex; medullary filament generally constricted at the junction with the base of utricles, (18)-30 to 48 μm broad; gametangia oblong, extending beyond apices, 57 to 69 μm broad at broadest point and 260 to 276 μm long including short stalk.

Local distribution - Murex ; Depth : -2 m.
Distribution - Indo-Pacific, central Pacific.
Specimen examined - REDW-141.

Family UDOTEACEAE

III *Avrainvillea* Decaisne

Avrainvillea obscura (C. Agardh) J. Agardh (Plate 1: g)

Dichonema erectum Berkeley, 1842: 157.
Anadyomene obscura C. Agardh, 1822: 401.
Avrainvillea erecta (Berkeley) A. Gepp and E. S. Gepp, 1911: 29; Weber-van Bosse, 1913: 114; Olsen-Stojkovich, 1985: 22-24.

Avrainvillea obscura (C. Agardh) J. Agardh, 1887 : 53; Olsen-Stojkovich, 1985: 19-22.

Thallus erect, differentiated into blade, stipe and holdfast, up to 4 cm tall (excluding bulbous holdfast), dark greenish-brown in color; blade born singly on stipe, flattened, with margin erose; blade siphons smooth (not tortuous) and cylindrical throughout measuring 42 to 48 μm across, with rounded apices, deeply constricted at dichotomies; holdfast long, thick, bulbous extending to 9.7 cm long.

Local distribution - Likupang ; Depth : +1 m.
Distribution - Tropical Indian Ocean, tropical Pacific.
Specimens examined - REDW-72 / -82.

IV *Halimeda* Lamouroux

Key to species of *Halimeda* from North Sulawesi :

1a. Holdfast bulbous ..... *H. macroloba*
1b. Holdfast not bulbous 2
2a. Basal segment flabellate and larger than all other segments, supporting numerous branches ..... *H. micronesica*
2b. Not as above 3
3a. Secondary utricles noticeably inflated and larger than all other utricles, generally exceeding 90 μ in diameter ..... *H. discoidea*
3b. Not as above 4

4a. Thallus on drying white with velvety appearance, peripheral utricles detached after decalcification .... *H. macrophysa*

4b. Not as above 5

5a. Branching in all directions, with numerous rhizoidal holdfasts at the contact with substratum ..... *H. opuntia*

5b. Branching in one plane, with single holdfast 6

6a. Segments large (up to 2.5 cm across), reniform to discoid; utricles clearly constricted at the base ..... *H. tuna*

6b. Segments smaller (less than 1 cm across) 7

7a. Thalli sparsely branched; branches relatively long; segments up to 0.9 mm across ..... *H. copiosa*

7b. Thalli densely branched; branching mostly trichotomous; segments less than 0.5 mm across ..... *H. melanesica*

Halimeda copiosa Goreau and Graham (Plate 1: h)

Halimeda copiosa Goreau and Graham, 1967: 433; Hillis-Colinvaux, 1980: 118-120.

Halimeda opuntia f. *hederacea* Barton, 1901: 21.

Halimeda opuntia var. *hederacea* (Barton) Hillis, 1959: 360.

Halimeda hederacea (Barton) Colinvaux, 1968: 30.

Thallus up to 8 cm tall, habit loose, arising from a single holdfast; calcification moderate; branching in a single plane, mostly

trichotomous, sparsely branched with branches relatively long; segments larger distally, up to 0.9 mm across, the first two to four segments at the base of the thallus small and trilobed, other segments depressed ovate with upper margin entire, three-lobed or crenate, and basal margin truncate or cordate; cortex with three to four series of utricles; outermost utricles attached firmly after decalcification, polygonal in surface view, measuring 24-54 μm in diameter; medullary filaments numerous in mature segments, commonly fused in pairs at the node for a short distance.

Local distribution - Murex, Bunaken ; Depth : -2 to -12 m.
Distribution - Tropical Indian Ocean, tropical western Pacific (Indonesia, the Philippines), Caribbean.
Specimens examined - REDW- 148 / -262.

Halimeda discoidea Decaisne (Plate 2: a)

Halimeda discoidea Decaisne, 1842: 102; Howe, 1907: 495; Taylor, 1950: 85; Egerod, 1952: 398; Hillis, 1959: 352; Hillis-Colinvaux, 1980: 136-139.
Halimeda discoidea var. *platyloba* BØrgesen, 1911: 134; BØrgesen, 1913: 107.
Halimeda tuna Barton, 1901: 11.

Thallus up to 13 cm tall, habit loose, arising form a single small but distinct holdfast; calcification light; branching in one plane, mainly trichotomous and occasionally polychotomous from

large segments; basal segments subcylindrical or broadly cuneate; other segments usually flat, commonly discoidal to reniform or compressed-cylindrical, cuneate or subcuneate, outer margin entire or undulating, to 2 cm long, 2.3 cm broad; cortex with two or occasionally three series of utricles; secondary utricles larger (up to 150 μm broad) than all other utricles; outermost utricles attached firmly after decalcification, polygonal in surface view, measuring 36-80 μm in diameter; medullary filaments commonly fused completely or incompletely in pairs at the node.

Local distribution - Wori, Nain Island ; Depth : -3 to -10 m.
Distribution - Pantropical.
Specimens examined - REDW-210 / -211 / -233.

Halimeda macroloba Decaisne (Plate 2: b)

Halimeda macroloba Decaisne, 1842 : 118; Decaisne, 1842 : 91; Barton, 1901: 24; Hillis, 1959: 375; Weber-van Bosse, 1913: 122-123; Hillis-Colinvaux, 1980: 108-110.
Halimeda macroloba var. *ecalcarea* Weber-van Bosse, 1926: 86-88.

Thallus erect, up to 13.5 cm tall excluding the bulbous holdfast, calcification moderate; branching in a single plane, mostly trichotomous to polychotomous at the basal part; basal segments compressed-cylindrical to trapezoidal, other segments subcuneate, discoidal or subreniform, margin entire, undulating or somewhat lobed, 2 cm long, 3 cm broad; cortex with three series of utricles;

outermost utricles detached after decalcification, rounded in surface view, measuring 27-48 μm in diameter; medullary filaments fused in groups and with communicating pores.

Local distribution - Likupang, Manado Tua, Manado Beach Hotel, Kumu, Tanjung Pisok ; Depth : +1 to -2 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), Eastern Australia, Red Sea.

Specimens examined - REDW-83 / -84 / 134 / -182 / -302 / -316.

Halimeda macrophysa Askenasy (Plate 2: e)

Halimeda macrophysa Askenasy, 1888: 14; Barton, 1901: 17; Hillis, 1959: 351; Weber - van Bosse, 1913: 121; Hillis - Colinvaux, 1980: 134-136.

Thallus fragile, up to 12 cm tall, dull and velvety in appearance; calcification moderate; branching in one plane, mostly trichotomous or polychotomous at large segments; basal segments subcuneate; other segments reniform to subreniform or subcuneate; margin entire, often folded, to 1.2 cm long, 2 cm broad; cortex with two series of utricles; outermost utricles detached after decalcification, round in surface view, measuring 130-172 μm in diameter; nodal medullary filaments completely fused in two's or three's.

Local distribution - Biaro Island ; Depth : -3 m.

Distribution - Tropical Indian Ocean, tropical western Pacific (Indonesia, the Philippines).

Specimens examined - REDW-1 / -5.

Halimeda melanesica Valet (Plate 2: d)

Halimeda melanesica Valet, 1966: 680; Hillis-Colinvaux, 1980: 153-154.

Thallus flaccid, up to 8 cm tall, rhizoidal filaments connected to several basal segments; calcification light; branched in one plane, mostly dichotomous and trichotomous; basal segments reniform 4 mm long and 5 - 8 mm broad; other segments cuneate or sometimes compressed-cylindrical, upper margin entire or three lobed, to 7 mm long, 5 mm broad; cortex with three series of utricles; utricles constricted at the base; outermost utricles attached after decalcification; polygonal in surface view, measuring 48-66 μm in diameter; nodal medullary filaments unfused.

Local distribution - Biaro Island, Nain Island, Batu Putih ; Depth : -1 to -3 m.

Distribution - Indonesia, Hawaii.

Specimens examined - REDW-11 / -250 / -343.

Halimeda micronesica Yamada (Plate 2: c)

Halimeda micronesica Yamada, 1941: 121; Taylor, 1950: 89-90; Hillis-Colinvaux, 1980: 149-151.

Thallus compact and spreading, up to 6 cm tall; calcification moderate; color when dried greenish to steel-gray, surface dull; densely branched in one plane, trichotomous and only polychotomous at the basal segment; basal segment flabellate and much larger than the rest, to 1 cm long and 1.3 cm broad, supporting numerous subcuneate segments; upper margin trilobed, to 5 mm long and 4 mm broad; cortex with three series of utricles; outermost mature segments usually detached but younger ones slightly attached after decalcification, rounded in surface view, measuring 30-51 μm in diameter; nodal medullary filaments unfused.

Local distribution - Murex, Batu Putih ; Depth : 0 to -2 m.
Distribution - Tropical Indian Ocean, tropical western Pacific (Indonesia, the Philippines, Caroline Islands, Basilan Islands).
Specimens examined - REDW-147 / -344/ -345.

Halimeda opuntia (Linnaeus) Lamouroux (Plate 2: f)

Halimeda opuntia (Linnaeus) Lamouroux, 1816: 308; Weber-van Bosse, 1926: 86; Taylor, 1950: 80-83; Hillis-Colinvaux, 1980: 110-112.

Halimeda opuntia Linnaeus, 1758: 805.

Halimeda cordata J. Agardh, 1887: 83.

Halimeda opuntia forma *cordata* (J. Agardh) Barton, 1901: 20.

Thallus sprawling laterally or erect, with many holdfasts at the contacts with substratum; calcification moderate to heavy; densely branched, branching in many planes, mostly trichotomous; segments highly variable, flat or more or less contorted, commonly ribbed, upper margin entire or lobed, 5 mm long, 8 mm broad; cortex of three to four series of utricles; outermost utricles attached slightly after decalcification, rounded to hexagonal in surface view, measuring 16-39 μm in diameter; nodal medullary filaments fused in pairs or remaining unfused.

Local distribution - Likupang, Manado Beach Hotel, reef area 1 km north of Manado Beach Hotel, Kumu, Tanjung Pisok, Batu Putih ; Depth : +1 to -2 m.

Distribution - Pantropical.

Specimens examined - REDW-62/ -183 / -287 / -297 /-326 / -346/ -347 / -348.

Halimeda tuna (Ellis and Solander) Lamouroux (Plate 2: g)

Corallina tuna Ellis and Solander, 1786: 111.

Halimeda tuna (Ellis and Solander) Lamouroux, 1816 : 309; Barton, 1901: 14; Weber-van Bosse, 1913: 120; Weber-van Bosse, 1926: 85; Taylor, 1950: 84; Hillis-Colinvaux, 1980: 122-124.

Halimeda platydisca Decaisne, 1842: 102.

Halimeda tuna f. *platydisca* (Decaisne) Barton, 1901: 14.

Thallus spreading and somewhat compact, to 6 cm tall; calcification moderate to light; branching in one plane, mostly trichotomous; basal segment subcuneate, other segments discoid or reniform, margin entire, 1.2 cm long, 2.5 cm broad; cortex of two sometimes three series of utricles; outermost utricles firmly attached after decalcification, outermost utricles of irregular shape in surface view, ranging widely in diameter (up to 90 μm); nodal filaments fused mostly in pairs sometimes in three's.

Local distribution - Kumu ; Depth : -2 m.
Distribution - All tropical and warm temperate seas of the world.
Specimen examined - REDW-300.

V *Tydemania* Weber-van Bosse

Tydemania expeditionis Weber-van Bosse (Plate 2: h)

Tydemania expeditionis Weber-van Bosse, 1901: 139; Weber-van Bosse, 1913: 116; A Gepp and E. S. Gepp, 1911: 66; Trono and Ganzon-Fortes, 1988: 63-64; Coppejans and Prud'homme van Reine, 1989a: 133-135.

Thallus erect, bushy, slightly calcified, green in color; main branches moniliform, 390-450 μm in diameter, with successive

whorls of glomeruliferous branchlets at intervals of 5.6 mm to 10 mm; each whorl with four or occasionally five verticillate branchlets; branchlets equal-dichotomously branched (rarely trichotomous) in seven or more orders, branching at terminal portion of branchlet segments, deeply constricted at dichotomies; segments of branchlet longer and smaller in diameter, suprabasal segments of the branchlets 480 μm in diameter and tapering to 112 μm in diameter at apices, apices blunt.

Local distribution - Biaro Island, Bangga Island, Manado Tua, Manado Beach Hotel, Bunaken ; Depth : -2 to -12m.

Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines), Red Sea.

Specimens examined - REDW-15 / -36 / -47 / 190 / 261.

VI *Udotea* Lamouroux

Udotea argentea Zanardini (Plate 3: a)

Udotea argentea Zanardini, 1858: 290; A. Gepp and E.S Gepp, 1911: 125; Weber-van Bosse, 1913: 117; Weber-van Bosse, 1926: 85; Coppejans and Prud'homme van Reine, 1989a: 136-137.

Thallus erect, green to grayish in color; frond fan-shaped composed of more than one series of overlapping flabellate or reniform segments, slightly calcified, zonate, to 20.5 cm tall

excluding the thick bulbous holdfast extending to 4.5 cm long; blade filaments with club-shaped or rounded appendages which are pinnate-alternately arranged along stipitate lateral branchlets.

Local distribution - Wori, Kumu ; Depth : -2 to -4 m.
Distribution - Tropical Indian Ocean, tropical western Pacific (Indonesia, the Philippines), Red Sea (Egypt, Suez).
Specimens examined - REDW-208 / -209 / -301 / -303.

Order CLADOPHORALES

Family ANADYOMENACEAE

VII *Anadyomene* Lamopuroux

Anadyomene stellata (Wulfen) C. Agard

Anadyomene stellata (Wulfen) C. Agardh, 1822: 400; Weber - van Bosse, 1913: 74-75; BØrgesen, 1913: 25-26; Littler and Littler, 1991: 112-114.
Ulva stellata Wulfen *in* Jacquin, 1786: 351.
Anadyomene flabellata Lamouroux, 1816: 366.

Thallus bladed, ovate or reniform and irregularly lobed; veins uniserate, decreasing in size distally, polychotomously branched in stellate configuration at segment apices, with lateral interstitial cells pinnate or pectinate and straddling veins, bases of vein

segments bifurcate and straddling apices of proximal segments; interstitial cells H-shaped, tightly parallel to one another at bases of veins; outer margin consisting of small spherical cells.

Local distribution - Wori, Bulo Beach, Manado Beach Hotel (floating fish cage net 200 m seaward) ; Depth : 0 m.

Distribution - Pan-(sub)tropical, Indonesia, the Philippines.

Specimens examined - REDW-201 / -229 / -330.

Family SIPHONOCLADACEAE

VIII *Boergesenia* Feldmann

Boergesenia forbesii (Harvey) J. Feldmann (Plate 3: b)

Valonia forbesii Harvey, 1860: 333; Weber-van Bosse, 1913: 59; Weber-van Bosse, 1926: 81.

Boergesenia forbesii (Harvey) J. Feldmann, 1938 : 1503; BØrgesen, 1948: 21; Trono, 1968: 157; Trono and Ganzon-Fortes, 1988: 16; Verheij and Prud'homme van Reine, 1993: 416.

Thallus solitary or in a colony, distinctly bright green, shiny, club-shaped, filled with fluid, up to 2.1 cm tall and 0.7 cm wide (at widest point); colony held together by small rhizoid-like holdfast.

Local distribution - Likupang, Wori, Pulau Nain ; Depth : +1 to -3 m.

Distribution - Tropical and warm temperate Indian Ocean, tropical Pacific ((Indonesia, the Philippines) and warm temperate Pacific.

Specimens examined - REDW-68 / -199 / -245.

Family VALONIACEAE

IX *Dictyosphaeria* Decaisne ex Endlicher

Key to species of *Dictyosphaeria* from North Sulawesi :

1a. Thallus saclike when young and ruptured when mature, monostromatic, cell walls nontrabeculate ..... *D. cavernosa*

1b. Thallus solid, pseudoparenchymatous, cell wall with spinulose trabeculae ..... *D. versluysii*

Dictyosphaeria cavernosa (Forsskål) BØrgesen (Plate 3: e)

Dictyosphaeria cavernosa (Forsskål) BØrgesen, 1932: 2; Trono, 1968: 157-158; Trono and Ganzon-Fortes, 1988: 18-19; Schneider and Searles, 1991: 78.

Ulva cavernosa Forsskål, 1775: 187.

Valonia favulosa C. Agardh, 1822: 432; Weber-van Bosse, 1926: 82.

Dictyosphaeria favulosa (C. Agardh) Decaisne ex Endlicher, 1843: 18; Weber-van Bosse, 1913:63.

Thallus green, to 2.2 cm in diameter, consisting of a single layer of large polygonal cells up to 1.2 mm broad; thallus saclike, hollow, and spherical when young, rupturing when old.

Local distribution - Likupang, 0.5 km west of Murex, Tanjung Pisok ; Depth : +1 to 0 m.

Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines), Mediterranean, Red Sea.

Specimens examined - REDW-67 / -197 / -198 / 317.

Dictyosphaeria versluysii Weber-van Bosse (Plate 3: f)

Dictyosphaeria versluysii Weber-van Bosse, 1905: 144; Weber-van Bosse, 1913: 64; Trono, 1968: 158.

Dictyosphaeria vanbosseae BØrgesen, 1912: 256.

Dictyosphaeria setchellii BØrgesen, 1940: 12.

Thallus green, to 9 mm in diameter, solid cushion composed of polygonal cells measuring 420 to 660 μm in diameter, pseudoparenchymatous (due to daughter cells maturing in many planes), cell's inner walls with horizontally striated spinulose trabeculae, tapered upward, measuring 60 to 75 μm long.

Local distribution - Tanawangko, Murex, reef area 1 km north of Manado Beach Hotel ; Depth : 0 to -2 m.

Distribution - Pantropical.

Specimens examined - REDW-94 / -95 /-146 / -286.

X *Valonia* C. Agardh

Valonia aegagropila C. Agardh (Plate 3: c)

Valonia aegagropila C. Agardh, 1822: 429; Weber-van Bosse, 1913: 60-61; Weber-van Bosse, 1926: 81; BØrgesen, 1948: 21; Trono, 1968: 156; Trono and Ganzon-Fortes, 1988: 20.

Thallus green, pulvinate, composed of numerous subclavate vesicles up to 5.2 mm long and 2.5 mm broad (measuring at broadest point); branching irregular but predominantly terminal, often obscured by lateral cohesion of adjacent vesicles; vesicles joined laterally by hapteroid extensions of minute lenticular cells formed at sporadic intervals along vesicle walls.

Local distribution - Likupang ; Depth : +1 m.

Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines).

Specimen examined - REDW-71.

XI *Ventricaria* Olsen and West

Ventricaria ventricosa (J. Agardh) Olsen and West (Plate 3: d)

Valonia ventricosa J. Agardh, 1887: 101; Weber-van Bosse, 1913: 60; BØrgesen, 1948: 20; Egerod, 1952: 347; Trono, 1968: 155-156; Trono and Ganzon-Fortes, 1988: 21.

Ventricaria ventricosa (J. Agardh) Olsen and West, 1988: 104.

Thallus composed of a single cell, unbranched, vesiculate, to 2.4 cm in diameter, green in color; thallus wall shiny; attached by hapteroid rhizoids arising from the base of the thallus.

Local distribution - Murex, Manado Beach Hotel ; Depth : -2 m.

Distribution - Tropical Indian Ocean, Tropical Pacific (Indonesia, the Philippines), Caribbean (Virgin Islands).

Specimens examined - REDW-147 / -191.

Remark - This genus is kept in the Family Valoniaceae rather than in the Family Siphonocladaceae as placed tentatively by Olsen and West (1988) since the taxonomic position of this genus is not yet validated.

Order DASYCLADALES

Family DASYCLADACEAE

XII *Acetabularia* Lamouroux

Acetabularia dentata Solms-Laubach

Acetabularia dentata Solms-Laubach, 1895: 22-24; Yamada, 1934: 54-55; Trono and Ganzon-Fortes, 1988: 71-72.

Thallus heavily calcified, up to 0.9 mm tall; cap flat to slightly cupulate, up to 3.2 mm in diameter, composed of up to 32 sporangial rays laterally coherent by calcification; rays clubshaped with distinctly apiculate tip; segments of corona superior 99 to 108 μm long, longish-ovate, rounded-truncate to slightly emarginate, with three hair scars; corona inferior slightly smaller, with outer margin deeply bilobed or sometimes trilobed.

Local distribution - Likupang, Manado Tua ; Depth : +1 to 0 m.

Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines).

Specimens examined - REDW- 79 / -132.

XIII *Bornetella* Munier-Chalmas

Key to species of *Bornetella* from North Sulawesi

1a. Thallus spherical ..... *B. sphaerica*

1b. Thallus not spherical 2

2a. Central axis constricted between whorls of primary branches, 1 to 2 aplanosporangia born laterally on each primary branch ..... *B. nitida*

2b. Central axis not constricted between whorls of primary branches, more than two aplanosporangia born laterally on each primary branch ..... *B. oligospora*

Bornetella nitida Munier-Chalmas ex Sonder (Plate 3: g)

Bornetella nitida Munier-Chalmas ex Sonder, 1880: 39; Weber-van Bosse, 1913: 89; Taylor, 1966: 347; Coppejans and Prud'homme van Reine, 1989b: 125-126.

Thallus slightly calcified, subcylindrical, clavate, curved, sometimes shortly stipitate, green in color, up to 3 cm high and 0.7 cm broad; central axis cylindrical extending almost entirely the length of the frond, constricted between whorls of primary branches; primary branches bearing laterally coherent and calcified short capitate branches of up to 270 μm broad (surface view and

measured between parallel sides of the hexagons); one to two aplanosporangia born laterally on primary branch.

Local distribution - Tanawangko, Kumu ; Depth : 0 to -2 m.
Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia).
Specimens examined - REDW-92 / -307.
Remark - Specimens observed had immature gametangia.

Bornetella oligospora Solms-Laubach

Bornetella oligospora Solms-Laubach, 1892: 87; Weber-van Bosse, 1913: 89; Coppejans and Prud'homme van Reine, 1989a: 125.

Thallus morphologically resembling *B. nitida,* up to 2.2 cm high and 0.5 cm broad; central axis not constricted between whorls of primary branches; primary branches bearing laterally coherent and calcified short capitate branches of up to 180 μm broad (surface view and measured between parallel sides of hexagons); usually 3 to 4 aplanosporangia born laterally on each primary branch.

Local distribution - Manado Beach Hotel ; Depth : -2 m.
Distribution - Malay Archipelago.
Specimen examined - REDW-178.
Remark - Specimens observed had immature gametangia.

Bornetella sphaerica (Zanardini) Solms-Laubach (Plate 3: h)

Neomeris ?sphaerica Zanardini, 1878: 38.

Bornetella sphaerica (Zanardini) Solms-Laubach, 1892: 80; Weber-van Bosse, 1913: 90; Taylor, 1966: 347.

Bornetella ovalis Yamada, 1933: 277; Yamada, 1934: 51.

Thallus slightly calcified, spherical, up to 1 cm in diameter, green in color, central axis extending about half the length of frond and bearing successive whorls of primary branches; primary branches bearing short, capitate branches with inflated ends measuring 240-600 μm broad (surface view and measured between parallel sides of hexagons), truncate, laterally coherent; two to four spherical aplanosporangia born laterally on primary branch, 144-168 μm in diameter

Local distribution - Tanawangko, Tanjung Pisok ; Depth : 0 m.

Distribution - Madagascar, Mauritius, Singapore, the Philippines, Indonesia.

Specimens examined - REDW-93 / -318.

XIV *Neomeris* Lamouroux

Key to species of *Neomeris* from North Sulawesi :

1a. Thallus with annulate appearance, decalcified sporangia oblong ..... *N. annulata*

1b. Thallus without annulate appearance, decalcified sporangia spherical ..... *N. vanbosseae*

Neomeris annulata Dickie (Plate 4: a)

Neomeris annulata Dickie, 1874: 198; Weber-van Bosse, 1913 : 88-89; Coppejans and Prud'homme van Reine, 1989b: 127-128.

Thallus calcified, subcylindrical, annulate in appearance, 3.3 cm tall and 0.3 cm broad, sometimes curved; erect simple axis with many successive whorls of primary branches bearing at their terminal end a stalked elongate sporangium measuring 90-110 μm in diameter and 240-270 μm long, and two branches of a second order, sporangia strongly calcified and cohering with groups of other sporangia giving the annulate appearance of the frond.

Local distribution - Manado Beach Hotel ; Depth : -2 m.
Distribution - Pantropical.
Specimen examined - REDW-179.

Neomeris vanbosseae Howe

Neomeris vanbosseae Howe, 1909: 80; Weber-van Bosse, 1913: 88; Coppejans and Prud'homme van Reine, 1989b: 127-128.

Thallus calcified, subcylindrical to clavate, 2 cm tall and 0.3 cm broad, sometimes curved; erect simple axis with many successive whorls of primary branches bearing at their terminal end a stalked spherical sporangium measuring 130-140 μm in diameter and 180-190 μm long, and two branches of a second order; sporangia strongly calcified but free from each other thus lacking the annulate appearance of the frond.

Local distribution - Likupang, Murex ; Depth : +1 to -2 m.

Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines).

Specimens examined - REDW-80 / -144.

Chapter 4

PHAEOPHYTA

The key to the genera of Phaeophyta from North Sulawesi :

1a. Frond of fan-shaped segments 2

1b. Frond not of fan-shaped segments 3

2a. Medulla a single layer with taller cells and cortex of several layers of small cells arranged in a tiers ..... *Lobophora*

2b. Medulla and cortex not distict; two to several several cells in thickness ..... *Padina*

3a. Frond flat, with strap-shaped branches ..... *Dictyota*

3b. Frond with distinct leaves, stem and bearing vesicles 4

4a. Vesicles born on stalk attached to the axes ... *Sargassum*

4b. Vesicles otherwise 5

5a. Vesicles born on the center of the leaves ..... *Turbinaria*

5b. Vesicles randomly imeresed in the frond ..... *Hormophysa*

Order DICTYOTALES

Family DICTYOTACEAE

I. *Dictyota* Lamouroux

Remarks - Unlike *Dictyota* species collected from The Spermonde Archipelago (Verheij and Prud'homme van Reine, 1993), all *Dictyota* specimens in my study have a single-layered medulla.

Key to species of *Dictyota* from North Sulawesi :

1a. Fronds less than 2 mm broad; branching irregularly subdichotomous; branches cervicorn ..... *D. cervicornis*

1b. Fronds more than 2 mm broad; branching dichotomous to subdichotomous; branches not cervicorn 2

2a. Fronds strap-shaped, margins bearing small teeth at irregular intervals ..... *D. ciliolata*

2b Midfronds broad and tapering toward the base and the apices; margins smooth or with proliferations; fronds dotted in appearance ..... *D. bartayresiana*

Dictyota bartayresiana Lamouroux (Plate 4: b)

Dictyota bartayresiana Lamouroux, 1809a: 43; Weber-van Bosse, 1913: 182-183; Jaasund,1977: 515; Allender and Kraft, 1983:

112-114; Silva *et al.*, 1987: 75; Farrant and King, 1989: 375-376; Verheij and Prud'homme van Reine, 1993: 423-424.

Dictyota bartayresii Lamouroux, 1809b: 331; Lawson and John,1987: 120.

Thalli up to 9 cm long, not entangled; fronds 1-2 mm wide at the apices, up to 2.5-4 mm wide at midfrond, and tapering to 1-1.5 mm wide at the base; branching subdichotomous to dichotomous with branch angles more than 45° and rounded, segments 0.6-20 mm long; frond margins smooth or proliferous; apices acute to obtuse. The plant is characterized by its dotted appearance due to darkly pigmented cell inclusions.

Local distribution - Manado Beach Hotel, floating fish cage mesh 200 m seaward (Manado Beach Hotel) ; Depth : 0 to -2 m.

Distribution - Tropical Indian Ocean, tropical Pacific Ocean (Indonesia, the Philippines).

Specimens examined - REDW-184 / -336 / -337.

Remarks - Specimens were growing on wire mesh of an anchored and floating fish cage. Specimens of North Sulawesi agree with the description by Allender and Kraft (1983) and Farrant and King (1989). Both acute and obtuse tips were observed. Jaasund (1977) and Lawson and John (1987) reported that older plants of *D. bartayresiana* have acute tips while the younger ones have obtuse tips. Specimens from North Sulawesi differ from those of the Spermonde Archipelago in that North Sulawesian

specimens do not have spiny outgrowths on the surface of the frond.

Dictyota cervicornis Sonder ex Kützing

Dictyota cervicornis Sonder ex Kützing, 1859: 11; Jaasund, 1977: 110; Silva *et al.*, 1987; Lawson and John, 1987: 119-120; Verheij and Prud'homme van Reine, 1993: 424.

Thalli up to 8 cm long, bushy and twisted; fronds less than 2 mm wide, basal fronds narrower than midfronds; apices generally obtuse with a few acute ones; branching irregularly subdichotomous with angles more than 30° and rounded, branches often deeply curved backward; frond margin smooth, sometimes with tongue-like projection.

Local distribution - Pulau Nain ; Depth : -3 m.
Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines), North Atlantic, Cuba.
Specimen Examined - REDW-254.

Dictyota ciliolata Kützing (Plate 4: c)

Dictyota ciliolata Kützing, 1859: 12; Jaasund, 1977: 76; Silva *et al.*, 1987: 75; Dawson and John, 1987: 122; Verheij and Prud'homme van Reine, 1993: 424.

Thalus 5.5 cm long, solitary and twisted, 2-2.5 mm wide, strap-shaped with obtuse to subacute tips; branching regularly dichotomous, with angles wide and rounded, fronds bearing small acute teeth that occur at irregular intervals; proliferation present on the margin of the frond.

Local distribution - Reef area 1 km north of Manado Beach Hotel; Depth : -2m.

Distribution - Tropical Indian Ocean, tropical Pacific (Indonesia, the Philippines), Atlantic (Venezuela).

Specimen examined - REDW-184 a.

Remarks - This North Sulawesian specimen fits the description of type three of the dentate *Dictyota* 's occuring in the Dar es Salaam region (Jaasund, 1977).

II. *Lobophora* J. Agardh

Lobophora variegata (Lamouroux) Womersley (Plate 4: d)

Lobophora variegata (Lamouroux) Womersley, 1967: 221; Allender and Kraft, 1983: 81-83; Lawson and John, 1987: 127; Silva *et al.*, 1987: 77; Womersley, 1987: 253; Farrant and King, 1989: 393-394; Verheij and Prud'homme van Reine, 1993: 426.

Dictyota variegata Lamouroux, 1809: 40.

Zonaria variegata (Lamouroux) C. Agardh, 1817: XX; Weber-van Bosse, 1913: 175, 178; Weber-van Bosse, 1926: 99.

Gymnosorus variegatus (Lamouroux) J. Agardh, 1894: 11.
Pocockiella variegata (Lamouroux) Papenfuss, 1943: 467.
Lobophora nigrescens Sonder, 1845: 50.
Pocockiella nigrescens (Sonder) Papenfuss, 1943: 467.

Plants prostrate or erect, flabellate and sometimes splitting into several lobes or consisting of somewhat smaller overlapping segments, 48-58 mm thick, fronds with medullary cells in regular tiers with the central layer of cells larger and colorless; thalli consisting five cell layers, with cells of the central layer 30-36mm taller than those of the surrounding cells.

Local distribution - Manado Tua, Reef area 1 km north of Manado Beach Hotel, Bunaken ; Depth : -2 to -12 m.
Distribution - Tropical and temperate regions.
Specimens examined - REDW-50 / -51 / -189 / -260.

III. *Padina* Adanson

Remarks - The North Sulawesian species of *Padina* show the same pattern of marginal inrolling as those reported in The Spermonde Archipelago (Verheij and Prud'homme van Reine, 1993) -*i.e.* marginal inrolling is not towards the side bearing the sporangia but away from that side. Therefore, they are not in agreement with the description of Allender and Kraft (1983) and Farrant and King (1989). To avoid confusion, I consider the inner (lower) surface to

be the site towards which the marginal inrolling occurs, and vice versa.

Key to species of *Padina* from North Sulawesi :

1a. Fronds two cell layers thick throughout the thallus, sporangia with indusium ..... *P. japonica*

1b. Fronds two cell layers thick throughout the thallus, sporangia without indusium 2

2a. Sporangia on upper surface in concentric lines bordered on each side by hair bands that alternate on upper and lower surface, sporangia regions separated from each other by a sterile zone ..... *P. australis*

2b. Sporangia on upper surface in concentric lines bordered on each side by hair bands that are only on the upper surface, sporangial regions not separated from each other by a sterile zone ..... *P. tenuis*

Padina australis Hauck (Plate 4: f)

Padina australis Hauck, 1887: 44; Weber-van Bosse, 1913: 179-180; Weber-van Bosse, 1926: 100; Allender and Kraft, 1983: 85-86; Silva *et al.*, 1987: 77; Lawson and John, 1987: 128; Farrant and King, 1989: 388; Verheij and Prud'homme van Reine, 1993: 428.

Thalli stipitate, light brown, 1.8-8 cm tall; fronds 2-10 cm broad, broadly flabellate often splitting into several lobes, moderately to heavily calcified on lower (inner) surface and slightly on the upper (outer) surface, distromatic throughout; with conspicuous hairs on both surfaces; hair bands alternate on the upper (outer) and lower (inner) surfaces so that the narrower sporangial zones are separated from each other by wider sterile zones; sporangia occur on the upper (outer) surface of the thallus, without indusium.

Local distribution - Manado Tua, Likupang, Tanjung Pisok, Batu Putih ; Depth : + 1 to - 1 m.

Distribution - Tropical and warm temperate Indian Ocean and Pacific Ocean (Indonesia, the Philippines), Tropical west Africa.

Specimens examined - REDW-76 / -126 / -320 / -341.

Padina japonica Yamada

Padina japonica Yamada, 1931a: 69; Trono and Ganzon-Fortes, 1987: 64.

Thalli stipitate, light brown, to 1.4 cm tall; fronds flabellate, to 1.2 cm broad, moderately calcified on lower (inner) surface and slightly calcified on the upper (outer) surface, distromatic throughout; cells in longitudinal sections not corresponding/not lined-up with each other, smaller square-shaped cells on the outer

surface and bigger rectangularly-shaped cells on the inner surface; sporangia covered with indusium; hairs absent.

Local distribution - Tanawangko ; Depth : 0 m.

Distribution - Japan, Micronesia, Luzon (South China Sea and Pacific Ocean).

Specimens examined - REDW-99 / -108.

Padina tenuis Borry de Saint-Vincent (Plate 4: e)

Padina tenuis Bory de Saint-Vincent, 1827: 590; Womersley and Bailey, 1970: 292; Allender and Kraft, 1983: 83; Farrant and King, 1989: 390-391; Verheij and Prud'homme van Reine, 1993: 429.

Thalli stipitate, light brown, to 4 cm tall; fronds up to 5 cm broad and often splitting into several lobes, calcification on both surfaces but more heavily on the inner surface than on the outer one, distromatic throughout; outer surface cells smaller than the inner ones; sporangia without indusium born on the upper surface, many hairs apparent on the 'outer' thallus margin while scarce along the thallus; hairs occur only on the outer surface.

Local distribution - Manado Beach Hotel ; Depth : -2 m.

Distribution - Tropical and warm temperate Indian Ocean and Pacific Ocean (Indonesia, Solomon Islands).

Specimen examined - REDW-185.

Order FUCALES

Family CYSTOSEIRACEAE

IV. *Hormophysa* Kützing

Hormophysa cuneiformis (Gmelin) Silva (Plate 5: a)

Hormophysa cuneiformis (Gmelin) Silva *et al.*, 1987: 81, 130; Verheij and Prud'homme van Reine, 1993: 431.

Fucus cuneiformis Gmelin, 1792: 1389.

Cystoseira triquetra C. Agardh, 1820: 61.

Hormophysa triquetra (C. Agardh) Kützing, 1843: 359; Papenfuss, 1967: 42-47; Womersley, 1987: 356; Trono, Jr. and Ganzon-Fortes, 1988: 101.

Thallus erect, bushy, up to 20 cm tall, yellowish to dark brown in color; irregularly branched; branches with terete axes, bearing short stipitate leaf-like segments that arranged triquetrously; triquetrous segments dentate along the margin, with ovate cryptostomata scatteredly present on both surfaces; vesicles immersed in the frond and commonly occur in the ultimate branches; receptacles absent.

Local distribution - Moniet ; Depth : -3 m.

Distribution - Tropical and warm temperate Indo-Pacific (Indonesia, the Philippines, Japan).

Specimen examined - REDW-268.

Family SARGASSACEAE

V. *Sargassum* C. Agardh

Sargassum turbinarioides Grunow (Plate 5: b)

Sargassum turbinarioides Grunow, 1915: 395; Pham-Hoang, 1967: 304; Trono Jr., 1992: 66.

Thallus large, up to 25 cm tall, attached by a small discoid holdfast; stem short, partly smooth and slightly warty; primary branches mostly terete and smooth, irregularly and alternately branched; leaves stiff, 11 mm long and 8 mm wide, without midrib, cryptostomata scattered and very apparent, margin coarsely serrate arranged in double rows, distal third "turbinaroid"; receptacles terete and occasionally dentate along margin, shortly stipitate, simple or branched; vesicles up to 10 mm long and 5 mm wide, shortly stipitate, with coronal leaf or with a row of coarse teeth on distal third.

Local distribution - Moniet ; Depth : -3 m.

Distribution - Indonesia, the Philippines.

Specimen examined - REDW-273.

Remark - *Sargassum turbinarioides* from North Sulawesi is a newly recorded species for Indonesia

VI. *Turbinaria* Lamouroux

Key to species of *Turbinaria* from North Sulawesi :

1a. Leaves much longer than broad and triangular in top view ..... *T. decurrens*

1b. Not as above 2

2a. leaves large (more than 15 mm wide); margin of leaves fully dentate, with a crown of coarse erect teeth in the centre of the leaves ..... *T. ornata*

2b. Leaves small (less than 6 mm wide); margin of leaves fully or partly dentate, inflated by small vesicle ..... *T. conoides*

Turbinaria conoides (J. Agardh) Kützing

Turbinaria conoides (J. Agardh) Kützing, 1860:24; Weber-van Bosse, 1913: 148; Weber - van Bosse, 1926: 98; Silva *et al.*, 1987: 88; Trono and Ganzon-Fortes, 1988: 103-104; Verheij and Prud'homme van Reine, 1993: 434.

Turbinaria vulgaris J Agardh var. *conoides* J. Agardh, 1948: 267.

Thalli erect, unbranched, up to 10 cm tall, dark brown in color; leaves usually less than 8 mm long and 5 mm broad, sharply turbinate, inflated by small vesicle, irregularly triangular in top view, the edges sharply dentate, the ridges obtuse and edentate; the stalk slender and terete; clustered receptacles attached near the base of the stalk.

Local distribution - Murex, Moniet ; Depth : -3 to -13 m.

Distribution - Tropical and warm temperate Indian Ocean and western Pacific (Indonesia, China, western and eastern Australia).

Specimens examined - REDW-196 / -272.

Turbinaria decurrens Bory de Saint-Vincent (Plate 5: d)

Turbinaria decurrens Bory de saint-Vincent, 1828: 119; Weber-van Bosse, 1913: 149; Silva *et al.*, 1987: 89; Trono and Ganzon-Fortes, 1988: 104-106; Verheij and Prud'homme van Reine, 1993: 434.

Thalli erect, unbranched or branched, tough, 10.5 cm tall, dark brown in color, and with branched holdfast. Special characteristic of this species is the triangular shape of the leaves in top view. Leaves somewhat fleshy, to 1.5 cm long and 1.2 cm wide, obpyramidal in lateral view on a very short terete stalk, concave except where small inflated vesicle present in the middle of the leaf, margins dentate; the marginal ridges extending to the angles of

the terminal blades and finely toothed; receptacular branches 0.9 mm long and attached to the base of the leaf at the stalk.

Local distribution - Tanawangko, Moniet, Batu Putih: Depth: 0 to -3m.
Distribution - Tropical Pacific.
Specimens examined - REDW-110 / -274 / -350.

Turbinaria ornata (Turner) J. Agardh (Plate 5: c)

Turbinaria ornata (Turner) J. Agardh, 1848: 266; Weber-van Bosse, 1913: 149; Silva *et al.*, 1987: 89; Trono and Ganzon-Fortes, 1988: 107-109; Verheij and Prud'homme van Reine, 1993: 434.
Fucus turbinatus Linnaeus var. *ornatus* Turner, 1808: 50.

Thalli erect, to 13.5 cm tall, simple or branched, dark brown in color, and with branched holdfast; leaves coarse and firm, 1.5-2.0 cm long and 0.8-1.7 cm wide, with a smooth terete stalk that tapers basally; distal marginal leaves expanded, distinctly thick, somewhat rounded-triangular in surface view, the margin with several prominent teeth of 1-2.5 mm long, centre of the leaves concave and crowned with coarse erect teeth; receptacular branches 1 cm long, racemose, with lateral branchlets irregularly forked, attached about one-third the distance from the base of the leaf stalks.

Local distribution - Biaro Island, Tanawangko, Moniet, Kumu, Batu Putih ; Depth : 0 m to -4 m.

Distribution - Tropical eastern Indian Ocean, tropical western Pacific Ocean (Indonesia, the Philippines).

Specimens examined - REDW-20 / -109 / -275 / -299 / -349.

Chapter 5

RHODOPHYTA

Key to genera of Rhodophyta from North Sulawesi :

1a. Thallus calcified 2

1b. Thallus not calcified 3

2a. Thallus amorphous or flattened, fan-shaped 4

2b. Thallus terete or strap-like 5

3a. Thallus foliose 6

3b. Thallus filamentous, terete to compressed, or flattened 7

4a. Thallus erect, dark cream and shapeless verrucose when fresh ..... *Titanophora*

4b. Thallus prostrate and encrusting, attached to substratum by rhizoids arising from under surface ..... *Peyssonnelia*

5a. Thallus rigid, branches with distinct whorls of projecting assimilatory filaments ..... *Actinotrichia*

5b. Thallus otherwise 8

6a. Thallus with midrib, branches blade - like, lanceolate forming rosettes ..... *Amansia*

6b. Thallus otherwise 9

7a. Thallus polysiphonous 10

7b. Thallus not polysiphonous 11

8a. Cortical cells firmly laterally attached, tetrasporophyte and gametophyte terete or strap-shaped and branched ..... *Galaxaura*

8b. Cortical cells not laterally attached, tetrasporophyte filamentous, gametophyte terete and branched ..... *Tricleocarpa*

9a. Frond strap-shaped ..... *Rhodymenia*

9b. Frond highly proliferated, medulla with large stellate ganglia-like cells ..... *Halymenia*

10a. Polysiphonous axes without cortification.... *Tolypiocladia*

10b. Polysiphonous axes with cortifications 12

11a. Thallus not denticulated 13

11b. Frond denticulated 14

12a. Frond with spiniform branchlets, ultimate branchlets sharply spinose ..... *Acanthophora*

12b. Frond without spiniform branchlets, ultimate branclets with distinct apical depression ..... *Laurencia*

13a. Frond strongly compressed, apices of branches recurved ..... *Portieria*

13b. Frond terete to somewhat compressed, apices of branches not recurved 15

14a. Frond compressed, denticulations with densely rhizoidal axes ..... *Betaphycus*

14b. Frond terete to somewhat compressed, denticulations lacking densely rhizoidal axes ..... *Kappaphycus*

15a. Frond slender and bushy ..... *Hypnea*

15b. Frond coarse and bushy 16

16a. Main axes smaller (up to 1 mm in diameter), with distinct horizontal stolon ..... *Gelidiella*

16b. Main axes larger (more than 1 mm in diameter), without stolon ..... *Gracilaria*

Order CERAMIALES

Family RHODOMELACEAE

I. *Acanthophora* Lamouroux

Acanthophora spicifera (Vahl) BØrgesen (Plate 6: a)

Fucus spiciferus Vahl, 1802: 44.

Acanthophora spicifera (Vahl) BØrgesen, 1910: 201; Weber-van Bosse, 1923: 347; Weber-van Bosse, 1926: 127; Cordero, 1981: 189; Cribb, 1983: Tseng, 1983: 142-143; 105; Lawson and John, 1987: 297; Silva *et al.*, 1987: 60; Trono and Ganzon-Fortes, 1988: 183-184; Verheij and Prud'homme van Reine, 1993: 444.

Fucus acanthophorus Lamouroux, 1805: 51.

Acanthophora thierryi Lamouroux, 1813: 132.

Acanthophora orientalis J. Agardh, 1863: 820.

Thallus lax, up to 8 cm tall, sparsely irregularly branched; main axes and branches terete and attenuate distally; main axis conspicuous, smooth (without spines), measuring 1 mm in diameter

at the base, middle and upper parts of thallus long and somewhat arcuate; determinate branches short, up to 2 mm long and dense in upper parts, covered with spine-like branchlets; cystocarps somewhat stipitate, urn-shaped, arising in axils of the spine-like branchlets.

Local Distribution - Wori, floating cage mesh 200 m seaward (Manado Beach Hotel) ; Depth : 0 m.

Distribution - Indo-Pacific (Indonesia, the Philippines), Mariana Islands, Japan, Caribbean.

Specimens examined - REDW-205/ -335.

II. *Amansia* Lamouroux

Amansia glomerata C. Agardh (Plate 6: b)

Amansia glomerata C. Agardh, 1822: 194; Weber-van Bosse, 1923: 369; Cordero, 1981: 192; Cribb, 1983: 106; Tseng, 1983: 142-143; Silva *et al.*, 1987: 61; Trono and Ganzon-Fortes, 1988: 184-185; Verheij and Prud'homme van Reine, 1993: 444.

Thallus erect, up to 2 cm tall, purplish red, blades foliose and radiating from very short stipe in a "rosette" manner; blades lanceolate and with somewhat inrolled apical margins, measuring 1.5-4 mm broad, margin proliferated, midribs present but

disappearing distally, distromatic except at the midrib; blade cells elongated and transversely arranged in alternate rows.

Local distribution - Bulo Beach, floating fish cage mesh 200 m seaward (Manado Beach Hotel) ; Depth : 0 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), Japan, Galapagos Archipelago, Mediterranean.

Specimens examined - REDW-220/ -328.

III. *Laurencia* Lamouroux

Key to the species of *Laurencia* from North Sulawesi :

1a. Fronds, even when young, densely covered with wart-like ultimate branchlets..... *L. papillosa*

1b. Not as above 2

2a. Secondary pit connections absent between cortical cells; tetrasporangial arrangement of the right - angle type ..... *L. cartilaginea*

2b. Secondary pit connections present between cortical cells; tetrasporangial arrangement of the parallel type 3

3a. Cortical cells not elongated radially and not palisade ..... *L. flexilis*

3b. Cortical cells palisade ..... *L. obtusa*

Laurencia cartilaginea Yamada (Plate 6: c)

Laurencia cartilaginea Yamada, 1931b: 230; Cordero, 1981: 206; Silva *et al.*, 1987: 65; Trono and Ganzon-Fortes, 1988: 188-189; Verheij and Prud'homme van Reine, 1993: 446.

Thallus erect, cartilaginous, terete to slightly subcompressed at the upper portion, purplish red, up to 9 cm tall, densely alternately branched; main axis up to 1 mm in diameter; branches and ultimate branchlets paniculate; medullary cell without lenticular thickenings; cortical cells not protruding, angular to cuboidal and not palisade in transverse section, secondary pit connections absent; tetrasporangial arrangement of the right-angle type.

Local distribution - Nain Island ; Depth : -3 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), tropical and warm temperate Pacific (Japan, Singapore, Caroline Islands, Hawaiian Archipelago).

Specimen examined - REDW-253.

Laurencia flexilis Setchell

Laurencia flexilis Setchell, 1926: 101; BØrgesen, 1945: 56-58; BØrgesen, 1952: 66-67; BØrgesen, 1953: 55; BØrgesen, 1954:

46-47; Baissac *et al*, 1962: 262; Hodgkin and Michel, 1963: 131; Isaac, 1967: 81; Cribb,1983: 118-119; Tseng, 1983: 150-151; Trono and Ganzon-Fortes, 1988: 189-190.

Thallus erect, rigid and cartilaginous, terete, dark purple to nearly black in color, up to 7 cm tall, irregularly, alternately, oppositely or subverticillately branched; main axis 0.6 - 1.0 mm in diameter; branches near the end of the thallus forming a pyramidal form; ultimate branchlets closely arranged and corymbose upwards, simple or divided, clavate, truncate at apices; medullary cells without lenticular thickenings; cortical cells not protruding, cuboidal to somewhat rounded in transverse section, secondary pit connections present; tetrasporangial arrangement of the parallel type.

Local distribution - Wori, Bulo Beach ; 0 m.

Distribution - Indo - west Pacific Ocean (Indonesia, the Philippines), China.

Specimens examined - R-207/ -221/ -222/ -226/ -227.

Remarks - *L. flexilis* is a newly recorded species for Indonesia and is the most common species of *Laurencia* found in this study.

Laurencia obtusa (Hudson) Lamouroux

Fucus obtusus Hudson, 1778: 586.

Laurencia obtusa (Hudson) Lamouroux, 1813: 130; Weber-van Bosse, 1923: 341; Yamada, 1931b: 222; Cordero, 1981: 211;

Cribb, 1983: 152-153; Trono and Ganzon-Fortes, 1988: 190-191; Silva *et al.*, 1987: 66; Lawson and John, 1987: 320; Verheij and Prud'homme van Reine, 1993: 447.

Thallus erect, fleshy, terete, generally purplish pink, up to 10 cm tall, alternately, oppositely, or subverticillately branched; main axis 1 mm in diameter; ultimate branchlets clavate or obtuse, slightly constricted at the base; medullary cells without lenticular thickenings; cortical cells not protruding, cuboidal to somewhat rounded in transverse section, secondary pit connections present; tetrasporangial arrangement of parallel type.

Local distribution - Bangga Island, Nain Island ; Depth : -3 to -8 m.
Distribution - Indo-Pacific (Indonesia, the Philippines), Atlantic Ocean, Mediterranean.
Specimens examined - REDW-33/ -236 A.

Laurencia papillosa (C. Agardh) Greville (Plate 6: d)

Chondria papillosus C. Agardh, 1822: 344.
Laurencia papillosa (C. Agardh) Greville, 1830: LII; Weber-van Bosse, 1923: 344; Weber-van Bosse, 1926: 126; Yamada, 1931: 190; Cordero, 1981: 215; Silva *et al.*, 1987: 67; Lawson and John, 1987: 320; Trono and Ganzon-Fortes, 1988: 191-193; Verheij and Prud'homme van Reine, 1993: 447.

Thalli cartilaginous, terete, dark brown to purple, up to 8.5 cm tall, irregularly alternately branched from all directions to suboppositely or subverticillately branched, densely covered with wart-like ultimate branchlets even when young; main axis 1.5 mm in diameter; branches slightly attenuate; ultimate branchlets wart-like, numerous (except in the lower part), truncate ; medullary cells without lenticular thickenings; cortical cells not protruding, elongated radially and palisade in transverse section, secondary pit connections absent; tetrasporangial arrangement of the right-angle type.

Local distribution - Bangga Island, Biaro Island, Nain Island, floating fish cage mesh 200 m seaward (Manado Hotel Beach); Depth : +1 to -8 m.

Distribution - Tropical and warm temperate Indian Ocean, Indo-Pacific (Indonesia, the Philippines), tropical and warm temperate Pacific, Atlantic Ocean, Mediterranean, Caribbean.

Specimens examined - REDW-16/ -37/ - 236/ -327.

IV. *Tolypiocladia* Schmitz

Tolypiocladia sp. (Plate 9: e)

Local distribution - Floating fish cage mesh 200 m seaward (Manado Beach Hotel) ; Depth : 0 m.

Specimen examined - REDW-206.

Order GELIDIALES

Family GELIDIACEAE

V. *Gelidiella* J. Feldmann and Hamel

Gelidiella acerosa (Forsskål) J. Feldmann and Hamel (Plate 6: e)

Fucus acerosus Forsskål, 1775: 190.

Gelidiella acerosa (Forsskål) J. Feldmann and Hamel, 1934: 533; Cordero, 1981: 70; Cribb, 1983: 29; Tseng, 1983: 64 -65; Trono and Ganzon-Fortes, 1988: 128-129; Verheij and Prud'homme van Reine, 1993: 455.

Fucus rigidus Vahl, 1802: 46.

Sphaerococcus rigidus C. Agardh, 1822: 285.

Gelidium rigidus (C. Agardh) Greville, 1830: LVII.

Fucus spinaeformis Lamouroux, 1805: 77.

Gelidium spiniforme (Lamouroux) Lamouroux, 1813: 129.

Thallus cartilaginous, tough and wiry, loosely matted, terete to very slightly compressed, up to 0.8 mm broad and 4.5 cm tall, irregularly and often unilaterally branched; branches erect or arcuate, arising from basal prostrate branches, terete and slightly compressed distally, bearing pinnately or suboppositely branchlets; branchlets terete, simple or branched, tapering towards apices, medulla of larger elongated cells in transverse section, grading to smaller rounded inner cortical cells and much smaller elongated outer cortical cells.

Local distribution - Wori ; Depth : 0 m.

Distribution - Tropical and warm temperate seas all over the world.

Specimen examined - REDW-206.

Order GIGARTINALES

Family GRACILARIACEAE

VI. *Gracilaria* Greville

Key to the species of *Gracilaria* from North Sulawesi :

1a. Fronds at least partly prostrate, segmented throughout ..... *G. salicornia*

1b. Fronds erect, not segmented 2

2a. Branches slender, less than 1.5 mm in diameter ..... *G. coronopifolia*

2b. Branches coarse, more than 1.5 mm diameter... *G. arcuata*

Gracilaria arcuata Zanardini (Plate 6: f)

Gracilaria arcuata Zanardini, 1858: 265; Weber-van Bosse, 1928: 429; Cordero, 1981:124; Cribb, 1983: 57; Tseng, 1983: 102-103; Silva *et al.*, 1987: 40; Abbott, 1988: 153; Trono and

Ganzon-Fortes, 1988: 164-165; Verheij and Prud'homme van Reine, 1993: 457-458.

Thallus erect, cartilaginous, thick and fleshy, terete to somewhat compressed, purplish red, alternately, dichotomously or more often unilaterally branched especially at the primary and secondary axes; main axes frequently curved and wider than lateral branches, somewhat compressed, measuring 3 mm wide; lateral branches terete, bearing short arcuate branchlets; branchlets attenuate upwards resulting in acute apices; transition from medulla to cortex abrupt.

Local distribution - Nain Island ; Depth : -3 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), tropical and warm temperate Pacific (Japan, Taiwan), Caribbean.

Specimen examined - REDW-240.

Gracilaria coronopifolia J. Agardh (Plate 7: a)

Gracilaria coronopifolia J. Agardh, 1852: 592; Cordero, 1981: 127; Tseng, 1983: 104-105; Silva *et al.*, 1987: 41; Trono and Ganzon-Fortes, 1988: 166-167; Verheij and Prud'homme van Reine, 1993: 458.

Gracilaria lichenoides (Lamouroux) Greville forma *coronopifolia* J. Agardh, 1848: 37; Zaneveld, 1956: 39.

Thallus erect, cartilaginous, slender, loosely entangled, terete, up to 1 mm in diameter and up to 9 mm tall, purple to greenish brown, irregularly dichotomously branched; branching numerous at the upper part of the thallus, up to six orders, divaricate; branches tapering upward; terminal portion often bifurcate; transition from medulla to cortex gradual.

Local distribution - Manado Tua, Tanjung Pisok ; Depth : 0 m.

Distribution - Tropical Pacific (Indonesia, the Philippines, Hawaiian Archipelago).

Specimens examined - REDW-137/ -324.

Gracilaria salicornia (C. Agardh) Dawson (Plate 7: b)

Sphaerococcus salicornia C. Agardh, 1820: pl. VIII.

Corallopsis salicornia (C. Agardh) Greville, 1830: LIII; Weber-van Bosse, 1928: 432.

Gracilaria salicornia (C. Agardh) Dawson, 1954: 4; Cordero, 1981: 132; Tseng, 1983: 108-109; Silva *et al.*, 1987: 43; Abbott, 1988: 142; Trono and Ganzon-Fortes, 1988: 171-172; Verheij and Prud'homme van Reine, 1993: 458.

Gracilaria crassa Harvey ex J. Agardh, 1876: 417.

Thallus partly prostrate, partly erect, cartilaginous, fleshy, terete to compressed, up to 8 cm tall, brownish green, segmented throughout, dichotomously to trichotomously branched; branching apically; segments terete, subclavate to clavate, up to 3 mm wide at

the widest point, inflated at the tips and constricted at the base; transition from medulla to cortex gradual.

Local distribution - Likupang, Manado Tua, Tanjung Pisok ; +1 to 0 m.
Distribution - Indo-Pacific (Indonesia, the Philippines).
Specimens examined - REDW-66/ -122/ -323.

Family GYMNOPHOEACEAE

VII. *Titanophora* (J. Agardh) J. Feldmann

Titanophora weberae BØrgesen (Plate 7: c,d)

Titanophora weberae BØrgesen, 1943: 39; Cordero, 1981: 118; Silva *et al.*, 1987: 40; Trono and Ganzon-Fortes, 1988: 180; Verheij and Prud'homme van Reine, 1993: 459.

Thallus highly calcified, slimy and softly cartilaginous after decalcification, dark cream and shapeless verrucose when fresh, dull pinkish and bladed with somewhat bumpy surface when dried, attached by a small discoid holdfast, shortly stipitate supporting main blade, up to 9 cm tall; main blade irregularly laterally branched, margins and surface proliferated; proliferations of knob-like shape on surface and of highly proliferated ultimate branchlets, with blunt tips; medullary cells of densely packed filaments; cortex of short subdichotomous filaments.

Local distribution - Kumu ; Depth : -2 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), tropical and warm temperate Pacific (Japan, Mauritius, Solomon Islands).

Specimen examined - REDW-311.

Family HALYMENIACEAE

VIII. *Halymenia* C. Agardh

Halymenia durvillaei Bory de Saint-Vincent (Plate 7: f)

Halymenia durvillaei Bory de Saint-Vincent, 1828: 180; Weber-van Bosse, 1921: 232: Cordero, 1981: 111; Cribb, 1983: 54; Silva *et al.*, 1987: 30; Trono and Ganzon-Fortes, 1988: 149-150; Verheij and Prud'homme van Reine, 1993: 460-461.

Thallus foliaceous, softly cartilaginous, purplish red in color, attached by a small discoid holdfast, shortly stipitate supporting up to three main blades, margin serrate, up to 14 cm tall; main blades with numerous lateral proliferations or ultimate branchlets, occasionally proliferated on both surfaces, alternately to pinnately branched in one plane; branches decreasing in width distally, axils round; ultimate branchlets slender, linear and with acuminate tips; medullary cells of loose filaments, with large stellate ganglia cells

present; cortex of elongated cells decreasing in size towards the surface.

Local distribution - Murex ; Depth : -2 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), Papua New Guinea.

Specimen examined - REDW-256.

Family HYPNEACEAE

IX. *Hypnea* Lamouroux

Key to the species of *Hypnea* from North Sulawesi :

1a. Main axes distinctively different from branches, up to 1 mm in diameter; branches densely covered with spine-like branchlets ..... *H. spinella*

1b. Main axes not distinctively different from branches; up to 1.5 mm broad; branches bearing stubby and spinose branchlets ..... *H. pannosa*

Hypnea pannosa J. Agardh (Plate 7: e)

Hypnea pannosa J. Agardh, 1847: 14; Weber-van Bosse, 1928: 455; Cribb, 1983: 59; Silva *et al.*, 1987: 50; Tseng, 1988: 100-

101; Trono and Ganzon-Fortes, 1988: 178; Verheij and Prud'homme van Reine, 1993.

Thallus purplish in color, terete to somewhat compressed, up to 4 cm tall, irregularly alternately branched, covered with spinose ultimate branchlets; main axes terete to compressed, up to 1.5 mm broad; branching in one plane, with wide angles and rounded axils; branches visible, bearing stubby and spinose ultimate branchlets with acute tips; medullary cells in transverse section occasionally with lenticular thickenings.

Local distribution - Biaro Island, Bangga Island, Murex, Nain Island, Kumu ; Depth : -2 to -8 m.

Distribution - Indo - Pacific (Indonesia, the Philippines), tropical Pacific (Mexico).

Specimens examined - REDW-17/ -39/ -165/ -168/ -241/ -309.

Hypnea spinella (C. Agardh) Kützing (Plate 8: a)

Sphaerococcus spinellus C. Agardh, 1822: 323.

Hypnea spinella (C. Agardh) Kützing, 1847: 23; Weber-van Bosse, 1928: 454; Cribb, 1983: 60; Silva *et al.*, 1987: 50; Lawson and John, 1987: 242; Haroen and Prud'homme van Reine, 1993: 122; Verheij and Prud'homme van Reine, 1993: 462-463.

Hypnea cervicornis J. Agardh, 1852: 451; Weber-van Bosse, 1926: 147; Weber-van Bosse, 1928: 454; Cordero, 1981: 143.

Thallus yellowish to greenish purple in color, terete, up to 1 mm in diameter and 10 cm tall, loosely intricated, irregularly alternately branched; main axis and branches distinctive, main axis a little wider in diameter than branches; branches densely covered with spine-like branchlets, occasionally cervicorn; spine-like branchlets slender, simple or forked, with blunt tips, up to 1.8 mm long, often anastomosing; medullary cells in transverse section sometimes with lenticular thickenings; tetrasporangia born in swollen tissue at basal, middle or upper parts of branchlets.

Local distribution - Manado Tua, Bulo Beach, Tanjung Pisok ; 0 m.

Distribution - Pantropical.

Specimens examined - REDW-123/ -217/ -321.

Remark - Haroen and Prud'homme van Reine (1993) have discussed the reduction of *H. cervicornis* to *H. spinella*.

Family PEYSSONNELIACEAE

X. *Peyssonnelia* Decaisne

Peyssonnelia sp. (Plate 8: c)

Local distribution - Bangga Island, Manado Tua, Murex, Manado Beach Hotel ; Depth : -2 to - 15 m.

Specimens collected - REDW-40/ -43/ -52/ -54/ -157/ -192.

Family RHIZOPHYLLIDACEAE

XI. *Portieria* Zanardini

Portieria hornemannii (Lyngbye) Silva *in* Silva *et al.* (Plate 8: d)

Desmia hornemannii Lyngbye, 1819: 35; Silva *in* Silva *et al.*, 1987: 128-129.

Portieria hornemannii (Lyngbye) P. C. Silva *in* Silva *et al.*, 1987: 128-129; Verheij and Prud'homme van Reine, 1993: 464.

Chondrococcus hornemannii (Lyngbye) Schmitz, 1895: 170; Weber-van Bosse, 1921: 255; Cordero, 1981: 96: Cribb, 1983: 35.

Thallus purple to dark red in color, strongly compressed, up to 0.6 mm broad and 6 cm tall, repeatedly alternately to subopposite branched; branching in one plane, mostly up to five orders, with round axils; branches patent, gradually tapering distally, occasionally anastomosing; branchlets at lower portion with acute tips, terminal branchlets with inrolled tips.

Local distribution - Manado Tua, Murex, Nain Island, reef area 1 km north of Manado Beach Hotel, Batu Putih ; 0 to -3 m.

Distribution - Indo-Pacific (Indonesia, the Philippines), Red Sea.

Specimens examined - R-120 /-160 /-252 /-292 /-325.

Family SOLIERIACEAE

XII *Betaphycus* Doty

Betaphycus gelatinum (Esper) Doty ex P. Silva *et al.*

Fucus gelatinus Esper, 1800 [1797-1800]: 188.
Sphaerococcus gelatinus (Esper) C. Agard, 1822 [1822-1823]: 270-271.
Eucheuma gelatinum (Esper) J. Agardh, 1847: 16 (as *E. gelatinae*).
Betaphycus gelatinum (Esper) Doty ex P. Silva *et al.*, 1996: 326.

Thallus prostrate, gelatinous, coarse, dorsiventrally compressed, up to 10 mm broad, with proliferations on the margins and both ventral and dorsal surfaces, irregularly branched laterally; primary segments broader than secondary branches; secondary branches arising from marginal proliferations along margins of primary segment, occasionally with completely fused part; proliferations of simple dentations, tubercles, or cylindrical protrusions, with blunt tips, more pronounced on the margins and ventral surface; medulla of mature segments, in transverse section axiferous, consisting of large and small rounded to oval cells, with thick cell walls, central axis with many flexuous filaments extending through all segments in longitudinal section; cortex of rounded to somewhat oblong cells, outer most cortex of layers of very small and pigmented cells.

Local distribution - Likupang ; Depth : +1 m.

Distribution - Australia, India, Indonesia, Hawaii.

Specimen examined - REDW-63.

Additional remark - *Betaphycus gelatinum* is a newly recorded species for Indonesia through this study.

XIII. *Kappaphycus* Doty

Kappaphycus alvarezii (Doty) Doty ex P. Silva *et al.* (Plate 8: b)

Eucheuma alvarezii Doty, 1985: 37 - 41; Silva *et al.*, 1987: 45.

Kappaphycus alvarezii (Doty) Doty ex Silva *et al.*, 1996 : 333; Verheij and Prud'homme van Reine, 1993: 466.

Thallus erect, gelatinous, rigid, terete to somewhat compressed, up to 0.9 mm broad, irregularly branched in one plane, proliferations not in whorl; branching loosely, commonly unilateral and somewhat curved inward, branch axils sinuoid; primary segments broader than secondary branches, somewhat compressed to angular in transverse section; secondary branches arising from lateral margins of primary segments, bearing indeterminate proliferations; proliferations simple or branched, appearing at irregular distance, mostly unilateral, terete at the base in transverse section, tapering towards apices, with blunt denticulations at tip; medulla in transverse section of large rounded cells interspersed with very small thick-walled cells, central axis

with flexuous filaments not extending through all segments in longitudinal section; inner and outer cortex distinctly different: inner cortex of radially elongated to round, thick-walled cells; outer cortex of very small, pigmented and radially elongated cells.

Local Distribution - Nain Island ; Depth : -3 m.

Distribution - Tropical central Indo-Pacific (Indonesia, Malaysia, Sabah, the Philippines).

Specimen examined - REDW-247.

Remark - Probably an escape from local seaweed farms

Order NEMALIALES

Family CHAETANGIACEAE

XIV *Actinotrichia* Decaisne

Actinotrichia fragilis (Forsskål) BØrgesen (Plate 8: e)

Fucus fragilis Forsskål, 1775 :190.

Actinotrichia fragilis (Forsskål) BØrgesen, 1932: 6; Cordero, 1981: 50; Cribb, 1983: 25; Silva *et al.*, 1987: 22; Trono and Ganzon-Fortes, 1988: 120-121; Tseng, 1988: 58-59; Verheij and Prud'homme van Reine, 1993: 439.

Galaxaura rigida Lamouroux, 1816:265.

Actinotrichia rigida (Lamouroux) Decaisne, 1942: 118; Weber-van Bosse, 1921: 207.

Thallus erect and rigid, forming a globose mass up to 6.5 cm high, purplish red to greenish-yellowish in color, calcified, regularly dichotomously branched with acute angles; branches terete, measuring 1 mm in diameter, covered with whorls of rigid projecting assimilatory filaments; assimilatory filaments short and simple; branch apices truncate or blunt.

Local distribution - Biaro Island, Bangga Island, Tanawangko, Manado Beach Hotel, reef area 1 km north. of Manado Beach Hotel, Batu Putih ; Depth : 0 to -8 m.

Distribution - Tropical western Pacific (Indonesia, the Philippines), tropical Indian Ocean (Yemen).

Specimens examined - REDW-6/ -14/ -35/ -90/ -97/ -98/ -186/ -295/ -361.

XV. *Galaxuara* Lamouroux

Key to species of *Galaxaura* from North Sulawesi :

1a. Branches deeply constricted ..... *G. obtusata*

1b. Branches not deeply constricted, flattened or terete 2

2a Branches flattened and with annulate appearance; margin slightly inrolled ..... *G. marginata*

2b Branches terete throughout 3

3a. All free assimilatory filaments uniform and long; supporting

cells of assimilatory filaments at the periphery not well-differentiated ..... *G. filamentosa*

3b. Free assimilatory filaments of short and long intermixed; basal cells of short assimilatory filaments smaller than apical ones ..... *G. fasciculata*

Galaxaura fasciculata Kjellman

Galaxaura fasciculata Kjellman, 1900: 53; Weber-van Bosse, 1921: 211; Tseng, 1941: 86; Chou, 1945: 44-45; Dawson, 1954: 419; Womersley and Bailey, 1970: 303; Papenfuss *et al.*, 1982: 406-407; Tseng, 1983: 58-59; Coppejans and Prud'homme van Reine, 1992a: 182.

Thallus heavily calcified, up to 5 cm tall, regularly dichotomously branched; branches terete throughout measuring 0.8-1.2 mm in diameter not including free assimilatory filaments, densely covered with evenly distributed short and long free assimilatory filaments; medullary filaments (measuring 9-12 μm in diameter) smaller than free assimilatory filaments; cortex of small cells, each giving rise to 1-2 free assimilatory filaments; short free assimilatory filaments with two or three cells and increasing in size distally, terminal cells somewhat globular measuring 27-45 μm in diameter; long free assimilatory filaments unbranched, 1 mm long and 18-27 μm in diameter, cells rather longer than broad and slightly constricted at the dissepiment.

Local distribution - Tanawangko, Murex ; Depth : 0 to -2 m.

Distribution - Marshall Islands, Solomon Islands, Bonin Island, Indonesia, Viet Nam, Tanzania, Japan, China, the Philippines, Micronesia.

Specimens examined - REDW-91/ -164.

Galaxaura filamentosa Chou ex Taylor

Galaxaura filamentosa Taylor, 1945: 139; Chou, 1945 :39; Womersley and Bailey, 1970: 303; Tseng, 1983; 58-59.

Galaxaura rudis sensu Okamura, 1931: 190; Tanaka, 1936: 144

Thallus heavily calcified, up to 4 cm tall, irregularly dichotomously branched; branches terete throughout, measuring 0.9-1.3 mm in diameter excluding free assimilatory filaments, densely covered with homogeneous long free assimilatory filaments; medullary filaments loosely intertwined, measuring 12-21 μm in diameter; no distinctive difference between medulla and cortex; free assimilatory filaments born at the periphery, unbranched, 1 mm long and 12-21 μm in diameter at the base, cells longer than broad.

Local distribution - 0.5 km west of Murex ; Depth : -13 m.

Distribution - Pacific Mexico, Marshall Islands, Caroline Islands, Solomon Islands, Hawaiian Islands, Viet Nam, Taiwan, southern parts of Japan.

Specimen examined - REDW-195.

Remark - *Galaxaura filamentosa* is a newly recorded species for Indonesia through this study.

Galaxaura marginata (Ellis et Solander) Lamouroux (Plate 9: a)

Galaxaura marginata (Ellis et Solander) Lamouroux, 1816: 264; Harvey, 1860: pl. CXXXVI; Harvey, 1863: XXXVIII; Trono and Ganzon-Fortes, 1988: 122-123; Huisman and Borowitzka, 1990: 157-161.

Corallina marginata Ellis et Solander, 1786: 115.

Galaxaura angustifronds Kjellman, 1900: 72; May, 1965: 360.

Galaxaura arborea Kjellman, 1900: 72; Levring, 1953: 514; May, 1965: 359; Cribb, 1983: 26.

Thallus calcified, up to 8 cm tall, subdichotomously branched; branches compressed, measuring up to 2 mm wide, lateral margins slightly inrolled, annulate in appearance; medullary cells of loose filaments; cortical cells inflated, of three to five layers, the inner two to three layers consisting of colorless and laterally adhering and occasionally fusing cells, the outer layer pigmented and consisting of small cells, usually two born per cell, polygonal in surface view, measuring 12-30 μm (measured between parallel sides of hexagons); spines constricted at both lateral margins.

Local distribution - ManadoTua ; Depth : -8 m.

Distribution - Tropical and warm temperate Indian Ocean and Pacific Ocean.

Specimen examined - REDW-57.

Galaxaura obtusata (Ellis and Solander) Lamouroux (Plate 9: b)

Corallina obtusata Ellis and Solander, 1786: 113.

Galaxaura obtusata (Ellis and Solander) Lamouroux, 1816: 262; Weber-van Bosse, 1921: 220; Cordero, 1981: 62; Lawson and John, 1987: 164; Silva *et al.*, 1987: 24; Huisman and Borowitzka, 1990: 162; Verheij and Prud'homme van Reine, 1993: 440.

Galaxaura robusta Kjellman, 1900: 85.

Thallus calcified, up to 10.5 cm tall; regularly dichotomously branched with narrow angles; branches terete and glabrous, segments of 0.4-18 mm long and 2-4 mm in diameter, deeply constricted at the dichotomies; medulla composed of loosely interwoven filaments measuring 9-15 μm in diameter; cortex parenchymatous with three cell layers, the outermost cells small and closely arranged forming a continuous epidermis, appearing polygonal in surface view, measuring 24-36 μm in diameter (measured between parallel sides of hexagons), cortical intermediate cells oblong, measuring 24-30 μm tall and 35-42 μm broad.

Local distribution - Murex, Wori ; Depth : -2 to -10 m.

Distribution - Indo-Pacific (Indonesia, the Philippines), Caribbean.

Specimens examined - REDW-163/ -213.

XVI. *Tricleocarpa* Huisman and Borowitzka

Tricleocarpa oblongata (Ellis and Solander) Huisman and Borowitzka (Plate 9: c)

Tricleocarpa oblongata (Ellis and Solander) Huisman and Borowitzka, 1990: 168; Verheij and Prud'homme van Reine, 1993: 441.

Corallina oblongata Ellis and Solander, 1786: 114.

Galaxaura oblongata (Ellis and Solander) Lamouroux, 1816: 262; Cordero, 1981: 60; Tseng, 1983: 60-61; Silva *et al.*, 1987: 23; Lawson and John, 1987: 164; Trono and Ganzon-Fortes, 1988: 123-124.

Galaxaura eburnea Kjellman, 1900: 62.

Thalli lightly calcified, bushy, up to 10 cm tall, densely dichotomously branched; branches terete, measuring 1.2-1.8 mm in diameter, glabrous, annulate in appearrance, segments rather rounded at both ends and usually narrower at the base; medulla composed of loosely arranged filaments, measuring 3-9 μm in diameter; cortical cells inflated, of three to four and occasionally five layers, the inner cells colourless, larger, loosely arranged and connected by narrow protoplasmic strands; the outermost cells pigmented, smaller and closely arranged, polygonal in surface view, measuring 6 - 15 μm in diameter (measured between parallel sides of hexagons).

Local distribution - Likupang, Wori, reef area 1 km of north Manado Beach Hotel, floating fish cage mesh 200 m seaward (Manado Beach Hotel), Batu Putih ; Depth : +1 to -1 m.

Distribution - Tropical and subtropical Pacific (China, Indonesia, the Philippines, Japan, Mexico), Caribbean.

Specimens examined - REDW-64/ -200/ -288/ -332/ -353/ -362A.

Remark - *Tricleocarpa oblongata* used to be recognized as *Galaxaura oblongata* based on its vegetative features. However, Huisman and Borowitzka (1990) have recently discovered that these two genera, *Tricleocarpa* and *Galaxaura*, are different in their life history in which *Tricleocarpa* has a heteromorphic life history with a filamentous tetrasporophyte whereas *Galaxaura* has an isomorphic life history.

Order RHODYMENIALES

Family RHODYMENIACEAE

XVII. *Rhodymenia* Greville

Rhodymenia intricata (Okamura) Okamura (Plate 9: d)

Phyllophora intricata Okamura, 1921: 129.

Rhodymenia intricata (Okamura) Okamura, 1930: 23; Tseng, 1983: 120-121; Silva *et al.*, 1987: 52; Verheij and Prud'homme van Reine, 1993: 469.

Thallus bright red, strap-shaped thin blade, stipitate, stipe terete, densely dichotomously to subpalmately branched; branching in one plane, visible, with round axils; lateral margins serrate, apical tips pointed or rounded; medullary cells oblong and colorless; cortex of small somewhat oblong pigmented cells.

Local distribution - Manado Tua, Murex, Manado Beach Hotel, Bunaken;
Depth : -2 to -12 m.

Distribution - Indo-Pacific (Indonesia, the Philippines), Japan.

Specimens examined - REDW-49/ -56/ -156/ -188/ -264.

Chapter 6

GENERAL DISCUSSION AND CONCLUSION

The preceeding three chapters represent the main objective of this study, which is to collect and identify the seaweeds of North Sulawesi. The other objective is to place this new information into the context of what is already known of Indonesian seaweeds, and this is discussed below. The conclusions are given in the form of final remarks.

Present knowledge of Indonesian seaweeds

Little is known about Indonesian seaweeds, hence published information on this topic is scanty. This chapter combines the results of my study with the scattered earlier information to provide a coherent data foundation for future phycological exploration and research in Indonesia. I gathered all information on Indonesian seaweeds that I could find, but I recognize that the usefulness of this information depends heavily upon the reliability of the species determinations that underlie the published records. I have exercised considerable caution with this information and I urge others to do likewise.

Extensive interest in Indonesian seaweeds started in 1899 - 1900, manifested by the Siboga Expedition to various parts of Indonesia. This was followed by the Danish Expedition in 1914 - 1916 to the Kei Islands, in the province of Mollucas. The detailed studies of Indonesian seaweeds collected during these two expeditions were subsequently published in French by Weber-van Bosse (Weber-van Bosse, 1913a; 1921; 1923; 1926; 1928). She reported, including many forms, 197 taxa of Chlorophyta, 87 taxa of Phaeophyta, and 411 taxa of noncoralline Rhodophyta. Out of the above reported taxa, however, only 131 taxa of Chlorophyta and 210 taxa of noncoralline Rhodophyta are recognized according to current taxonomic revisions (Verheij and Prud'homme van Reine, 1993). Of the 87 taxa of Phaeophyta collected during these expeditions, almost half are members of the genus *Sargassum* and one-third are microalgae.

The first publication on Indonesian seaweeds in English was the work by Gilbert (1942) in which he reported 10 species of *Caulerpa* from Java. They are *Caulerpa brachypus*, *C. cupressoides*, *C. fastigiata*, *C. lentillifera*, *C. peltata*, *C. racemosa*, *C. serrulata*, *C. sertularioides*, *C. taxifolia*, and *C. verticillata*. Taylor (1966) reported a total of 64 taxa of Indonesian seaweeds, together with their localities, including 58 taxa of Chlorophyta and 6 taxa of Phaeophyta. All specimens he observed were collected by Setchell and Kostermans who partly identify the specimens.

Almost two decades later (1984), the Snellius-II Expedition collected seaweeds but only in September. This expedition focused on the eastern part of the Indonesian archipelago, Ambon, Pulau Maisel, Tukang Besi Is., Sumba, Komodo, Sumbawa, Taka Bone Rate and Salayer. At least 300 different species of seaweeds were collected and most have been identified to genus. A total of 124 genera consisting of 33 genera of Chlorophyta, 16 genera of Phaeophyta, and 75 genera (including corallines) of Rhodophyta were reported from this expedition (Coppejans and Prud'homme van Reine, 1992a). Among the reported taxa, members of the order Caulerpales, Dasycladales (Chorophyta), and Gelidiales (Rhodophyta) have been thoroughly studied to date (Coppejans and Prud'homme van Reine, 1989a; 1989b; 1992a; 1992b; Hatta and Prud'homme van Reine, 1991).

Coppejans and Prud'homme van Reine (1989a) discussed the morphology and anatomy of five genera of Dasycladales - *Acetabularia*, *Bornetella*, *Cymopolia*, *Neomeris* and *Polyphysa*, collected during the Snellius-II Expedition. Nine species - two species of *Acetabularia* (*A. dentata* and *A. ryukyuensis*), one species of *Polyphysa* (*P. parvula*), two species of *Bornetella* (*B. nitida* and *B. oligospora*), one species of *Cymopolia* (*C. vanbosseae*), and three species of *Neomeris* (*N. annulata*, *N. bilimbata*, and *N. vanbosseae*) - were studied in detail. Five species of this order -*Acetabularia exigua*, *Bornetella capitata* (f. *brevistylis*), *B. sphaerica*, and *Halicoryne spicata* - which were recorded during the Siboga Expedition of 1899-1990 (Weber-van Bosse, 1913) and *Halicoryne*

wrightii collected from Bali (Taylor, 1966), were not collected during the Snellius-II Expedition. On the other hand, *Acetabularia ryukyuensis* (var. *philippinensis*) and *Neomeris bilimbata* were new records for Indonesia.

Two papers report studies of members of the Caulerpales collected during the Snellius-II Expedition. The first account excluded *Caulerpa* and *Halimeda* (Coppejans and Prud'homme van Reine, 1989b) and the second one was for species of *Caulerpa* (Coppejans and Prud'homme van Reine, 1992b). The former included descriptions of 16 species: *Avrainvillea amadelpha*, *A. erecta*, *A. lacerata*, *A. longicaulis*, *Chlorodesmis fastigiata*, *C. hildenbrandtii*, *Rhipilia diaphana*, *R. nigrescens*, *R. orientalis*, *Rhipiliopsis gracilis*, *Tydemania expeditionis*, *Udotea argentea*, *U. flabellum*, *U. glaucescens*, *U. javensis*, and *U. orientalis*. The latter described twelve species of *Caulerpa* (including different ecads). They are *Caulerpa brachypus* (ecad *parvifolia*), *C. cupressoides* (ecad *cupressoides*, ecad *flabellata*, ecad *lycopodium-disticha*, ecad *lycopodium-elegans*, ecad *mamillosa*, and ecad *urvilliana*), *C. elongata*, *C. fergusonii*, *C. lentillifera*, *C. lessonii*, *C. microphysa*, *C. racemosa* (ecad *corynephora*, ecad *laetevirens*, ecad *lamourouxii*, ecad *peltata*, ecad *peltata-macrodisca*, ecad *racemosa*, ecad *turbinata*, and ecad *laetevirens / turbinata / peltata*), *C. serrulata* (ecad *boryana* and ecad *serrulata*), *C. sertulariodes*, *C. taxifolia* (ecad *mexicana* and ecad *taxifolia*), and *C. verticillata*. Among these, *Rhipalia nigrescens* Coppejans and Prud'homme van Reine was newly described (Coppejans and Prud'homme van Reine (1989b). Species of

Halimeda from the Snellius-II Expedition, on the other hand, have not been studied in detail, although Coppejans and Prud'homme van Reine (1992a) listed 15 species of *Halimeda* including some species that were doubtfully assigned and were indicated with (*ad*). This doubt was caused by either the morphology not corresponding with the species description and (some of) the anatomical characters, or vice versa. They were *Halimeda ad copiosa*, *H. cylindrica*, *H. discoidea*, *H. ad distorta*, *H. gracilis*, *H. ad incrassata*, *H. lacunalis*, *H. macroloba*, *H. micronesica*, *H. minima*, *H. opuntia*, *H. ad simulans*, *H. taenicola*, *H. tuna*, and *H. velasquezii*.

Members of the Gelidiales are the only species of noncoralline Rhodophyta from Indonesia which have been critically studied (Hatta and Prud'homme van Reine, 1991). These authors reported 12 taxa belonging to four different genera of Gelidiales. They are *Gelidiella acerosa*, *G. lubrica*, *G. myrioclada*, *G. pannosa*, *Gelidium amboniense*, *G. latifolium* (forma *elongatum*), *G. pusillum* (var. *pusillum*, var. *minusculum*, and var. *cylindricum*), *Porphyroglossum zollingeri*, *Pterocladia caerulescens*, and *P. caloglossoides*. *Wurdemannia* (*W. miniata*), a monotypic genus of uncertain systematic position, was also discussed in the same publication. Taylor (1960) placed this genus in the family Wurdemanniaceae within the Gelidiales, although the Papenfuss (1966) interpretation may assign it to either the Cryptonemiales or to the Gigartinales, the latter order perhaps being the more likely one (Hatta and Prud'homme van Reine, 1991).

The study of Indonesian seaweeds by Verheij and Prud'homme van Reine (1993) was very thorough and included seaweeds collected during the Buginesia-III Project (Nov 1988 - Nov 1990) and additional collections during June 1991 and Oct 1991 from the Spermonde Archipelago, SW Sulawesi. Work on the collections from the Spermonde Archipelago included re-examination and revision of previous collections obtained by the Siboga Expedition, the Danish Expedition, and the Snellius-II Expedition. A large proportion of seaweeds reported from those expeditions was excluded by Verheij and Prud'homme van Reine due to taxonomic errors. Unfortunately, the information used to exclude those taxa has not been published elsewhere. Only 131 taxa of Chlorophyta, 88 taxa of Phaeophyta, and 210 taxa of noncoralline Rhodophyta were accepted according to modern taxonomic concepts (Verheij and Prud'homme van Reine, 1993). Of the accepted taxa, 68 taxa of Chlorophyta, 72 taxa of Phaeophyta, and 162 taxa of noncoralline Rhodophyta were not collected during the Buginesia-III Project. On the other hand, 17 taxa of Chlorophyta, 20 taxa of Phaeophyta, and 35 taxa of noncoralline Rhodophyta were newly reported for Indonesia (Verheij and Prud'homme van Reine, 1993). Hence, a total of 199 taxa were reported from the Spermonde Archipelago consisting of 80 taxa of Chlorophyta, 36 taxa of Phaeophyta, and 83 taxa of noncoralline Rhodophyta (Verheij and Prud'homme van Reine, 1993). Of these, one species, *Caulerpa buginense*, and one forma, *Udotea flabellum* f. *longifolia*, were newly described. In addition, three species of Phaeophyta, *Sargassum hawaiiensis*, *Turbinaria parvifolia* and *Hydroclathrus tenuis* were first reported from outside the type

localitiy regions, the first from the Hawaiian Archipelago, and the latter two from China. Verheij (1994) in his publication of the nongeniculate Corallinaceae of the Spermonde archipelago, critically studied 16 taxa belonging to 7 genera.

The Buginesia-III and the Buginesia-IV Projects also included studies on the distribution of seagrasses and associated macroalgae in the Spermonde Archipelago between October 1988 and February 1992. Verheij and Erftemeijer (1993) reported 117 taxa of macroalgae associated with seagrass beds. This comprised 50 taxa of Chlorophyta (including five ecads of *Caulerpa racemosa*), 17 taxa of Phaeophyta, and 50 taxa of Rhodophyta (including two ecads of *Neogoniolithon brassica-floridum*) of which most were also recorded previously by Verheij and Prud'homme van Reine (1993). Of these, only 13 species were found associated exclusively with seagrasses. The habitats and overview of the seasonal occurrence of dominant macroalgae associated with seagrass beds were included in their study.

Hardy *et al.* (1994) reported some 14 species of seaweeds collected from Ambon Island between January 24th and 28th, 1994 and 14 species collected from Kotok Besar (Kepulauan Seribu, Java) between January 30th and February 1st, 1994. The Ambon collection consisted of five species of Chlorophyta - *Chaetomorpha crassa*, *Codium geppii*, *Halimeda gigas*, *H. micronesica* and *H. minima* - four species of Phaeophyta - *Padina* sp., *P. australis*, *P. boergesenii* and *Turbinaria ornata* - and five species of Rhodophyta - *Actinotrichia*

fragilis, *Gelidium pusillum*, *Jania* sp., *Mastophora pacifica* and *Pterocladia caloglossoides*. The Kotok Besar collection included six species of Chlorophyta - *Caulerpa opposita*, *C. racemosa* (ecad *corynephora*), *Halimeda gigas*, *H. micronesica*, *Enteromorpha intestinalis*, and *Ulva reticulata* - six species of Phaeophyta - *Dictyota dichotoma*, *Padina australis*, *Turbinaria ornata*, *Hormophysa cuneiformis*, *Sargassum ilicifolium*, and *S. pallidum* - and two species of Rhodophyta - *Ceramium* sp. and *Mastopora* ? *pacifica*.

Seaweeds of North Sulawesi

In the present study, seaweeds collected from North Sulawesi represent 67 taxa consisting of 29 taxa of Chlorophyta, 12 taxa of Phaeophyta, and 26 taxa of noncoralline Rhodophyta. Of these, five taxa - *Padina japonica*, *Sargassum turbinarioides*, *Betaphycus gelatinum*, *Galaxaura filamentosa*, and *Laurencia flexilis*- are newly reported for Indonesia. The morphology of species, keys to genera and, whenever possible, to species, the description of species, and their depth and distribution, are presented in Chapters 3-5 for Chlorophyta, Phaeophyta, and Rhodophyta, respectively.

Some filamentous Chlorophyta and *Sargassum* spp (Phaeophyta) were also collected during this study but could not be identified because specimens were incomplete. Members of the coralline Rhodophyta collected are also not included in this report.

Table 1 lists the taxa found during my study and those reported from the Siboga Expedition, the Danish Expedition, the Snellius-II Expedition, and the Buginesia-III Project. Taxa reported from the Siboga Expedition are compiled together with those from the Danish Expedition for three reasons : first, all algal specimens were studied, determined, and published by Weber-van Bosse; second, a large portion of that information was excluded due to subsequent taxonomic revisions; and third, the information relating to the excluded taxa cannnot be obtained elsewhere.

Although Table 1 presented here allows comparison of seaweeds reported so far for Indonesia, it would be hazardous to compare the results of each of all previous expeditions with the results from my study. This is due to different methods of collection, length of collecting time, collection time of the year, and collecting sites. For instance, during the Siboga Expedition and the Danish Expedition, collections were done by wading intertidally or by dredging, whereas those of the Snellius-II Expedition, the Buginesia-III, and this current study were done by hand in the intertidal and in the subtidal, the latter by snorkeling and SCUBA diving. In addition, the Siboga Expedition was done during a whole year and all over the Indonesian archipelago (visiting more than 300 stations), whereas the Danish Expedition, the Snellius-II Expedition, and the Buginesia-III Project were exclusively in the Kai Islands (south of Mollucas), in the eastern part of Indonesia, and in the Spermonde archipelago (SW Sulawesi), respectively. This present study includes seaweed collections from some parts of north

Sulawesi (Figure 1) taken at different times between July 1993 and December 1994. As with most of the seaweed specimens collected in this study, the specimens collected during the Snellius-II Expedition and the Buginesia-III Project were also primarily collected from coral reefs or closely associated sites.

Regardless of these differences, the documentation presented here should serve as a useful compilation of previously scattered information on the seaweeds of Indonesia. It is hoped that this will stimulate both Indonesian and foreign phycologists to study the Indonesian seaweeds intensively, including further re-examination and revision of the already reported taxa.

The use of seaweeds in Indonesia

Seaweeds are extremely important both ecologically and economically. Seaweeds have been used widely for food by both humans and animals, for fertilizer, and for cosmetics. Pharmaceutically, some seaweed chemicals have been analyzed for antibiotics, antivirus activity, anticoagulants, and drugs. In Indonesia, however, their recognition as an important "fishery" resource is less appreciated. This could be due to a lack of knowledge of the diversity of seaweeds, of the economic value(s) they have, and of their potential uses as well as a still limited interest and research activity in the general area of phycology.

Trono and Ganzon-Fortes (1988) summarized economically important Philippine seaweeds and their uses, while Chapman and Chapman (1980) reviewed the uses of seaweeds from different countries. Most of these seaweeds, particularly those of the Philippines, also occur in Indonesia. Although interest has focused mainly on some agar and carrageenan-producing seaweeds such as *Eucheuma*, *Kappaphycus*, *Gracilaria*, and *Pterocladia* (Adnan *et al.*, 1987; Eisses, 1953; Firdausy and Tisdell, 1991; Luxton *et al.*, 1993; Soegiarto, 1978; Soegiarto *et al.*, 1990; Zaneveld, 1955). According to Verheij and Prud'homme van Reine (1993), two other agar-producing seaweeds, *Gelidium* and *Gelidiella* should also be farmed because they produce a better quality agar than *Gracilaria*, and *Pterocladia*.

Tondo (1926) *in* Chapman and Chapman (1980) listed seaweeds used as food in Indonesia. They are *Caulerpa laetevirens*, *C. peltata*, *C. racemosa*, *Codium tomentosum*, *Sargassum* sp., *Turbinaria* sp., *Acanthophora spicifera*, *Corralopsis minor*, *C. minor*, *Gelidiopsis rigida*, *Gracilaria lichenoides*, *G. taenoides*, *Gymnogongrus javanicus*, *Hypnea cervicornis*, *Laurencia obtusa*, and *Sarcodia montagneana*. *Ulva*, *Chaetomorpha*, and *Caulerpa* are usually eaten either raw or slightly cooked. *Padina australis* is made into a gelatin-like sweetmeat (Chapman and Chapman, 1980). *Dictyota*, *Sargassum*, and *Turbinaria* are commonly cooked with coconut milk (Michanek, 1975). The utilization of seaweeds as food, however, varies from region to region. The use(s) of some of the seaweeds collected during this study is presented in Table 2. Abbott and Williamson (1974), Abbott

(1984) and Trono and Ganzon-Fortes (1988) also provided some seaweed recipes.

FINAL REMARKS

In this study, a total of 67 taxa of seaweeds of North Sulawesi were thoroughly studied. Among these, *Padina japonica*, *Sargassum turbinarioides*, *Betaphycus gelatinum*, *Galaxaura filamentosa* and *Laurencia flexilis* are newly reported species for Indonesia. Location, depth, and the description of each species along with the keys for genera and species are provided.

The intent of this work is to provide a site specific information base and useful keys for the identification of these species. The results of the study are a contribution to our knowledge of Indonesia's biodiversity in general, and particularly of its seaweed diversity and distribution. In addition, this new knowledge can be used for other ecology and conservation research purposes. I hope that this documentation, other publications and future research on seaweeds from other regions in the Indonesian archipelago will help phytogeographic studies and serve as a baseline for management and conservation of marine resources.

There are signs of considerable progress in the cataloging of seaweeds of Indonesia although most work has been in limited areas/localities of the eastern part of the country. Many other areas remains to be studied. Since a large proportion of Indonesian

seaweed information published by Weber van Bosse early in this century was excluded due to taxonomic errors (Verheij and Prud'homme van Reine, 1993), and that information on those excluded taxa could not be obtained elsewhere, there is an urgent need to publish such information. At the same time, taxonomic and nomenclatural changes have been sufficiently numerous to warrant revisions of most of the currently available algal documentation. We need a critical evaluation and revision of already identified specimens, particularly of those studied and published by Weber van Bosse.

Although most of the economically important seaweeds reported from elsewhere occur in the Indonesian archipelago, and the most of the human population inhabits the coastal areas, the diversity of seaweeds and their uses in general have long been neglected, owing to reasons mentioned earlier in this Chapter. Therefore, a thorough knowledge of the Indonesian algal flora is of vital importance to any phycological and phyco-biotechnology research in the archipelago.

A major factor contributing to the incomplete inventory and documentation of seaweeds, as for other biological resources of Indonesia, relates to the fact that taxonomic studies have been neglected by Indonesian scientists. This is due to a lack of adequate financial support from the Indonesian Government to recruit and train the very few existing Indonesian taxonomists, and to fund the necessary taxonomic studies. The documentation of Indonesian

biological resources that does exist has largely come from outside sources, particularly the Netherlands.

Indonesia currently has a population of over two hundred million people, and it is quite obvious that research priorities in Indonesia have been prioritized to those directly contributing to the Indonesians' welfare and/or enhancing the Indonesian economic situation. This has led to more intensive studies being focused on the areas of technology, e.g. agro-biotechnology and, to a lesser extent, phyco-biotechnology. The latter is focused only on the carrageenan and agar yields of some species of *Eucheuma*, *Kaphaphycus*, *Gracilaria*, and *Pterocladia*. This phenomenon has caused an imbalance in other biological science related fields, with taxonomy suffering the most.

With the increasing size of the Indonesian population and the acceleration of economic development, Indonesia is facing a unprecedented rate of loss of natural and biological resources. Although the Indonesian Government has proclaimed the details of a biodiversity action plan for Indonesia (Ministry of National Development Planning/National Development Planning Agency, 1993), its success greatly depends on the awareness of all Indonesians of how crucial such resources are, not only ecologically, but also economically. Apart from the need for more taxonomic studies, there is much to be done, with little time, in documenting most of Indonesia's biological resources at all levels, from species to ecosystems. This is particularly true for the areas experiencing the

most pressure (*e.g.* rain forests, coral reefs, mangroves, beaches, swamp and peat lands) as a result of rapid national development. Therefore, I strongly urge that further taxonomic and ecological studies in Indonesia be undertaken without delay.

References

Abbott, I. A. 1984. *Limu; an ethnobotanical study of some Hawaiian seaweeds.* Pacific Tropical Botanical Garden, Hawaii. 35 p.

Abbott, I. A. 1988. Some species of *Gracilaria* and *Polycavernosa* from the Siboga Expedition. *In* : (I. A. Abbott, ed.) *Taxonomy of Economic Seaweeds With Some Reference to Some Pacific and Caribbean Species* Vol. II. Report No. TCSGCP-018. The California Sea Grant College Program, University of California, California. pp. 151-156.

Abbott, L. A., F. A. Bisby and D. J. Rogers. 1985. *Taxonomic Analysis in Biology : Computers, Models and Databases.* Colombia University Press, New York.

Abbott, I. A. and E. H. Williamson. 1974. *Limu; an ethnobotanical study of some edible Hawaiian seaweeds.* Pacific Tropical Botanical Garden, Hawaii. 20 p.

Adnan, H., H. Porse, M. A. Ragan and C. J. Bird (Eds.). 1987. Culture of *Eucheuma cottonii* and *Eucheuma spinosum* in Indonesia. Twelfth International Seaweed Symposium. *Hydrobiologia* 151-152 : 355-358.

Agardh, C. A. 1817. *Synopsis algarum Scandinaviae.* I-XL, 135 pp. Lundae [Lund].

Agardh, C. A. 1820b. *Icones algarum ineditae.* Fasc. 1. Lundae [Lund].

Agardh, C. A. 1822. *Species algarum.* Vol. 1, part 2 : 169-531. Lundae [Lund]

Agardh, C. A. 1824. *Systema algarum..* XXXVIII + 312 pp. Lundae [Lund].

Agardh, J.G. 1837. Novae species algarum, quas in itinere ad oras maris rubri collegit Eduardus Rüppell; cum observationibus nonnullis in species rariores antea cognitas. *Museum Senckenbergianum* 2:169-174.

Agardh, J. G. 1847. Nya alger från Mexico. *Öfversigt af Kongl. [Svenska] Vetenskaps-Akademiens Förhandlingar* 4: 5-17.

Agardh, J. G. 1848. *Species genera et ordines algarum. Volumen primum: algas fucoideas complectens.* I-VIII, 1-363. Lundae (Lund).

Agardh, J. G. 1851 (1851-1863). *Species genera et ordines algarum. Volumen secundum: algas florideas complectens.* part 3 : 787-1291. Lundae (Lund).

Agardh, J. G. 1852. *Species genera et ordines algarum. Volumen secundum: algas florideas complectens.* part 2 : 337-720.

Agardh, J. G. 1873. Till algernes systematik. Nya bidrag. *Lunds Universitets Års-Skrift, Afdelningen för Mathematik och Naturvetenskap* 9(8) : 1-71.

Agardh, J. G. 1887. Till algernes systematik. Nya bidrag. (Femte afdelningen.) *Lunds Universitets Års-Skrift, Afdelningen för Mathematik och Naturvetenskap* 23(2): 1-174.

Agardh, J. G. 1894. Analecta algologica. Continuatio I. *Lunds Universitets Års-Skrift, Andra Afdelningen, Kongl. Fysiografiska Sällskapets i Lund Handlingar*, 29(9). 1-144.

Allender, B. M. and G. T. Kraft. 1983. The marine algae of Lord Howe Island (New South Wales): the Dictyotales and Cutleriales (Phaeophyta). *Brunonia* 6: 73-130.

Askenasy, E. 1888. Algen. *In*: *Forschungsreise S.M.S. ``Gazelle''. IV.Theil: Botanik.* (Fascicle 2) : 1-58.

Baissac, J. de, B., P. E. Lubet and C. M. Michel. 1962. Les biocoenoses benthiques littorales de l'Ile Maurice. *Recueil des Travaux de la Station Marine d'Endoume, Bulletin* 25: 253-291.

Barton, E. S. 1901. The genus *Halimeda. Siboga-Expeditie Monographie* 60 : 1-32.

Berkeley, M. J. 1842. Enumeration of fungi, collected by H. Cuming, Esq. F.L.S. in the Philippine Islands. *London Journal of Botany* 1: 142-157.

Bisby, F. A. 1984. Information service in taxonomy. *In* : (R. Allkin and F. A. Bisby, eds.) *Databases in Systematics* , pp. 17-33. Academic Press, London.

Børgesen, F. 1907. An ecological and systematic account of the caulerpas of the Danish West Indies. *Kongelige Danske Videnskabernes Selskabs Skrifter, 7.Raekke, Naturvidenskabelig og Mathematisk Afdeling*, 4: 337-392.

Børgesen, F. 1910. Some new or little known West Indian Florideae. II. *Botanisk Tidsskrift* 30: 177-207.

Børgesen, F. 1911. Some Chlorophyceae from the Danish West Indies. *Botanisk Tidsskrift* 31: 127-152.

Børgesen, F. 1912. Some Chlorophyceae from the Danish West Indies. II. *Botanisk Tidsskrift* 32: 241-273.

Børgesen, F. 1913. The marine algae of the Danish West Indies. Part 1. Chlorophyceae. *Dansk Botanisk Arkiv* 1(4): 1-158.

Børgesen, F. 1932. A revision of Forsskål's algae mentioned in Flora Aegyptiaco-Arabica and found in his herbarium in the Botanical Museum of the University of Copenhagen. *Dansk Botanisk Arkiv* 8(2) : 1-14.,

Børgesen, F. 1940. Some marine algae from Mauritius. I. Chlorophyceae. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 15(4) : 1-81.

Børgesen, F. 1943. Some marine algae from Mauritius. III. Rhodophyceae. Part 2. Gelidiales, Cryptonemiales, Gigartinales. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 19(1) : 1-85.

Børgesen, F. 1945. Some marine algae from Mauritius. III. Rhodophyceae. Part 4. Ceramiales. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 19(10): 1-68.

Børgesen, F. 1948. Some marine algae from Mauritius. Additional lists to the Chlorophyceae and Phaeophyceae. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 20(12) : 1-55.

Børgesen, F. 1952. Some marine algae from Mauritius. Additions to the parts previously published, IV. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 18(19) : 1-72.

Børgesen, F. 1953. Some marine algae from Mauritius. Additions to the parts previously published, V. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 21(9) :1-62.

Børgesen, F. 1954. Some marine algae from Mauritius. Additions to the parts previously published, VI. *Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser* 22(4) : 1-51.

Bory de Saint-Vincent, J. B. G. M. 1827. Padine. *Dictionnaire Classique d'Histoire Naturelle* 12 : 589-591.

Bory de Saint-Vincent, J. B. G. M. 1828. Cryptogamie. *In* L.I. Duperrey, *Voyage autour du monde, exécuté par ordre du Roi, sur la corvette de sa majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825* : 97-200 (1828)

Boudouresque, C. F. and M. Denizot. 1975. Révision du genre *Peyssonnelia* (Rhodophyta) en Méditerranée. *Bulletin du Muséum d'Histoire Naturelle de Marseille* 35 : 7-92.

Chapman V. J. and D. J. Chapman. 1980. *Seaweeds and Their Uses.* Chapman and Hall, New York. 334 p.

Chou, R. C. -Y. 1945. Pacific species of *Galaxaura.* I. Asexual types. *Papers of the Michigan Academy of Science, Arts and Letters* 30 : 35-56.

Colinvaux, L. H. 1968. New species of *Halimeda*: a taxonomic reappraisal. *Journal of Phycology* 4 : 30-35.

Coppejans, E. and A. Meinesz 1988. Marine algae of Papua New Guinea (Madang Prov.). 1. Caulerpaceae (Chlorophyta-Caulerpales). *Blumea* 33: 181-196.

Coppejans, E. and T. Beeckman 1989. *Caulerpa* section Sedoideae (Chlorophyta, Caulerpales) from the Kenyan coast. *Nova Hedwigia* 49: 381-393.

Coppejans, E. and T. Beeckman. 1990. *Caulerpa* (Chlorophyta, Caulerpales) from the Kenyan coast. *Nova Hedwigia* 50: 111-125.

Coppejans, E. and W. F. Prud'homme van Reine 1989a. Seaweeds of the Snellius-II Expedition. Chlorophyta : Caulerpales (except *Caulerpa* and *Halimeda*). *Blumea* 34 : 119-142.

Coppejans, E. and W. F. Prud'homme van Reine 1989b. Seaweeds of the Snellius-II Expedition. Chlorophyta : Dasycladales. *Netherlands Journal of Sea Research* 23 : 123-129.

Coppejans, E. and W. F. Prud'homme van Reine 1992a. The oceanographic Snellius-II Expedition. Botanical results. List of stations and collected plants. *Bulletin des Séances de l'Académie Royale des Sciences d'Outre-Mer* 37 : 153-194.

Coppejans, E. and W. F. Prud'homme van Reine. 1992b. Seaweeds of the Snellius-II Expedition (E. Indonesia): the genus *Caulerpa* (Chlorophyta-Caulerpales). *Bulletin des Séances de l'Académie Royale des Sciences d'Outre-Mer* 37`: 667-712.

Coppejans, E. 1992. Marine algae of Papua New Guinea (Madang Prov.). 2. A revised and completed list of *Caulerpa* (Chlorophyta-Caulerpales). *Blumea* 36: 383--410.

Cordero, P. A. 1981. Studies on Philippines marine red algae. National Museum of the Philippines, Manila. pp. 1-258.

Cribb, A. B. 1983. *Marine algae of the southern Great Barrier Reef : Rhodophyta*. Australian Coral Reef Society (Handbook 2), Brisbane. 174 p.

Dawson, E. Y. 1954a. Notes on tropical Pacific marine algae. *Bulletin of the Southern California Academy of Sciences* 53 : 1-7.

Dawson, E. Y. 1954b. Marine plants in the vicinity of the Institute Océanographique de Nha Trang, Viêt Nam. *Pacific Science* 8: 372-469.

Dawson, E.Y. 1956. Some marine algae of the southern Marshall Islands. *Pacific Science* 10 : 25-66.

Dawson, E. Y. 1957. An annotated list of marine algae from Eniwetok Atoll, Marshall Islands. *Pacific Science* 11 : 92-132.

Decaisne, J. 1841. Plantes de l'Arabie Heureuse, recueillies par M.P.-E. Botta et décrites par M.J. Decaisne. *Archives du Muséum d'Histoire Naturelle (Paris)* 2 : 89-199.

Decaisne, J. 1842. Essais sur une classification des algues et des polipiers calciferes de Lamouroux, Memoires sur les corallines ou polypiers calciferes. *Ann. Sci. Nat., ser. Bot.* 2(18) : 96-128.

Díaz-Piferrer, M. 1969. *Caulerpa hummii*, a new species of marine algae (Chlorophyta, Caulerpales) from Venezuela. *Phycologia* 7: 12-17.

Dickie, G. 1874. On the algae of Mauritius. *Journal of the Linnean Society (London), Botany* 14 : 190-202.

Doty, M. S. 1985. *Eucheuma alvarezii* sp. nov. (Gigartinales, Rhodophyta) from Malaysia. *In* : (I. A. Abbott and J. N. Norris, eds.) *Taxonomy of economic seaweeds with reference to some Pacific and Caribbean species.* , (Report T-CSGCP-011). California Sea Grant College Program , California. pp. 37-45.

Egerod, L. E. 1952. An analysis of the siphonous Chlorophycophyta with special reference to the Siphonocladales, Siphonales, and Dasycladales of Hawaii. *University of California Publications in Botany* 25 : 325-453.

Egerod, L. E. 1974. Report of the marine algae collected on the Fifth Thai-Danish Expedition of 1966. Chlorophyceae and Phaeophyceae. *Botanica Marina* 17 : 130-157.

Eisses, J. 1953. Seaweeds in Indonesian trade. *Ind. J. Natur. Sci.* 109 : 41-56.

Ellis, J. and D. Solander. 1786. *The natural history of many curious and uncommon zoophytes, collected from various parts of the globe by the late John Ellis; Systematically arranged and described by the late Daniel Solander.* London. 208 p.

Endlicher, S. L. 1843. *Mantissa botanica altera : Sistens generum plantarum supplementum tertium.* 1-111. Vindobona (Vienna).

Esper, E. J. C. 1800 (1797-1800). *Icones fucorum. Erster Theil.* Nürnberg. part 4 : 167-217.

Eubank, L. L. 1946. Hawaiian representatives of the genus *Caulerpa*. *University of California Publications in Botany* 18: 409-431.

Farrant, P. A. and R. J. King. 1989. The Dictyotales (algae : Phaeophyta) of New South Wales. *Proc. Linn. Soc. N. S. W.* 110 (4) : 369-406.

Feldmann, J. 1938. Sur un nouveau genre de Siphonocladacées. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences (Paris)* 206 : 1503-1504.

Feldmann, J. and G. Hamel. 1934. Observations sur quelques Gélidiacées. *Revue Générale de Botanique* 46 : 528-549.

Firdausy, C. and C. Tisdell. 1991. Economic returns from seaweeds (*Eucheuma cottonii*) farming in Bali. *Asian Fish. Sci.* 4(1) : 61-73.

Forsskål, P. 1775. *Flora aegyptiaco-arabica. Post mortem auctoris edidit Carsten Niebuhr* : I-CXXVI, 1-219. Havniae (Copenhagen).

Gepp, A. and E. S. Gepp. 1911. The Codiaceae of the Siboga Expedition including a monograph of Flabellarieae and Udoteae. *Siboga-Expeditie Monographie* 62 : 1-150.

Gilbert, W. J. 1942. Notes on *Caulerpa* from Java and the Philippines. *Papers of the Michigan Academy of Science, Arts and Letters* 27 : 7-26.

Gmelin, J. F. 1792. *Caroli a linné ... Systema naturae per regna tria naturae: Editio decima tertia.* Volume 2, part 2 : 885-1661. Lipsia (Leipzig).

Gmelin, S. G. 1768. *Historia fucorum.*1-239. Petropoli (St. Petersburg).

Goreau, T. F. and E. A. Graham. 1967. A new species of *Halimeda* from Jamaica. *Bulletin of Marine Science* 17 : 432-441.

Greville, R. K. 1830. *Algae britannicae*. i-lxxxviii, 1-218. Edinburgh.

Grunow, A. 1915. Additamenta ad cognitionem Sargassorum. *Verhandlungen der Kaiserlich-Koniglichen Zoologisch-Botanischen Gesellschaft in Wien* 65 : 329-448.

Hardy, F. G., A Retraubun and Mulyadi. 1994. Some notes on collecting sites for marine diatoms and macroalgae in Indonesia. *The Phycologist* 39 : 17-23.

Haroun, R. J., and W. F. Prud'homme van Reine. 1993. A biogeographical study of *Laurencia* and *Hypnea* species of the Macaronesian region. *Courier Forschungsinstitut Senckenberg* 159 : 119-125.

Hauck, F. 1887. Ueber einige von J.M. Hildebrandt im Rothen Meere und Indischen Ocean gesammelte Algen. *Hedwigia* 26: 8-21, 41-45.

Harvey, W. H. 1860. Characters of new algae, chiefly from Japan and adjacent regions, collected by Charles Wright in the North Pacific Exploring Expedition under Captain John Rodgers. *Proceedings of the American Academy of Arts and Sciences* 4 : 327-335.

Harvey, W. H. 1863. *Phycologia australica*. Vol. 5. London. pp. [i]-x + v-lxxiii [Synoptic catalogue], pls. CCXLI-CCC.

Hillis, L. W. 1959. A revision of the genus *Halimeda* (order Siphonales). *Publications of the Institute of Marine Science [University of Texas]* 6 : 321-403.

Hillis-Colinvaux, L. 1980. Ecology and taxonomy of Halimeda: primary producer of coral reefs. *Advances in Marine Biology* 17 : 1-327.

Hodgkin, E. P. and C. Michel. 1963. Zonation of plants and animals on rocky shores of Mauritius. *Proceedings of the Royal Society of Arts and Sciences of Mauritius* 2 : 121-145.

Howe, M. A. 1907. Phycological studies. III. Further notes on *Halimeda* and *Avrainvillea*. *Bulletin of the Torrey Botanical Club* 34 : 491-516.

Howe, M. A. 1909. Phycological studies. IV. The genus *Neomeris* and notes on other Siphonales. *Bulletin of the Torrey Botanical Club* 36 : 75-104.

Hudson, W. 1778. *Flora anglica*. Editio altera. Londini (London). 690p.

Huisman, J. M. and M. A. Borowitzka. 1990. A revision of the Australian species of *Galaxaura* (Rhodophyta, Galaxauraceae), with a description of *Tricleocarpa* gen. nov. *Phycologia* 29(2) : 150-172.

Isaac, W. E. 1967. Marine botany of the Kenya coast 1. A first list of Kenya marine algae. *Journal of the East Africa Natural History Society and National Museum* 26(2) : 75-83.

Jaasund, E. 1977. Marine algae in Tanzania VIII. *Botanica Marina* 20 : 509-520.

Jacquin, N. J. 1786. *Collectanea ad botanicam, chemiam, et historiam naturalem spectantia, cum figuris*. Vol. 1 : 1-386. Vindobonae (Wien).

Kjellman, F. R. 1900. Om Floridé-slägtet *Galaxaura*, dess organografi och systematik. *Kongl. Svenska Vetenskaps-Akademiens Handlingar* (ser. 4) 33(1) : 1-109.

Kützing, F. T. 1856. *Tabulae phycologicae* Vol. 6 Nordhausen. i-iv, 1-35.

Kützing, F. T. 1859. *Tabulae phycologicae* Vol. 9. Nordhausen. I-VIII, 1-42.

Kützing, F.T. 1860. *Tabulae phycologicae*. Vol. 10. Nordhausen. I-IV, 1-39.

Lamouroux, J. V. F. 1805. *Dissertations sur plusieurs espèces de Fucus*.. i-xxiv, 1-83. Agen.

Lamouroux, J. V. F. 1809a. Exposition des caractères du genre *Dictyota*, et tableau des espèces qu'il renferme. *Journal de Botanique (Desvaux])*2 : 38-44.

Lamouroux, J. V. F. 1809b. Observations sur la physiologie des algues marines, et description de cinq nouveaux genres de cette famille. *Nouveau Bulletin des Sciences, par la Société Philomathique de Paris* 1 : 330-333.

Lamouroux, J. V. F. 1813. Essai sur les genres de la famille des thalassiophytes non articulées. *Annales du Muséum d'Histoire Naturelle (Paris)* 20 : 115-139.

Lamouroux, J. V. F. 1816. Histoire des polypiers coralligènes flexibles, vulgairement nommés zoophytes. i-lxxxiv, 1-559. Caen.

Lawson, G. W. and D. M. John. 1987. The marine algae and coastal environment of tropical west Africa (second edition). *Nova Hedwigia* 93 : i-vi, 415 p.

Levring, T. 1953. The marine algae of Australia. I. Rhodophyta: Goniotrichales, Bangiales and Nemalionales. *Arkiv för Botanik,* (ser. 2) 2 : 457-530.

Linnaeus, C. 1758. *Systema naturae per regna tria naturae. Editio decima*. Vol. 1: 1-823. Holmiae (Stockholm).

Littler, D. S. and M. M. Littler. 1991. Systematics of *Anadyomene* species (Anadyomenaceae, Chlorophyta) in the tropical western Atlantic. *Journal of Phycology* 27 : 101-118.

Luxton, D. M., R. A. O. Chapman, M. T. Brown and M. Lahaye (Eds). 1993. Aspect of farming and processing of *Kappaphycus* and *Eucheuma* in Indonesia. Fourtennth International Seaweed Symposium. *Hydrobiologia* 260-261 : 365-371.

May, R. M. 1990. Taxonomy in destiny. *Nature* 347 : 129-130.

May, V. 1965. A census and key to the species of Rhodophyceae (red algae) recorded from Australia. *Contributions from the New South Wales National Herbarium* 3: 349-429.

Ministry of National Development Planning/National Development Planning Agency. 1993. *Biodiversity : Action Plan for*

Indonesia. Ministry of National Development Planning/National Development Planning Agency, Jakarta (Indonesia). 141 p.

Okamura, K. 1921 (1916-1923). *Icones of Japanese algae*. Vol. 4 : 63-149.

Okamura, K. 1930. *Icones of Japanese algae*. Vol. 6 : 19-28.

Okamura, K. 1931. On the marine algae from Kotosho (Botel Tobago). *Bulletin of the Biogeographical Society of Japan* 2 : 95-122.

Olsen-Stojkovich, J. 1985. A systematic study of the genus *Avrainvillea* Decaisne (Chlorophyta, Udoteaceae). *Nova Hedwigia* 41 : 1-68.

Olsen, J. L.and J. A. West. 1988. *Ventricaria* (Siphonocladales-Cladophorales complex, Chlorophyta), a new genus for *Valonia ventricosa*. *Phycologia* 27 : 103-108.

Papenfuss, G. F. 1943. Notes on algal nomenclature. II. *Gymnosorus* J. Agardh. *American Journal of Botany* 30 : 463-468.

Papenfuss, G. F. 1967. The history, morphology and taxonomy of *Hormophysa* (Fucales: Cystoseiraceae). *Phytomorphology* 17 : 42-47.

Papenfuss, G. F., K. E. Mshigeni and Y. M. Chiang. 1982. Revision of the red algal genus *Galaxaura* with special reference to the species occurring in the western Indian Ocean. *Botanica Marina* 25 : 401-444.

Peterson, R. D. 1972. Effects of light intensity on the morphology and productivity of *Caulerpa racemosa* (Forsskål) J. Agardh. *Micronesica* 8 : 63-86.

Pham-Hoang, H. 1967. Contribution à l'étude des algues littorales du Vietnam: Le genre *Sargassum*. *Ann. Fac. Sci. Saigon*, pp. 259-332.

Schmitz, F. 1895. Marine Florideen von Deutsch-Ostafrika. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 21 : 137-177.

Schmitz, F.and P. Falkenberg. 1897. Rhodomelaceae. *In* : (A. Engler and K. Prantl, eds.) *Die natürlichen Pflanzenfamilien.I.Teil, Abt.* 2: 421-480. Leipzig.

Schneider, C. W. and R. B. Searles. 1991. *Seaweeds of the southeastern United States: Cape Hatteras to Cape Canaveral.* Duke University Press, Durham and London. 553 pp.

Setchell, W. A. 1926. Tahitian algae collected by W. A. Setchell, C. B. Setchell, and H. E. Parks. *University of California Publications in Botany* 12 : 61-142.

Silva, P. C. 1952. *Codium* Stackhouse. *In* : (L. E. Egerod, ed.) An analysis of the siphonous Chlorophycophyta, with special reference to the Siphonocladales, Siphonales, and Dasycladales of Hawaii. *University of California Publications in Botany* 25 : 381-395.

Silva, P. C., E. G. Meñez and R. L. Moe. 1987. Catalog of the benthic marine algae of the Philippines. *Smithsonian Contributions to the Marine Sciences* 27 : 1-179.

Silva, P. C., Basson and R. L. Moe. 1996. *Betaphycus gelatinum* Doty ex Silva *et al. University of California Publications in Botany* 79 : 326.

Soegiarto, A. 1978. Indonesian seaweed resources : their utilization and management. *Proc. Int. Seaweed Symp.* 9 : 463-471.

Soegiarto, A., Sulistijo, I. J. Dogma, Jr., G. C. Trono, Jr. and R. A. Tabbada (eds). 1990. Utilization and farming of seaweeds in Indonesia; Culture and use of algae in Southeast Asia. *Proceedings of the Symposium on Culture and Utilization of Algae in Southeast Asia, 8-11 Dec., 1981, Tigbauan, Iloilo, Philippines*, pp. 9-19.

Solms-Laubach, H. 1892. Ueber die Algengenera *Cymopolia*, *Neomeris* und *Bornetella*.. *Annales du Jardin Botanique de Buitenzorg* 11 : 61-97.

Solms-Laubach, H. 1895. Monograph of the Acetabularieae. *Transactions of the Linnean Society of London, Second Series, Botany* 5 : 1-39.

Sonder, O. G. 1845. Nova algarum genera et species, quas in itinere ad oras occidentales Novae Hollandiae, collegit L. Preiss, Ph. Dr. *Botanische Zeitung* 3 : 49-57.

Sonder, O.G. 1880. Supplementum ad volumen undecimum Fragmentorum phytographiae Australiae, indices plantarum acotyledonarum complectens. I. Algae australianae hactenus cognitae. *In* F. von Mueller, *Fragmenta phytographiae Australiae* Vol. 11 (Suppl.) : 1-42. Melbourne.

Tanaka, T. 1936. Four new species of Galaxaura from Japan. *Sc. Pap. Inst. Algol. Res. Fac. Sc. Hokkaido Imp. Univ.*1 : 51-57.

Taylor, W. R. 1945. Pacific marine algae of the Allan Hancock Expeditions to the Galapagos Islands. *Allan Hancock Pacific Expeditions* 12 : 1-528.

Taylor, W. R. 1950. *Plants of Bikini and other northern Marshall Islands*. Ann Arbor: University of Michigan Press. i-xv, 227 p.

Taylor, W. R. 1960. *Marine algae of the eastern tropical and subtropical coasts of the Americas*. Ann Arbor: University of Michigan Press. 870 p.

Taylor, W. R. 1966. Records of Asian and western Pacific marine algae, particularly algae from Indonesia and the Philippines. *Pacific Science* 20 : 342-359.

Trono, Jr, G. C. 1968. The marine benthic algae of the Caroline Islands, I. Introduction, Chlorophyta and Cyanophyta. *Micronesica* 4(2) : 137-206.

Trono, Jr, G. C. 1992. The genus Sargassum in the Philippines. *In* : (I. A. Abbott, ed.) *Taxonomy of Economic Seaweeds With reference to some Pacific and Western Atlantic Species*. Vol. III, Report No. T-CSGCP-023. Pablication of the California Sea Grant College, University of California, California. pp. 43-94.

Trono, Jr, G. C. and E. Ganzon-Fortes. 1988. *Philippine Seaweeds*. National Book Store Inc., Manilla. 330 p.

Tseng, C. K. 1941. Studies on the Chaetangiaceae of China. *Bulletin of the Fan Memorial Institute of Biology, Botany* 11 : 83-118.

Tseng, C. K. 1983. *Common seaweeds of China.* Science Press, Beijing. 316 p.

Turner, D. 1808. *Fuci.* Vol. I : 1-64. (London).

Turner, D. 1816 (1815-1819). *Fuci.* Vol. III : 1-153. (London).

Vahl, M. 1802. Endeel kryptogamiske Planter fra St.-Croix. *Skrifter af Naturhistorie-Selskabet [Kiøbenhavn]* 5(2) : 29-47.

Valet, G. 1966. Sur une espece rare et une nouvelle espece d'*Halimeda* de Melanesie. *Revue Generale de Botanique* 73 : 680-685.

Verheij, E. 1994. Nongeniculate Corallinaceae (Corallinales, Rhodophyta) from the Spermonde Archipelago, SW Sulawesi, Indonesia. *Blumea* 39 : 95-137.

Verheij, E. and P. L. A. Erftemeijer. 1993. Distribution of seagrasses and associated macroalgae in South Sulawesi, Indonesia. *Blumea* 38 : 45-64.

Verheij, E. and W. F. Prud'homme van Reine. 1993. Seaweeds of the Spermonde Archipelago, SW Sulawesi, Indonesia. *Blumea* 37: 385-510.

Wallace, A. R. 1895. *Island Life or the Phenomena and Causes of Insular Faunas and Floras Including a Revision and Attempted Solution of the Problem of Geological Climates.* MacMillan and Co., New York. 563 p.

Weber-van Bosse, A. 1898. Monographie des Caulerpes. *Annales du Jardin Botanique de Buitenzorg* 15: 243-401.

Weber-van Bosse, A. 1901. Études sur les algues de l'Archipel Malaisien. [III.] *Annales du Jardin Botanique de Buitenzorg* 17 : 126-141.

Weber-van Bosse, A. 1905. Note sur le genre *Dictyosphaeria* Dec. *Nuova Notarisia* 16: 142-144.

Weber-van Bosse, A. 1913. Liste des algues du Siboga. I. Myxophyceae, Chlorophyceae, Phaeophyceae avec le concours de M. Th. Reinbold. *Siboga-Expeditie Monographie* 59a :1-186.

Weber-van Bosse, A. 1921. Liste des algues du Siboga. II. Rhodophyceae. Première partie. Protoflorideae, Nemalionales, Cryptonemiales. *Siboga-Expeditie Monographie* 59b : 187-310.

Weber-van Bosse, A. 1923. Liste des algues du Siboga. III. Rhodophyceae. Seconde partie. Ceramiales. *Siboga-Expeditie Monographie* 59c : 311-392.

Weber-van Bosse, A. 1926. Algues de l'expédition danoise aux îles Kei. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening i København* 81 : 57-155, 43 figs.

Weber-van Bosse, A. 1928. Liste des algues du Siboga. IV. Rhodophyceae. Troisième partie. Gigartinales et Rhodymeniales et tableau de la distribution des Chlorophycées, Phaeophycées et Rhodophycées de l'Archipel Malaisien. *Siboga-Expeditie Monographie* 59d : 393-533.

Whitten, A. J., M. Mustafa and G. S. Henderson. 1987. *The Ecology of Sulawesi.* Gajah Mada University Press, Yogyakarta (Indonesia). 777 p.

Wilson, E. O 1988. The current state of biological diversity *In* : (E. O. Wilson, ed.) *Biodiversity* , pp. 3-18. National Academy Press, Washington, D.C.

Womersley, H. B. S. 1967. A critical survey of the marine algae of southern Australia. II. Phaeophyta. *Australian Journal of Botany* 15 : 189-270.

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

Womersley, H. B. S. and A. Bailey. 1970. Marine algae of the Solomon Islands. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences* 259 : 257-352.

Yamada, Y. 1931a. Notes on some Japanese Algae, II. *Journal of the Faculty of Science, Hokkaido Imperial University, Botany* 1 : 65-76.

Yamada, Y. 1931b. Notes on *Laurencia*, with special reference to the Japanese species. *University of California Publications in Botany* 16 : 185-310.

Yamada, Y. 1933. Notes on some Japanese algae. J*ourn. Pac. Sci., Hokaido Univ., Ser.* 5,2 (3) : 277-285.

Yamada, Y. 1934. The marine Chlorophyceae from Ryukyu, especially from the vicinity of Nawa. *Journal of the Faculty of Science, Hokkaido Imperial University, Series V, Botany* 3 : 33-88.

Yamada, Y. 1941. On the species of *Halimeda* from Micronesia. *Kagaku Nanyo* 4 : 108-121.

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

Zanardini, G. 1878. Phyceae papuanae novae vel minus cognitae a cl. O. Beccari in itinere ad Novam Guineam annis 1872-75 collectae. *Nuovo Giornale Botanico Italiano*.10 : 34-40.

Zaneveld, J. S. 1955. Economic marine algae of tropical south and east Asia and their utilization. *Indo-Pacif. Fish. Counc. Spec. Publ.* 3 : 1-55.

APPENDIX A

Table 1. Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
CHLOROPHYTA				
Acetabularia				
caraibica	+	-	-	-
dentata	-	+	+	+
exigua	+	-	+	-
parvula	+	-	-	-
ryukyuensis	-	+	-	-
Anadyomene		*		
brawnii	+		-	-
plicata	+		-	-
stellata	+		+	+
wrightii	+		-	-
Avrainvillea				
amadelpha	-	+	+	-
erecta	+	+	-	-
gardineri	-	-	+	-
lacerata	+	+	+	-
longicaulis	-	+	+	-
nigricans	-	-	+	-
obscura	-	-	+	+
Boergesenia				
forbesii	+	+	+	+
Boodlea		*		o
composita	+		+	
paradoxa	+		-	
siamensis	+		-	
vanbosseae	+		-	
Boodleopsis			o	o
pusilla	-	+		
siphonacea	+	-		
Bornetella				
capitata	+	-	-	-
nitida	+	+	+	+
oligospora	+	+	-	+
sphaerica	+	-	-	+
Bryobesia		o	o	o
johannae	+			

Table 1 (*Cont'd.*) . Taxa collected during this present (North Sulawesi) study in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
Bryopsis			o	o
indica	+	-		
pennata	+	+		
plumosa	+	-		
Caulerpa				
ambigua	+	-	-	-
brachypus	+	+	+	-
buginense	-	-	+	-
crassifolia	+	-	-	-
cupressoides	+	+	+	-
elongata	+	+	+	-
falcifolia	+	-	-	-
fastigiata	+	-	-	-
fergusonii	+	+	-	-
freycinetii	+	-	-	-
kilneri	+	-	-	-
lentillifera	+	+	+	+
lessonii	+	+	+	-
lycopodium	+	-	-	-
manorensis	-	-	+	-
microphysa	-	+	-	-
opposita	-	-	+	-
parvifolia	+	-	-	-
parvula (?)	+	-	-	-
peltata	+	-	-	-
prolifera	+	-	-	-
racemosa	+	+	+	+
scalpelliformis	-	-	+	-
sedoides	+	-	-	-
selago	+	-	-	-
serrulata	-	+	+	+
sertularioides	+	+	+	-
subserrata	+	-	+	-
taxifolia	+	+	+	-
urvilliana	+	-	-	-
verticillata	+	+	+	+
Chaetomorpha				o
clavata	+	-	-	

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
crassa	+	+	+	
linum	+		-	
tortuosa	+		-	
Chlorodesmis				o
comosa	+	-	-	
fastigiata	-	+	+	
hildenbrandtii	-	+	+	
Chnoospora		*		o
implexa	+		+	
Cladophora		*	o	o
aegagropila	+			
breviarticulata	+			
hamifera	+			
heteronema	+			
neesiorum	+			
nitida	+			
patentiramea	+			
savoena	+			
socialis	+			
subsimplex	+			
tondanensis	+			
Cladophoropsis			o	o
sundanensis	+	+		
vaucheriaeformis	-	+		
zollingeri	+	-		
Codium				
adhaerens	+	-	-	-
arabicum	-	+	+	+
bartlettii	-	-	+	-
difforme	+	-	-	-
divaricatum	+	-	-	-
edule	-	-	+	+
elongatum	+	-	-	-
geppii	-	-	+	-
harveyi	-	-	+	-
ovale	+	+	-	-
petaloideum	+	-	-	-
tenue	+	-	-	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
tomentosum	+	-	-	-
Cymopolia			o	o
vanbosseae	+	+		
Derbesia		o	o	o
minima	+			
Dictyosphaeria				
cavernosa	-	+	+	+
favulosa	+	-	-	-
intermedia	+	-	-	-
versluysii	+	+	+	+
Enteromorpha		*		o
clathrata	-		+	
compressa	-		+	
crinita	+		-	
flexuosa	+		-	
hopkirkii	+		-	
intestinalis	-		+	
lingulata	+		-	
linza	+		-	
prolifera	+		-	
torta	+		-	
Halicoryne		o	o	o
spicata	+			
Halimeda				
copiosa	-	+(?)	+	+
cuneata	+	-	-	-
cylindracea	-	+	+	-
discoidea	-	+	+	+
distorta	-	+ (?)	+	-
gigas	-	-	+	-
gracilis	+	+	+	-
incrassata	+	+(?)	-	-
lacunalis	-	+	-	-
macroloba	+	+	+	+
macrophysa	+	-	+	+
melanesica	-	-	+	+
micronesica	-	+	+	+
minima	-	+	+	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
opuntia	+	+	+	+
simulans	-	+(?)	+	-
taenicola	-	+	+	-
tuna	+	+	+	+
velasquezii	-	+	-	-
Microdictyon		*	o	o
montagnei	+			
umbilicatum	+			
Monostroma		o	o	o
grevillei	+			
pulchrum	+			
sandei	+			
Neomeris				
annulata	+	+	+	+
bilimbata	-	+	-	-
dumetosa	+	-	-	-
vanbosseae	+	+	+	+
Penicillus		o	o	o
sibogae	+			
Polyphysa	o		o	o
parvula		+		
Pseudocodium	o	o		o
floridanum			+	
Rhipidosiphon	o	o		o
javensis			+	
Rhipilia				o
diaphana	-	+	-	
nigrescens	-	+	-	
orientalis	+	+	+	
Rhipiliopsis	o		o	o
gracilis		+		
Rhizoclonium		o	o	o
hookeri	+			
Spongocladia		o	o	o
dichotoma	+			
neocaledonica	+			
vaucheriaeformis	+			

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
Strurvea		*	o	o
delicatula	+			
Tydemania				
expeditionis	+	+	+	+
Udotea				
argentea	+	+	+	+
explanata	+	-	-	-
flabellum	+	+	+	-
glaucescens	+	+	+	-
javensis	+	+	-	-
orientalis	+	+	+	-
papillosa	+	-	-	-
Ulva				o
fasciata	+	-	-	
lactusa	+	-	-	
pertusa	+	+	-	
reticulata	+	+	+	
Valonia				
aegagropila	+	+	+	+
fastigata	+	-	+	-
macrophysa	-	+	+	-
pachynema	+	-	-	-
utricularis	+	+	-	-
Ventricaria				
ventricosa	+	+	+	+
PHAEOPHYTA				
Colpomenia			o	o
sinuosa	+	+		
Cystophyllum			o	o
muricatum	+	-		
trinode	-	+		
Cystoseira		o	o	o
prolifera	+			
Dictyopteris		*		o
delicatula	+		-	
jamaicensis	-		+	

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
muelleri	+		-	
repens	-		+	
Dictyota		*		
apiculata	+		-	-
bartayresiana	+		+	+
beccariana	+		-	-
cervicornis	-		+	+
ceylanica	+		-	-
ciliolata	-		+	+
crenulata	-		+	-
dichotoma	-		+	-
fasciola	+		-	-
intermedia	-		+	-
marginata	-		+	-
pardalis	+		-	-
pinnatifida	+		-	-
robusta	+		-	-
Ectocarpus		o	o	o
elachistaeformis	+			
indicus	+			
Hormophysa	o			
cuneiformis		+	+	+
Hydroclathrus				o
cancellatus	+	-	-	
clathratus	-	+	+	
tenuis	-	-	+	
Ilea		o	o	o
fascia	+			
Lobophora				
variegata	+	+	+	+
Mesospora		o	o	o
schmidtii	+			
Microspongium	o	*	o	o
Myrionema	o	*	o	o
Padina		*		
australis	+		+	+
boergesenni	-		+	-
commersonii	+		-	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
japonica	-		-	+
minor	-		+	-
sanctae-crucis	-		+	-
tenuis	-		+	+
tetrastomatica	+			
Ralfsia		o	o	o
expansa	+			
Rosenvingea				o
intricata	-	+	+	
orientalis	-	+	-	
Sargassum				
aquifolium	+	-	-	-
bacciferum	+	-	-	-
baccularia	+	-	-	-
binderi	+	-	-	-
biserrula	+	-	-	-
carpophyllum	+	-	-	-
cinctum	+	-	-	-
claviferum	+	-	-	-
concinnum	+	-	-	-
crassifolium	+	-	-	-
cristaefolium	+	+	+	-
decaisnei	+	-	-	-
desoauxii	+	-	-	-
duplicatum	+	-	-	-
echinocarpum	+	-	-	-
filifolium	+	-	-	-
flavicans	+	-	-	-
fragile	+	-	-	-
gracile	+	-	-	-
gracillimum	+	-	-	-
granuliferum	+	-	-	-
grevillei	+	-	-	-
hawaiiensis	-	-	+	-
hemiphyllum	-	-	+	-
hemiphylloides	+	-	-	-
heterocystum	+	-	-	-
ilicifolium	+	-	+	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
microcystum	+	-	-	-
microphyllum	+	-	-	-
molleri	+	-	-	-
myriocystum	+	-	-	-
opacum	+	-	-	-
pallidum	-	-	+	-
paniculatum	+	-	-	-
parvifolium	+	-	-	-
peronii	+	-	-	-
plagiophyllum	+	-	-	-
polycystum	+	-	-	-
pulchellum	+	-	-	-
sandei	+	-	-	-
siliquosum	+	-	+	-
spathulaefolium	+	-	-	-
spinifex	+	-	-	-
spinuligerum	+	-	-	-
subfalcatum	+	-	-	-
swartzii	+	-	-	-
tenue	+	-	-	-
turbinarioides	-	-	-	+
Spatoglossum		*	o	o
variabile	+			
Sphacelaria			o	o
cornuta	+	-		
furcigera	+	-		
fusca	+	-		
nova-hollandiae	+	-		
sauvageaui	+	-		
tribuloides	+	+		
Stypopodium		o		o
flabelliforme	+		+	
zonale	-		+	
Turbinaria				
condensata	+	-	-	-
conoides	+	+	+	+
decurrens	+	-	+	+
murrayana	+	+	-	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
ornata	+	+	+	+
parvifolia	-	-	+	-
tricostata	+	-	-	-
Zonaria		o	o	o
crenata	+			
RHODOPHYTA				
Acanthophora				
dendroides	+	-	-	-
muscoides	-	+	+	-
spicifera	+	+	+	+
Actinotrichia				
rigida	+	-	-	-
fragilis	-	+	+	+
Acrocystis		o	o	o
nana	+			
Amansia				
daemelii	+	-	-	-
glomerata	+	+	+	+
pumila	+	-	-	-
Antithamnion		*	o	o
adnatum	+			
applicitum	+			
Betaphycus		o	o	
gelatinum	+			+
Bostrychia			o	o
radicans	+	+		
tenella	+	+		
Botryocladia		*		o
microphysa	+		+	
Callithamnion	*	o	o	o
Callophylis		o	o	o
sibogae	+			
Caloglossa			o	o
amboinensis	+			
leprieurii	+	+		
Carpopeltis		*	o	o

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
capitellata	+			
phyllophora	+			
rigida	+			
vaigeensis	+			
Catenella			o	o
caespitosa	-	+		
impudica	+	-		
nipae	-	+		
opuntia	+	-		
Caulacanthus		*	o	o
indicus	+			
Centroceras	o		o	o
clavulatum		+		
Ceramiella			o	o
huysmansii	+	+		
Ceramium		*	*	o
borneense	+			
byssoideum	+			
cingulatum	+			
clavulatum	+			
cruciatum	+			
howei	+			
isogonum	+			
maryae	+			
subdichotomum	+			
subverticillatum	+			
tenuissimum	+			
Ceramothamnion		o	o	o
codii	+			
Ceratodictyon				o
intricatum	-	+	+	
repens	-	+	+	
spongioides	+	-	-	
spongiosum	-	+	+	
variabilis	-	+	+	
Chalicostroma		o	o	o
nierstraszii	+			
Champia		*		o

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
compressa	+		-	
parvula	+		+	
salicornoides	+		-	
spathulata	+		-	
Chondria				o
armata	+	+	-	
dasyphylla	+	-	+	
decumbens	+	-	-	
minutula	+	-	-	
riparia	+	-	-	
sibogae	+	-	-	
Claudea	o	*	o	o
Coriophyllum		o		o
setchellii	+		+	
Corynomorpha		o	o	o
prismatica	+			
Crouania		o	o	o
attenuata	+			
australis	+			
Cryptonemia		*		o
decumbens	+		+	
lomation	+		-	
yendoi	+		-	
Dasya	*	*		o
baillouviana			+	
caraibica			+	
Dasyopsis		o	o	o
anastomosans	+			
palmatifida	+			
pilosa	+			
pulchella	+			
tenella	+			
Dermonema		o	o	o
gracile	+			
Dictyurus		*	o	o
purpurascens	+			
Digenea	o		o	o
simplex		+		

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
Dorella		o	o	o
simplex	+			
Endosiphonia		o	o	o
curvata	+			
spinuligera	+			
Euchema				o
adhaerens	+	-	-	
arnoldii	+	-	-	
cervicorne	+	-	-	
cottonii	+	-	-	
crassum	+	-	-	
? *crustaeforme*	+	-	-	
cupressoideum	+	-	-	
denticulatum	-	+	+	
dichotomum	+	-	-	
edule	+	+	-	
horizontale	+	-	-	
horridum	+	-	-	
inerme	+	-	-	
leeuwenii	+	-	-	
muricatum	+	-	-	
platycladum	+	-	-	
serra	+	-	+	
simplex	+	-	-	
speciosum	+	-	-	
vermiculare	+	-	-	
Falkenbergia		o	o	o
rufolanosa	+			
Fauchea		*	o	o
nitophylloides	+			
procumbens	+			
Galaxaura				
angustifrons	+	-	-	-
clavigera	+	-	-	-
cohaerens	-	-	+	-
contigua	+	-	-	-
cuculligera	+	-	-	-
dimorpha	+	-	-	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
eburnea	+	-	-	-
elongata	+	-	-	-
fasciculata	+	+	-	+
fastigiata	+	-	-	-
filamentosa	-	-	-	+
fragilis	+	-	-	-
kjellmanii	+	-	-	-
lenta	+	-	-	-
marginata	-	+	-	+
obtusata	+	-	+	+
robusta	+	-	-	-
rogusa	-	-	+	-
sibogae	+	-	-	-
striata	-	-	+	-
tissotii	+	-	-	-
Gelidiella				
acerosa	+	+	+	+
lubrica	+	+	-	-
myrioclada	-	+	-	-
pannosa	-	+	-	-
Gelidiopsis		o	o	o
intricata	+			
repens	+			
variabilis	+			
rigida	+			
Gelidium				o
amboniense	-	+	-	
caloglossoides	+	-	-	
corneum	+	-	-	
crinale	+	-	-	
latifolium	+	+	-	
pannosum	+	-	-	
pusillum	+	+	+	
Gigartina	o	*	o	o
Gracilaria				
arcuata	+	-	+	+
blodgettii	+	-	+	-
compressa	+	-	-	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
confervoides	+	-	-	-
corallicola	+	-	-	-
corniculata	+	-	-	-
coronopifolia	-	-	+	+
crassa	+	-	-	-
cylindrica	+	-	-	-
denticulata	+	-	-	-
dichotoma-flabellata	+	-	-	-
eucheumoides	+	+	+	-
gigas	+	-	-	-
lacinulata	+	-	-	-
lemanaeformis	+	-	-	-
lichenoides	+	-	-	-
obtusa	+	-	-	-
purpurascens	+	-	-	-
radicans	+	-	-	-
salicornia	-	+	+	+
textorii	+	-	-	-
verrucosa	-	-	+	-
wrightii	+	-	-	-
Grateloupia			*	o
filicina	+	+		
Griffithsia		*	*	o
crinata	+			
rhizophora	+			
schimperi	+			
Gymnogongrus		o	*	o
dilatatus	+			
Haloplegma		*	o	o
duperreyi-spinolosum	+			
Halymenia				
acuminata	-	-	+	-
agardhii	+	-	-	-
amoena	+	-	+	-
arachnophylloidea	+	-	-	-
clavaeformis	+	-	-	-

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
dilatata	-	-	+	-
durvillaei	+	+	+	+
floresia	+	-	+	-
kallymenioides	+	-	-	-
maculata (?)	+	-	-	-
tubulosa	+	-	-	-
ulvoidea	+	-	-	-
Herposiphonia		*	o	o
prorepens	+			
secunda	+			
subdisticha	+			
tenella	+			
Heterosiphonia		*		o
muelleri	+		-	
secunda	-		+	
wurdemanni	+		-	
Hildenbrandtia		o	o	o
prototypus	+			
rivularis	+			
Hydropuntia	o		o	o
fastigiata		+		
Hypnea		*		
cenomyce	+	-	-	-
charoides	+	-	+	-
chordacea	+	-	-	-
cornuta	+	-	-	-
hamulosa	+	-	-	-
musciformis	+	-	+	-
nidifica	+	-	-	-
nidulans	+	-	-	-
pannosa	+	-	+	+
spinella	+	-	+	+
vaga	+	-	-	-
valentiae	+	-	-	-
Hypoglossum		o	o	o
serrulatum	+			
spathulatum	+			

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
Janczewskia		o	o	o
teysmannii	+			
Kallymenia		*		o
feldmannii	-		+	
maculata	+		-	
perforata	+		-	
requienii	+		-	
Kappaphycus				
alvarezii	-	-	+	+
striatum	+	-	+	-
Laurencia				
cartilaginea	-	-	+	+
clavata	+	-	-	-
concinna	+	-	-	-
dendroidea	+	-	-	-
dotyi	-	-	+	-
flexilis	-	-	-	+
gemmifera	+	-	-	-
glandulifera	-	-	+	-
majuscula	-	+	-	-
mariannensis	-	-	+	-
nidifica	+	-	-	-
obtusa	+	-	+	+
paniculata	+	-	-	-
pannosa	+	-	-	-
papillosa	+	+	+	+
parvipapillata	-	-	+	-
pinnata	+	-	+	-
poitei	+	-	-	-
pygmaea	+	-	-	-
thuyoides	+	-	-	-
Leveillea				o
jungermannioides	+	+	+	
Liagora		*		o
australasica	+		-	
caenomyce	+		-	
ceranoides	-		+	
cheyneana	+		-	

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
fragilis	+		-	
leprosa	+		-	
pulverulenta	+		-	
Lomentaria		*	o	o
uncinata	+			
Lophocladia		o	o	o
lallemandi	+			
Lophosiphonia			o	o
obscura	+	-		
reptabunda	-	+		
Martensia		*	o	o
beccariana	+			
denticulata	+			
elegans	+			
flabelliformis	+			
speciosa	+			
Meristotheca		o		o
papulosa	+		+	
Murrayella			o	o
periclados	+	+		
Nitophyllum		o	o	o
carneum	+(?)			
erosum	+			
lenormandii	+			
tongatense	+			
uncinatum	+			
Oligocladus		o	o	o
boldinghii	+			
Peyssonnelia		*		*
calcea	+		-	
conchicola	+		-	
evae	+		-	
gunniana	+		-	
hariotii	+		-	
obscura	+		-	
rubra	+		-	
squamaria	-		+	
Phyllophora	o	*	o	o

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
Platoma		o	o	o
pikeana	+			
Plocamium		*	o	o
cornutum	+(?)			
Polysiphonia		*		o
fastigiata	+		-	
ferulacea	+		-	
infestans	-		+	
mollis	+		-	
pulvinata	+		-	
Porphyroglossum			o	o
zollingeri	+	+		
Portieria				
hornemannii	+	+	+	+
Predaea	o	*	o	o
Prionitis		o	o	o
wentii	+			
Pterocladia				o
caerulescens	-	+	+	
caloglossoides	-	+	+	
lucida	+	-	-	
Rhodymenia		*		
australis	+		-	-
coacta	-		+	-
corallina	+		+	-
indica	+		-	-
intricata	-		+	+
leptophyllia	+		+	-
pacifica	-		+	-
setchellii	+		-	-
Sarconema	o	*	o	o
Schizymenia	*	o	o	o
Scinaia		o	o	o
complanata	+			
Spemothamnion		o	o	o
orientale	+			
Spyridia				o
filamentosa	+	+	+	

Table 1 (*Cont'd.*). Taxa collected during this present study (North Sulawesi) in comparison with those of the Siboga Expedition (1899-1900), the Danish Expedition (1914-1916), the Snellius-II Expedition (1984) and the Buginesia-III Project (1988 - 1990). (+ = taxon present, - = taxon absent, * = taxon collected but not yet studied in detail, ? = taxonomic uncertainty, o = the genus not found).

Taxa	Siboga &Danish Expeditions	Snellius-II Exp.	Buginesia III Project	North Sulawesi
Tapeinodasya		o	o	o
bornetii	+			
Thamnoclonium		o	o	o
procumbens	+			
tissotii	+			
treubii	+			
Titanophora		*		
weberae	+		+	+
Tolypiocladia				*
calodictyon	+	+	-	
condensata	+	-	-	
glomerulata	+	+	+	
Trichogloea		*		o
requienii	+		+	
Tricleocarpa	o	o		
oblongata			+	+
Vanvoorstia		*	o	o
spectabilis	+	o	o	o
Vidalia		o	o	o
fimbriata	+			
Weberella		o	o	o
micans	+			
Wrangelia			o	o
argus	+	+		
bicuspidata	+	-		
penicillata	+	-		
velutina	+	-		
Wurdemannia	o		o	o
miniata		+		
Zellera				o
tawallina	+	+	+	

APPENDIX B

Table 2. List of economically important seaweeds collected during this present study. (Sources : Abbott and Williamson (1974), Chapman and Chapman (1980), Abbott (1984), Trono and Ganzon-Fortes (1988)).

Taxa	Potential use(s)
CHLOROPHYTA	
Caulerpa	human food
C. lentillifera	human food ; mineral content : Ca, K, Mg, Na, Cu, Fe, Zn
C. racemosa	human food; with vitamins : folic and folinic acids
C. serrulata	human food
Codium	human food; medicine : antibacterial and antitumor
C. edule	human food
Dictyosphaeria cavernosa	medicine : antimicrobial
Halimeda	medicine : antibacterial
H. macroloba	with growth regulators: auxin, cytokinin, gibberellin
H. tuna	animal feed
PHAEOPHYTA	
Dictyota	medicine : antibacterial; source of alginic acid; with proteins and minerals: Ca, K, Mg, Na, Cu, Fe, Zn
Padina	source of alginic acid; fertilizer
P. australis	human food; source of alginic acid

Table 2 (*Cont'd.*). List of economically important seaweeds collected during this present study. (Sources : Abbott and Williamson (1974), Chapman and Chapman (1980), Abbott (1984), Trono and Ganzon-Fortes (1988)).

Taxa	Potential use(s)
P. japonica	source of alginic acid
Sargassum	human food; animal feed; fertilizer; with iodine, vitamin C, protein, minerals: Ca, K, Mg, Na, Fe, Cu, Zn, S, P, Mn; medicine: for goiter and other glandular troubles, antibacterial and anti tumor; source of algin, tannins and phenols
Turbinaria	human food; fertilizer; source of algin, tannins and phenols; insect repellant
T. conoides	human food; source of alginic acid; with minerals : Ca, K, Mg, Na, Cu, Fe, Zn
T. ornata	human food; source of alginic acid
RHODOPHYTA	
Acanthophora spicifera	human food; source of carrageenan and agar
Amansia glomerata	medicine : antibiotic
Betaphycus gelatinum	human food; source of carrageenan and agar
Gelidiella acerosa	human food; source of agar

Table 2 (*Cont'd.*). List of economically important seaweeds collected during this present study. (Sources : Abbott and Williamson (1974), Chapman and Chapman (1980), Abbott (1984), Trono and Ganzon-Fortes (1988)).

Taxa	Potential use(s)
Gracilaria	human food; source of agar; medicine: treatment of stomach disorders; as laxative; with vitamin B_1; fertilizer
G. arcuata	human food; animal feed; for wastewater
G. coronopifolia	human food; source of agar, with minerals: Ca, K, Mg, Na, Cu, Fe, Zn; with fats, proteins and vitamin C
G. salicornia	human food; source of agar
Halymenia durvillaei	human food; source of carrageennan
Hypnea	human food; source of agar fertilizer; animal feed; medicine: anti tumor; with protein
Kappaphycus alvarezii	human food; source of carrageenan; with minerals: Ca, K, Mg, Na, Cu, Fe, Mn; controls heavy metal (Pb, Cd) pollution
Laurencia	human food; source of agar; with carbohydrates; medicine: antifungal and antibacterial
L. flexilis	source of agar
L. obtusa	human food; source of amino acids; medicine: antibacterial and antibiotic
L. papillosa	human food; source of agar and carrageenan; medicine: antibacterial

Table 2 (*Cont'd.*). List of economically important seaweeds collected during this present study. (Sources : Abbott and Williamson (1974), Chapman and Chapman (1980), Abbott (1984), Trono and Ganzon-Fortes (1988)).

Taxa	Potential use(s)
Rhodymenia	human food; animal feed; with vitamin B_1
Tricleocarpa oblongata	source of sulfated polysaccharides related to carrageenans

APPENDIX C

Plate 1. Habit of species of *Caulerpa lentillifera* (a), *Caulerpa racemosa* ecad *macrodisca* (b), *Caulerpa racemosa* ecad *racemosa* (c), *Caulerpa serrulata* (d, e), *Codium arabicum* (f), *Avrainvillea obscura* (g), and *Halimeda copiosa* (h). (Scale bar = 1 cm).

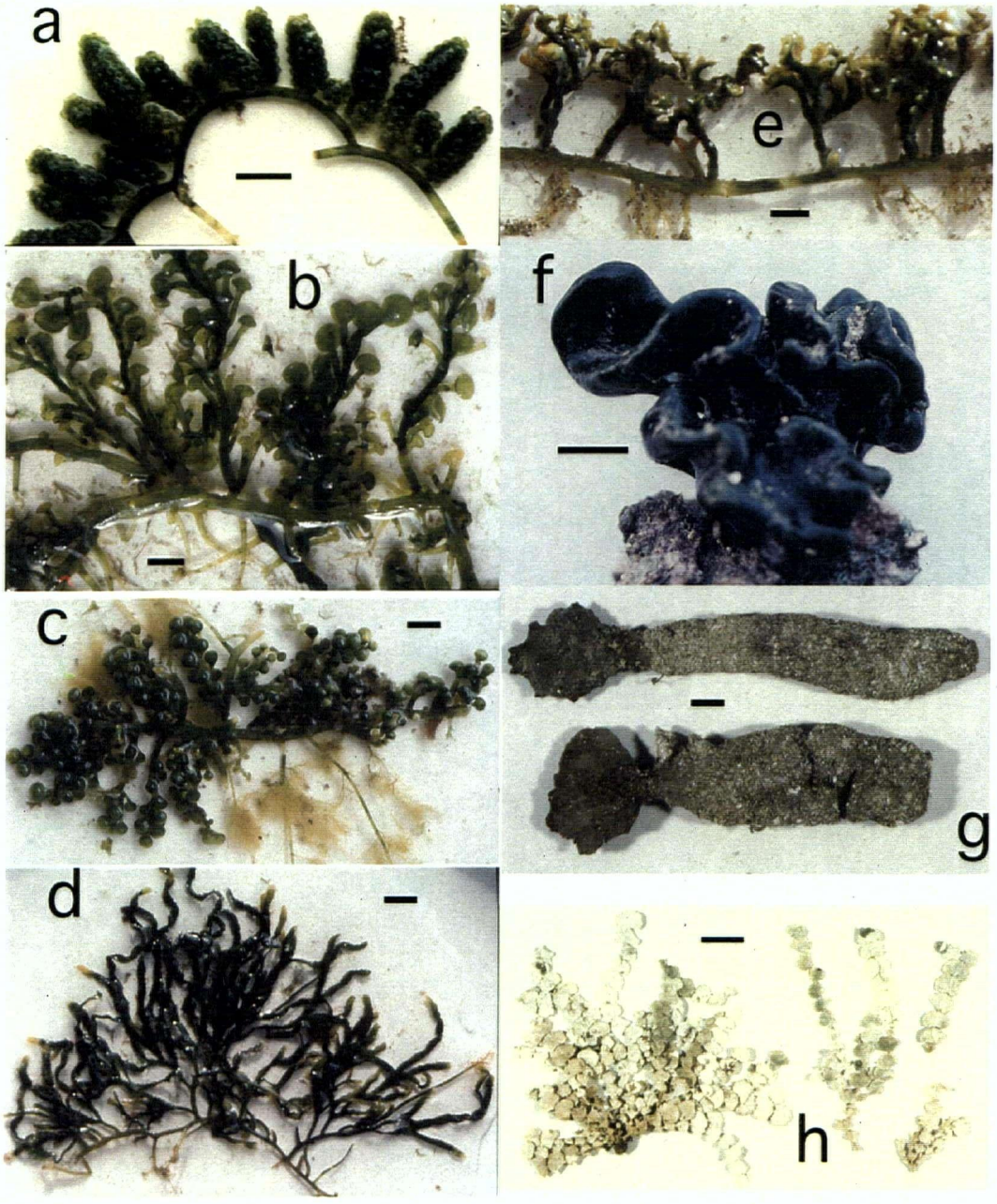


Plate 1

Plate 2. Habit of species of *Halimeda discoidea* (a), *Halimeda macroloba* (b), *Halimeda micronesica* (c), *Halimeda melanesica* (d), *Halimeda macrophysa* (e), *Halimeda opuntia* (f), *Halimeda tuna* (g), and *Tydemania expeditionis* (h). (Scale bar = 1 cm).

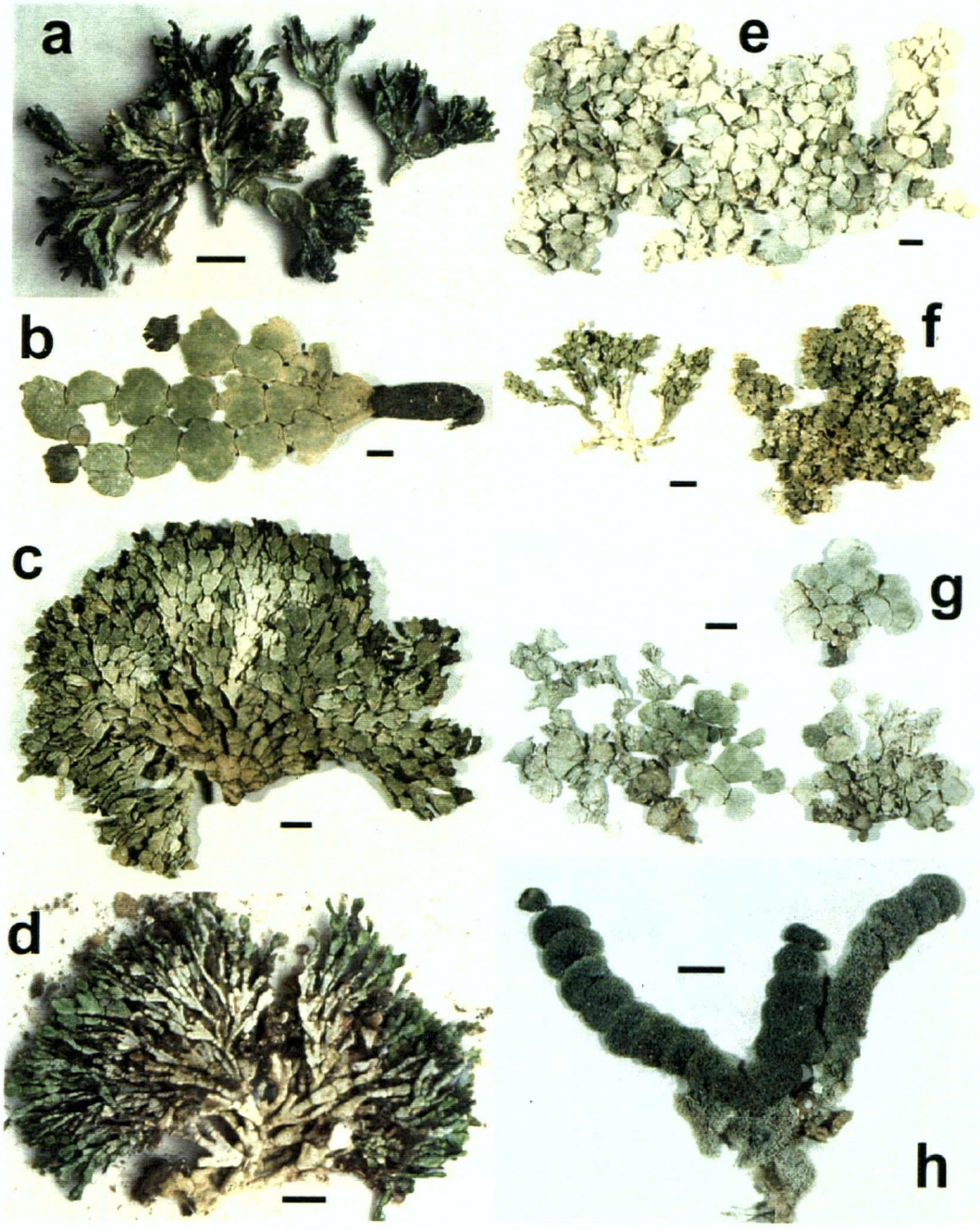


Plate 2

Plate 3. Habit of species of *Udotea argentea* (a), *Boergesenia forbesii* (b), *Valonia aegagropila* (c), *Ventricaria ventricosa* (d), *Dictyosphaeria cavernosa* (e), *Dictyosphaeria versluysii* (f), *Bornetella nitida* (g), and *Bornetella sphaerica* (h). (Scale bar = 1 cm).

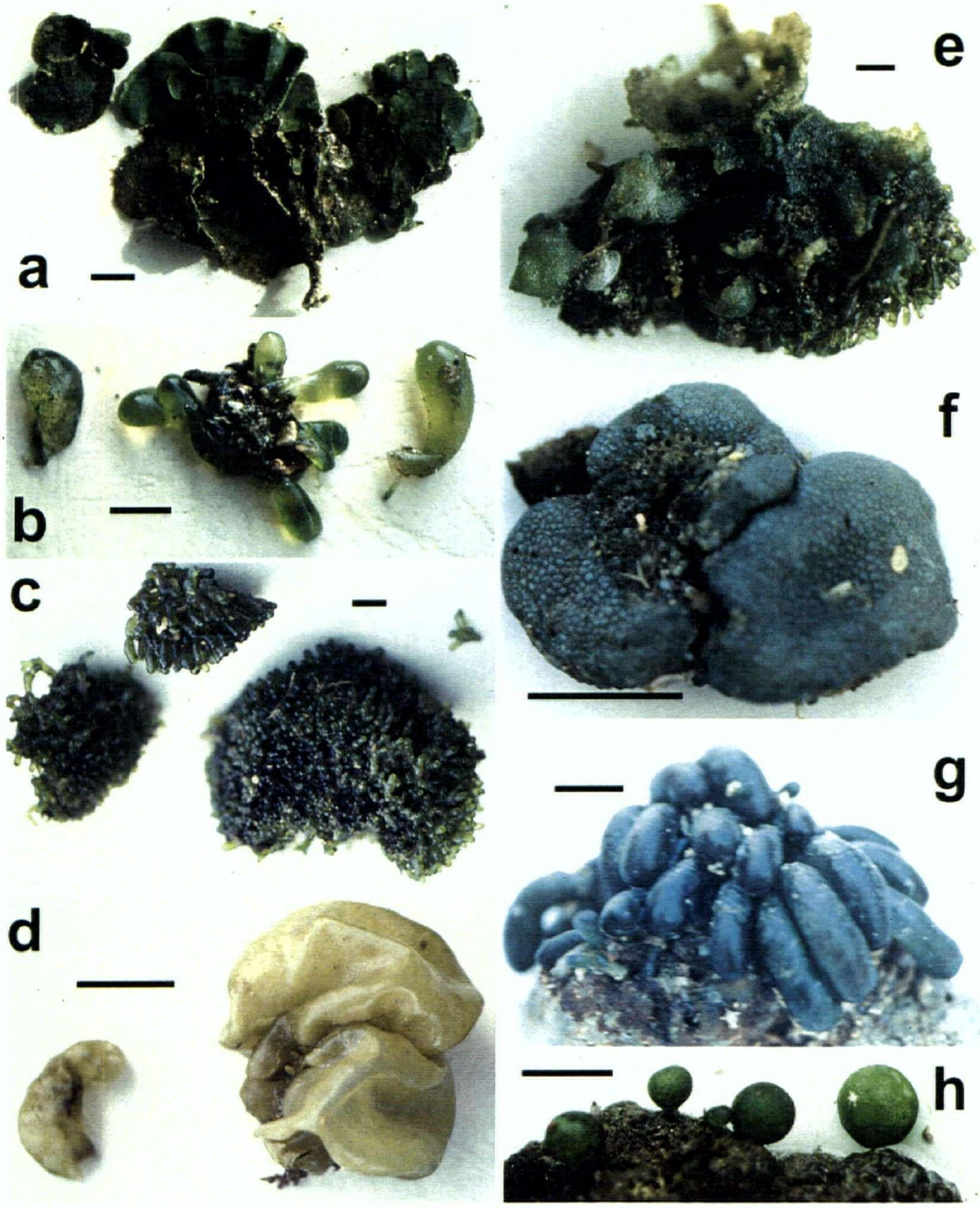


Plate 3

Plate 4. Habit of species of *Neomeris annulata* (a), *Dictyota bartayresiana* (b), *Dictyota ciliolata* (c), *Lobophora variegata* (d), *Padina tenuis* (e), and *Padina australis* (f). (Scale bar = 1 cm).

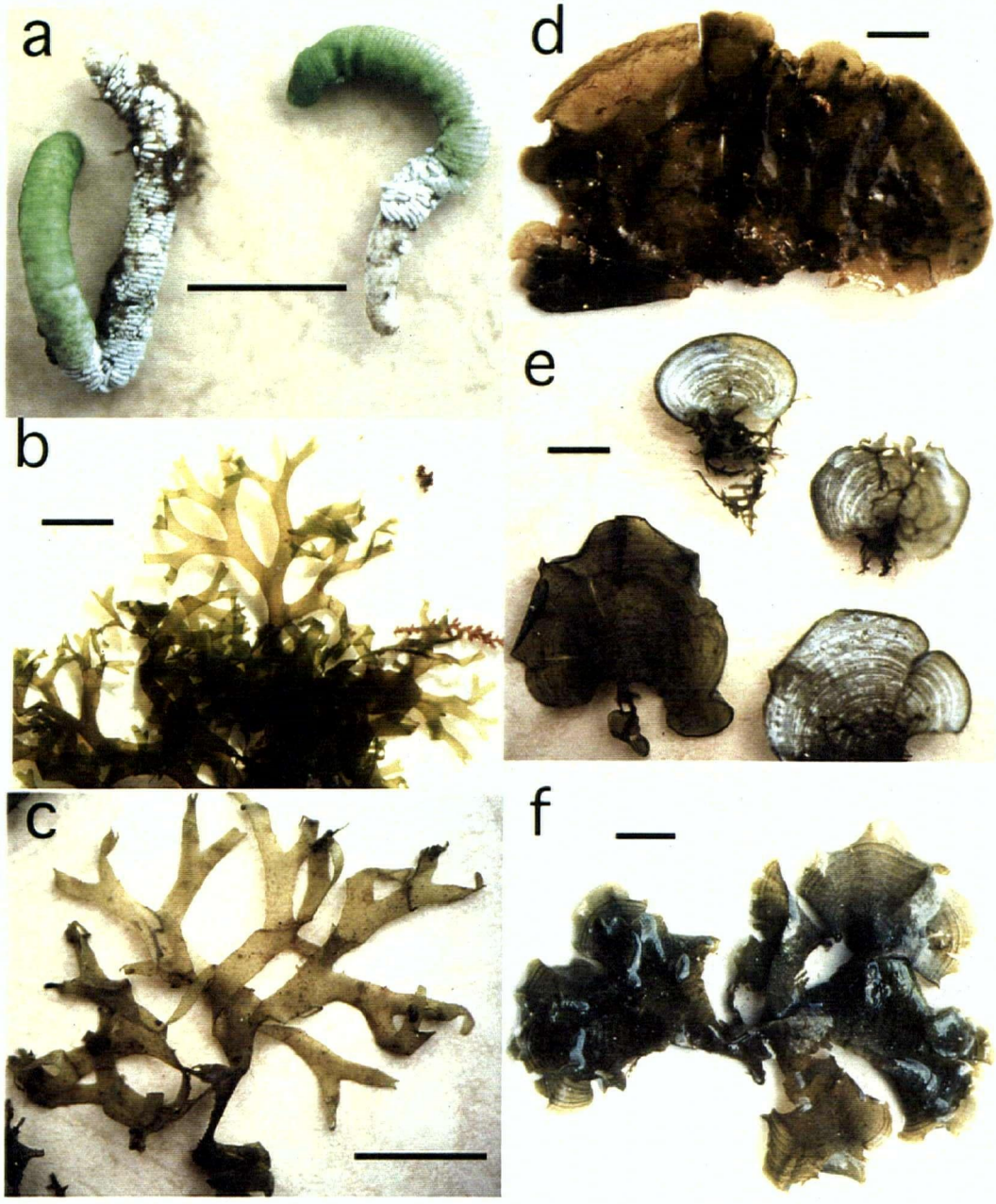
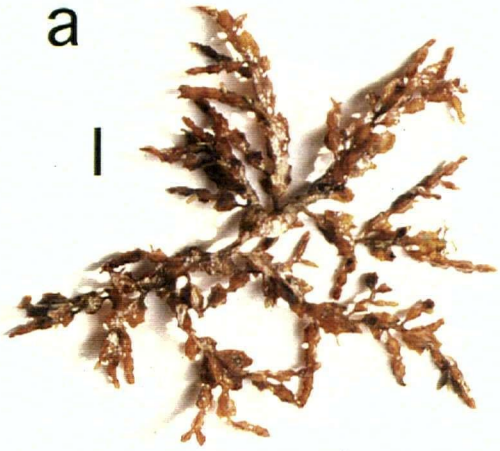


Plate 4

Plate 5. Habit of species of *Hormophysa cuneiformis* (a),*Sargassum turbinarioides* (b), *Turbinaria ornata* (c), and *Turbinaria decurrens* (d). (Scale bar = 1 cm).



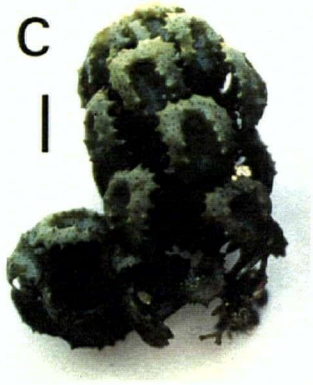


Plate 5

Plate 6. Habit of species of *Acanthophora spicifera* (a), *Amansia glomerata* (b), *Laurencia cartilaginea* (c), *Laurencia papillosa* (d), *Gelidiella acerosa* (e), and *Gracilaria arcuata* (f). (Scale bar = 1 cm).

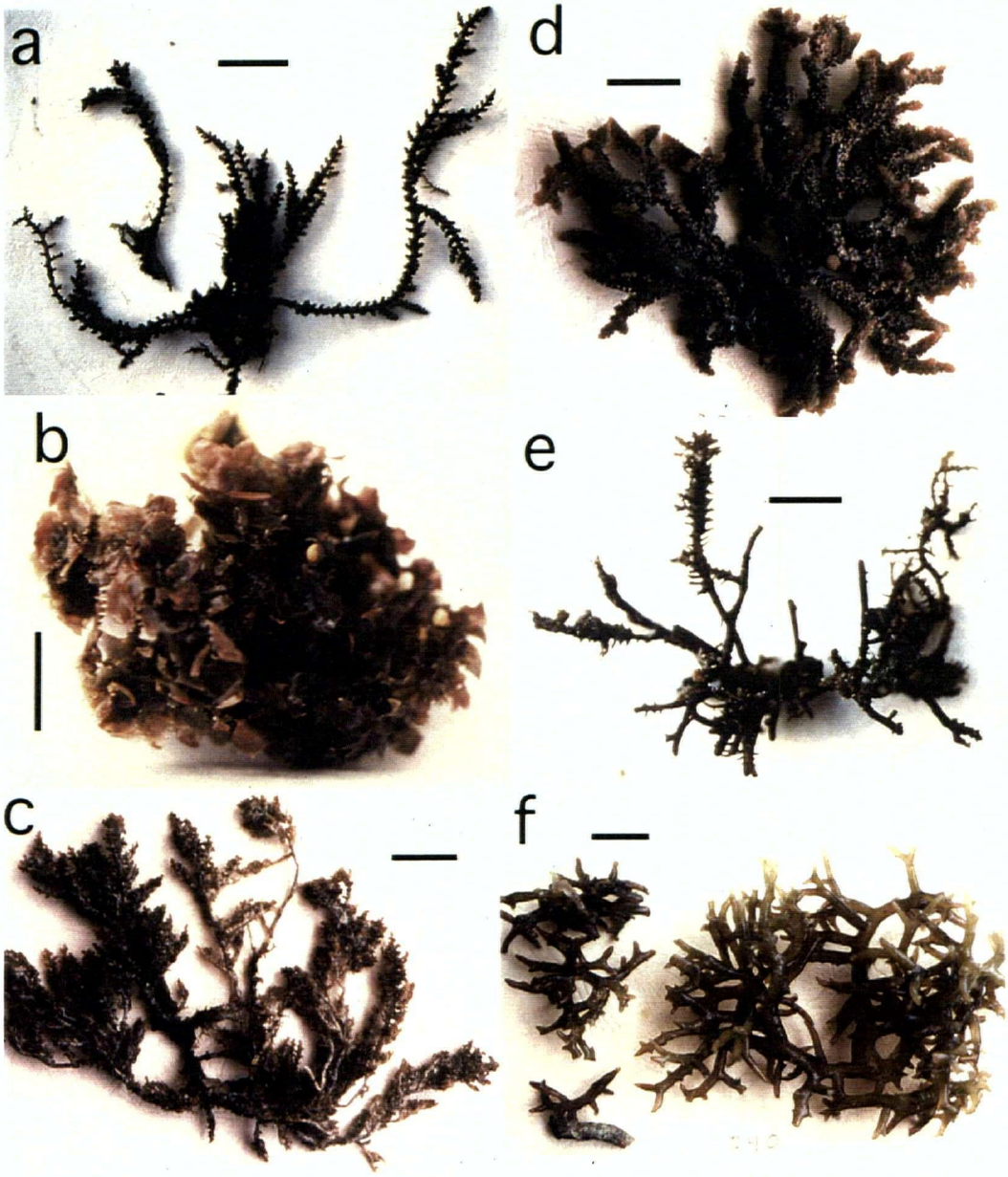


Plate 6

Plate 7. Habit of species of *Gracilaria coronopifolia* (a), *Gracilaria salicornia* (b), *Titanophora weberae* - fresh (c) and dried (d), *Hypnea pannosa* (e), and *Halymenia durvillaei* (f). (Scale bar = 1 cm).

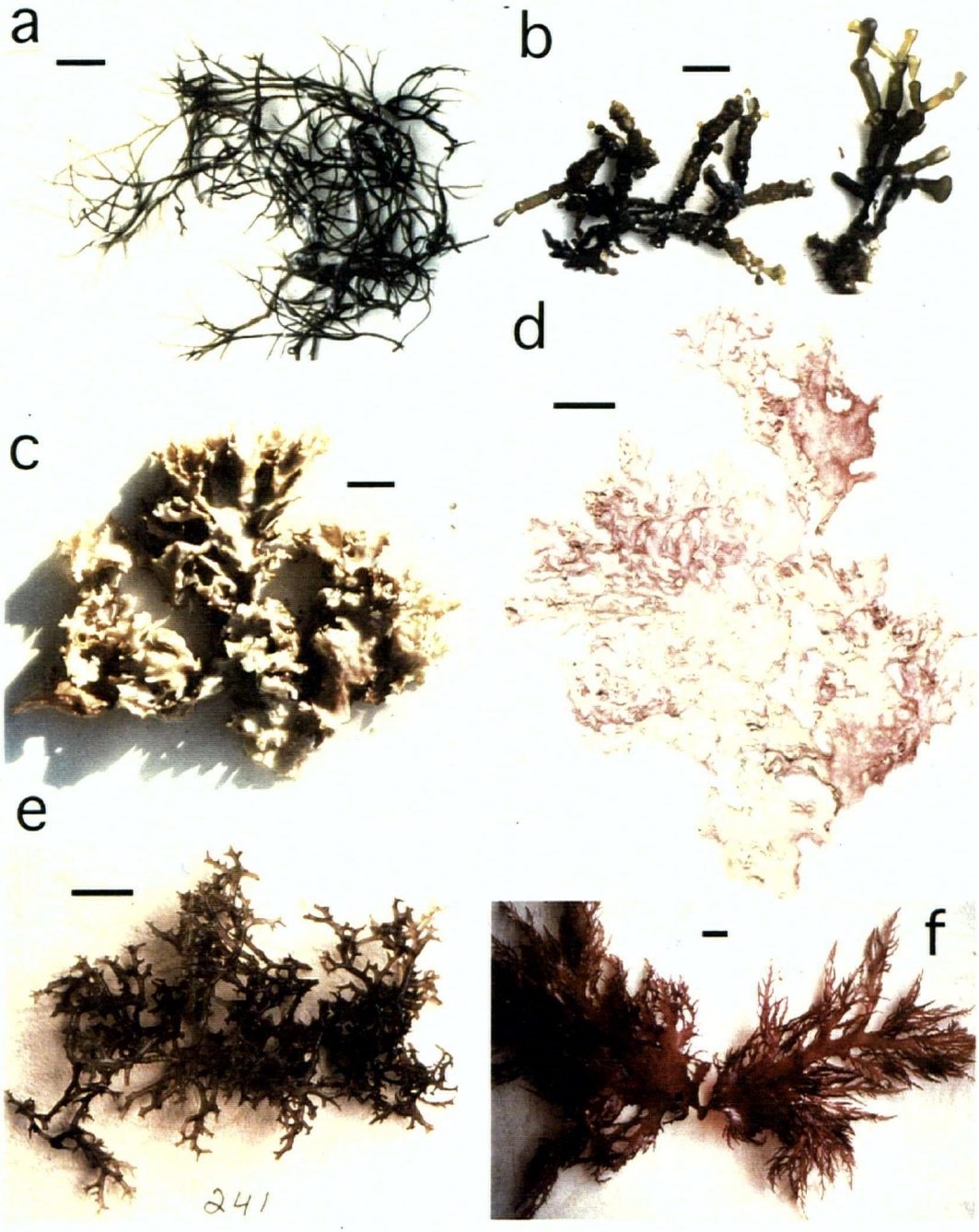


Plate 7

Plate 8. Habit of species of *Hypnea spinella* (a), *Kappaphycus alvarezii* (b), *Peyssonnelia* sp (c), *Portiera hornemannii* (d), and *Actinotrichia fragilis* (e). (Scale bar = 1 cm).

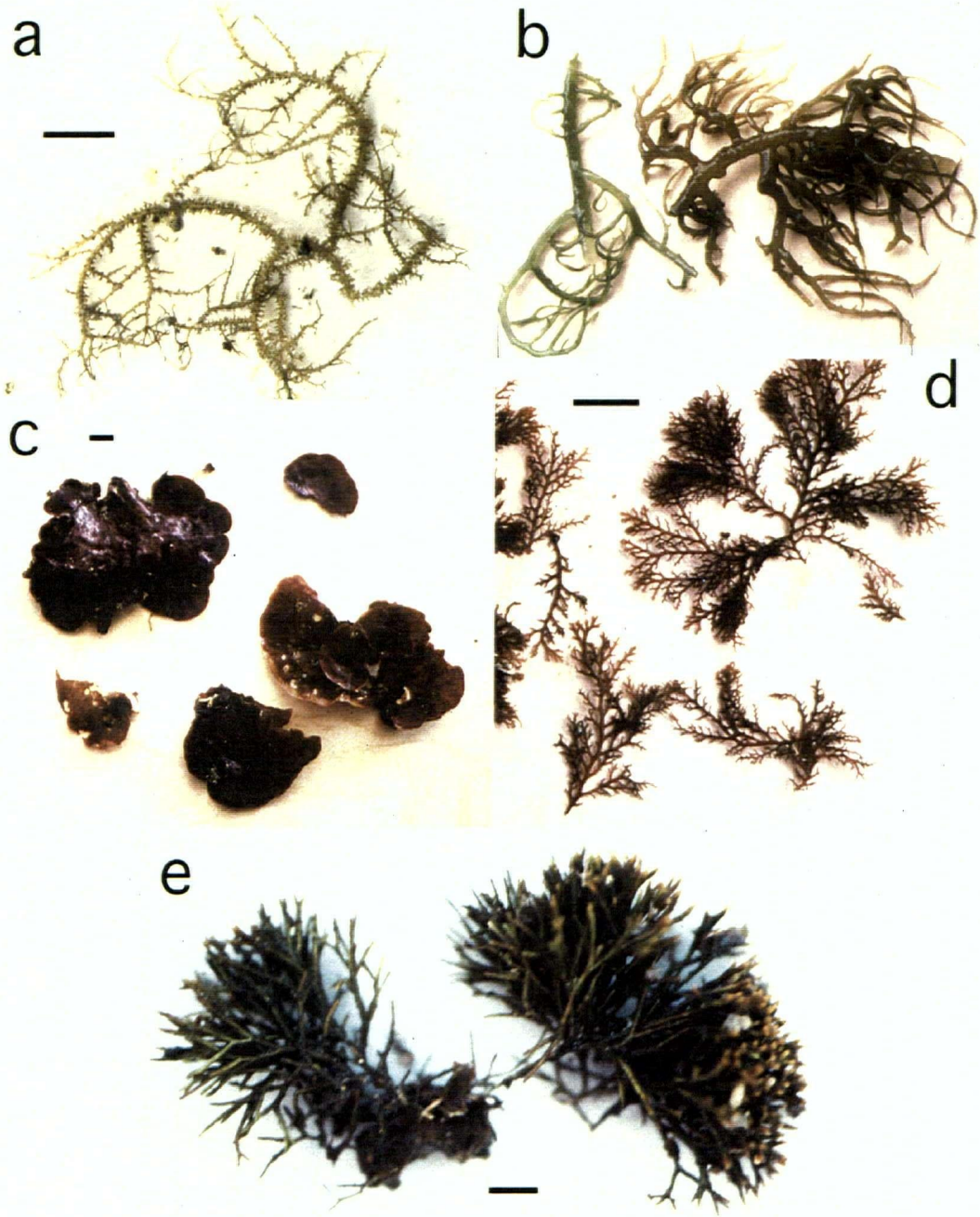


Plate 8

Plate 9. Habit of species of *Galaxaura marginata* (a), *Galaxaura obtusata* (b), *Tricleocarpa oblongata* (c), *Rhodymenia intricata* (d), and *Tolypiocladia* sp (e). (Scale bar = 1 cm).

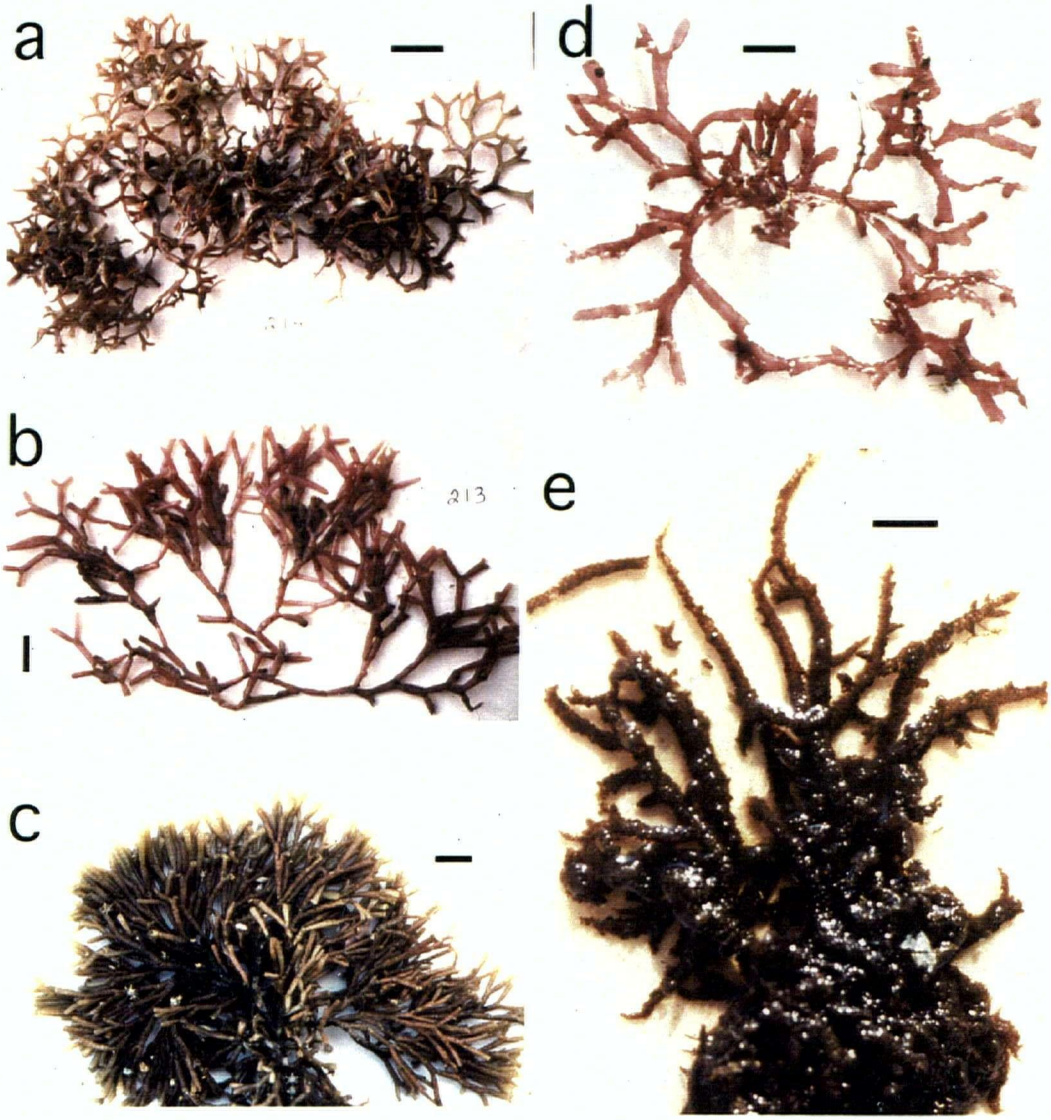


Plate 9

GLOSSARY OF TECHNICAL TERMS

acuminate : tapering to a point
acute : sharp at the end; ending in a point
amorphous : having no specific shape or form
anastomosing : joining together irregularly to form a network
annulate : marked with rings; surrounded by rings or bands
aplanosporangia : sporangia producing non-motile spores
arcuate : bent or curved like a bow
assimilatory filaments : pigmented or photosynthetic filaments
attenuate : narrow and gradually tapering
axil : angle formed by the main axis and a lateral branch; angle formed by a branch and lateral branchlet
bifurcate : to divide or fork into two branches
bulbous : bulb-like; with a distinct swollen end
capitate : having a globular or spherical head
cervicorn : resembling a deer's horn
clavate : club-shaped
cordate : heart-shaped
corona : a whorl of appendages or cells surmounting a structure
cortex : the peripheral tissue lying outside the medulla
corymbose : resembling a flower cluster that has a flat-topped or convex structure
crenate : scalloped, crinkled
cryptostomata : minute cavity in the outer of Fucales bearing sterile hairs
cuneate : wedge-shaped, broad above, tapering by nearly straight lines to the base
dentate : toothed, with the teeth sharp and pointed outward
determinate branchlets : branchlets that have limited growth
dichotomous : divided into two equal portions
discoid : having a form of a disc
dissepiment : a partition
distal : toward the farthest point; free end; opposite of basal or proximal

distromatic : composed of two layers of cells
divaricate : branching at wide angles
dorsiventral : with distinct front (ventral) and back (dorsal) sides; these are often concave or flat and convex
edentate : not dentate
entire : having the margin continuous and not broken by division, teeth, or serration
erose : an apparently gnawed margin; having the margin irregularly toothed, as if bitten by some animal
filiform : thread-like
flabellate : fan-shaped; broad and round at the top, narrowed below like a bow
flexuous : winding; bent alternately in opposite directions, zig-zag
foliaceous : leaf-like
frond : blade or leaf-like structure of an alga
gametangia : reproductive structures producing gametes
glabrous zone : smooth zone; the surface devoid of hairs
glomeruliferous : resembling a head-like cluster of flowers
habit : the morphological form of a plant
holdfast : root-like or disc-like structure that attaches an alga to the substrate
indusium : a cover to sporangia
internode : the part of an axis or branch between two nodes
lanceolate : narrow and tapering toward the apex or each end
lateral : pertaining to the side
lenticular (thickening) : shaped like a thick convex lens
medulla : the tissue lying in the center of a thallus
moniliform : consisting of a series of bead-like swelling alternating with contractions
monostromatic : composed of one layer of cells
mucron : a small, sharp point
mucronate : abruptly tipped by a small, sharp point
node : a joint
obpyramidal : inversely pyramidal
obtuse : slightly rounded at the end
ovate : more or less twice as long as broad, widest below the

middle and more or less narrowed upward

palisade : a row of elongated cells at right angles to the surface and united laterally into a compact tissue

palmate : flattened and lobed or divided like the palm of a hand

paniculate : arranged in a loosely branching flower cluster

pectinate : branches or branchlets set close together like the teeth of a comb

pedicel : the ultimate stalk

peltate : a flattened, parasol-shaped disc with a central stalk

pinnate : having branches on opposite sides of the main axis; in a feather-like arrangement

pit connections : tubular pores connecting adjacent cells in the Rhodophyta

polysiphonous : having several coherent longitudinal rows of cells surrounding a central axis

prostrate : lying flat on the substrate

proximal : toward the point of attachment or lower part; opposite of distal

pulvinate : hemispherical or chusion shaped

racemose : having the form of a raceme; the structures are stalked and attached to a common axis

rachis : the axis of a compound leaf or frond

ramuli : determinate branchlets

receptacle : a specialized structure bearing reproductive organs; in Fucales the receptacles are swollen regions containing the conceptacles

reniform : kidney-shaped; broader than long and with a sinus at the base

serrate : having sharp small teeth that are projected forward

sessile : not stalked; attached directly to the substrate

spherical : globe- or ball-shaped; round

spinulose : having spines

sporangia : structures producing spores

stellate : star-shaped; having numerous projections from a central region

stipitate : having a stipe

stolon : a prostrate axis, lying on or in the substrate, from which erect branches arise

terete : with a circular transverse section

tetrasporangia : structures containing four tetraspores

thallus : a plant body undifferentiated into true leaves, stems and roots

tortuous : full of twists; turns or bends; twisting, winding or crooked

trabeculae : slender strands or bars

trapezoidal : with an unsymmetrical four-sided shaped

trichotomous : divided into three equal parts

trilobed : having a three lobe-shaped

triquetrous : having a triangular cross section; three-sided

truncate : cut off abruptly; blunt; flat-topped

turbinate : inversely conical; bell-shaped

ultimate : the final order

upright : the blade or branch of an alga that stands at a right angle to the substrate

urn-shaped : egg-shaped with a narrow, protruding orifice

utricle : a bladder-like siphon swelling usually in the outer layer of a thallus

verrucose : covered with wart-like protuberances; warty

verticillate : having branchlets arising from one level on the axis

verticil : a whorl of branches or branchlets

vesicle : a small sac-like structure

vesiculate : vesicle-like

whorl : a group of branches radially distributed about and attached at the same level of an axis

zonate : banding of the thallus

Alphabetic Species Index