BENTHIC ALGAL AND SEAGRASS COMMUNITIES IN BAA ATOLL, MALDIVES

BY

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ABSTRACT

The present survey was undertaken to provide the first census of the marine flora (macroalgae and seagrasses) of Baa Atoll, one of the 26 Maldivian atolls, and to serve along with the macro-fauna biodiversity inventories for conservation purposes. Species collection and inventories have been conducted at 27 sites covering the widest selection of habitats recognized based on satellite images including islands shorelines, reef flats, faros, patch reefs, passes as well as shallow and deep outer reef slopes. A total of 405 specimens were collected and 176 species representing 10 Phaeophyceae, 58 Chlorophyta, 108 Rhodophyta and two seagrasses were identified. The lagoon patch reefs and the oceanic reef slopes were the most diverse geomorphological habitat types and displayed the highest species richness with 38 spp. All lagoon sites shown a similar richness compared to each other with an average species number of 26 spp, while the deep lagoon floor and the seagrass beds in oceanic-exposed reef flats were the less species-rich habitats. The most common species, occurring at all visited sites, were *Tydemania expeditionis* and *Halimeda minima* and the most species rich genera appeared to be *Halimeda* and *Caulerpa*. No community structure nor strongly supported species assemblages associated to geomorphological habitat types was found.

Previous lists available for other Maldivian atolls listed 208 algal species. Sixty of these records were found in Baa Atoll while 113 of the species recorded in the present study represent new records for the Maldives bringing the total number of algal species to 321. The resulting species list shows that the Maldivian algal flora is typically tropical and most of the species belong to the Indo-Pacific biogeographic province. In this paper, we give a general description of the representative macrophyte communities of Baa Atoll in relation to the geomorphology of reefs.

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INTRODUCTION

Very limited information is available on Maldives archipelago marine flora despite a large number of oceanographic expeditions carried out in the region. Most of the records are based on sporadic studies. The first phycological taxonomic records were published from the limited biological material collected during the expeditions of J.S. Gardiner in the early 1900s (Gardiner, 1903) and studied by Barton (1903), Foslie (1903, 1907), and Weber and Foslie (1904). The Sealark Expedition in 1905 resulted in Gepp and Gepp's (1904) and Weber-van Bosse's (1914) records of some Chlorophyta ("green algae") and Rhodophyta ("red algae"). Newton (1953) published only one seaweed record from the J. Murray expedition 1933-1934. At this time the knowledge of the Maldivian algal flora was restricted to 24 species including 17 Rhodophyta, five Chlorophyta and two Pheaophyceae ("brown algae"). During the expedition led by D.R. Stoddart from Cambridge in 1964, Sigee (1966) sampled land and marine vegetation at Addu Atoll. The preliminary results of the Addu Atoll expedition were published in *Atoll Research Bulletin* by Stoddart (1966). The Sigee collection was studied by Tsuda and Newhouse (1966) who published a taxonomic list, adding significantly to the total species number of macroalgae with 37 Rhodophyta, 30 Chlorophyta , nine Phaeophyceae and seven cyanobacteria ("bluegreen algae"). Extensive collections of benthic macroalgae were made at nine Maldivian atolls during Cruise B and Cruise 5 of the R/V *Te Vega* Expeditions in 1964 by H.E. Hackett and M.J. Wynne respectively. Hackett (1969) studied his own collection for his PhD dissertation as well as material collected by C. Rhyne in 1967 at Addu Atoll during the U.S. Navy Biological Expedition to the Chagos Archipelago. Based on these collections additional records were published in Hollenberg's (1968a, b) monographs and Aregood and Hackett (1971) described a new species of Rhodophyta (*Dictyurus maldiviensis* Hackett & Aregood). Later, Hackett (1977) published the most comprehensive catalogue of the Maldivian marine algae with 248 records including 136 Rhodophyta, 74 Chlorophyta, 17 Phaeophyceae and 21 Cyanobacteria. A number of these records however were identified only at the genus level. A year later, Titlyanova and Butorin (1978) published a short list of macroalgae (18 taxa) from two atolls of the Maldives. Finally Wynne (1993) published a list of 50 species based on his own collections including the description of *Bangia halymeniae* Wynne from Malé Atoll.

In 2009, before the Baa expedition, the most updated compilation of the marine flora of the Maldives was available from "algaebase.com" and listed 120 Rhodophyta , 70 Chlorophyta, 18 Phaeophyceae and 21 Cyanobacteria records (Guiry and Guiry, 2011).

The present survey was undertaken to provide the first census of the marine flora of Baa Atoll and to serve along with the macro-fauna biodiversity inventories for conservation and identification of biodiversity hot-spots (Hamel and Andréfouët, this issue). We also provide here a general description of the representative macrophyte communities of Baa Atoll in association with the geomorphology of reefs.

SAMPLING SITES AND METHODS

Baa Atoll is situated in the Northern Indian Ocean at latitude 5°11'N and longitude 72°59'E. Baa is one of the 26 Maldivian atolls stretching in a north-south direction off India's Lakshadweep islands. It stands in the Laccadive Sea, about 700 km south-west of Sri Lanka and 400 km south-west of India. Baa Atoll is 42 km long and 32 km wide. The tropical climate is composed of two main seasons: the dry season associated with the winter north-eastern monsoon and the rainy season with strong winds and storms.

The present algal flora and seagrass investigation of Baa Atoll was achieved during May and June 2009 just after the moist south-west monsoon. Surveys were conducted at 27 sites (Fig. 1) covering the widest selection of habitats recognized based on satellite images including islands shorelines, reef flats, faros, patch reefs, passes as well as shallow and deep outer reef slopes. Most of the sites were prospected by SCUBA from 50 m to the surface. The shallow areas including fringing reef flats, patch reefs and shorelines were sampled by snorkelling or reef walk. The sampling effort was standardized and inventory duration at each site was set to 80 min.

All specimens collected were sorted, pressed and air-dried as herbarium vouchers. Photographs of collected specimens were taken *in-situ* and referenced according to herbarium accessions. Samples of selected specimens were pickled in a solution of buffered formalin in seawater (5%) for further anatomical studies. Samples from a selection of taxa were preserved in silicagel or ethanol for further DNA analyses. Since all herbarium specimens were air dried (no formalin), DNA extraction is feasible for further studies if necessary. DNA samples of Dictyotales (*Dictyota* J.V. Lamouroux and *Padina* Adanson) and *Halimeda* J.V. Lamouroux have already been processed and will be included in regional phylogenetic studies.

Overall, specimens were collected to represent a baseline taxonomical collection for the area and the species inventory was compiled in order to reach the more comprehensive species list for Baa Atoll. In agreement with the Maldive Research Center (MRC), the collection was deposited in the phycological herbarium of IRD (Institut de Recherche pour le Développement) in Nouméa (IRD-NOU), New Caledonia.

RESULTS

Representative Algal Communities and Associated Habitats

Seven class habitats have been defined based on geomorphology and most of them were prospected. All habitats could not be sampled with the same effort and some of them, such as seagrass beds or oceanic reef flats, were only visited once (Table 1).

During the present investigation 405 specimens were collected from 27 sites (Fig. 1). A total of 176 species were identified and represented 10 Phaeophyceae, 58 Chlorophyta, 108 Rhodophyta [NB: only the most common red corallines algae were considered] and 2 seagrasses. The taxonomic classification used during this work followed *The catalogue of the benthic marine algae of the Indian Ocean* by Silva and co-authors (1996). The species list is given in Appendix 1. Records belong to 17 orders, 35 families and 94 genera (Table 2).

Table 1. Sampling sites distribution in the seven habitat classes defined based on geomorphology.

Class Habitat	Oceanic reef flat (seagrass)	Lagoon reef flat and slope	Lagoon patch reef	Lagoon reef flat	Deep lagoon	Oceanic reef flat	Oceanic reef slope
number of sites	(1)	(10)	(5)	(3)	(1)	(2)	(5)
Site label	2	1, 5, 6, 8, 12, 13, 21, 22, 24, 28	10, 11, 17, 19, 25	3, 16, 20	23	15, 9	4, 7, 14, 18, 27

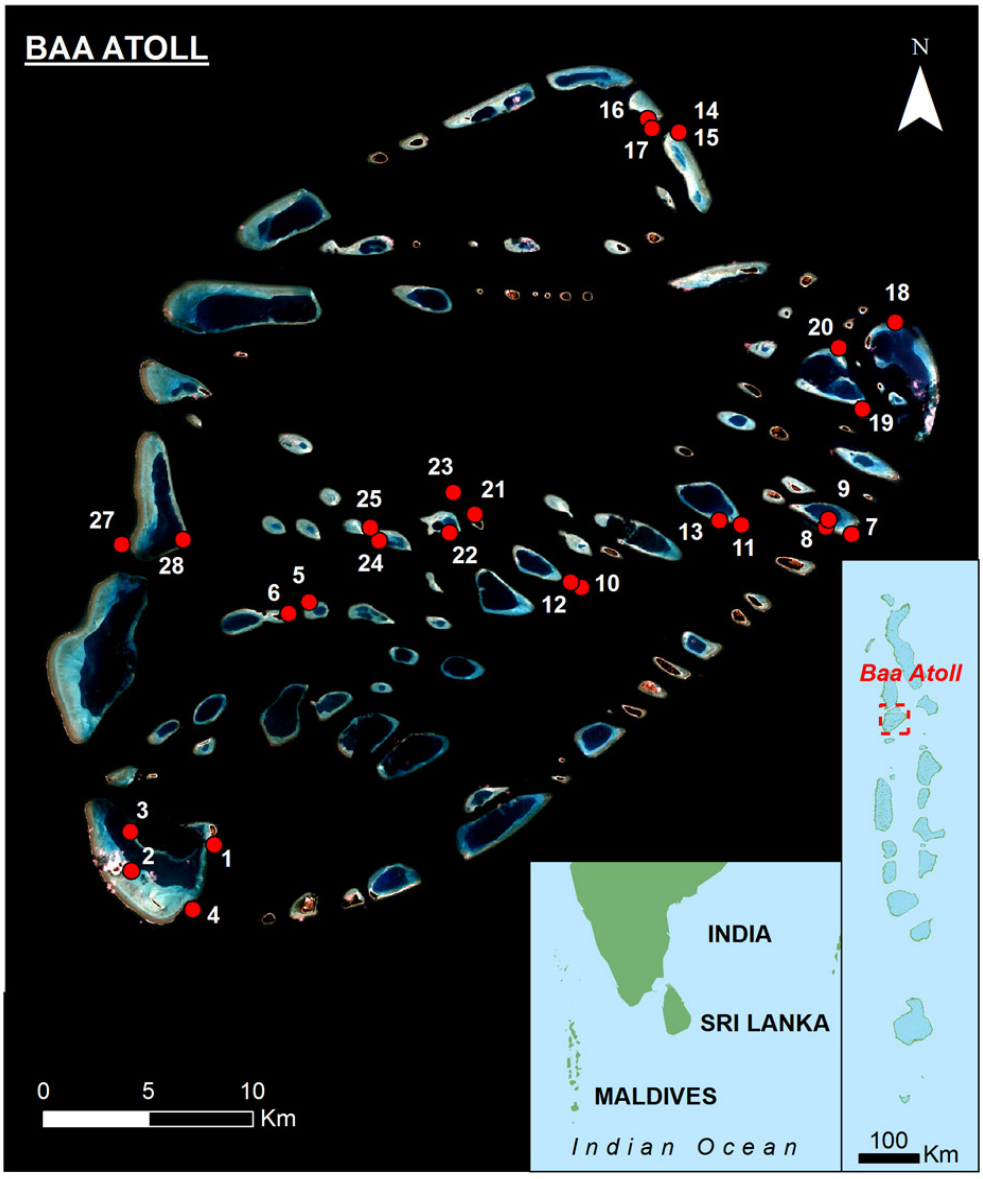

Figure 1. Location of the sampling sites in Baa Atoll.

Table 2. Number of Orders, Families, Genera and Species of macrophytes identified from Baa Atoll

		Orders	Families	Genera	Species
Macroalgae	Rhodophyta	10	22	64	108
	Chlorophyta	5	11	25	58
	Phaeophyceae	2	2	5	10
	TOTAL	17	35	94	176
Seagrasses	Magnoliophyta	1	2	2	2

Most of the specimens have been identified to species level (85 % of the collection), but some of the specimens (15 % of the collection) remain unidentified for lack of reproductive parts or poor sampling. In addition the two seagrasses *Syringodium isoetifolium* (Ascherson) Dandy and *Thalassia hemprechii* (Ehrenberg) Ascherson have been observed forming beds in only a single location (Baa2, Fig.1).

The most species rich genera appeared to be the green algae *Halimeda* and *Caulerpa* J.V. Lamouroux, however surprisingly, no bulbose *Halimeda* spp. were recorded during this survey nor the large Fucales such as *Sargassum* C. Agardh. All the species sampled during the expedition were associated to hard substratum except one: *Boodleopsis pusilla* (F.S. Collins) W.R. Taylor, A.B. Joly & Bernatowicz which occurred on faros' sandy bottoms. (Appendix 2).

Species Richness Distribution in Baa Atoll.

Species richness per site. Species richness per site (Fig. 2) ranged from two at Baa 23 (deep lagoon) to 38 species at Baa 11 (lagoon patch reef) and Baa 7 (oceanic reef slope) (Fig. 1). These two sites, coral built and exposed to strong water movements, were the most diverse and displayed the highest species richness with 38 spp.

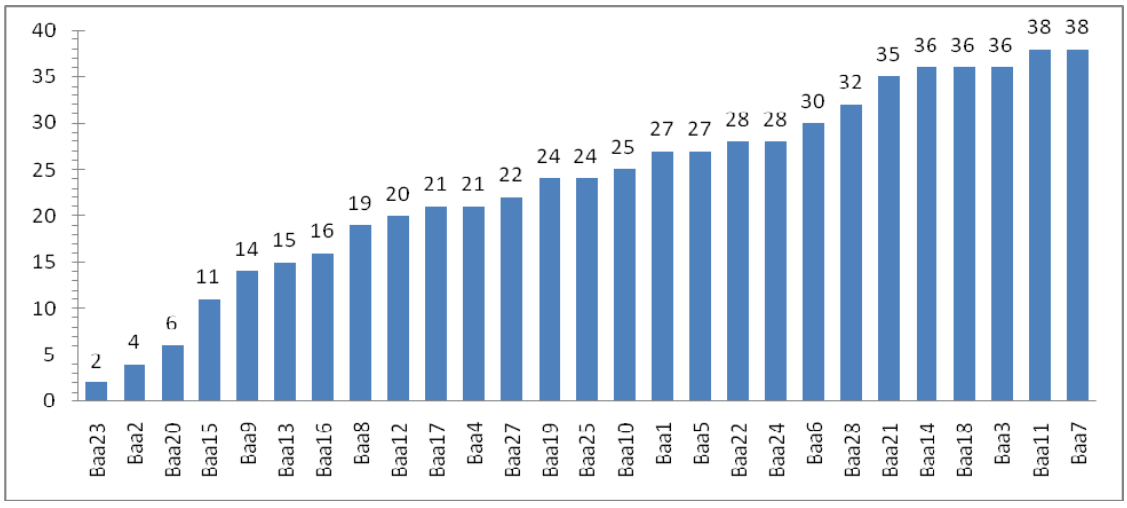

Figure 2. Distribution of species richness per sites.

Because only two species have been collected from the sandy bottom of the deepest lagoon site (Baa 23, 50 m deep) and that Baa 20 (lagoon reef flat) was not properly prospected (no SCUBA on the deeper part), we believe that the data are not reliable enough to report on the species richness of corresponding habitats. The seagrass bed (Baa 2) housed few algal species (four spp, including two coralline rhodoliths). The sandy habitats (Baa 9, 13, 16) and the reef flats (Baa 8, 12, 15) with lower biotope diversity or exposed to very strong current (Baa 17, 19) showed moderate species richness (from 11to 24 spp). For all the other sites algal richness varied between 25 and 35 species (Fig. 3).

Figure 3.Spatial distribution of the species richness in Baa Atoll.

Species richness per geographic areas. The main features of Maldivian reef complex can be classified into two major classes: (i) the first class includes the atoll rim made of faros with enclosed lagoons delimited by large seaward reef flats, deep outer reef slopes, forereefs, inner slopes and channels/passes; (ii) the second class includes the lagoon structures with mostly faros and enclosed lagoons, reef flats, reef patches, pinnacles and deep lagoon sections.

No contrasting spatial variation could be observed between the different sections of the atoll rim (Table 3). The sampling effort in each geographic area was not strictly similar and could partially affect the resulting values. The average species richness did not contrast strongly from North (21 spp.) to South (28 spp.) and from East (26.2 spp.) to West (27 spp.). Nevertheless, the lowest species richness was observed in the northern rim section. No contrasting difference could be found between the average species richness of the global atoll rim (25.2 spp.) and the lagoonal faros (24.7 spp.).

Table 3. Species richness per geographic area (sites 2 and 20 were excluded because not properly prospected)

Geographic Area	Northern Rim	Southern Rim	Eastern Rim	Western Rim	Atoll Rim	Atoll Lagoon
Number of sites	(4)	(3)	(5)	(2)	(14)	(8)
Site label (BaaX)	14, 15, 16, 17	1, 3, 4	7, 8, 9, 18, 19	27, 28	1, 3, 4, 7,8, 9, 14, 15, 16, 17, 18, 19, 27, 28	5, 6,10, 11,12,13, 21, 22, 23, 24, 25
Average species	21	28	26.2	27	25.2	24.7

Species richness per geomorphological habitat type. Average species richness varied within each geomorphological habitat type (Fig. 4). Figure 4 shows that the deep lagoon and the seagrass beds in oceanic reef flats were the least species rich habitats, while these sites were also the least sampled (*n*=1 site for each of them). All lagoon sites showed a similar richness compared to each other with an average species number of 26 spp. but different sampling efforts (*n= 3* sites for the 'lagoon reef flat', *n=10* sites for the 'lagoon reef flat and slope' and *n= 5* sites for the 'lagoon patch reef'). The oceanic slope showed an average of 30 spp. for the 5 sites.

The spatial distribution of the species varied with bathymetry and some species were observed at a wide range of depths. This is true for instance for the green algae *Caulerpa diligulata*, *Halimeda discoidea*, *Rhipidosiphon javensis, Tydemania expeditionis* and the red *Botryocladia* which were found from 5 m down to 40 m, independently of geographical location. Other species were found to be restricted to deep zones, such as: *Padina okinawensis*, *Cladophora feredayoides*, *Microdictyon okamurae, Caulerpa sedoides,* or cryptic and only in shaded areas such as *Cryptonemia umbraticola* or *Corynocystis prostrata*. Many other species were restricted to shallow waters such as *Valonia aegagropila*, *Dictyurus purpurascens*, *Halymenia actinophysa*, *Hypnea* spp. and *Turbinaria ornata.*

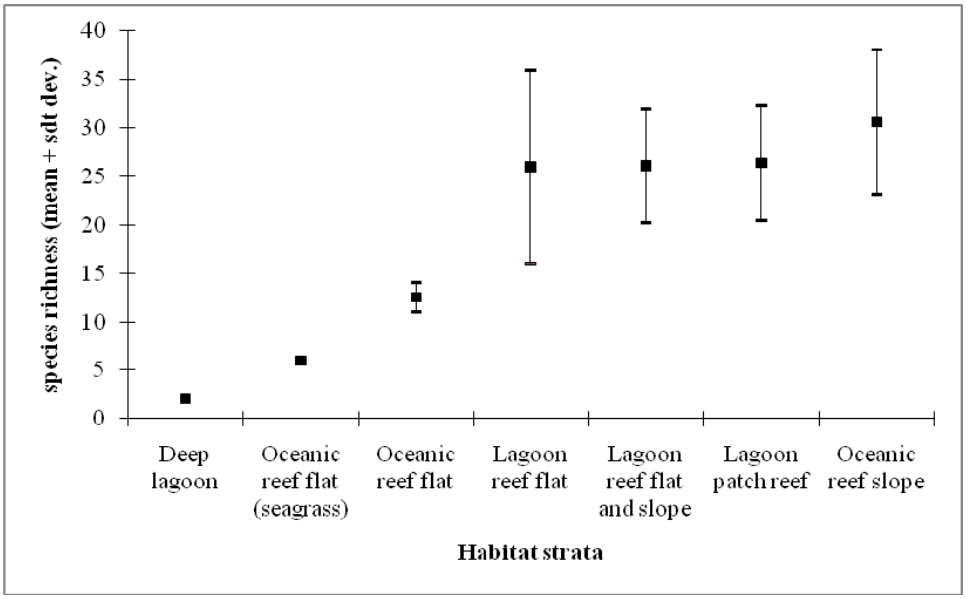

Figure 4. Variation of species richness per habitat type.

Species rarity. Patterns of the algal vegetation in the Baa Atoll were characterized by the dominance of species with very low occurrences at all the prospected sites (Fig. 5). Half of the species (*n*=87) were found in less than 8 % (2/27) of the sites thus revealing a high beta-diversity. No species were present at each of the 27 sites. The most frequent species were the Chlorophyta *Tydemania expeditionis* Weber-van Bosse occurring in 20/27 sites and *Halimeda minima* (W.R.Taylor) Hillis-Colinvaux) present in 19/27 sites. Ninety percent of the species occurred in only 13 sites which represents less than half of the prospected sites. Less than 10% of the species were represented by a single specimen.

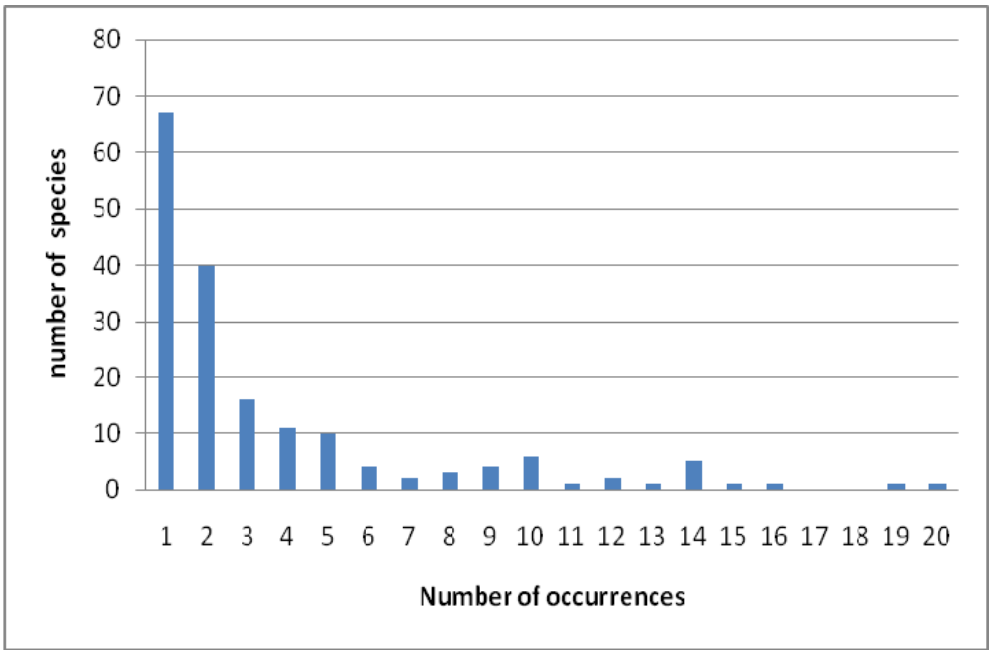

Figure 5. Histogram of species occurrences at the 27 sites.

Main Algal Assemblages.

The most common species are illustrated in Appendix 3.

Algal vegetation on lagoon reef flats and slopes. The algal communities of the Lagoon reef flats and slopes account for a large number of encrusting coralline algae. They are mostly represented either by *Hydrolithon onkodes* which develops thick crusts and a candle-like *Hydrolithon* sp., or branched clumps of *Lithophyllum kotschyanum* mixed with several fleshy species growing in coral crevices. On the reef flats, many species (mostly red algae) grow under the branches of corals. They include the large spreading mats of *Dictyurus purpurascens*, *Hypnea pannosa* and *Hypnea spinella*, isolated clumps of *Galaxaura filamentosa*, *Actinotrichia fragilis*, or the delicate and frondose *Halymenia durvillei*. The green algae were well represented with *Tydemania expeditionis* and several *Halimeda* spp. including the very common and abundant *H. minima*, *H. opuntia* and *H. gracilis* (with tiny segments) while the larger species *H. distorta* and *H. discoidea* were common features of the reef slope's deeper parts.

Some branched *Codium geppiorum* were also observed. Dead corals were colonized by turfs of *Gelidiopsis intricata*, *Champia vieillardii* and *Caulerpa nummularia*. The vegetation on the slopes was scarce, less abundant and dominated by calcareous species such as *Lithothamnium proliferum* and *Halimeda gracilis*. Fleshy algae were less abundant and mostly represented by *Gibsmitha hawaiiensis*, *G. dotyii*, and *Botryocladia skottsbergii*,*Chamaebotrys boergesenii* and *Portieria hornemanii*. Various thin and small fronds of the dark green algae *Rhipiliella* spp. and *Rhipiliopsis* spp. formed small associations in the shady areas with *Corynocystis prostrata* Kaft and *Cryptonemia umbraticola*. The *Caulerpa* spp. were poorly represented in these environments and Phaeophyceae were mainly represented by small Dictyotales such as *Dictyota friabilis* and *Dictyopteris repens*. The large Fucales *Turbinaria ornata* was very rarely found and represented only by juveniles while no *Sargassum* species were observed.

Algal vegetation on lagoon reef flats. The shallow reef flats in the lagoon appeared heterogeneous and some of them in the south-west of the atoll (Baa 3, Fig. 1) showed much more species richness and biomass than those located in the north-eastern section of the atoll. *H. micronesica* and *H. taenicola* were observed only in the north (Baa 20). The vegetation assemblage was similar to that of the lagoon reef flats with numerous encrusted corallines including *Hydrolithon onkodes*, the candle-like *Hydrolithon* sp. and numerous rhodoliths of *Hydrolithon reinboldii*. Various articulated coralline species such as *Amphiroa* spp. formed clumps on the reef top.

Thin and delicate Rhodophyta such as *Hypoglossum* spp., *Nitophyllum* spp. and several *Laurencia* spp., were observed in the crevices of hard substratum along with the very abundant green fan-like *Rhipidosiphon javensis*, the bright green *Anadyomene wrigthii* and *Rhipiliella verticillata*. The typical fan-like *Lobophora variegata* and several large *Dictyota* spp. were found growing on dead corals along with the green sponge-like *Boodlea composita* and the plumose dark green *Bryopsis pennata*.

Algal vegetation in lagoon patch reefs. The species assemblages and richness observed in lagoon patch reefs were relatively variable from one site to another with an average of 25 spp. More than half of the species were present at least three out of five sites visited in this same geomorphologic habitat type. The assemblage was dominated by large green *Tydemania expeditionis*, as well as *Halimeda minima* and *H. opuntia* with a lesser abundance of by *H. cuneata* and *H. gracilis*, the bright green pompom-like *Chlorodesmis fastigiata*, the dark green *Avrainvillea lacerata* and *Asteromenia anastomosans*. *Caulerpa diligulata* occurred at all sites classified in this geomorphological habitat type. Most of the investigated sites showed turf assemblages associated with dead coral including mostly *Gelidiopsis intricata*, *Dictyota humifusa*, and *Champia compressa*. Several species such as *Acanthophora pacifica*, *Caulerpa diligulata*, *Cladophoropsis vaucheriaeformis*, *C. herpestica* were also common component of the oceanic reef slopes assemblages which are described hereafter.

Algal vegetation of the oceanic reef slope. The species assemblages associated with the outer reef slope appeared to be the most diverse and rich, even if the fleshy species were not very diversified. About 30 species were observed in most of the sites. The

vegetation was dominated by coralline species especially on the upper part of the slope. Some sections of the outer reef slope were very steep or vertical walls with numerous crevices, overhangs and small caves. Coral walls were encrusted by coralline species and *Peyssonnelia* spp. picturing an attractive mosaic of forms and colors. *Lithothamnion proliferum* was easily recognizable thanks to its pink crust and numerous short knobs. Along the slope several Rhodymeniales including *Leptofauchea* spp. and *Rhodymenia* spp. occurred in caves and crevices as well as *Cryptonemia umbraticola*, *Corynocystis prostrata*, the iridescent *Halichrysis irregularis* and the star–shaped *Asteromenia anastomosans*. Numerous small green species such as *Phyllodictyon anastomosans*, *Rhipidosiphon javensis* and *Rhipilia crassa* were present in the crevices while *Cladophora feredayoides* and *Caulerpa sedoides* were collected from rubbles. Conversely the large *Gibsmithsia hawaiiensis* and *G. dotyii* as well as the delicate *Kallymenia thompsonii*, *Dasya anastomosans* and *D. baillouviana* remained scarce. The most obvious species were the green *Halimeda* spp. (*H. gracilis*, *H. minima* and *H. cuneata*) and *Tydemania expeditionis*. Apart from *Caulerpa diligulata*, which was relatively abundant, the other species of *Caulerpa* (*C. filicoides* and *C. sedoides*) were very inconspicuous.

Algal vegetation of the oceanic reef flat. Oceanic reef flats were not surveyed as frequently as the above described habitats and are represented in this study by only two sites. The species richness was similar from one site to the other with an average of 12 species. Species assemblages however differed strongly. Only two species were common to both sites: the very widespread *Halimeda opuntia* and the West Pacific *Padina okinawensis*. Considering the low sampling effort applied to this geomorphological habitat type during the survey, no definitive features can be described here.

Algal vegetation associated to seagrass beds. Seagrasses are flowering plants belonging to the Cymodoceaceae and Hydrocharitaceae families which are currently classified in the order Alismatales (nomenclature based on phylogenetic studies APGIII, 2009). In tropical regions, they are almost permanently immersed in sheltered marine and estuarine biotopes which offer a suitable substrate for rooting in mud, sand or coarse rubble. In some instances they may also develop into large meadows or beds in deeper lagoon parts down to 40 m deep, or on barrier reefs surrounding lagoon islands. They are remarkable habitats in tropical shallow waters and they often represent keystone ecosystems on sandy bottoms and along shorelines between mangroves and coral reefs.

In Baa, only one site showing typical seagrass habitat was surveyed (oceanic reef flat, Baa 2). The seagrass species diversity was quite low with only two species: *Syringodium isoetifolium* and *Thalassia hemprechii*, forming a dense bed in an area exposed to strong currents. The algal vegetation associated to this meadow was very poor with only four large species including *Halimeda opuntia*, *Valonia aegagropila* and two rhodolith-forming coralline algae: *Neogoniolithon frutescens* and *N. laccadivicum*. More prospection is needed to assess the status of seagrass beds in Baa Atoll.

DISCUSSION

Marine Macrophytes in Baa: General Insights.

A total of 174 macroalgal species were identified from the survey of Baa Atoll. This result does not include the full diversity of coralline algae especially for the encrusting forms which were not fully sampled in the present study. This group is taxonomically difficult and a more comprehensive inventory is needed to properly describe its diversity in Baa. Similarly, microscopic epiphytes and epilithic species have not been exhaustively sampled and studied. A more focused study would most probably reveal a higher diversity. Nevertheless, our results document and acknowledge the ecological rarity typical in tropical ecosystem as well as confirm previous studies conducted in coral reef environments on biodiversity of molluscs and crustaceans (Bouchet et al., 2002). Overall, and in the framework of the Baa expedition, taxonomic results, species distribution and occurrences obtained for the marine flora are similar to those obtained for the other marine groups studied during this expedition (cf. this issue of *Atoll Research Bulletin*).

We carried out a multivariate analysis based on species absence/presence within the 27 studied sites (results available upon request to the first author). Results showed no community structure or strong indication of specific species assemblages associated to geomorphological habitat type. This relative homogeneity could be explained by limited habitat diversity. From its geographical location, Baa atoll appears greatly influenced by shifting monsoonal oceanic conditions. This could generate homogeneous environmental forcing thus limiting habitat diversity and in turn leading to a more or less homogeneously distributed flora at the atoll scale. At reef scale environmental factors are not strictly homogeneous and benthic community assemblages may show spatial heterogeneity (Vroom et al. 2005) which could be the case in Baa. Here, no significant difference in the species richness of the marine flora has been shown among the different areas of the atoll, however the number of restricted species was much higher that the number of species widely distributed. This result questions whether macroalgal communities within a same geomorphological area are ecologically similar.

Cyclones and bleaching events are significant disturbances resulting potentially in a shift from coral dominated to macroalgae dominated reefs (McCook, 1999; Bellwood et al., 2006). However no evidence of algal dominated communities was observed during the expedition, conducted 11 years after the massive 1998 bleaching event that impacted Maldives.

Previous lists available for other Maldivian atolls (Guiry and Guiry, 2011) listed 208 algal species. Sixty three of these records were found in Baa Atoll. Conversely, 113 of the species recorded in the present study represent new records for the Maldives, bringing the total number of algal species to 321 (200 Rhodophyta, 97 Chlorophyta and 24 Phaeophyceae). Comparison with previous studies undertaken in the Maldives show a narrow overlap of the diversity of the species between the different atolls studied. As observed from the literature and from this study, the Maldivian macroalgal diversity varies from one atoll to another and several very common tropical species have not been

recorded during the present survey. Some of the species are seasonal (e.g. *Rosenvingea intricata*) and did not occur in May-June at the time of the survey. Another likely hypothesis is that Baa Atoll does not offer the suitable habitats that support those particular species.

Biogeography

The species list established from this survey shows that the Maldivian algal flora is typically tropical and most of the species belong to the Indo-Pacific biogeographic province. Several species described from the Pacific region were recorded for Baa during this study and represent their first record for the Indian Ocean. They are for example the Dictyotales *Padina okinawensis* described from Southern Japan, the Delesseriaceae *Myriogramme heterostroma* and *M. melanesiensis* originally described from the Solomon Islands and Vanuatu (Western Pacific) and the Halimedaceae *Halimeda xishaensis* from China (Gulf of Tonkin). This suggests that the species geographic distribution is broader than originally thought and underlines the biogeographic affinities of the Maldives marine flora with the tropical West Pacific.

Comparison with floras from adjacent regions is limited due to difference in sampling effort and lack of recently revised species lists. However we compared different archipelogoes from the West Indian Ocean based on species lists available at algaebase.com (Table 4). The proportion of species shared by Baa and other atolls/islands of the Maldives, Laccadives, Chagos, Seychelles and La Reunion was 35.7, 25.5, 17.6, 43.1 and 29.5% respectively. The highest percentage similarity appeared to be with the Seychelles Islands and the other Maldivian atolls. The lowest similarity was observed with the Laccadives (10.57° N and 72.62° E) and Chagos (6° S and 72° E). The reason for such a low similarity despite the geographical location of these Islands (Chagos and Laccadives are located about 600 km off the south and about 250 km off the north of the Maldives, respectively), could be explained by low collecting efforts at these localities resulting in incomplete species lists. A Sorensen's Similarity Index was calculated between the Baa marine flora composition and those of the other localities (Table 4). The highest values were observed for the other Maldivian atolls (0.24). SI values were mostly low and illustrate a species diversity specific to each of the different areas considered. A number of species were not observed in Baa; including Phaeophyceae taxa, among which several species of *Turbinaria* and *Sargassum*. This latter genus was not observed in Baa atoll during the present study nor has it been reported before. Nevertheless, several *Sargassum* species have been mentioned by MRC staff and drift specimens have been collected from other Maldivian atolls. The reason why species of this widespread genus is missing from the Baa inventory warrants further investigation. Grazing pressure, seasonality or very restricted distribution within Baa atoll (i.e. unprospected sites) are plausible hypotheses. The absence of *Sargassum* on Pacific atolls was first discussed by Doty (1954). Tsuda (1976) described the presence of *S. crassifolium* on two Pacific atolls, Ulithi Atoll (Yap State) and Kayangel Atoll (Palau); later Hodgson and McDermid (2000) reported *Sargassum* sp. on Ant Atoll (Pohnpei State). Sterile plants were found in January at Kayangel and fertile plants were found in June and July at Ulithi. The interesting fact is

that all *Sargassum* were collected on the northeast (windward side) of the atolls (Tsuda com.pers.).It is interesting that the relative absence of *Sargassum* on Indian Ocean atolls is similar to cases in the Pacific Ocean.

Finally, our results address the issue of representativeness, which is critical in biodiversity management. The little overlap of the macroalgal assemblages between the different atolls demonstrates that, even at small biogeographical scales the spatial heterogeneity is important. This leads to question the concept of "representative protected area" in larger marine ecosystem like the Maldives regions atoll complex.

Table 4. Species richness, Sorensen's similary Index (SI =2*x*/2*x*+*y*+*z*; where *x* is the number of shared species, *y* the number of the total species of the first island and *z* is the total species of the second island or group) and % of common species calculated between species diversity in Baa atoll and other archipelagoes of the West Indian Ocean.

	Baa	Maldives	Laccadives	Chagos	Seychelles	Reunion
Rhodophyta	108	200	71	26	212	122
Chlorophyta	58	97	41	34	102	58
Phaeophyceae	10	24	20	7	54	36
Total species	176	321	132	68	374	215
Shared species		63	45	31	76	52
% Baa		35.7	25.5	17.6	43.1	29.5
Sorensen index (SI)		0.24	0.22	0.2	0.21	0.21

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Appendix 1. Taxonomic list of the macrophytes recorded for Baa Atoll during the present study

Rhodophyta	**Bonnemaisoniales**	**Bonnemaisoniaceae**	*Asparagopsis*	*taxiformis*	(Delile) Trevisan
	Ceramiales	**Callithamniaceae**	*Crouania*	*minutissima*	Yamada
			Seirospora	*orientalis*	G. T. Kraft
		Ceramiaceae	*Centroceras*	*clavulatum*	(C. Agardh) Montagne
			Centroceras	*minutum*	Yamada
			Ceramium	*maryae*	Weber-van Bosse
			Ceramium	*mazatlanense*	E.Y. Dawson
			Corallophila	*apiculata*	(Yamada) R.E. Norris
			Cryptonemia	*umbraticola*	E.Y. Dawson
			Gayliella	*transversalis*	(F.S. Collins et Hervey) T.O. Cho et Fredericq
			Griffithsia	*heteromorpha*	Kützing
		Dasyaceae	*Dasya*	*anastomosans*	(Weber-van Bosse) M.J. Wynne
			Dasya	*baillouviana*	(S. G. Gmelin) Montagne
			Dasya	*palmatifida*	(Weber-van Bosse) A.J.K. Millar et E. Coppejans
			Dictyurus	*purpurascens*	Bory de Saint-Vincent
			Heterosiphonia	*crispella*	(C. Agardh) M.J. Wynne
			Thuretia	sp	
		Delesseriaceae	*Hypoglossum*	*simulans*	M.J. Wynne, Price et Ballantine
			Martensia	*fragilis*	Harvey
			Martensia	*sp. 'petit'*	
			Myriogramme	*heterostroma*	N'Yeurt, M.J. Wynne et Payri
			Myriogramme	*melanesiensis*	N'Yeurt, M.J. Wynne et Payri
			Myriogramme	sp.	
			Nitophyllum	*adhaerens*	M. J. Wynne
		Rhodomelaceae	*Acanthophora*	*pacifica*	(Setchell) Kraft
			Chondria	*arcuata*	Hollenberg
			Chondria	*bullata*	N'Yeurt et Payri
			Chondria	*ryukyuensis*	Yamada
			Chondria	*simpliciuscula*	Weber-van Bosse
			Chondrophycus	*succisus*	(A.B. Cribb) K.W. Nam
			Coelothrix	*irregularis*	(Harvey) Børgesen
			Dipterosiphonia	*dendritica*	(C. Agardh) F. Schmitz

Appendix 1 (Con'td)

			Herposiphonia	*secunda*	(C. Agardh) Ambronn f. *tenella* (C. Agardh) M.J. Wynne
Rhodophyta	**Ceramiales**	**Rhodomelaceae**	*Laurencia*	*cf minuta*	Vandermeulen, Garbary et Guiry
			Laurencia	*distichophylla*	J. Agardh
			Laurencia	sp. 1	
			Laurencia	sp. 2	
			Laurencia	sp. 3	
			Laurencia	sp. 4	
			Laurencia	sp. 5	
			Leveillea	*jungermannioides*	(K. Hering et G. Martens) Harvey
			Neosiphonia	*apiculata*	(Hollenberg) Masuda et Kogame
			Neosiphonia	*ferulacea*	(Suhr ex J. Agardh) S.M. Guimarães et M.T. Fujii
			Palisada	*parvipapillata*	(C. K. Tseng) K. W. Nam
			Polysiphonia	*delicatula*	Hollenberg
			Polysiphonia	*sertularioides*	(Grateloup) J. Agardh
			Tolypiocladia	*glomerulata*	(C. Agardh) F. Schmitz
		Wrangeliaceae	*Wrangelia*	*sp. inedit*	
	Corallinales	**Corallinaceae**	*Amphiroa*	*foliacea*	Lamouroux in Quoy et Gaimard
			Amphiroa	*fragilissima*	(Linnaeus) Lamouroux
			Amphiroa	*rigida*	J.V. Lamouroux
			Amphiroa	*tribulus*	(Ellis et Solander) Lamouroux
			Amphiroa	sp	
			Hydrolithon	*gardneri*	(Foslie) Verheij & Prud'homme van Reine
			Hydrolithon	*onkodes*	(Heydrich) D. Penrose et Woelkerling
			Hydrolithon	*reinboldii*	(Weber-van Bosse et Foslie) Foslie
			Hydrolithon	sp	
			Jania	*adhaerens*	Lamouroux
			Lithophyllum	*bamleri*	(Heydrich) Heydrich
			Lithophyllum	*kotschyanum*	Unger
			Lithothamnion	*proliferum*	Foslie
			Lithothamnion	sp	
			Mesophyllum	*erubescens*	(Foslie) M. Lemoine
			Mesophyllum	sp	
			Neogoniolithon	*brassica-florida*	(Harvey) Setchell et L.R. Mason
			Neogoniolithon	*frutescens*	(Foslie) Setchell & L.R.Mason

Appendix 1 (Con'td)

			Neogoniolithon	*laccadivicum*	(Foslie) Setchell & Mason
Rhodophyta	**Gelidiales**	**Gelidiaceae**	*Caulacanthus*	*ustulatus*	(Turner) Kützing
			Gelidium	*isabelae*	W.R. Taylor
			Gelidium	sp	
			Pterocladiella	*caespitosa*	(Kylin) Santelices
			Pterocladiella	*caloglossoides*	(M.A. Howe) Santelices
		Gelidiellaceae	*Gelidiella*	*acerosa*	(Forsskål) Feldmann et G. Hamel
			Gelidiella	*myrioclada*	(Børgesen) Feldmann et G. Hamel
	Gigartinales	**Corynocystaceae**	*Corynocystis*	*prostrata*	G.T. Kraft
		Dumontiaceae	*Gibsmithia*	*dotyi*	Kraft et Ricker
			Gibsmithia	*hawaiiensis*	Doty
		Hypneaceae	*Hypnea*	*nidulans*	Setchell
			Hypnea	*pannosa*	J. Agardh
			Hypnea	*spinella*	(C. Agardh) Kützing
		Kallymeniaceae	*Kallymenia*	*thompsonii*	Abbott et McDermid
		Peyssonneliaceaea	*Peyssonnelia*	cf. *boergesenii*	Weber-van Bosse
			Peyssonnelia	*inamoena*	Pilger
		Rhizophyllidaceae	*Portieria*	*hornemannii*	(Lyngbye) P.C. Silva
	Halymeniales	**Halymeniaceae**	*Halymenia*	*actinophysa*	M. A. Howe
			Halymenia	*durvillei*	Bory de Saint-Vincent
			Halymenia	*maculata*	J. Agardh
	Nemaliales	**Galaxauraceae**	*Actinotrichia*	*fragilis*	(Forsskål) Børgesen
			Actinotrichia	sp	
			Galaxaura	*filamentosa*	R. Chou
	Rhodymeniales	**Champiaceae**	*Champia*	*compressa*	Harvey
			Champia	*parvula*	(C. Agardh) Harvey
			Coelothrix	*irregularis*	(Harvey) Børgesen
		Faucheaceae	*Gloiocladia*	*iyoensis*	(Okamura) R. Norris
		Leptofaucheaceae	*Leptofauchea*	sp	
		Rhodymeniaceae	*Asteromenia*	*anastomosans*	(Weber-van Bosse) G. W. Saunders, C. E. Lane, C. W. Schneider et Kraft
			Botryocladia	*skottsbergii*	(Børgesen) Levring
			Botryocladia	*tenuissima*	W.R. Taylor

Appendix 1 (Con'td)

Rhodophyta	**Rhodymeniales**	**Rhodymeniaceae**	*Chamaebotrys*	*boergesenii*	(Weber-van Bosse) Huisman
			Gelidiopsis	*intricata*	(C. Agardh) Vickers
			Halichrysis	*irregularis*	Kützing
			Lomentaria	*corallicola*	Børgesen
			Rhodymenia	sp.1	
			Rhodymenia	sp.2	
			Rhodymenia	sp.4	
			Rhodymenia	sp.5	
			Spirocladia	*barodensis*	Børgesen
	Sporolithales	**Sporolithaceae**	*Sporolithon*	*ptychoides*	Heydrich
Chlorophyta	**Bryopsidales**	**Bryopsidaceae**	*Bryopsis*	*pennata*	J.V. Lamouroux
			Bryopsis	*plumosa*	(Hudson) C. Agardh
			Bryopsis	sp	
		Caulerpaceae	*Caulerpa*	*cupressoides*	(Vahl) C. Agardh
			Caulerpa	*diligulata*	G.T. Kraft et A.J.K. Millar
			Caulerpa	*filicoides*	Yamada
			Caulerpa	*nummularia*	Harvey ex J. Agardh
			Caulerpa	*racemosa*	(Forsskål) J. Agardh var. *peltata* (Lamouroux) Eubank
			Caulerpa	*sedoides*	C. Agardh
			Caulerpa	*serrulata*	(Forsskål) J. Agardh
			Caulerpa	*sertularioides*	(S. Gmelin) M. Howe
			Caulerpa	*taxifolia*	(Vahl) C. Agardh
			Caulerpa	*tongaensis*	Papenfuss
		Codiaceae	*Codium*	*arabicum*	Kützing
			Codium	*geppiorum*	O.C. Schmidt
		Halimedaceae	*Halimeda*	*cuneata*	Hering
			Halimeda	*discoidea*	Decaisne
Chlorophyta	**Bryopsidales**	**Halimedaceae**	*Halimeda*	*distorta*	(Yamada) Hillis-Colinvaux
			Halimeda	*fragilis*	W.R. Taylor
			Halimeda	*gracilis*	Harvey ex J. Agardh
			Halimeda	*micronesica*	Yamada
			Halimeda	*minima*	(W.R. Taylor) Colinvaux
			Halimeda	*opuntia*	(Linnaeus) Lamouroux
			Halimeda	*taenicola*	W.R. Taylor

Appendix 1 (Con'td)

Chlorophyta	**Bryopsidales**	**Halimedaceae**	*Halimeda*	*velasquezii*	W.R. Taylor
			Halimeda	*xishaensis*	M.L.Dong & C.K.Tseng
			Halimeda	sp	
		Udoteaceae	*Avrainvillea*	*lacerata*	Harvey ex J. Agardh
			Boodleopsis	*pusilla*	(F.S. Collins) W.R. Taylor, A.B. Joly et Bernatowicz
			Boodleopsis	sp.	
			Chlorodesmis	*fastigiata*	(C. Agardh) Ducker
			Chlorodesmis	*hildebrandtii*	A. Gepp et E.S. Gepp
			Rhipidosiphon	*javensis*	Montagne
			Rhipilia	*crassa*	A.J.K. Millar et Kraft
			Rhipiliella	*verticillata*	G.T. Kraft
			Rhipiliopsis	*gracilis*	Kraft
			Tydemania	*expeditionis*	Weber-van Bosse
Chlorophyta	**Cladophorales**	**Anadyomenaceae**	*Anadyomene*	*wrightii*	Harvey ex J. Gray
			Cladophora	*dotyana*	Gilbert
			Cladophora	*feredayoides*	Kraft et Millar
			Cladophora	*goweri*	A.H.S. Lucas
			Cladophora	*prehendens*	Kraft et Millar
			Cladophora	*rupestris*	(Linnaeus) Kützing
			Cladophora	*vagabunda*	(Linnaeus) Hoek
			Cladophora	sp.	
			Microdictyon	*okamurae*	Setchell
		Siphonocladacaeae	*Boergesenia*	*forbesii*	(Harvey) J. Feldmann
			Boodlea	*composita*	(Harvey) F. Brand
			Cladophoropsis	*herpestica*	(Montagne) M.A. Howe
			Cladophoropsis	*vaucheriaeformis*	(J.E Areschoug) Papenfuss
			Dictyosphaeria	*cavernosa*	(Forsskål) Børgesen
			Dictyosphaeria	*versluysii*	Weber-van Bosse
			Phyllodictyon	*anastomosans*	(Harvey) Kraft et M.J. Wynne
		Valoniaceae	*Valonia*	*aegagropila*	C. Agardh
			Valonia	*fastigiata*	Harvey ex J. Agardh
			Valonia	*ventricosa*	J. Agardh
			Valoniopsis	*pachynema*	(G. Martens) Børgesen
Chlorophyta	**Dasycladales**	**Dasycladaceae**	*Neomeris*	*annulata*	Dickie

Appendix 1 (Con'td)

		Polyphysaceae	*Parvocaulis*	*parvulus*	(Solms-Laubach) S. Berger et al.
	Ulvales	**Ulvaceae**	*Ulva*	*flexuosa*	(Wulfen) J. Agardh
Phaeophyceae	**Dictyotales**	**Dictyotaceae**	*Dictyopteris*	*repens*	(Okamura) Børgesen
			Dictyota	*bartayresiana*	Lamouroux
Phaeophyceae	**Dictyotales**	**Dictyotaceae**	*Dictyota*	*ceylanica*	Kützing
			Dictyota	*friabilis*	Setchell
			Dictyota	*grossedentata*	De Clerck et Coppejans
			Dictyota	*humifusa*	Hörnig, Schnetter et Coppejans
			Dictyota	sp.1	
			Lobophora	*variegata*	(Lamouroux) Womersley ex Oliveira
			Padina	*okinawaensis*	Ni-NI-Win, S. Arai & H. Kawai
	Fucales	**Sargassaceae**	*Turbinaria*	*ornata*	(Turner) J. Agardh
Magnolophyta	**Alimastales**	**Cymodoceacea**	*Syringodium*	*isoetifolium*	(Ascherson) Dandy
		Hydrocharitaceae	*Thalassia*	*hemprichii*	(Ehrenberg) Ascherson

Appendix 2. Presence /absence of macroalgal species at prospected sites in Baa Atoll

Genus	species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28
Anadyomene	*wrightii*			1					1				1			1		1	1			1			1			
Avrainvillea	*lacerata*											1			1					1		1	1			1		1
Boergesenia	*forbesii*				1																							1
Boodlea	*composita*								1	1		1		1			1		1	1		1						1
Boodleopsis	*pusilla*																			1								
Boodleopsis	sp.			1																								
Bryopsis	*pennata*			1	1			1	1		1	1	1		1		1			1		1	1		1	1		
Bryopsis	*plumosa*												1															
Bryopsis	sp.											1														1		1
Caulerpa	*cupressoides*									1																		
Caulerpa	*diligulata*	1			1			1			1	1			1			1	1	1							1	
Caulerpa	*filicoides*														1													
Caulerpa	*nummularia*						1																		1	1		
Caulerpa	*racemosa*																									1		1
Caulerpa	*sedoides*																		1									
Caulerpa	*serrulata*					1				1								1	1									
Caulerpa	*sertularioides*						1																					
Caulerpa	*taxifolia*								1								1	1										
Caulerpa	*tongaensis*										1																	
Chlorodesmis	*fastigiata*											1						1	1	1								
Chlorodesmis	*hildebrandtii*	1							1																		1	
Cladophora	*dotyana*																	1	1									
Cladophora	*feredayoides*	1			1			1			1				1				1									
Cladophora	*goweri*									1																		
Cladophora	*prehendens*																1						1					
Cladophora	*rupestris*	1																										
Cladophora	*vagabunda*																								1			
Cladophora	sp.				1																							
Cladophoropsis	*herpestica*										1							1										
Cladophoropsis	*vaucheriaeformis*	1			1			1			1	1			1	1			1	1							1	
Codium	*arabicum*																											1

Appendix 2 (Con'td)

Genus	species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28
Codium	*geppiorum*	1							1				1															
Dictyosphaeria	*cavernosa*																									1		
Dictyosphaeria	*versluysii*								1																			
Halimeda	*cuneata*	1		1		1	1								1			1	1	1		1	1		1	1	1	1
Halimeda	*distorta*	1				1	1	1				1			1					1				1			1	
Halimeda	*gracilis*	1				1	1	1				1					1	1	1			1			1	1		1
Halimeda	*micronesica*																			1	1							
Halimeda	*minima*			1		1	1	1	1		1	1	1		1		1	1	1	1		1	1		1	1	1	1
Halimeda	*opuntia*	1	1				1		1	1	1	1	1	1	1	1			1	1	1					1		1
Halimeda	*taenicola*																			1	1							
Halimeda	*velasquezii*														1													
Halimeda	*xishaensis*							1							1												1	
Halimeda	sp.					1																						
Microdictyon	*okamurae*														1													
Neomeris	*annulata*								1	1																		
Parvocaulis	*parvulus*													1														
Phyllodictyon	*anastomosans*			1				1				1			1				1			1			1		1	
Rhipidosiphon	*javensis*			1	1	1	1						1		1			1	1	1			1		1	1		1
Rhipilia	*crassa*														1													1
Rhipiliella	*verticillata*			1									1					1							1			
Rhipiliopsis	*gracilis*																					1						
Tydemania	*expeditionis*	1		1	1		1	1			1	1	1		1	1		1	1	1	1	1	1		1	1	1	1
Ulva	*flexuosa*													1									1					
Valonia	*aegagropila*		1																									
Valonia	*fastigiata*				1										1													
Valonia	*ventricosa*	1		1		1									1								1		1			
Valoniopsis	*pachynema*																					1						
Dictyopteris	*repens*			1									1			1						1				1		
Dictyota	*bartayresiana*						1	1																				
Dictyota	*ceylanica*									1																		
Dictyota	*friabilis*	1					1	1	1		1	1						1	1	1		1			1	1		
Dictyota	*grossedentata*											1																
Dictyota	*humifusa*							1			1	1							1									1
Dictyota	sp.1			1																								
Lobophora	*variegata*	1		1		1	1	1			1	1	1						1			1			1			
Padina	*okinawaensis*									1						1			1									

Appendix 2 (Con'td)

Genus	species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28
Turbinaria	*ornata*					1	1																					
Acanthophora	*pacifica*						1	1			1	1			1		1										1	
Actinotrichia	*fragilis*			1		1						1	1															1
Actinotrichia	sp.	1		1			1	1				1																
Amphiroa	*foliacea*			1																								
Amphiroa	*fragilissima*														1													
Amphiroa	*rigida*			1																								
Amphiroa	*tribulus*			1																								
Amphiroa	*sp.*										1																	
Asparagopsis	*taxiformis*								1							1												
Asteromenia	*anastomosans*				1			1							1												1	
Botryocladia	*skottsbergii*						1					1				1						1					1	1
Botryocladia	*tenuissima*			1																								
Caulacanthus	*ustulatus*												1															1
Centroceras	*clavulatum*													1														
Centroceras	*minutum*									1																		
Ceramium	*maryae*			1		1					1	1					1											
Ceramium	*mazatlanense*																1											
Chamaebotrys	*boergesenii*	1						1					1														1	
Champia	*compressa*			1	1		1	1				1						1					1		1	1		1
Champia	*parvula*									1																1		
Chondria	*arcuata*																			1								
Chondria	*bullata*														1													
Chondria	*ryukyuensis*										1									1								
Chondria	*simpliciuscula*			1						1																		
Chondrophycus	*succisus*											1																
Coelothrix	*irregularis*																											1
Corallophila	*apiculata*						1																					
Corynocystis	*prostrata*					1													1			1						
Crouania	*minutissima*																1											
Cryptonemia	*umbraticola*	1				1									1			1	1									
Dasya	*anastomosans*							1														1						
Dasya	*baillouviana*														1				1									
Dasya	*palmatifida*								1																			
Dictyurus	*purpurascens*			1					1													1						1
Dipterosiphonia	*dendritica*							1																				

Appendix 2 (Con'td)

Genus	species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28
Leveillea	*jungermannioides*											1		1		1												
Lithophyllum	*bamleri*	1																										
Lithophyllum	*kotschyanum*	1		1		1	1										1					1	1		1	1		1
Lithothamnion	*proliferum*	1			1	1		1			1	1			1				1			1	1		1	1	1	1
Lithothamnion	sp				1	1					1				1				1			1	1		1	1	1	
Lomentaria	*corallicola*											1																
Martensia	*fragilis*																			1							1	
Martensia	sp																		1							1		
Mesophyllum	*erubescens*										1	1																
Mesophyllum	sp				1																	1						
Myriogramme	*heterostroma*							1														1			1			
Myriogramme	*melanesiensis*														1													
Myriogramme	sp																					1			1			
Neogoniolithon	*brassica-florida*									1				1								1	1					
Neogoniolithon	*frutescens*	1	1											1								1	1					
Neogoniolithon	*laccadivicum*		1																				1					
Neosiphonia	*apiculata*																			1								
Neosiphonia	*ferulacea*																		1									
Nitophyllum	*adhaerens*			1																								
Palisada	*parvipapillata*								1																			
Peyssonnelia	*cf. boergesenii*																								1			
Peyssonnelia	*inamoena*														1								1					
Polysiphonia	*delicatula*				1							1																
Polysiphonia	*sertularioides*						1																1					
Portieria	*hornemannii*								1																			
Pterocladiella	*caespitosa*																										1	
Pterocladiella	*caloglossoides*					1																						
Rhodymenia	sp.1										1	1																
Rhodymenia	sp.2																							1				
Rhodymenia	sp.3																										1	
Rhodymenia	sp.4																											1
Seirospora	*orientalis*																	1										
Spirocladia	*barodensis*											1							1									
Sporolithon	*ptychoides*				1	1	1	1				1			1				1						1			1
Thuretia	sp.			1	1																							
Tolypiocladia	*glomerulata*							1		1				1									1					

Appendix 2 (Con'td)

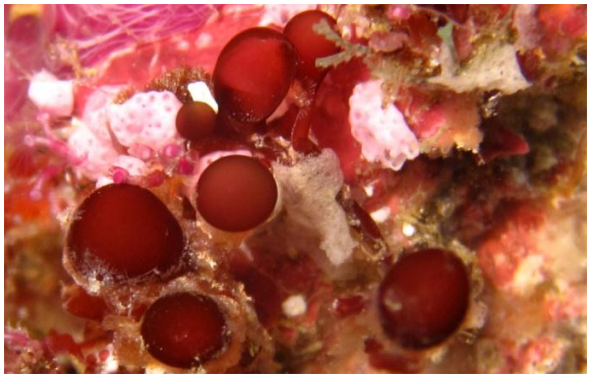
Genus	species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28
Wrangelia	*sp. inedit*															1										1		
Syringodium	*isoetifolium*		1																									
Thalassia	*hemprichii*		1																									

Appendix 3

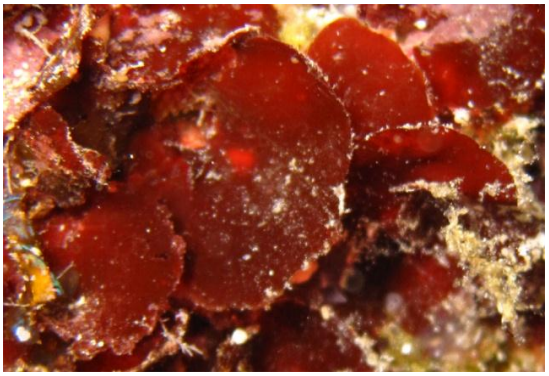
Rhodophyta 1/4

Gibsmithia hawaiensis

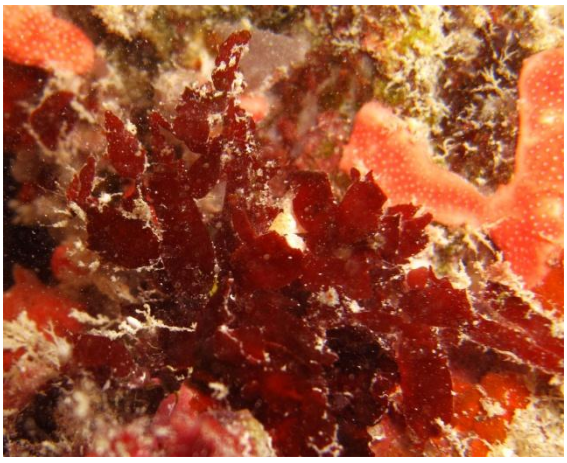
Gibsmithia dotyii



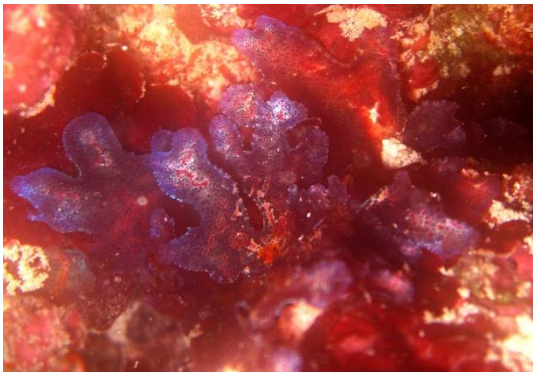
Botryocladia skottsbergii



Cryptonemia umbraticola



Corynocystis prostrata



Asteromenia anastomosans

Rhodophyta 2/4

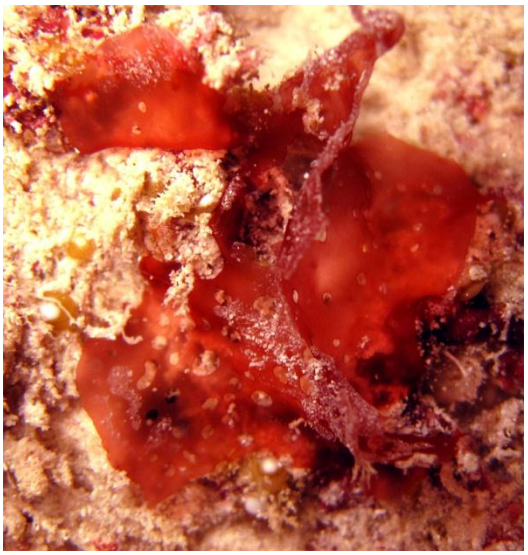
Actinotrichia sp

Actinotrichia fragilis

Acanthophora pacifica

Amphiroa tribulus

Dictyurus purpurascens

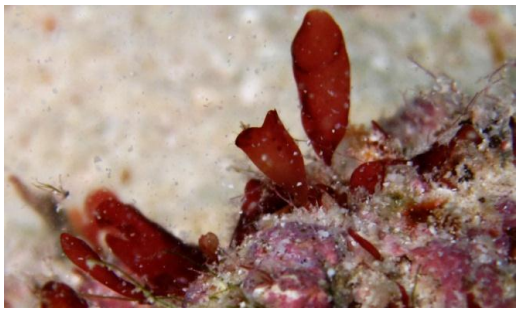


Kallymenia thompsonii

Rhodophyta 3/4

Halymenia durvillei

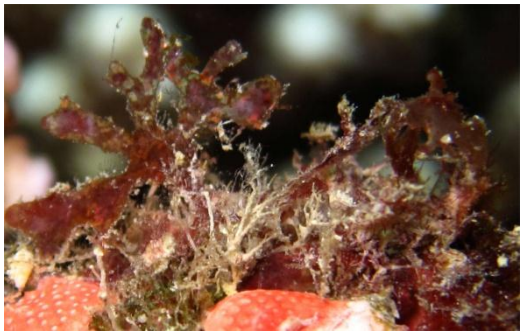
Coelothrix irregularis



Gelidium isabelae

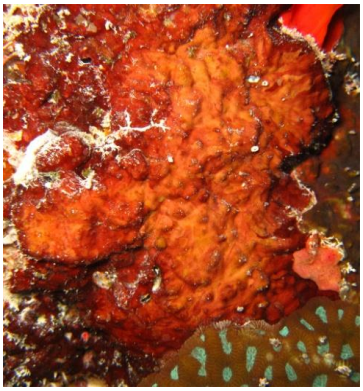
Heterosiphonia crispella

Martensia fragilis



Myriogramme heterostroma

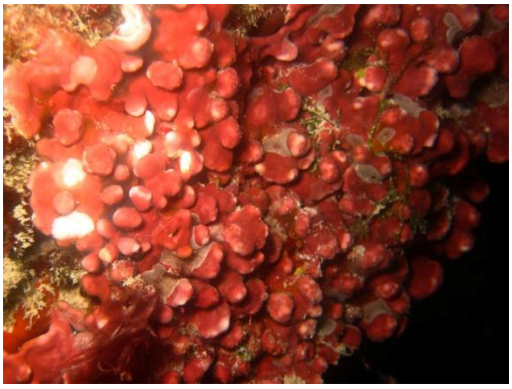
Myriogramme sp.



Peyssonnelia sp.

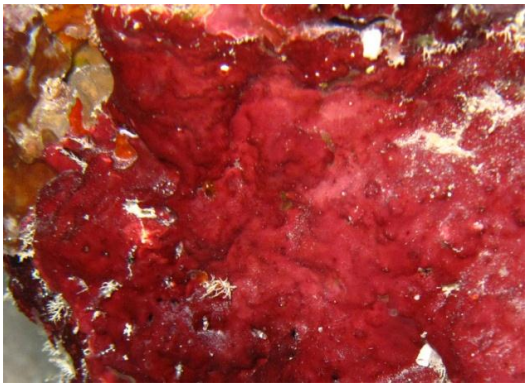
Rhodophyta 3/4

Hydrolithon gardneri



Lithothamnion proliferum

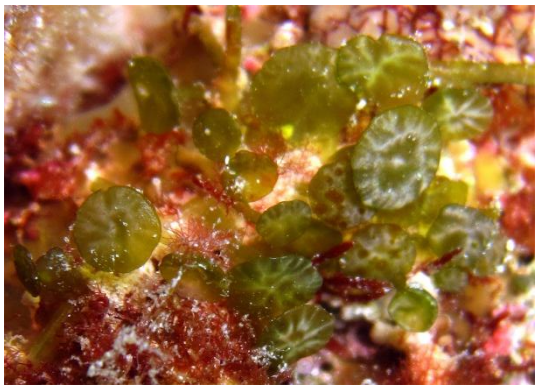
Hydrolithon sp1



Sporolithon ptychoides.

Chlorophyta 1/4

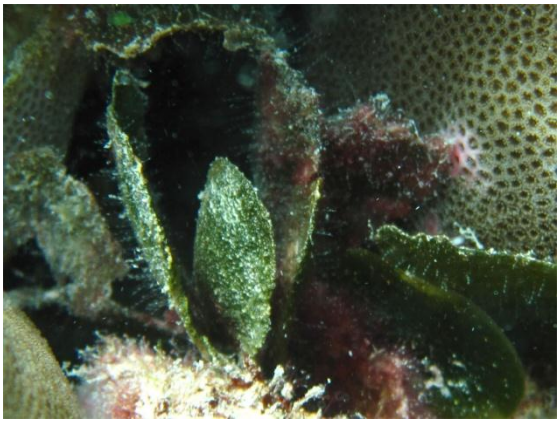
Caulerpa serrulata



Caulerpa racemosa var. peltata

Caulerpa diligulata

Tydemania expeditionis



Avrainvillea lacerata

Rhipidosiphon javensis

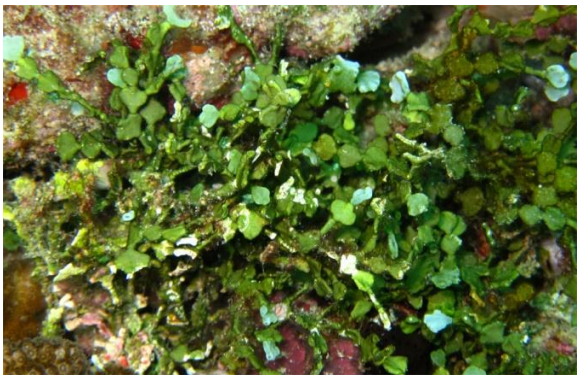
Chlorophyta 2/4

Halimeda cuneata

Halimeda distorta

Halimeda gracilis

Halimeda micronesica

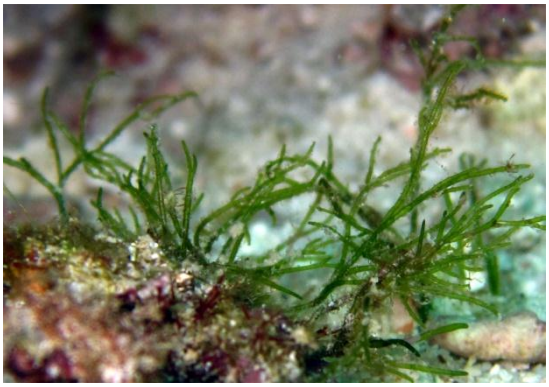


Halimeda minima

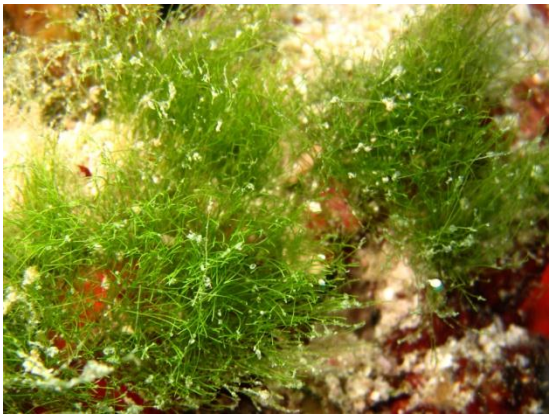
Halimeda opuntia

Chlorophyta 3/4

Bryopsis pennata



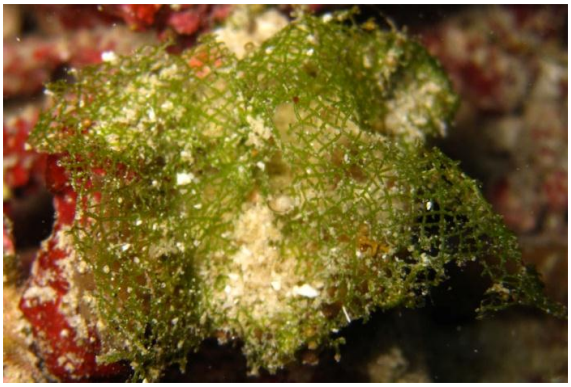
Cladophoropsis vaucheriaeformis



Chlorodesmis fastigiata

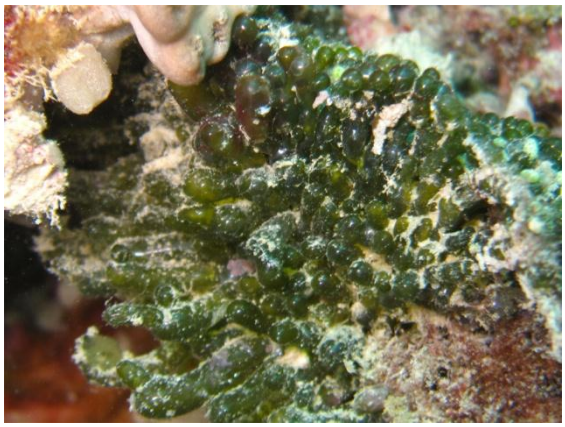
Phyllodictyon anastomosans

Cladophora feredayoides



Microdictyon umbilicatum

Chlorophyta 4/4



Valonia fastigiata

Valonia ventricosa

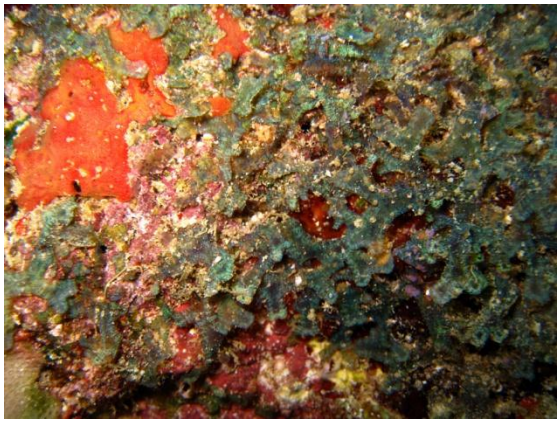
Boergesenia forbersii

Boodleopsis pusilla

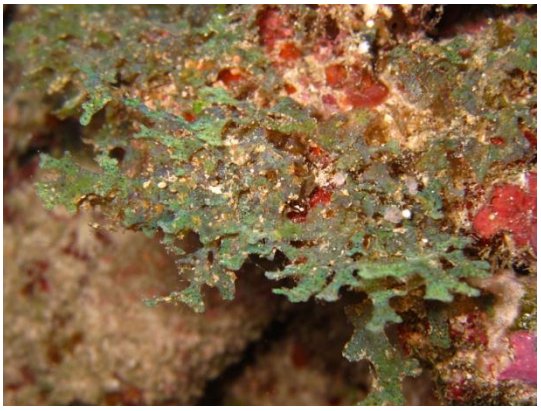
Phaeophyceae 1/1

Lobophora variegata

Padina okinawensis

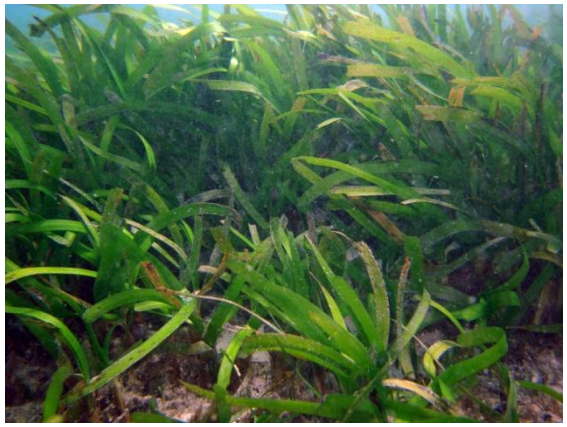


Dictyota friabilis



Dictyota humifusa

Magnolophyta 1/1



Cymodocea serrulata

Syringodium isoetifolium