MARINE BENTHIC ALGAE OF SITTWE COASTAL AREAS, RAKHINE STATE

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Abstract

A total of 19 species of marine benthic algae belonging to 13 families of 11 orders collected from the Sittwe Coastal Areas (lat. 20º 09´ N, Long. 92º 54´ E), Rakhine Coastal Region from December 2021 to August 2022 were identified. The identification of species was carried out based on the external and internal morphologies, herbarium, and living plants in the field. In the present study, 10 species, 9 genera of Rhodophyta, 5 species, 2 genera of Chlorophyta and 4 species, 4 genera of Phaeophyta had been identified. Among these algae, *Bangia atropurpurea*, *Catenella impudica*, *Polysiphonia subtilissima*, *Ulva flexuosa*, *Ulva clathrata* and *Colpomenia sinuosa* were newly recorded for Sittwe Coastal Areas. C*ompsonema serpens* and *Chondracanthus intermedius* were first recorded for Myanmar. The descriptive key emphasized to the species of these algae was provided. A brief note on the potential uses of each alga was described. Some ecological notes of these species were briefly described.

Keywords Ecological notes, Herbarium, Identification, Marine Benthic Algae, Morphology, Potential uses.

Introduction

Seaweeds are part of a complex ecosystem essential to marine life; the delicate filamentous species are important food sources for different animals (snails, sea urchins, crabs, fishes, turtles, etc.). Agal stocks provide dissolved organic matter, an important food source for bacteria, fungi, and protozoa. And finally, they provide habitat and nourishment for the higher links in the food chain; fishes, seabirds, and marine mammalian species. Juveniles get support, protection and coverage from predators in dense agal stands.

Since ancient times, seaweeds are a direct food source for humans. In China and Japan, more than 70 species of marine algae are consumed, and in both countries, there are marine farms which are hundreds of square kilometers in extent (aquaculture systems), where specific species (*Porphyra*, *Laminaria*, *Undaria*) are cultivated for human consumption. There are an almost infinite variety of healthcare products available commercially; lotions, bath gels, shampoos and soaps for skin protection and as a source of vitamins and minerals (Braune and Guiry (2011).

In Myanmar, floristic studies on some marine benthic algae of various localities such as Mazin coastal areas by Mya Kyawt Wai and Soe Htun (2009), Gwa coastal areas by Soe Pa Pa Kyaw and Soe Htun (2012), and Soe-Htun (2009a, b, c), Kyaikkhame coastal areas by Sein Moh Moh Khine (2012), Campani and Maungmagan coastal areas by Myo Min Tun (2013), Sit Thu Aung (2012) and Kalagauk coastal areas by Thet Htwe Aung (2013) had been undertaken.

As many as 122 genera and 307 species of seaweeds grow along the coastal areas of Myanmar (Kyi-Win 1972, Kyaw Soe and Kyi Win 1977, Soe-Htun 1998). A total of 229 marine benthic algae with 61 taxa, belonging to 22 genera of Chlorophyta, 44 taxa, belonging to 17 genera of Phaeophyta and belonging to 79 genera of Rhodophyta grow along the three coastal regions (Soe-Htun 2010). A total of 261 species of marine benthic algae under 121 genera, comprising 72 taxa belonging to 26 genera of Chlorophyta, 45 taxa belonging to 18 genera of

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Phaeophyta and 144 taxa belonging to 77 genera of Rhodophyta growing along the three coastal regions of Myanmar were recorded by Soe-Htun *et al.* 2021.

According to previously records, *Padina antillarum, Gelidium pusillum, Peyssonnelia rubra, Gracilaria canaliculata, Gracilaria foliifera, Ceratodictyon repens* and *Ulva rigida* from ittwe coastal area were reported by Kyaw Soe and Kyi Win (1977) and Soe-Htun *et al* (2009 a, b, c).

The objectives of this study are - (1) to know the morphology of marine benthic algae based on the external and internal structures and ecological features, (2) to show the distribution of marine benthic algae within the Sittwe Coastal Areas and (3) to understand the potential utilization of these algae for the benefits to the local people living in Sittwe township.

Materials and Methods

The marine benthic algae were collected in the intertidal and shallow subtidal zones of the Sittwe coastal areas (Lat. 20º 09´ N, Long. 92º 54´ E) from December 2021 to August 2022. In the field, the algae were observed the form of live materials growing in the natural beds and noted in the description of the site location. To remove the adhering materials, the plants were washed with seawater in the field. And then the plants were dried in a sheltered place for about 12 hrs and preserved in plastic bags. In the Phycological Research Laboratory of the Department of Marine Science in Sittway University, the healthy plants were thoroughly washed with the help of a painting brush in the sterile seawater to remove the adhering materials such as sand particles and other debris as well as epiphytes. And then the plants were identified under the binocular and compound microscopes. After that specimens were fixed and preserved in 5% formaldehyde in seawater and also mounted on the herbarium sheets. Herbarium, slides, liquid-preserved and living specimens were used for detailed investigations emphasized vegetative (external and internal) structures.

For the experiments on the cross sections of the thalli were made by hand cutting using double-edged razor blades. Sizes of vegetative organs were studied under the compound microscope using an ocular meter. Microscopic measurements were recorded in micrometer (µm) using the ocular meter. All materials prepared for observations are deposited in the Herbarium of the Department of Marine Science, Sittway University.

The useful and important characteristics, vegetative (external and internal) and reproductive structures were photographed under the light microscope with a digital camera and the observed results from digital photographs are processed by Adobe Photoshop CS5. This study has basically followed the classification system used by Lee (2008) and Guiry and Guiry (2022). Potential uses of these algae were recorded from the literature available.

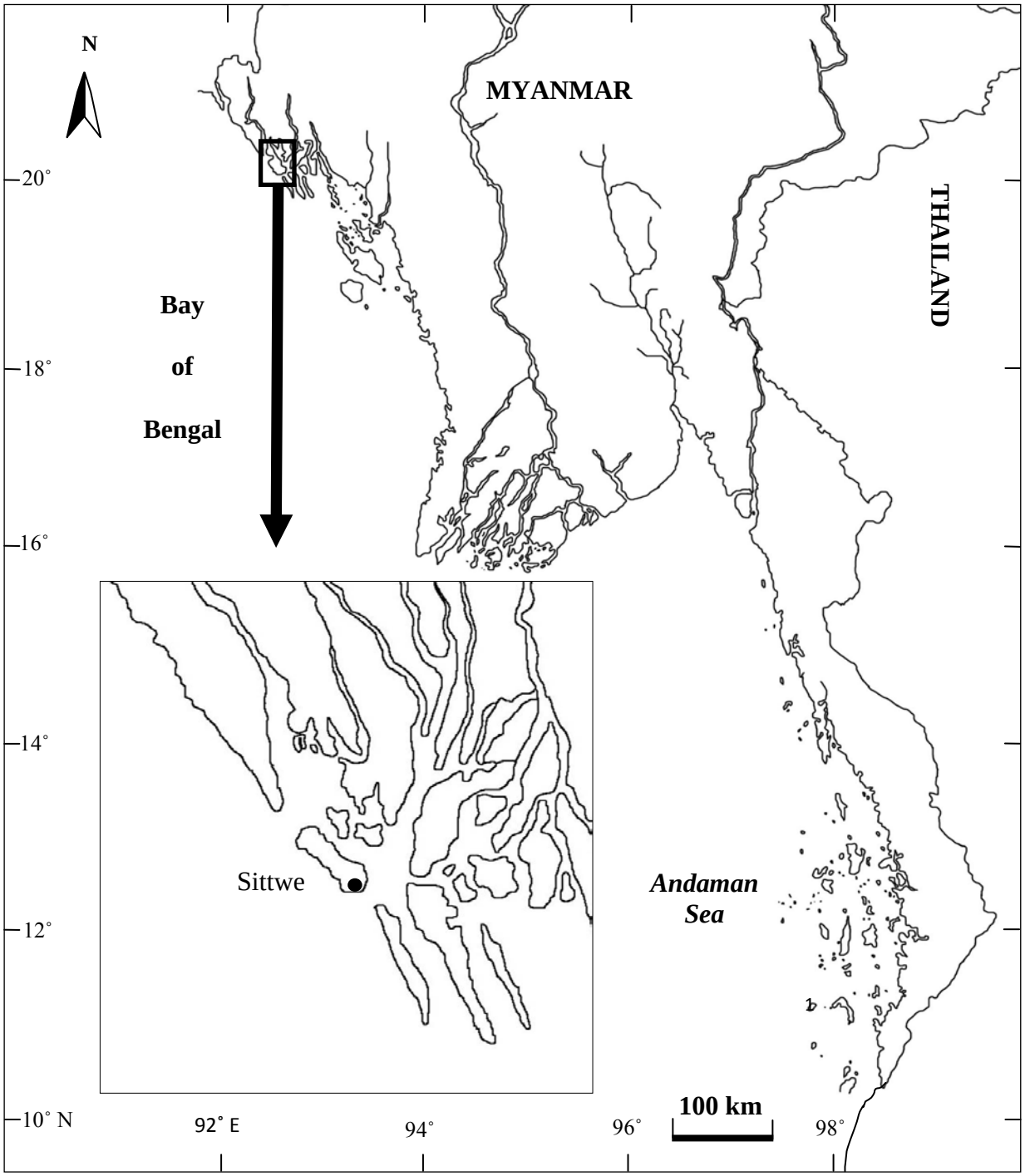


Figure 1 Map showing the collection sites of the marine benthic algae in Sittwe coastal areas.

Results

Table 1 Classification, Distribution and Potential Uses of Red Algae found and identified from Sittwe Coastal Areas

Phylum	**Rhodophyta**		**Distribution**			**Potential Uses**
Class	**Bangiophyceae**		**R**	**A**	**T**	
Order	I	Bangiales				
Family		Bangiaceae				
Genus		*Bangia* Lyngbye, 1819				
Species	1.	*B.atropurpurea* (Mertens ex Roth C.Agardh, 1824	+	-	-	fodder, fish meal, manure and organic fertilizers
Class	**Florideophyceae**					
Order	II	Gelidiales				
Family		Bangiaceae				
Genus		*Gelidium* J.V. Lamouroux 1813				
Species	2.	*G. pusillum* (Stackhouse) Le Jolis, 1863	+	-	-	fodder, fish meal and manure
Order	III	Peyssonneliales				
Family		Peyssonneliaceae				
Genus		*Peyssonnelia* Decaisne, 1841				
Species	3.	*P. rubra (Greville)* J.Agardh, 1851	+	+	+	fodder and manure
Order	IV	Gigartinales				
Family		Gigartinaceae				
Genus		*Chondracanthus* Kutzing, 1843				
Species	4.	*C. intermedius* (Suringar) Hommersand,1993	+	-	-	raw material for carrageenan production
Family		Caulacanthaceae				
Genus		*Catenella* Greville, 1830				
Species	5.	*C. impudica* (Montagne) J. Agardh, 1852	+	+	-	carrageenan, fodder, fish meal, human foods, manure and salad
Order	V	Gracilariales				
Family		Gracilariaceae				
Genus		*Gracilaria* Greville, 1830				
Species	6.	*G. canaliculata* Sonder, 1871	+	+	+	agar, drugs, fodder, fish meal and human foods
	7.	*G. foliifera* (Forsskal) Boergesen , 1932	+	-	+	agar, drugs, fodder, fish meal and human foods
Order	VI	Rhodymeniales				
Family		Lomentariaceae				
Genus		*Ceratodictyon* Zanardini, 1878				
Species	8.	*C. repens* (Kutzing) R.E.Norris,1987	+	+	-	fodder and manure
Family		Rhodomelaceae				
Genus		*Laurencia* F.Schmitz, 1889				
Species	9.	*Laurencia sp.*	+	+	-	drugs fodder and fish meals
Order	VII	Ceramiales				
Genus		*Polysiphonia* Greville, 1823				
Species	10.	*P. subtilissima* Montagne, 1840	+	+	+	fodder, drugs and agar

* (R= Rakhine Coastal Area, A= Ayeyawaddy Delta and Gulf of Moattama Area, T= Taninthayi Coastal Area)

1. *Bangia atropurpurea* (Mertens ex Roth) C.Agardh, 1824 (Fig.2)

Womersley 1922: 34-36, figs. 3.D-H; Chihara 1970: 57, Pl. 29, Fig. 2; Soe-Htun *et al*. 2009b: 120, fig. 6; Guiry and Guiry 2022.

Description. - Filaments are initially erect, unbranched with single series of cells 10-13 µm broad, becoming more than one cell broad in the upper portion. Each young thalli attached by the lowermost cells; thalli are rose to dark red in colour.

Ecological notes. - Young plants occur in subtidal zones on rhizoids and blades of *Padina antillarum* with *Compsonema serpens.*

2. *Gelidium pusillum* (Stackhouse) Le Jolis, 1863 (Fig.3-4)

Womersley 1922: 133-136, figs. 39. E-K; Taylor 1967: 354-355, Pl. 45, fig. 4; Durairatnam 1961: 50, Pl. 13, figs. 1-5; Smith 1969: 195, Pl. 44, fig. 1; Kyaw Soe and Kyi Win 1977: 103, fig. 179; Soe-Htun *et al*. 2009b: 127, fig. 22; Guiry and Guiry 2022.

Description. - Plants are creeping, small, dense, 13 mm tall, brownish red in colour, forming short loosely tufts. Erect branches are freely branched and compressed to flattened at upper; differentiated into horizontal thread-like, cylindrical, 11mm in diameter and attached to substratum by small attaching pads, branched opposite.

Ecological notes. - Plants are found on rocks and coralline tones in the upper intertidal zones.

3. *Peyssonnelia rubra* (Greville) J.Agardh, 1851 (Fig.5-6)

Dawson 1954: 424, fig. 36c; Abbott and Hollenberg 1976: 371, fig. 310; Kyaw Soe and Kyi Win 1977: 123, fig.216; Soe-Htun *et al*. 2009c: 147, fig.3; Guiry and Guiry 2022.

Description. - Plants are membranaceous, somewhat calcified on the lower side, rose red to deep red; loosely attached by the entire lower face directly or by numerous short rhizoids and with distinct radial and faint concentric lines.

Ecological notes. - Plants found common in most subtidal habitats on dead corals, rocks and other hard surfaces.

4. *Chondracanthus intermedius* (Suringar) Hommersand, 1993 (Fig.7-8)

Yang and Kim 2016: 520-523, figs. 3.a-h; Guiry and Guiry 2022.

Description. – Thalli are cartilaginous and flexible, purplish red to black with bluish iridescence in colour, attached firmly to the substratum by a small discoid holdfast forming a low-growing tuft. Axes are cylindrical at the base and compressed, irregularly branched, strongly recurved, and adhering to each other by a secondary attachment.

Ecological notes. - Plants grow in intertidal zone adhered to exposed rocks.

5. *Catenella impudica* (Montagne) J.Agardh, 1852 (Fig.9-10)

Kyi Win 1972: 7; Kyaw Soe and Kyi Win 1977: 130, fig. 231; Sein Moh Moh Khaing 2012: 87-88, figs. 4.4.3. A-F; Jha *et al*. 2009: 138, figs. a-c; Guiry and Guiry 2022.

Description. - Plants are creeping, complanate-expanded, 1-2 cm high, blackish violet in colour. Branches have 1-3 segments, articulate with irregularly di - or tri-chotomously branched and outsends from the joint; the younger segments slender, with the terminal ones more terete and acute; the older segments broader and more flattened. The segments are elliptical- oblong and strongly constricted at the nodes.

Ecological notes. - Plants grow in intertidal zone adhered to exposed rocks.

Key to the species of *Gracilaria* Grevielle

1a. Branches club- shaped; fronds rounded.....*Gracilaria canaliculata*

1b. Branches fin- shaped; fronds flattened.....*Gracilaria foliifera*

6. *Gracilaria canaliculata* Sonder, 1871 (Fig.11-12)

Hla Hla Cho 1975: 48-59, figs. 40-42; Kyaw Soe and Kyi Win 1977: 134, fig. 239, A.1-2; Soe-Htun *et al*. 2009c: 150-151, figs. 9-10; Guiry and Guiry 2022.

Description. – Fronds are short cylindrical attached by means of a discoid holdfast, constricted below when old, purplish red or dark greenish in colour. The young plants are twisted, creeping, branching and attached to the rocks or other hard substrates; branches up to 20 mm in length and 1-2 mm broad. The mature branches conspicuously articulated with oblong and ovoid segments.

Ecological notes. - Plants grow in exposed places at the littoral zone.

7. *Gracilaria foliifera* (Forsskal) Boergesen, 1932 (Fig.13-14)

Durairatnam 1961: 63, Pl. 31, fig. 2; Taylor 1967: 446, Pl. 55, fig. 1; Kyaw Soe and Kyi Win 1977: 135, fig. 241; Jha *et al*. 2009: 121, figs. a-b; Soe-Htun *et al*. 2009c: 151-152, fig. 11; Guiry and Guiry 2022.

Description. - Plants are compressed, bushy firmly attached to the substratum with a discoid holdfast, brownish to yellowish red or faded in colour. Plants twisted, creeping, branching and attached to the rocks or other hard substrates, branches up to 2 cm in length and 0.1 cm broad. The fronds are conspicuously compressed or flattened throught out the thallus, branched proliferations along the margins or at the upper parts of the branches.

Ecological notes. - Plants occur common on rocks and shells in quiet in the subtidal zones associated with *Laurencia sp., G. canaliculata and G. pusillum.*

8. *Ceratodictyon repens* (Kutzing) R.E.Norris, 1987 (Fig.15-17)

Jha *et al.* 2009: 163, Fig.a; Soe-Htun *et al.* 2009c: 153, fig. 13; Guiry and Guiry 2022.

Description. - Plants are erect and filiform, light red in colour, 4 cm in height, forming extremely dense and dichotomously alternately; branches spread out in subflagellate manner, apex of the segments often narrow, upper segment slender, very well attached to rocks, creeping shoots.

Ecological notes. - Plants occur on the rocks at the subtidal zone associated with *Laurencia sp.* and *G. canaliculata*.

9. *Laurencia sp.* (Fig.18-19)

Description. - Thalli are solitary tufts from a common disc-shaped base, 2 cm tall, dark red to brown in colour. The erect shoots are cylindrical or markedly flattened, 4 mm in height, branching pinnate or radial. The branch tips are blunt and terminating in a small depression containing a single apical cell.

Ecological notes. - Plants occur on solid substrate in the subtidal zone, especially in wave - exposed locations associated with *C. sinuosa.*

10. *Polysiphonia subtilissima* Montagne, 1840 (Fig.20-22)

Soe-Htun *et al.* 2009c: 161, figs. 32-33; Jar San and Soe-Htun 2014: 2-5, figs. 2-18; Guiry and Guiry 2022.

Description. - Young plants are composed of siphons, reddish brown in colour, 2750 µm high; soft, arising from a creeping base; erect filaments divided into two branches below, alternately branched above; attached by scattered unicellular rhizoids.

Ecological notes. - Plants are found on rocks in subtidal zone attached in rocks.

Table 2 Classification, Distribution and Potential Uses of Green Algae found and identified from Sittwe Coastal Areas

Phylum	**Chlorophyta**		**Distribution**			**Potential Uses**
Class	**Ulvophyceae**		**R**	**A**	**T**	
Order	I	Ulvales				
Family		Ulvaceae				
Genus		*Ulva* Linnaeus, 1753				
Species	1.	*U. rigida* C.Agardh, 1823	+	-	-	human foods, drugs and fish meal
	2.	*U. compressa* Linnaeus, 1753	+	+	+	
	3.	*U. flexuosa* Wulfen, 1803	+	+	-	
	4.	*U. clathrata* (Roth) C.Agardh,1811	+	+	+	
Order	II	Cladophorales				
Family		Cladophoracceae				
Genus		*Chaetomorpha* Kutzing, 1845				
Species	5.	*C. linum* (O.F.Muller) Kutzing,1845	+	+	+	fodder, fish meal, human foods and organic fertilizers

* (R= Rakhine Coastal Area, A= Ayeyawaddy Delta and Gulf of Moattama Area, T= Taninthayi Coastal Area)

Key to the species of *Ulva* Linnaeus

1a. Thallus flat lamina, margins of thallus usually slenderly dentate.....*Ulva rigida*
1b. Thallus cylindrical filaments.....2
2a. Thalli are erect, tube-shaped hollow, narrow sheet with ruffled edges…..*U. compressa*
2b. Thallus usually sparsely branched at the base, few small proliferations,
constricted at intervals with tubular blades……..…….……*U. flexuosa*
2c. Thallus usually densely branched from main branches, more proliferations with thin cylindrical blades.....*U. clathrata*

1.*Ulva rigida* C.Agardh, 1823 (Fig.23-24)

Durairatnam 1961: 18, Pl. 1, fig. 1; Kyaw Soe and Kyi Win 1977: 42, fig. 42; Wormersley 1984: 142-144, figs. 44D. 45 G-J; Norris 2010: 39-40, fig. 18; Guiry and Guiry 2022.

Description. - Blades of thalli are dark green in colour, a flat lamina, deeply divides, 1-3 cm height, with folded margins, forming small rounded to orbicular slightly wavy blades with short and thick stipe, surface somewhat crinkled, usually with microscopic teeth along the blade margins, epiphytic on other algae.

Ecological notes**. -** Plants grow on rocks, or other algae in the intertidal pools.

2.*Ulva compressa* Linnaeus, 1753 (Fig.25-26)

Durairatnam 1961: 18, Pl. 1, fig. 7; Taylor 1969: 64, Pl 3, fig. 3; Smith 1969: 52, Pl 5, fig. 7; Guiry and Guiry 2022.

Descriptions. - Thalli are erect, tube-shaped hollow, 4 cm length and 0.2 cm width, narrow sheet with ruffled edges and light to medium green in colour. Thalli are commonly becoming compressed in upper blade, usually much branched near the base.

Ecological notes. - Plants grow on pneumatophores of mangrove trees and mud flat.

3. *Ulva flexuosa* Wulfen, 1803 (Fig.27-28)

Abbott and Hollenberg 1976: 76, fig. 30; Abbott and Huisman 2004: 48-49, figs.6. A-C; Jha *et al*. 2009: 9, figs. a- b; Guiry and Guiry 2022.

Description. - Young thalli are yellowish green in colour, usually unbranched, 3 mm height, simple or occasionally branched at the base, rarely with secondary branches; branches have cylindrical, becoming inflated bent or flexuous, sometimes constricted at intervals, epiphytic on other algae. Thallus is erect and attached to substratum by a small round basal disk.

Ecological notes. - Plants grow as epiphytes on the *P. antillarum* and *G. pusillum* in the upper and middle intertidal zone.

4. *Ulva clathrata* (Roth) C.Agardh, 1811 (Fig.29-31)

Abbott and Hollenberg 1976: 73-74, figs 27-29; Myo Min Tun 2013: 27-29, figs. 4.2.1. A-B; Guiry and Guiry 2022.

Description. - Thalli are light to yellowish-green in colour, profusely branched, 4 mm height, taperingly branched at the base; branches are cylindrical to slightly compressed and repeatedly branched, becoming dense floor, many thin branchlets produced almost throughout. In surface view, cells are in more or less longitudinal series; in narrow portions and either similarly ordered or more arranged in broader older portions.

Ecological notes. - Plants are found in the upper intertidal zones as a densely mat.

5. *Chaetomorpha linum* (O.F.Muller) Kutzing, 1845 (Fig.32-34)

Taylor 1967: 71, Pl 2, fig. 8; Abbot and Hollenberg 1976: 101, fig. 60; Kyaw Soe and Kyi Win 1977: 57, fig. 76; Wormersley 1984: 176, Pl 13, fig. 2; Guiry and Guiry 2022.

Descriptions. - Thalli are rigid, slightly curved, composed of loosely entangled and uniseriate filaments. Surface view of cells are yellowish green in colour, cylindrical in shape, 32-45 µm wide.

Ecological notes. - Plants grow in shallow, sheltered water and mangrove tree trunk in the intertidal zone.

Table 3 Classification, Distribution and Potential Uses of Brown Algae found and identified from Sittwe Coastal Areas

Phylum	**Phaeophyta (Ochrophyta)**		**Distribution**			**Potential Uses**
Class	**Phaeophyceae**		**R**	**A**	**T**	
Order	I	Ectocarpales				
Family		Chordariaceae				
Genus		*Compsonema* Kuckuck, 1899				
Species	1.	*C. serpens* Setchell & N.L.Gardner, 1922	+	-	-	Unknown
Family		Scytosiphonaceae				
Genus		*Colpomenia* (Endlicher) Derbes & Solier, 1851				
Species	2.	*C. sinuosa* (Mertens ex Roth) Derbès & Solier, 1851	+	+	-	human foods, drugs, fodder, fish meal and manure
Order	II	Dictyotales				
Family		Dictyotaceae				
Genus		*Dictyota* J.V.Lamouroux, 1809				
Species	3.	*D. adnata* Zanardini, 1878	+	+	-	alginate, drugs, fodder, fish meal, human food and manure
Genus		*Padina* Adanson, 1763				
Species	4.	*P. antillarum* (Kutzing) Piccone, 1886	+	-	+	the production of a jelly-like sweetmeat, fertilizer, human food

* (R= Rakhine Coastal Area, A= Ayeyawaddy Delta and Gulf of Moattama Area, T= Taninthayi Coastal Area)

1. *Compsonema serpens* Setchell & N.L.Gardner, 1922 (Fig.35-36)

Smith 1969: 110- 111, Pl. 3, fig. 3; Abbott and Hollenberg 1976: 160- 162, fig. 128; Norris 2010: 194- 195, fig. 93; Guiry and Guiry 2022.

Description. - Plants are minute, microscopic size, epiphytic, brownish in colour, lower portion of irregularly branched prostrate filaments with a few endophytic rhizoids attached to host; above erect, unbranched filaments, up to 175 µm tall.

Ecological notes. - Algae are found in intertidal zone as epiphytic and endophytic on *P. antillarum* with *U. flexuosa* and *B. atropurpurea.*

2. *Colpomenia sinuosa* (Mertens ex Roth) Derbes & Solier, 1851 (Fig.37-38)

Arasaki 1871: 34, fig. 103; Setchell 1931: 49, fig.2; Abbott and Hollenberg 1976: 204, fig. 168; Jha *et al*. 2009: 80, figs. a-b; Guiry and Guiry 2022.

Description. - Thallus is hollow, yellowish brown in colour, 4 cm in diameter and attached by a broad basal disc. Thallus surface is smooth and twisted in some portion, filled with seawater when young but broke down later. Young plants are approximately round, becoming flattened, expanded and irregularly convoluted.

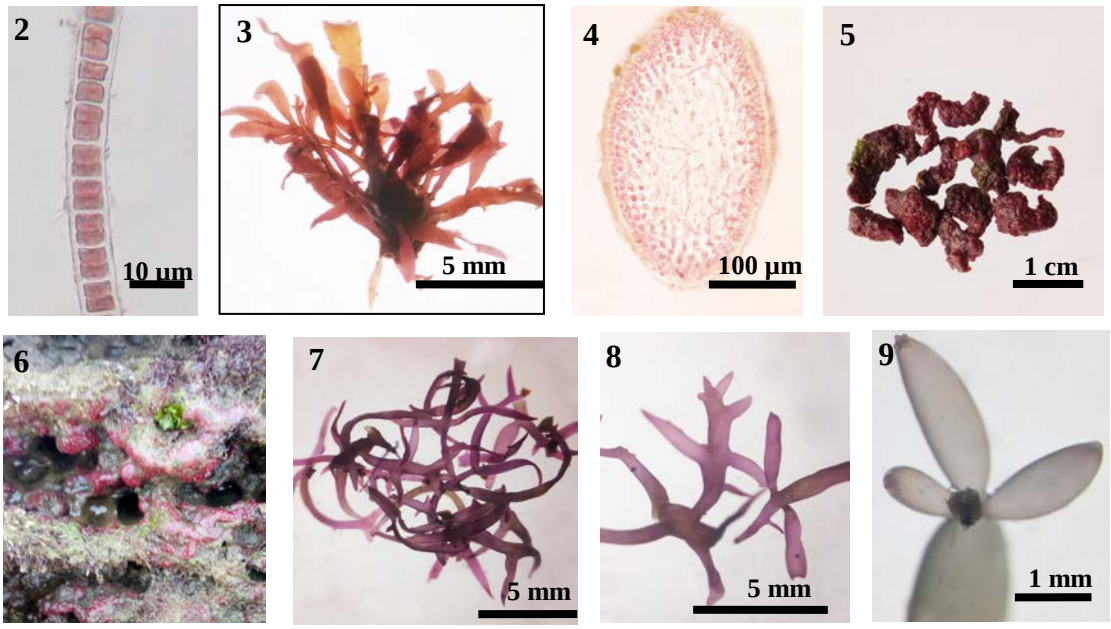
Ecological notes. - Plants are found in intertidal rocks and epiphytic on other large algae such as *Laurencia sp.*

3. *Dictyota adnata* Zanardini, 1878 (Fig.39-40)

De Clerck 2003: 32, fig.7; Soe Pa Pa Kyaw 2008: 19-22, figs. 1-8; Soe Pa Pa Kyaw and Soe Htun 2012: 269-282, figs. 2-9; Guiry and Guiry 2022.

Description. - Branches are 3 cm long, obtriangular, apices obtuse or sometimes acute, non-twisted, margins entire with poliferations and fuscicules of rhizoids arising from the underside margins of thallus. Thalli are dichotomously branches.

Ecological notes. – Plants attached to the pneumatophores of mangrove trees and other substrate in upper intertidal zone.



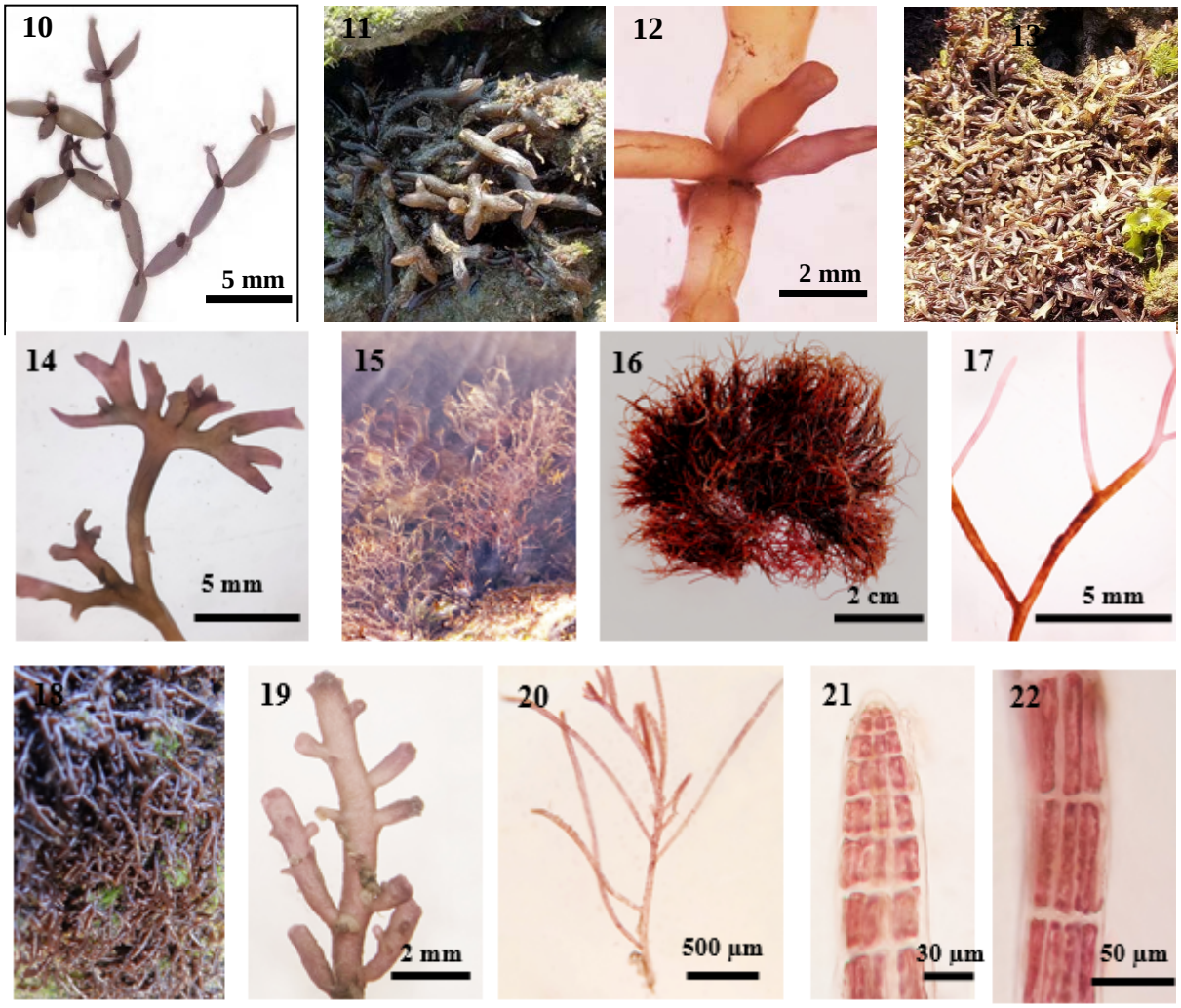


Figure 2-22. The morphological structures of red algae. (2) Erect filament of *Bangia atropurpurea* showing single series; (3) Habit of *Gelidium pusillum*; (4) Cross section showing several axes; (5)-(6) Habit of *Peyssonnelia rubra*; (7)-(8) Habit of *Chondracanthus intermedius*; (9) Branch system showing 3 segments of *Catenella impudica*; (10) Habit; (11) Habit of *Gracilaria canaliculata*; (12) Branch system; (13) Habit of *G. foliifera* (14) Branch system showing flattened thallus; (15)-(16) Habit of *Ceratodictyon repens*; (17) Branch system; (18) Habit of *Laurencia sp.*; (19) Blunt tip of branch; (20) Habit of *Polysiphonia subtilissima*; (21) Tip of thallus; (22)

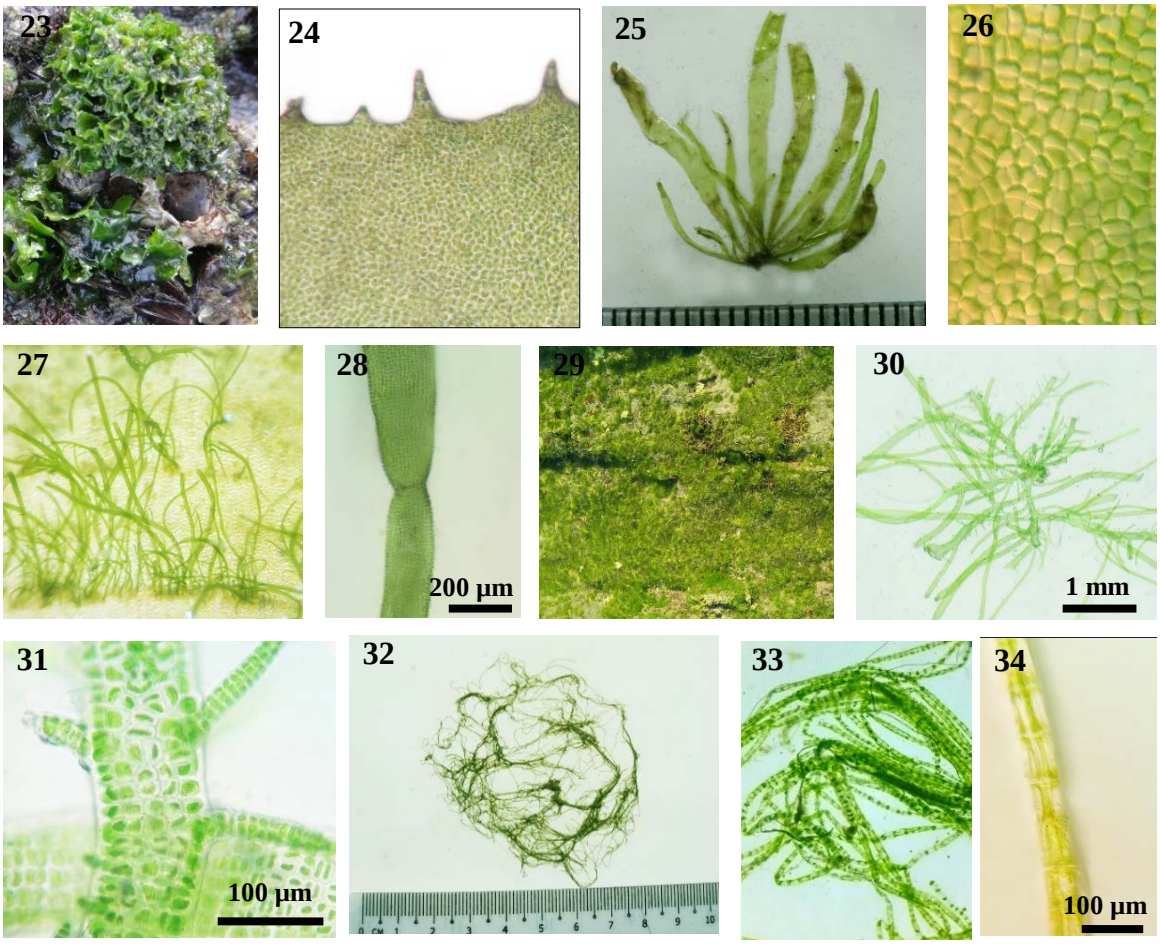


Figure 23-34. The morphological structures of green algae. (23) Habit of *Ulva rigida* (24) Blade margin showing microscopic teeth; (25) Habit of *U. Compressa*; (26) Surface cell; (27) Habit of *U. flexuosa*; (28) Thallus showing constricted at interval; (29) Habit of *U. Clathrata*; (30) Habit showing dense floor; (31) Branch system showing thin branchlets; (32) Habit of *Chaetomorpha linum*; (33)-(34) Surface view of the filaments.

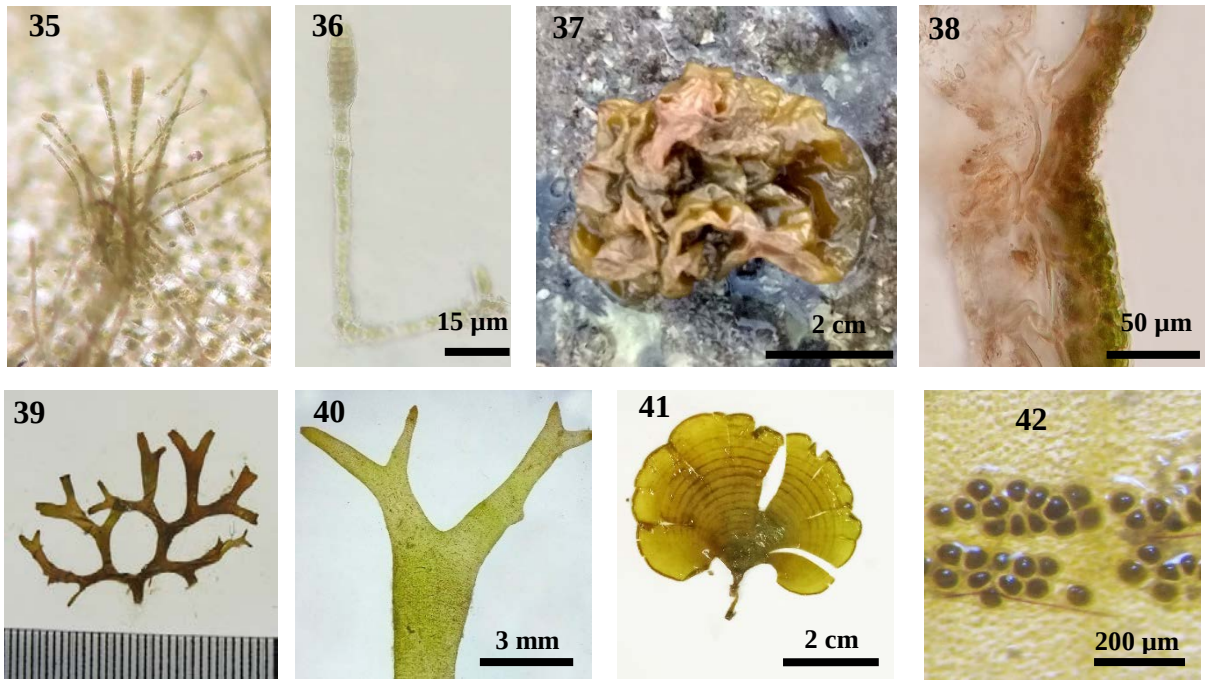


Figure 35-42. The morphological structures of brown algae. (35) Habit of *Compsonema serpens*; (36) Erect filament with terminal plurilocular reproductive structures; (37) Habit of *Colpomenia sinuosa* showing hollow form; (38) Cross section showing 1-2 layers of cortex cells; (39) Habit of *Dictyota adnate*; (40) Dichotomus branches; (41) Habit of *Padina antillarum*; (42) Surface view showing tetrasporangial sori.

4. *Padina antillarum* (Kutzing) Piccone, 1886 (Fig.41-42)

Misra 1966: 158-159, fig. 84; Kyaw Soe and Kyi Win 1977: 80, fig. 130; Wynne and De Clerck 1999: 286-295, figs. 1-10; Soe-Htun *et al.* 2009a: 95-96, fig. 9; Guiry and Guiry 2022.

Description. - Plants are pale yellow to reddish brown in colour, 4-7 cm tall and 4.5- 6.5 cm in breadth developing from rhizomatous disc; fan-shaped lobes. Thallus has two cell-layered in upper portion, three cell-layered in middle portion and four cell-layered or more near the base in mature plant. Margin of the thallus is entire or irregularly separated and deeply split into several lobes with involute margin at the apex. Reproductive organs possess on both sides of each hair line, forming fertile rows, 0.6-1 mm in breadth.

Ecological notes. - Plants are found in the intertidal and subtidal zone with *G. foliifera*.

Discussion

In the present study, the study area was with a salinity range 33-34 ‰, at water temperature 30-32° C. The diversity of a total of 19 species of marine benthic algae belonging to 15 genera, 13 families of 11 orders was recorded from Sittwe coastal areas and identified as *Bangia atropurpurea* (Mertens ex Roth) C.Agardh, *Gelidium pusillum* (Stackhouse) Le Jolis, *Peyssonnelia rubra* (Greville) J. Agardh, *Chondracanthus intermedius* (Suringar) Hommersand, *Catenella impudica* (Montagne) J. Agardh, *Gracilaria canaliculata* Sonder, *G. foliifera* (Forsskal) Boergesen, *Ceratodictyon repens* (Kützing) R.E.Norris, *Laurencia sp*., *Polysiphonia subtilissima* Montagne, *Ulva rigida* C. Agardh, *U. compressa* Linnaeus, *U. flexuosa* (Wulfen), *U. clathrata* (Roth) C. Agardh, Linnaeus, *Chaetomorpha linum* (O.F.Muller) Kutzing, *Compsonema serpens* Setchell & N.L.Gardner, *Colpomenia sinuosa* (Mertens ex Roth) Derbès & Solier, *Dictyota adnata* Zanardini and *Padina antillarum* (Kutzing) Piccone.

Firstly, the distinct characters of *B. atropurpurea* are the presence of erect filaments and unbranched with single series of cells. In 1922, Womersley previously identified *B. atropurpurea* which has a dense mass of flaccid and is basally attached by rhizoids from several suprabasal cells. In the present study, it had not been found densely mass because it was so young. *G. pusillum* are abundantly distributed during the study period. In this study, external morphology, branched systems and internal cell structures of *G. pusillum* are closely similar to those of this plant described by Smith (1969). Kyaw Soe and Kyi Win (1977) recorded *G. pusillum* from Myanmar. Moreover, *P. rubra* can be seen as loosely attached plants to rocks by the entire lower face or by numerous short rhizoids. Thalli of *C. intermedius* are cartilaginous and flexible forms. The characters of *C. intermedius* are closely similar to the observations on this plant by Yang and Kim (2016) especially in presence of recurving axes. The younger segments of *C. impudica* are slender in shape and the older segments are broader and more flattened. The two species of *Gracilaria* such as *G. canaliculata* and *G. foliifera* can be recorded in the present study. Fronds of the former species are short and cylindrical and attached by means of a discoid holdfast. Plants of the later species are twisting, creeping and branching, and attached to the rocks or other hard substrates. In *Laurencia sp*., the tips of branch are blunt and terminate in a small depression containing a single apical cell. The prominent features of *P. subtilissima* are the presence of soft and erect filaments divided into two branches. In surface view, thallus has usually one per segment with reddish brown in colour and square to elongate in shape.

In Chlorophyta, the wavy blades of *U. rigida* usually have microscopic teeth along the blade margins and are epiphytes on other algae. The presence of microscopic teeth along the blade margins is an identical factor in the description of Norris (2010).

Thalli *of U. compressa* are commonly becoming compressed in upper blade, usually much branched near the base. Thalli of *U. flexuosa* are becoming inflated, are bent or flexuous forms, sometimes constricted at intervals in the present study. The information from the field is identically similar to the observations of Jha *et al.* (2009). Thalli of *U. clathrata* are taperingly branched at the base and cylindrical to slightly compressed in shape. The records are closely similar to observations of young plants of these plants by Abbott and Hollenberg (1976). Thalli of *C. linium* is rigid, slightly curved, composed of loosely entangled and uniseriate filaments.

In Phaeophyta, plants of *C. serpens* are minute and microscopic size. The growth forms and physical features mentioned above are identically alike to the observations by Abbott and Hollenberg (1976), and Norris (2010). They described the presence of terminal plurilocular reproductive structures of that plant. Plants of *C. sinuosa* are filled with air and irregularly lobe vesicles with corrugated surface. The morphology of inner cells and shape of cells is closely related to the descriptions of Abbott and Hollenberg (1976), Kyaw Soe and Kyi Win (1977) and Abbott and Huisman (2004). Branches of *D. adnata* are obtriangular, apices obtuse or sometimes acute, non-twisted, margins entire with poliferations and fuscicules of rhizoids. Plants of *P. antillarum* are pale yellow to reddish brown in colour; fan-shaped lobes. Reproductive organs possess on both sides of each hair line, forming fertile rows, 0.6-1 mm in breadth. The reproductive patterns of present study agree well with the key to species by Wynne and De Clerck (1999) and Misra (1966). In Myanmar, Mya Kyawt Wai (2008) also studied the vegetative and reproductive structures of *P. antillarum*.

Conclusion

Sittwe is the ordinary plentiful seaweeds comparatively other places. Seaweeds were richly growing along the Sittwe Point because of abundance of rock reefs. Conspicuously *C. serpens* can be seen as epiphytes in Sittwe Point. The most overflowingly seaweeds of Sittwe coastal area are *G. pusillum, G. canaliculata, G. foliifera, C. repens, Laurencia sp., U. clathrata, U. rigida, C. sinuosa* and *P. antillarum*. And then *B. atropurpurea, P. subtilissima, U. flexuosa* and *C. serpens* could be searched as epiphytes or parasites on other large algae. Moreover, *P. rubra* was found by firmly attaching to rocks in the field. Moreover, *U. compressa*, *C. linum* and *D. adnata* were found in the pneumatophores of mangroves in this study. They are also important food sources for different animals such as snails, sea urchins, crabs, fish, sea turtles and so on. *Catenella spp*., locally known as "Kyaukpwint" has been utilized as traditional sea vegetable in Myanmar (Soe-Htun *et al*. 1999). Finally, seaweeds play an essential role around the world and are saving the life of animals.

Acknowledgements

I would like to express my gratitude to Dr. Khin Maung Zaw, Rector of Sittway University; Dr. Khin Thet Kyaw, Dr. Mi Mi Gyi, and Dr. Kyaw Win Oo, Pro-Rectors of Sittway University for permitting to do this research works. I am deeply beholden to Professor Dr. Mya Kyawt Wai, Head of Department of Marine Science, Sittway University for her suggestion and for giving departmental fulfilments.

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