

SEAWEED FLORA OF THE ST. MARTIN'S REEF, BANGLADESH

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Abstract

St. Martin's Reef (SMR) about 14 km west of the St. Martin's Island, Teknaf, Cox's Bazar, Bangladesh was not known during last over 50 years of seaweed researches. Recent six collections made with the assistance of Bangladesh Navy revealed 8 seaweed species which are *Pterocladia maribagoensis* Boo and Geraldino, *Hypnea spinella* (C. Agardh) Kützinger, *Peyssonnelia polymorpha* (Zanar.) Schmitz, *Jania pumila* Lam., *J. unguata* f. *brevior* (Yendo) Yendo (Rhodophyta); *Caulerpa racemosa* var. *clavifera* (Turner) Bosse, *Bryopsis plumosa* (Huds.) C. Ag. and *Halimeda tuna* (Ellis & Solander) Lam. (Chlorophyta). Of these six seaweeds such as *Pterocladia maribagoensis* Boo et Geraldino, *Hypnea spinella* (C. Agardh) Kützinger, *Jania pumila* Lam., *J. unguata* f. *brevior* (Yendo) Yendo, *Bryopsis plumosa* (Huds.) C. Ag. and *Halimeda tuna* (Ellis & Solander) Lam. have been newly recorded and described from the SMR in Bay of Bengal (Bangladesh territory). Presence of *Peyssonnelia polymorpha* and *Bryopsis plumosa* in the collections and physical and chemical water environments recorded indicated it as a true newly forming reef. The present illustrated account is however may be considered as base-line information on seaweed flora of the new SMR in the North-east Bangladesh coast. A total of six seaweeds have been newly recorded making the total seaweeds to 216 mostly from the SMI and nearby SMR.

Introduction

A total of 210 seaweed species (some as new var. and species from the St. Martin's Island and brackish water, Bangladesh) have been recorded from Bangladesh coast mostly from the SMI (Aziz, 1997, 2001, 2016; Aziz and Alfasane, 2020; Aziz and Islam, 2008; Aziz and Islam. S., 2009; Aziz and Rahman, 2010, 2011; Aziz *et al.*, 2001, 2002a,b, 2004, 2008a,b, 2009, 2015; Islam, 1976; Islam and Aziz, 1982,1986; Islam *et al.*, 2002, 2004; Islam S *et al.*, 2010). Occurrence of St. Martin's Reef (SMR) about 14 km west of the St. Martin's Island was known in the year 2013 (Fig. 1) during studying sub-littoral seaweed flora with the assistance of Bangladesh Navy and has been explored.

Along some of the continental shelves Reefs (special structure) develop as an elevated structure from rocky sea bottom, no deeper than 50 m and rises at or near the surface of water at temperature just above 20° C, high water transparency and water movement but low nutrient status *i.e.* oligotrophic (Castro and Huber, 2003).

Diaz-Pulido *et al.* (2007) identified three types of functional seaweed groups interact in reefs: (i) algal turfs, (ii) fleshy macroalgae or seaweeds and (iii) crustose calcareous algae. A total over 600 species are occurring on the Great Barrier Reef (Diaz-Pulido and Mc Cook, 2008). Encrusting coralline algae are the glue that holds the reef together (Castro and Huber 2003).

Alacranes Reef (Mexico) was found to be composed of 35% *Halimeda*, 8% Coralline algae, 29% Corals, 8% Mollusks, 6% Foraminifera, 1% miscellaneous skeletal grains, 9% fecal pellets and 4% aggregates dry volume, indicating about 50% contribution by seaweeds. Like corals,

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coralline red algae produce a “skeleton” of calcium carbonate and encrusting coralline algae (*Lithothamnion*) grow in rock-head sheets over the reef (Castro and Huber, 2003). Sidik *et al.* (2012) reported a total of 16 common seaweeds from a Malaysian coral reef at Pulau Bidong Laut and of these seven were Rhodophyta (*Acrochaetium* sp., *Hypnea* sp., *Ceramium* sp., *Laurencia* sp., *Polysiphonia* sp., *Acanthophora* sp. and *Herposiphonia* sp. not much calcified); six Chlorophyta (*Rhizoclonium* sp., *Cladophora* sp., *Enteromorpha* sp., *Caulerpa peltata*, *C. racemosa* var. *peltata* and *C. serrulata*) and three Phytophyta (*Dictyota bartayressi*, *D. indica* and *Padina commersonii*)

In a scientific expedition Tsuda *et al.* (2015) recorded 30 red algae, 24 green algae and 5 brown algae many of them were small sized from Seamounts along the Mariana Islands, Western Pacific, covering Pathfinder Reef, Arakan Reef, Santa Rosa Reef, Tatsumi Reef, Supply Reef, etc.

The St. Martin’s Reef is very young, visible only at lowest low tide as two rocky heaps of about 3 and 4 m² and first of its kind reported along Bangladesh coast only recently. Several physical and chemical factors of the location along with an illustrated account of eight seaweeds (few more are to be worked out) from the reef have been included in the result that will serve as a base-line data for future researches and development.

Materials and Methods

Studies were carried out on the seaweed specimens collected from St. Martin’s Reef on 24 April 2014, taking a complete support from the Bangladesh Navy and its Scuba diving team equipped with underwater Communication systems. The SMR is situated at 20° 33’ 24” - 20° 34’ 48” N and 92° 10’ 24” - 92° 11’ 12” E, about 14 km west of the SMI (Fig. 1). The larger southern heap is wide northerly and narrowed southerly. The SMR is visible only at low tide as two rocky heaps of about 3 and 4 m² in a nearly north-south direction. The rocky floors between the two heaps were whitish with red colour here and there. Boulders were predominantly round with abundant calcified seaweeds and flat corals having typical polygonal polyp zones.

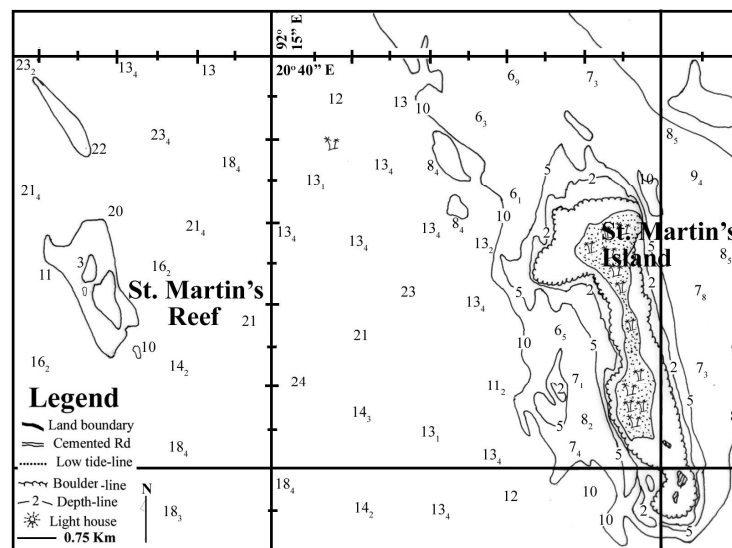


Fig. 1. Map of the St. Martin’s Reef, a long arrow-head like structure (in the left), about 14 km west of the Narikeldia, St. Martin’s Island.

Collected seaweed samples were taken in transparent polythene bags filled with seawater, kept in icebox, transferred to laboratory, preserved in 10% formalin and herbaria were prepared. All the preserved specimens and herbarium sheets are kept in the National Professor AKM Nurul Islam Laboratory, Department of Botany, University of Dhaka. Several physical and chemical factors of the location were determined (Table 1). Low Turbidity (0.23 NTU), >5.5 m Secchi depth (visibility) and 22% light penetration up to 1 m depth indicate a highly transparent water. Water temperature was 28° C on 24 April 2014 (summer period, Table 1). During December and January the temperature may go down to about 20° C.

Table 1. Physical and Chemical parameters of St. Martin's Reef, Bangladesh.

pH (Hanna pH meter)	8.0
Salinity (‰, Refractometer)	36.0
Turbidity (NTU, Turbidity meter)	0.23
Secchi depth (m, Secchi disc)	>5.5
Light penetration (1m depth, Li-Cor, USA light meter)	22%
Temperature (° C, Thermometer)	28.0
TDS (mg l ⁻¹ , Aqua TDS meter)	37.0
Conductivity (µS/cm, Aqua conductivity meter)	38.5

Results and Discussion

Occurrence and illustrated account of eight seaweeds in the St. Martin's Reef, are presented in the present paper. An illustrated account of the two groups of seaweed taxa recorded from the St. Martin's Reef along with discussion against each taxon is given. Of the eight seaweeds recorded six are recorded as new making the total number of seaweeds to 215, mostly from SMI.

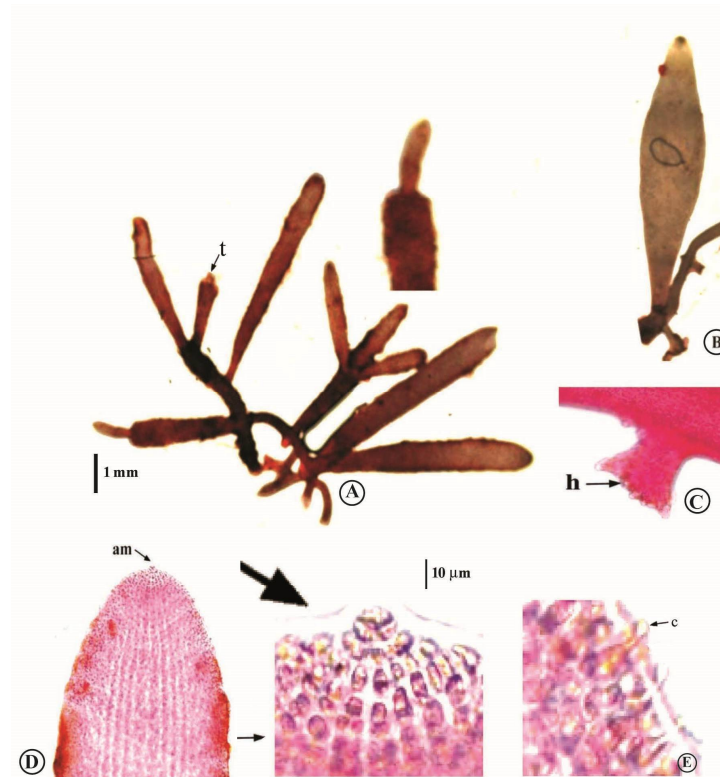
RHODOPHYCEAE

Order: Gelidiales; Family: Gelidiaceae;

Genus: *Pterocliadiella* Santelices et Hommersand

1. *Pterocliadiella maribagoensis* Boo and Geraldin (Figs 1A-E)
(Boo and Geraldino 2016, 239-248, Figs 1-9)

Plants small, forming loose turfs or solitary; cartilaginous, brownish-red or purplish-red when wet but black or blackish-red when dry, extensive creeping base the rhizome giving rise to erect blades up to 8 mm long, about 1 mm broad, sub-cylindrical below, branches trichotomous and sparsely pinnate proliferations with apical cell (representing uniaxial growth). Each branch possesses haptera from the lower side of rhizomes 180- 300 µm broad (Figs 1A-D); central part composed of slender colorless filaments with exceedingly thick confluent walls, surrounded by the inner cortex of short, large cells and the epidermal layer of rounded angular cells slightly elongated lengthwise of the axis, about 4-10 µm surface diameter; tetrasporangial sori are formed at the tip of branches as cylindrical structure about



Figs 1A-E. *Pterocladia maribagoensis* Boo and Geraldino: A) A tetrasporic whole plant showing erect dichotomous and trichotomous branching systems, some branches with developing and developed tetrasporangia enlarged; B) A part of gametophytic plant with leafy erect branch; C) Highly enlarged hapteron with little spiky projections; D) Single layered with apical meristem, enlarged on the right hand side (arrow); E) A side highly enlarged showing three carpogonia. (am= apical meristem, c= carpogonium h= hapteron, t= tetrasporangia).

one-third the diameter of branches (Fig. 1A); branches may be flat and look like a leaf, about 2 mm broad, apices sometimes spoon-shaped, sharply thinner than the main axis/branch where tetrasporangia are formed (Fig. 1B). Tetrasporangia are initially in fairly regular rows, later becoming scattered.

Habitat: It is attached on rocky substratum.

Collection no. 1A (14), It is a new record for Bangladesh territory.

Order: Floridiophyceae; Family: Gracilariales

Genus: *Hypnea* Grev.

2. *Hypnea spinella* (C. Agardh) Kützinger

(Figs 2A-E)

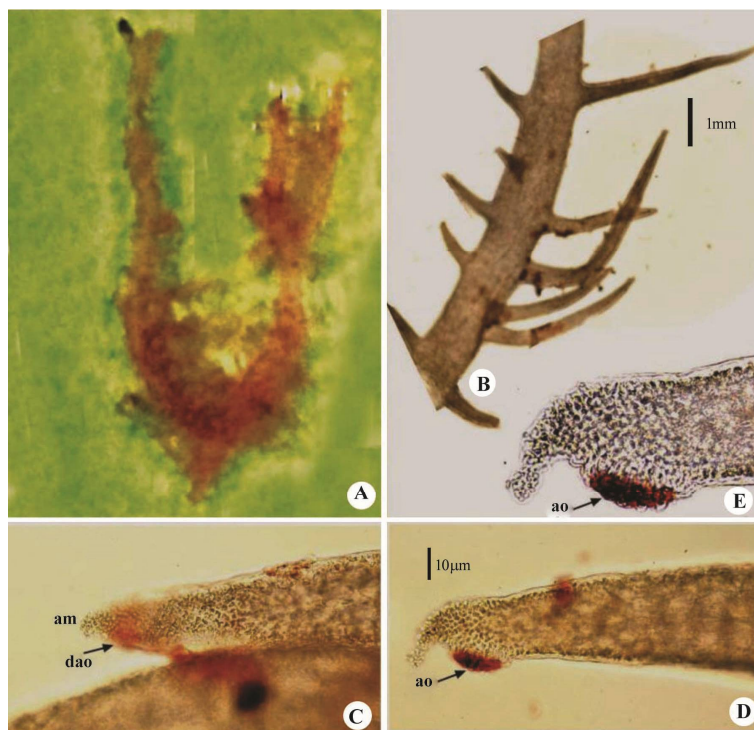
(Joly 165, Pl. XXVII, Fig. 375-376)

Plants usually very bushy, developed from a small discoid base, thallus about 4.5 cm tall and 0.75 mm broad, fleshy-cartilaginous, profusely branched, tip pointed with acentric apical meristem; purplish-violet in colour; cell wall thickened, small in the peripheral region but gradually larger

cells towards the center, multiaxial; the outer cell rows radiating (Figs 2A-D); tips of branches slightly curved with several small apical meristem cells, apex look like mouth and head portion of a seahorse and attachment organ develops a bit behind (Figs 2D)

Habitat: Grows on boulders along with *Gelidium pusillum* and *Jania ungulata*. They remain strongly attached with the substratum by attachment organ near the tip region.

Collection no. 1A (14), It is a new record for Bangladesh territory.



Figs 2 A-E. *Hypnea spinella* (C. Agardh) Kütz.: A) A part of the plant with minute branches; B) A branch enlarged showing spiny secondary branches; C) A branch tip showing apical meristem cells and formation of attachment organ (dao), stained red; D-E) Branch tip with attachment organ just behind the apex, note larger empty looking areas representing several axial cells. (am= apical meristem; ao = attachment organ, dao = developing attachment organ).

Family: Peyssonneliaceae

Genus: Peyssonnelia Decaisne

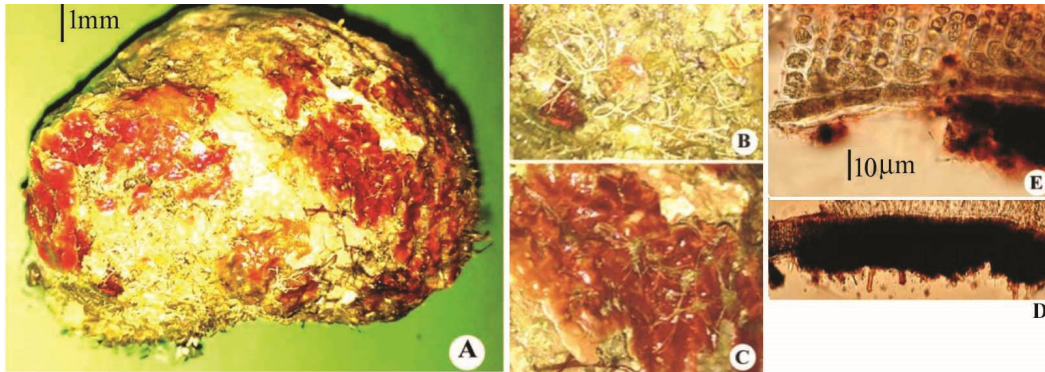
3. *Peyssonnelia polymorpha* (Zanar.) Schmitz

(Figs 3A-E)

(Aziz 1997, 81-83, Figs. 1-4)

Plants have fan-shaped frond, commonly overgrown on another, margin free, sometimes lobed; fronds nearly 2 mm in diameter, brittle due to thick encrustations on the lower surface and thin on the upper surface, upper surface with concentric zones, wavy to deep slope, rosy-red to brownish-red in colour; adhere to small boulders with almost whole of their lower surface with a plenty of rhizoids (Figs 3A-E); large hypothallus cells in two rows giving rise to usually dichotomously branched vertical filaments; upper perithallus layer formed of juxtaposed filaments

borne upon these, gives rise of two celled thick filaments rising from one hypothallus cell, becoming erect and closely laterally united.



Figs 3A-E. *Peyssonnelia polymorpha* (Zanar.) Schmitz: A) A boulder showing epilithic red seaweeds; B) *Peyssonnelia polymorpha* cementing *Jania unguolata*; C) Mature *Peyssonnelia* covering the *Jania*; D) A vertical section enlarged showing dichotomous branches from hypothelial cells with epithelial filament; E. A vertical section shows the upper part of the thallus produced into sporangial swelling consisting of paraphyses and several rhizoids develop crossing calcified lower part.

The species differs from other species mainly by its calcification. In *P. rubra* develops non-calcified membranous thallus but *P. polymorpha* is calcified. This appears to be most common calcified bright-red coloured alga found in St. Martin's Island, Bangladesh (Aziz, 1997) even up to a depth of 13 m. The alga was found to be encrusting on small boulders covering *Jania unguolata* (Figs 3A-C) increasing the size of the boulders every year. In other words it helps in building the coral reef.

Habitat: They are found on small boulders covering *Jania unguolata*.

Collection no. 1B (14).

Genus: *Jania* Lam.

4. *Jania pumila* Lam.

(Figs 4A-D)

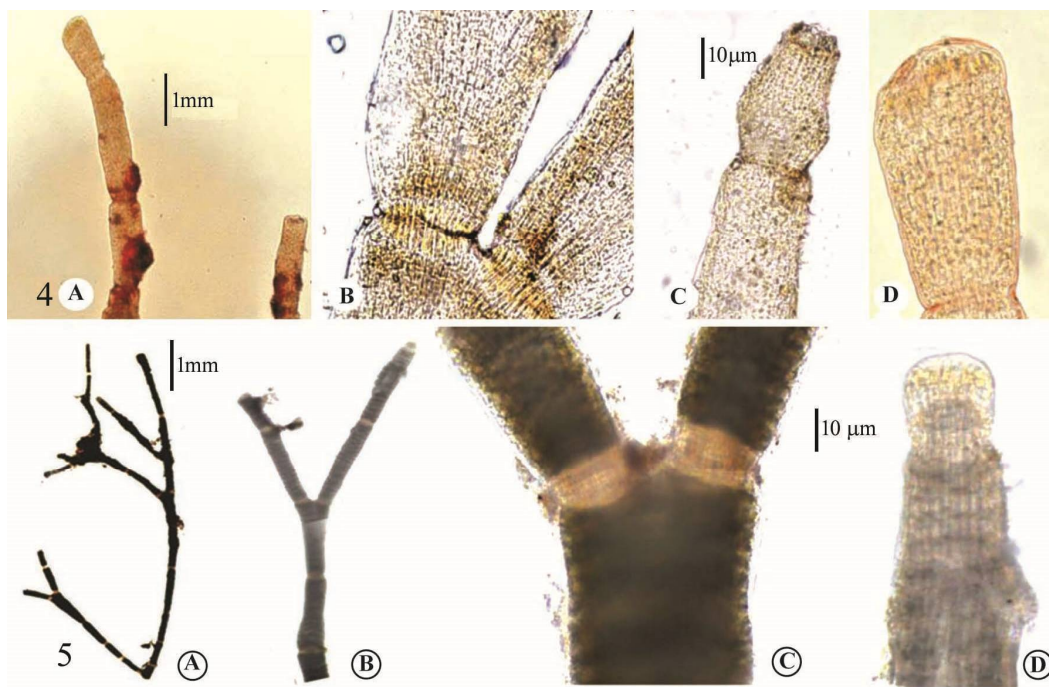
(Taylor 1960, 414, Pl. 49, Fig. 5)

Plants pulvinate, caespitose or forming extensive mats, 2-5 mm tall, dichotomously branched, diameter of the branch axis ranges from 155- 245 µm angles rather acute, forking at the joint, constriction region present, 114 µm in diameter, segments commonly 8-20 times as long as broad, prominently swollen at the ends, terminal dichotomy base diam. 104 µm and terminal part 122 µm., parent cell of dichotomy is about 400 µm long, segments become shorter distantly, last dichotomy length 176 µm and diameter ranges from 60 to 70 µm, structure of the articulations similar but the cell wall thicker, plants sterile (Figs 4A-D).

This species has been considered as *Jania pumila*. Dimension, nature and dichotomy are close to the species.

Habitat: Forms wide loose mat on rocky substratum.

Collection no. 3A (14), *Jania pumila* Lam. is a new record for Bangladesh territory.



Figs 4A- D. *Jania pumila* Lamx. (Upper row): A) Upper part of a plant showing branching pattern; B) Base of branches part showing articulation; C-D). Tip characteristics. Figs 5A-D. *Jania unguolata* f. *brevior* (Yendo) Yendo (Lower row): A) A whole plant; B) Showing enlarged segment of a plant; C) Enlarged segment showing dichotomy; D) A growing branch tip showing multiaxial characteristics.

5. *Jania unguolata* f. *brevior* (Yendo) Yendo (Figs 5A-D)
(Islam 1976, 53-54, Pl. 65, Figs. 383-386)

Thallus generally erect from a small basal disk, about 2 mm long, irregularly dichotomously branched, the branches segmented, in between each branching flexible articulations present, articulation single near the basal segment, 2 in the first branch and 3 in the second branch, so articulation number increases in between the branches towards the apex; segment length ranges from 200-800 μm ; branch forming cell 160 μm diameter in upper part and 75 μm diameter in basal parts; segment part cell ranges from 90-160 μm in diameter; eventually thick-walled cells; tip is multiaxial (Figs. 5A-D).

This species is small in size. Other species such *Jania adherens* (1.0-3.5 cm), *Jania rubens* (2.0-6.0 cm) are larger than *Jania unguolata*. This species has few branches. However, the reported species by Islam 1976 had more repeated dichotomous branch. The number of taxa reported appears to be low (8) and this might due to the small size and relatively young reef and scanty sampling due to rough sea having 2 to 5 m wave splashes after every 2 to 3 minutes.

Habitat: Found growing on small boulders forming loose mat along with *Peyssonnelia* where fleshy *Peyssonnelia* works as a cementing agent.

Collection no. 5A (14), It is a new record for Bangladesh territory.

CHLOROPYCEAE

Order: Bryopsidales; Family: Caulerpaceae

Genus: *Caulerpa* Lamx.

6. *Caulerpa racemosa* var. *clavifera* (Turner) Bosse (Fig. 6)
(Islam 1976, 19, Pl. 5, Figs. 40- 41; Taylor 1960, 151-153, Pl. 11, Fig. 89- 90)

Plants wide spreading, with long, coarse branching stolons, stout descending rhizoid-bearing branches are common, erect short branches, not often much crowded on the stolons, irregularly developed photosynthetic erect axes up to 5 cm tall, the branchlet or ramuli stalks 1.5-3.0 mm suddenly developing to a rounded top, generally compressed tangentially with respect to the surface of the frond (Fig. 6). *Caulerpa racemosa* has several varieties which differs from each other by the shape of ramuli. This variety differs from *C. racemosa* var. *uvifera* by short erect branches, ramuli short with clavate to globular up to 1.5-2.0 μm broad.



Fig. 6. *Caulerpa racemosa* var. *clavifera* (Turner) Bosse. (slightly deformed/plasmolysed): An anterior part of the plant, showing an enlarged tip of a rhizome with rhizoids on the lower left and an enlarged inset of the axis in the upper right showing pinnules developing into stalked hemispheres.

Habitat: Found on rocky substratum strongly attached by the rhizoids from the lower surface.

Collection no. 3A (14).

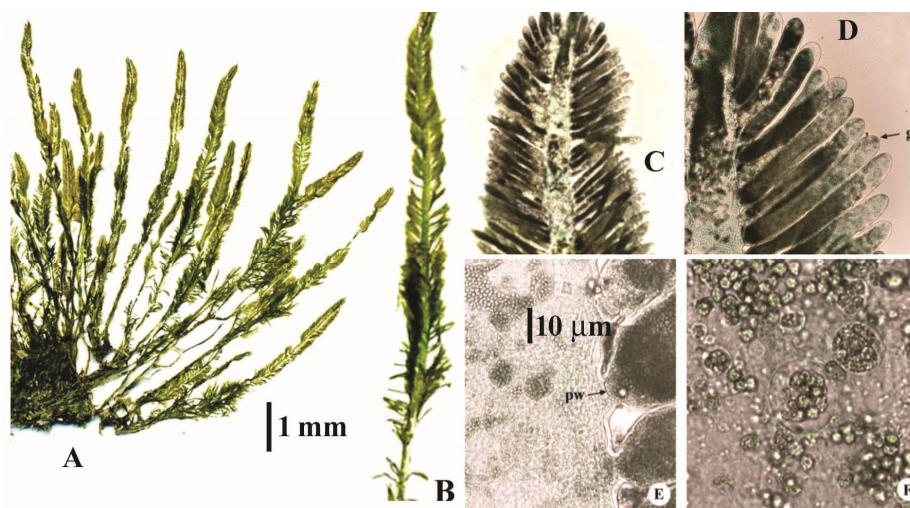
Family: Bryopsidaceae

Genus: *Bryopsis* Lamx.

7. *Bryopsis plumosa* (Huds.) C. Ag. (Figs 7A-F)
(Taylor 1960, 131- 132, Pl. 9, Fig.11)

Plants erect, tufted, about 5 cm. tall, 2.5 mm in diameter, light to olive green; the axis often naked below producing plumule-like branchlets oppositely at regular interval forming exactly feather-like structure; branchlets sharply constricted at the base, obtuse at the apex, simple, maximum length 2.0 mm and 200 μm broad; basal end of the main axis produces as many as 7

rhizoidal branches for attachment to semisolid substratum (Figs. 7A-B) all branches differentiated into gametangia during April; maximum width of the main axis 500 μm ; from the base of the axis during gametangial phase two branches developed from about 1.3 cm above. In other species of *Bryopsis*, branchlets may be very short and inconspicuous (*B. ramulosa*); more or less linear-triangular with 1-2 rows of branchlets (*B. pennata*). But in *B. plumosa*, plants having longer and conspicuous branchlets giving a characteristic lanceolate frond structure. This species shows prominent cross walls with constricted base separating it from the main axis (Fig. 7E). Chloroplasts show divisions within membranes packets (Fig. 7 F).



Figs 7A-F. *Bryopsis plumosa* (Huds.) C. Ag.: A) An one-half of a bush of the plant where un-branched feather-like assimilatory filaments developed; B) A single plant (lower part not shown) showing pinnule; C) A branch-tip showing opposite pinnules; D) Pinnules enlarged showing partition wall at the base of pinna indicating gametangia(g); E) A portion of the plant highly enlarged showing partition walls (pw) at the base of gametangia; F) Division of chloroplasts and release in the axis.

Habitat: Loosely attached with the substratum by several rhizoids, no calcification occurs; do not play a direct role in reef formation. But has an important role in primary productivity. This species is an indicator species for reefs.

Collection no. 6A (14), *Bryopsis plumosa* (Huds.) C. Ag. is a new record for Bangladesh territory.

Family: Halimedaceae

Genus: *Halimeda* Lam.

8. *Halimeda tuna* (Ellis & Solander) Lam.

(Figs 8A- B)

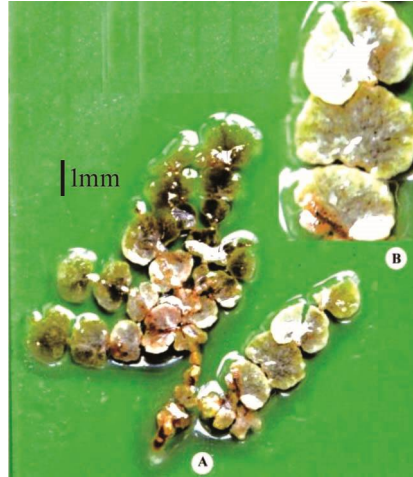
(Taylor 1960, 178-179, Pl. 24, Fig. 5)

Plants erect from holdfast, total length 2.5 cm, branched segmented with fragile joints, segments length ranges from 1.75- 2.5 mm and width 1.5- 4 mm, 5 to 20 erect branches compact or somewhat loose in orientation, arising in more than one plane from successive segments; calcification moderate to heavy, terminal segments may remain greenish due to incomplete calcification; colour on drying white or greenish, surface dull with naked eye but glossy with fine honey-comb structure under dissecting microscope; segments variable, large flat hemispherical

with upper margin entire in distal parts, small undulate or conical in proximal parts (Figs 8A-B). Branches of this plant originate at random, not in one plane. This characteristic feature differs from another species of the this genus. *H. scabra* arise from a stalk and highly differentiated.

Habitat: Grows on boulders, due to its highly calcified nature plays a direct role in reef formation.

Collection no. 2B (14), It is a new record for Bangladesh territory.



Figs 8A-B. *Halimeda tuna* (Ellis & Solander) Lam. showing calcification: A) A whole plant; and B) A segment enlarged.

The total number of reef algae collected from St. Martin's Island is small, which may be due to small number of collections or due to very specific characteristics of the Reef environment that limits the seaweed diversity. Literature search also indicated the presence of smaller number of seaweed species in Reefs around world. Predominance of calcareous and coralline algae indicate reef environment and acting as the cementing organisms in the formation of a Reef. The present illustrated account is however, may be considered as base-line information on seaweed flora of the new Reef.

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