Morphotaxonomy and Distribution of Marine Green Algal Flora in Kalegauk Island

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Abstract: The marine green algae were collected from Apor Seik, Pashyu Chaung, Chaytoryar Pagoda, Alè Seik, Auk Sei, and Kyunn Pyet or Cavendish Island along the Kalegauk Island from September 2016 to January 2017. In the study areas, salinity range and temperature regimes seawater were 26-27 ‰ and 29° C to 31° C, respectively. Mainly the present study had been made to know the diversity and distribution of marine green algae along the Kalegauk Island. Marine green algae were identified based on their internal and external morphological characters. The total 14 species could be recorded in Kalegauk Island. Of these species, almost all species were first new records for Kalegauk Island. Also, it was concluded that all species would be the most diverse and abundant in Apor seik. Moreover, the present study could provide evaluating the impacts of marine green algae resources caused by infrastructures in the future.

Keywords: Morphological characters, Kalegauk, New record, and green algae.

Introduction

Marine benthic green algae are usually found in the intertidal zone and in shallow waters where there are plenty of nutrients and sunlight. Green algae usually appear in green because they contain the same ratio of chlorophyll a and b as that of higher plants. Hence, it is generally believed that green algae are closely related to terrestrial higher plants in the theory of biological evolution.

Kalegauk Island is the island in Ye township, Mon state, Myanmar. It is located in the northern part of the Andaman Sea, 8.25 km from the coast of Mon. The island has a long shape with a length of over 10 km and a width of 1.6 km in its most extensive area, and there is a small Cavendish island lies 0.5 km off the southern point of Kalegauk Island. It is mainly composed of four villages, viz., Apor Seik Village, Auk Seik Village, Alè Seik Village and Pashyu Chaung Village. Also, Chaytoryar Pagoda is also one of the most famous places in Kalegauk Island. Mangrove forests rather than rocky shores generally cover the coastal areas of the Kalegauk Islands. The coastlines of Kalegauk Island dominantly comprise oovered by mud, silt and clay and many capes or promontories on these areas. In the study areas, salinity range and temperature regimes seawater were 26-27 ‰ and 29° C to 31° C, respectively. Nowadays, Kalegauk Island has been declared as the island to be constructed deep sea port.

Therefore, the primary objective of the present study is to record the diversity and distribution of marine benthic green algae from Kalegauk Island with their morphological characters. As a result, this study will become primary in providing data for further observing on the marine green algae of Kalegauk Island.

Materials and methods

Marine green algae were collected in the forms of drift and live specimens growing in the high tide line, intertidal and shallow subtidal areas from Apor Seik, Pashyu Chaung, Chaytoryar Pagoda, Alè Seik, Auk Sei and Kyunn Pyet from September 2016 to January 2017. The site location, topography, associated flora and fauna and other related parameters of Kalegauk Island were recorded. In the field, all the adhering materials such as sand particles and other debris as well as epiphytes were removed from the samples with the help of painting brush before preservation. The seaweed samples preserved 4% formaldehyde with seawater. All the bags and containers were labeled with the date, time of collection, locality and transport to the laboratory of Marine Science Department for further analysis.

In the laboratory, color and morphological differences between different genus, species and taxonomic characters firstly studied and then the collected seaweeds had been identified with emphasis on the external and internal morphologies of vegetative and reproductive features. For internal details studies of the thallus-cross-sectionion (c.s) were obtained free-hand and with shaving blades, then stained in Aniline Blue (0.5 g water soluble aniline blue in 100 ml distilled water and 5 ml conc. Acetic acid) and mounted in glycerine. Vegetative and reproductive structures of the plants were studied under the Olympus compound microscope and Kaneko Yushima dissecting microscope. Microscopic measurements were recorded in micrometer (μm) using the ocular meter. This study followed the classification system of Guiry and Guiry.
Results

Descriptions of marbenthicnctic green algae (Chlorophyta) in Kalegauk Island

Key to the species of Ulva from Kalegauk Island

1a. Thalli tubular, the blade tapering to the base *Ulva compressa*

1b. Thalli unbranched, the blade linear to broad *U. linza*

*Ulva compressa* Linnaeus (figs. 2-6)

*Ulva compressa* Linnaeus 1753: 163. Taxonomic synonyms: *Enteromorpha compressa* (Linnaeus) J. Agardh: Martens 1871: 465; Anand 1940: 11, fig.1A; Dawson 1944: 203; Kylin 1949: 22-23; Yamada 1950: 173; Durairatnam 1961:18, pl.I, fig.7; Soe-Htun 1998: 104; Anand 1940: 28-29, figs. 12A-B; Womersley 1956: 358; Arasaki 1964: 8, fig. 18A-B; Taylor 1967: 63; Soe Pa Pa Kyaw et al. 2009: 45-46, fig.6; Jha et al. 2009: 11, fig. A-C; Soe-Htun et al. 2009: 27A; Guiry and Guiry 2018.

Description. Thalli tubular, gregarious, more or less compressed, dilated towards the apex, tapering to the base, to 1-3 cm tall, greenish yellow. Profusely branched but the branches occasionally branched, branches narrowed to base, similar to centralmbrontond, often with hollow margins. In surface view cells irregularly arranged, polygonal, 12-16 μm long and 12-20 μm wide. In transverse section cells irregularly rounded, 16-20 μm long and 12-16 μm wide. In the upper portion, cells 8-12 μm long and 4-8 μm wide.

Distribution. Apor Seik, Pashyu Chaung, Chaytoryar Pagoda, Àlé Seik, Auk Seik, Kyunn Pyet.

*Ulva linza* Linnaeus (figs. 7-9)

*Ulva linza* Linnaeus 1753: 163. Taxonomic synonyms: *Enteromorpha linza* (Linnaeus) J. Agardh: Kylin 1949: 19-20; Womersley 1956: 358; Arasaki 1964: 8, fig. 18A-B; Taylor 1967: 63; Soe Pa Pa Kyaw et al. 2009: 45-46, fig.6; Jha et al. 2009: 11, fig. A-C; Soe-Htun et al. 2009: 27A; Guiry and Guiry 2018.

Description. Thalli unbranched, silky, often gregarious, up to 2-5 cm tall, yellowish green in color. The blade linear to broad, usually with crisped or ruffled margins and at times spirally twisted, blade alentirely compressed apart from a narrow marginal cavity with the two layers separated by mucilage and moderately adher. The margin of blades frequentlyallow because of separation of the two cell layer. In surface view, cells arranged irregularly, 8-16 μm in diametercross-section cit is usually elongated, two rows, 8-16 μm long and 6-15 μm wide. In the upper portion, cells 8-12 μm and 8-15 μm wide.

Distribution. Apor Seik, Pashyu Chaung, Chaytoryar Pagoda, Àlé Seik, Auk Seik, Kyunn Pyet.

Key to the species of Cladophora from Kalegauk Island

1a. Branches profuse, in curved near the tips and common pseudodichotomous branches *Cladophora vagabunda*

1b. Branches sparse, not in curved near the tips and rare pseudodichotomous branches *Cladophorasp.*

*Cladophora vagabunda* (Linnaeus) Hoek (figs. 10-11)

*Cladophora vagabunda* (Linnaeus): Anand 1940: 28-29, figs. 12A-B; Womersley 1956: 358; Durairatnam 1961: 21-22, pl. II, fig.13; Guiry and Guiry 2018.
**Description.** Thalli of uniseriate branched filaments with apical and intercalary growth, up to 3.5 cm tall, light green in color, composed of pseudodichotomously branched main axis ending in densely branched fasciculate terminal branch systems. In main branches, cells cylindrical, 875-1000 μm long and 75-100 μm wide. Secondary branches, cells 375-625 μm and 50-75 μm wide. Branchlets pectinately arranged and the tip are cells tapering.

**Distribution.** Apor Seik and Alè Seik.

**Cladophora sp. (figs. 12-14)**

**Description.** Thalli, uniseriate branched filaments with apical and intercalary growth, green to dull green color, entathick, bushy, slender-celled filaments contorted, repeatedly dichotomously branched in rock pools in the intertidal zone. Main axis stout, alternately branched, 180-150 μm long and 50-100 μm wide. Branches are sparse and rare pseudodichotomous branches. In lateral branches, the tip are cells tapering, 100-110 μm long and 40-70 μm wide.

**Distribution.** Apor Seik and Alè Seik.

**Chaetomorpha spiralis Okamura (figs. 15-16)**

*Chaetomorpha spiralis* Okamura 1903: 131-132; Arai 1964: 10; fig. 25; Abbott and Hollenberg 1976: 101-103; Kyaw Soe and Kyi Win 1977: 56, figs. 73A1-2; Guiry and Guiry 2018.

**Description.** Plants uniseriate, unbranched, erect, gregarious, dark green in color, slender toward the base and curved toward the back at the top. Cells slightly contracted at the septa, subclavate, 50-100 μm long and 50-90 μm wide. The length of the cells usually 1-2 times that of the diameter.

**Distribution.** Apor Seik, Pashyu Chaung, Alè Seik and Auk Seik.

**Chaetomorpha aerea (Dillwyn) Kützing (figs. 17-21)**

*Chaetomorpha aerea* (Dillwyn) Kützing 1903: 131-132; Arasaki 1964: 10; fig. 25; Abbott and Hollenberg 1976: 101-103; Kyaw Soe and Kyi Win 1977: 55, fig. 74A1-2; Guiry and Guiry 2018.

**Description.** Plants are erect, uniseriate, unbranched, rigid, gregarious, dark green in color, slender toward the base and attached to a basal cell which is below. Cells swell one about 2-3 times that diameter.

**Distribution.** Apor Seik, Pashyu Chaung, Alè Seik and Auk Seik.

**Rhizoclonium curvatum Chapman (figs. 29-34)**

*Rhizoclonium curvatum* V.J Chapman 1949: 406; Womersley 1984: 170, figs. 53E-F; Guiry and Guiry 2018.

**Description.** Plants forming mats, dark green in color, entangled with each other, commonly bent and laterally attached with branchlets. Branchlets 250-300 μm long and 20-30 μm wide, septate, erect and segmented. Cells are stout, 30-40 μm long and 20-30 μm wide.

**Distribution.** Apor Seik, Pashyu Chaung and Alè Seik.

**Rhizoclonium riparium (Roth) Harvey (figs. 35-37)**

*Rhizoclonium riparium* (Roth) Harvey: Kylin 1949: 50; Womersley 1984: 361; Durairevan 1961: 20; pl. 1, fig. 10; Taylor 1967: 72; Kyaw Soe and Kyi Win 1977: 55, fig. 74A1-2; Guiry and Guiry 2018.

**Description.** Plants small, along unbranched filaments, dark green to yellowish-green in color, straight to irregularly curved, sometimes twisted and entangled in thin mats or strands. Cells are cylindrical, 12-28 μm long and 8-12 μm wide. Cells are usually 2-3 times longer than broad. Rhizoids are irregular in position and rare or nonseptate.

**Distribution.** Apor Seik, Pashyu Chaung, Alè Seik and Kyunn Pyet.

**Rhizoclonium grande Boergesen (figs. 38-41)**

*Rhizoclonium grande* Boergesen: Yoshida, Nakajima and Nakata 1985: 60, 1990: 272; Abbott and Huisman 2004: 82, fig. 25A; Soe-Htun et al. 2009: 271; Guiry and Guiry 2018.

**Description.** Plants in small mats or short stands, dyelow-green yellow green in color, straight to irregularly curved. Rhizoidal branches many, long, twisted, septate or nonseptate and tapering toward the tip. Cells elongated, 50-120 μm long and 40-60 μm wide.

**Distribution.** Apor Seik, Pashyu Chaung, Alè Seik, and Kyunn Pyet.

**Rhizoclonium africanum Kützing (figs. 42-45)**

*Rhizoclonium africanum* Kützing: Lawson and Price 1968: 329; Abbott and Huisman 2004: 82, fig. 2A; Soe-Htun et al. 2009: 271; Guiry and Guiry 2018.

**Description.** Plants filamentous, tending to be stiff or coarse and pale to dark green in color. Cells are 140-160 μm long and 8-12 μm wide.
long and 35-40 μm wide, 2-4 times longer than wide. Rhizoidal branches few, short and septate.

**Distribution.** Apor Seik, Pashyu Chaung, and Alè Seik.

**Cladophoropsis membranaceae** (Hofman Bang ex C. Agardh) Boergesen (figs. 46-48)

*Cladophoropsis membranaceae* (Hofman Bang ex C. Agardh) Boergesen: Anand 1940: 47-48, figs. 25-26; Egerod 1952: 356, fig.34; Dawson 1956: 80, fig.103; Taylor 1967: 117, pl.2, fig.1, pl.3, fig.2; Soe-Htun *et al.* 2009: 27112, Guiry and Guiry 2018.

**Description.** Plants forming tuft or clump of branched filaments, gloomy, light green in color, up to 4.5 cm long or broad. Most of the filaments declined, twisted and contorted forming entangled masses. Branches are sparse, usually second, irregular, and without septa. In main axis, segments 300-800μm long and 100-120 μm wide. Branches are 300-600 μm long and 100-100 μm wide.

**Distribution.** Apor Seik, Pashyu Chaung, Chaytoryar Pagoda, Alè Seik, Auk Seik, Kyunn Pyet.

**Dichotomosiphon sp.** (figs. 49-52)

**Description.** Plants small, composed of siphonous tubes with constriction at points of dichotomous branching, pale green in color and not segmented. Branches network in shape, rounded at the tip, 80-40 μm long and 12-20 μm wide.

**Distribution.** Apor Seik and Chaytoryar Pagoda.

**Discussion.**

Tin Aung Myint37 was firstly observed the eeds around the Kalegauk Island in 1971. After that, some marine algae of Kalegauk Island had been described as a small part of their algal flora study in Myanmar by Kyaw Soe and Kyi Win in 1977. Since 1977, there was no record and study about the marine algae in Kalegauk Island. Compared with the present study in which the total 12 species of green algal flora could be recorded, almost all species were new records for the seaweed resources of Kalegauk Island with the exception of *Rhizoclonium riparium* and *Dichotomosiphon sp.* which had been described in the previous studies. Therefore, it could be possible that the present study was the first specific record for the marine green algal flora of Kalegauk Island.

Compared with the previous studies of green algal flora in Myanmar, *Rhizoclonium um curvatum* was new record for Myanmar in the present study according to the references available. However, *Cladophora* sp. and *Dichotomosiphon sp.* could not be identified up to the species level due to lack of specimens and references.

*Chaetomorpha africana* and *Rhizoclonium linza* were too numerous in the rocky shore and mangrove forest of Apor Seik, Alè Seik and Pashyu Chaung. *Dichotomosiphon sp.* grows on silt and mud of Apor Seik and Chaytoryar Pagoda and then it was too smaquickly-coAlsoeasily. In addition, the green algal flora species were found 14 numbers of species in Apor Seik, 11 numbers of species in Pashyu Chaung, 4 numbers of species in Chaytoryar Pagoda, 6 numbers of species in Apor Seik and 3 numbers of species in Kyunn Pyet.
Conclusion

In relation with the present study, it can be considered that marine green algae seem to be the most diverse and abundant species in Apor Seik and there would be other unrecorded seaweed in Kalegauk Island because Kalegauk Island is necessary for the study of other marine algae and the observations of the seasonal ecology.

Acknowledgements

I would like to express my gratitude to U Kyin Aung and Daw Myint Myint San, my dearest parents for financial supports to carry out this study.

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Received: 13 November 2018
Accepted: 2 January 2019