

## The Genus *Polysiphonia* Greville (Ceramiales, Rhodophyta) in Kalegauk Island, Myanmar

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### ABSTRACT

The morphological and taxonomic studies on the genus *Polysiphonia* collected from Kalegauk Island were conducted from August 2016 to January 2017. A total of five species of the genus *Polysiphonia* were identified with their distinguishing characters. Among them, *P. atlantica* and *P. howei* were new records for the seaweed resources of Myanmar. The detailed descriptions of each species were provided. In addition to, keys for species identification, some distinctive characteristics, ecological notes and potential uses were provided as well. Moreover, the distributions of each species along both the coastal zones of Myanmar and the world oceans were provided.

**Keywords:** *Polysiphonia*, Kalegauk Island, morphological, new records.

### INTRODUCTION

*Polysiphonia* is one of the filamentous red algae. It is usually well branched and its branches can reach length of about 30 cm in some species.<sup>1</sup> They can be found along the coastal regions of Myanmar profusely, attaching by rhizoids and haptera to a rocky surface, other algae, mussel or limpets. In Myanmar, the total 9 species of *Polysiphonia* have been recorded by Kyaw Soe and Kyi Win<sup>2</sup>, Soe Htun<sup>3</sup>, Sein Moh Moh Khine<sup>4</sup>, Jar San<sup>5</sup>, Myo Min Tun<sup>6</sup>, Zayar Aung<sup>7</sup>, Hlaing Hlaing Htoon<sup>8</sup> and Ei Ei Hlaing<sup>9</sup>.

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 widest 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., Apur Seik Village, Auk Seik Village, Alè Seik Village and Pashyu Chaung Village. In addition Chaytoryar Pagoda is also one of the most famous places in Kalegauk Island. The coastal areas of the Kalegauk Island are generally covered by mangrove forests rather than rocky shores. The coastlines of Kalegauk Island dominantly comprise or cover 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.

Nowaday Kalegauk Island has been declared as the island to be constructed deep sea port.

In the present study, an attempt had been made to know the diversity of the genus *Polysiphonia* in Kalegauk Island, the morphological and taxonomic features of *Polysiphonia* found along the coast of the Kalegauk Island.

### MATERIALS AND METHODS

#### Study areas

Kalagoke Island is located in the northern part of the Andaman Sea, in the Bay of Bangal maily composed of four villages, viz., Apur Seik Village, Auk Seik Village, Alè Seik Village and Pashyu Chaung Village. Other common places are Chaytoryar Pagoda and Kyunn Pyet or Cavendish Island. Apur Seik Village is situated at the upper edge of the island (Lat. 15° 35' N, Long. 97° 38' E). Pashyu Chaung Village is situated between the Apur Seik and Alè Seik Villages (Lat. 15° 34' N, Long. 97° 39' E). Chaytoryar Pagoda is situated between the Alè Seik Village and Pashyu Chaung Village (Lat. 15° 33' N, Long. 97° 39' E). Alè Seik Village is situated between the Apur Seik Village and Auk Seik Village (Lat. 15° 32' N, Long. 97° 39' E). Auk Seik Village is situated at the lower edge of the island (Lat. 15° 30' N, Long. 97° 39' E). Kyunn Pyet is situated on the opposite site of Auk Seik (Lat. 15° 29' N, Long. 97° 39' E). In the study areas, salinity range and temperature

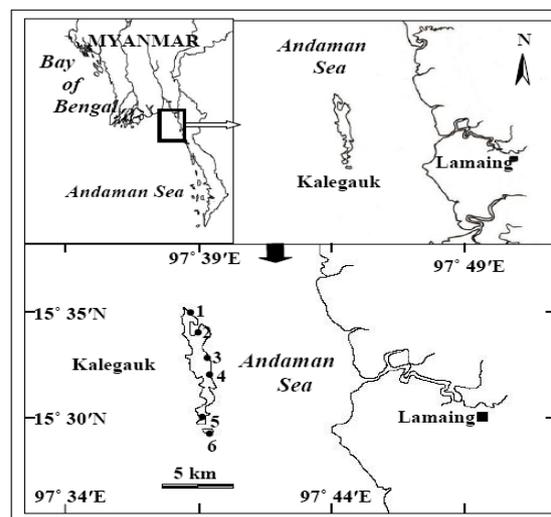
regimes seawater were 26-27 ‰ and 29° C to 31° C, respectively.

### Procedures for taxonomic studies

Marine 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 Seik and Kyunn Pyet from August 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 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 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 thalli, cross section (c.s) were obtained by free hand 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.

All seaweed slides and herbarium sheets were deposited at the Herbarium of Department of Marine Science, Mawlamyine University, Mawlamyine, Myanmar (MMB). Photographs of external and internal morphological structures of the materials were taken with a Canon IXUS 210 digital camera and by processing Adobe Photoshop 7.0. This study basically followed the classification system of Guiry and Guiry<sup>10</sup>. Local distribution of each species was prepared by using herbarium specimens examined and potential uses of these algae were recorded from the literature available.



**Figure 1.** Map showing the specimens collection sites of the marine benthic algae of Kalegauk Island in the northern part of the Andaman Sea. 1. Apor Seik. 2. Pashyu Chaung. 3. Chaytoryar Pagoda. 4. Alè Seik. 5. Auk Seik. 6. Kyunn Pyet or Cavendish Island.

### RESULTS

Phylum: Rhodophyta

Class: Florideophyceae

Order: Ceramiales

Family: Rhodomelaceae

Genus: *Polysiphonia* Greville

Species: (i) *Polysiphonia atlantica* Kapraun & Norris

(ii) *P. subtilissima* Montagne

(iii) *P. howei* Hollenberg in Taylor

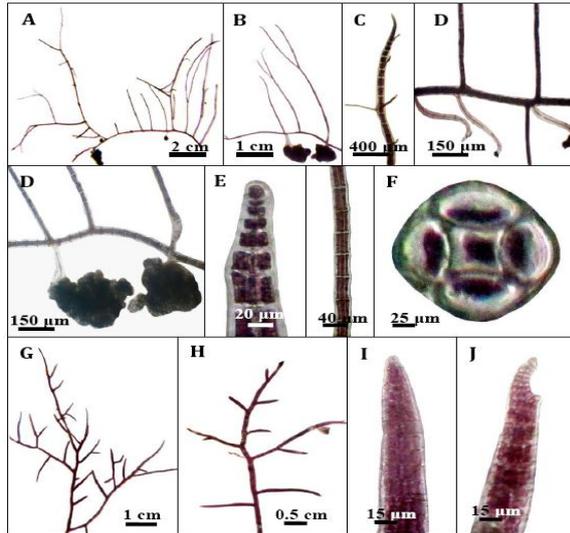
(iv) *P. sp. 1*

(v) *P. sp. 2*

### Key to the species of *Polysiphonia* from Kalegauk Island

- 1a. Branchlets not in curved at the tip.....2
- 1b. Branchlets in curved at the tip.....3
- 2a. Branchlets dichotomous branches and four pericentral cells in cross-section...*Polysiphonia atlantica*
- 2b. Branchlets commonly secund or alternate branches and nine to eleven pericentral cells in cross-section.....*P. subtilissima*
- 3a. Thallus tufted, densely matted cushions and surface view cells elongated.....*P. howei*
- 3b. Thallus tufted and surface view cells polysiphonous .....4
- 4a. Branches secundly, and have two or five rows of surface cells.....*P. sp.1*
- 4b. Branches alternately or secundly, and have two or four rows of surface cells.....*P. sp. 2*

*Polysiphonia atlantica* Kapraun & Norris



**Figure 2.** A) Habit of *Polysiphonia atlantica*; B) Branchlets of *P. atlantica*; and C) Rhizoidal filaments of *P. atlantica*; D) Apical portion of *Polysiphonia atlantica*; E) Surface view of *P. atlantica*; F) Cross section of *P. atlantica*; G) Habit of *P. subtilissima*; H) Branch system of *P. subtilissima* Montagne; I-J) Apical portion of *P. subtilissima*.

**Type locality.** - "Portstewart [Co. Antrim]; Miltown Malbay [Co. Clare], Ireland".<sup>10</sup>

**Types:** TCD.<sup>10</sup>

**Description.** - Thallus tufted with decumbent branches, 2-3 cm high, reddish brown in color, entangled with each other and attached by unicellular rhizoids. Erect filaments arising prostrate axis, cells two or three rows and commonly secund branches. Branchlets are not in curved and dichotomous branches. Rhizoidal filaments are distinct and 120-320 µm long. In surface view cells elongated, 80-88 µm long and 12-16 µm wide. In cross section all branches one central cell, 10-15 µm in diameter and four pericentral cells 20-30 µm in diameter.

**Specimens examined.** - Kalegauk I. (Apor Seik) (Thet Htwe Aung, 28.xii.2016, MMB 111076), Kalegauk I. (Pashyu Chaung) (Thet Htwe Aung, 28.xii.2016, MMB 111077), Kalegauk I. (Kyunn Pyet) (Thet Htwe Aung, 28.xii.2016, MMB 111078), Kalegauk I. (Chaytoryar Pagoda) (Thet Htwe Aung, 28.xii.2016, MMB 111079).

**Distribution.** - (i) **Local distribution - Rakhine Coastal Region** - No data; **Ayeyarwady Delta and Gulf of Mottama (Martaban) Coastal Region** - Kalegauk I.; **Tanintharyi Coastal Region** - No data.

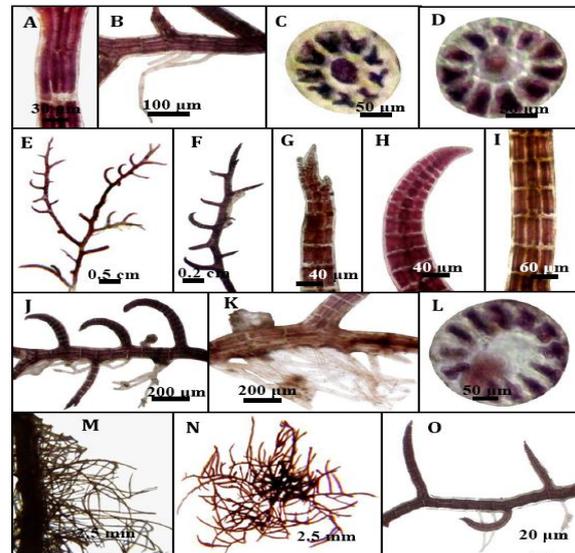
(ii) **World distribution** - Ireland: Antrim, Clare, Cork, Derry, Donegal, Mayo, Wexford. Europe: Britain, France, Ireland, Netherlands, Portugal,

Spain. Atlantic Is: Bermuda, Canary Is, Madeira, Salvage Is. North America: Florida, North Carolina. Caribbean Is: Barbados, Virgin Is. South America: Chile. Africa: Morocco, Tunisia. Australia and New Zealand: Queensland.<sup>10</sup>

**Ecological notes.** - Plants occur on mangrove trees in the subtidal zone.

**Potential uses** - The uses of this species are unknown.

*Polysiphonia subtilissima* Montagne



**Figure 3.** A) Surface view of *P. subtilissima*; B) Rhizoidal filaments of *P. subtilissima*; C-D) Cross section of *P. subtilissima*; E) Habit of *Polysiphonia howei*; F) Branch system of *P. howei*; G-H) Apical portion of *P. howei*; I) Surface view of *P. howei*; J-K) Rhizoidal filaments of *P. howei*; L) Cross section of *P. howei*; M-N) Habit of *Polysiphonia* sp. 1; and O) Rhizoidal filaments of *Polysiphonia* sp. 1.

**Type locality** - Cayenne, French Guiana<sup>10</sup>.

**Type** - Herb. Montagne, PC<sup>10</sup>.

**Description.** - Thallus tufted with decumbent branches, 0.5- 2 cm high, redish brown in color and attached by unicellular rhizoids. In secondary branches cells three rows and dichotomous branches. Branchlets are not in curved and commonly secund or alternate branches. Rhizoidal filaments are colorless and 200-210 µm long. In surface view cells elongated, 40-60 µm long and 12-14 µm wide. In cross section branchlets one central cell, 15-20 µm in diameter and nine pericentral cells, 20-24 µm in diameter. In main branches one central cell, 20-23 µm in diameter and eleven pericentral cells, 20-25 µm in diameter.

**Specimens examined.**- Kalegauk I. (Apor Seik) (Thet Htwe Aung, 28.xii.2016, MMB 111080), Kalegauk I. (Kyunn Pyet) (Thet Htwe Aung, 28.xii.2016, MMB 111081), Kalegauk I.

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(Chaytoryar Pagoda) (Thet Htwe Aung, 28.xii.2016, MMB 111082).

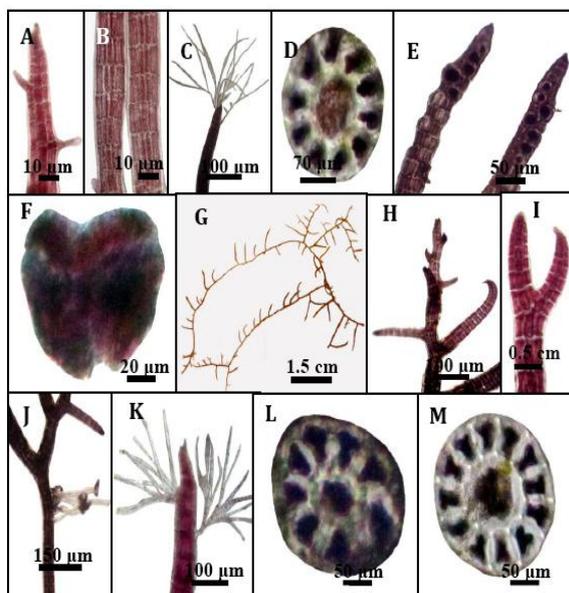
**Distribution.** - (i) **Local distribution - Rakhine Coastal Region** - Shwe Ya Gyaing, Hlyaw Gaung Taung, Maw Shwe Gyaing; **Ayeyarwady Delta and Gulf of Mottama (Martaban) Coastal Region** - Kalegauk I.; **Tanintharyi Coastal Region** - High I<sup>11</sup>.

(ii) **World distribution** - Europe: Adriatic, Britain, Greece, Ireland, Italy, Spain. Atlantic Is: Ascension, Cape Verde Is, St Helena. North America: Florida, Georgia, Louisiana, Mississippi, New Hampshire, North Carolina, Texas, Virginia. Central America: Costa Rica, El Salvador, Panama. Caribbean Is: Bahamas, Barbados, Caribbean, Cayman Is, Cuba, Jamaica, Lesser Antilles, Martinique, Trinidad, Trinidad & Tobago, Virgin Is. Western Atlantic: Trop. & Subtrop. W. Atlantic. South America: Brazil, Chile, Guyana, Uruguay, Venezuela. Africa: Angola, Cameroon, Côte d'Ivoire, Equatorial Guinea, Gambia, Ghana, Kenya, Liberia, Mauritius, Senegal, Sierra Leone, South Africa. Indian Ocean Is: Aldabra Is, Seychelles. South-west Asia: India, Levant states. Asia: Korea. South-east Asia: Philippines, Vietnam. Australia and New Zealand: New South Wales, New Zealand, Queensland, South Australia, Tasmania, Victoria, Western Australia. Pacific Is: Federated States of Micronesia, Hawaiian Is<sup>10</sup>.

**Ecological notes.** - Plants occur on mangrove trees in the subtidal zone.

**Potential uses.** - *Polysiphonia subtilissima* Montagne is used as fodder, drugs and agar<sup>11</sup>.

***Polysiphonia howei* Hollenberg in Taylor**



**Figure 4.** A) Apical portion of *Polysiphonia* sp. 1; B) Surface view of *Polysiphonia* sp.1; C) Trichoblasts of

*Polysiphonia* sp.1; D) Cross section of *Polysiphonia* sp. 1; E) Tetrasporangia branch of *Polysiphonia* sp. 1; F) Cell division of *Polysiphonia* sp. 1; G) Habit of *Polysiphonia* sp. 2; H) Branch system of *Polysiphonia* sp. 2; I) Apical portion of *Polysiphonia* sp. 2; J) Rhizoidal filaments of *Polysiphonia* sp. 2; and K) Trichoblast of *Polysiphonia* sp. 2. L) Cross section of branchlets of *Polysiphonia* sp. 2; M) Cross section of main branch of *Polysiphonia* sp. 2.

**Type locality** - Whale Cay, Berry I., Bahamas<sup>10</sup>.

**Type** - M.A. Howe; 29 January 1905; NY Howe 3478<sup>10</sup>.

**Description.**- Thallus tufted, densely matted cushions, 0.5- 1 cm high, reddish brown in color and attached by unicellular rhizoids. In all branches cells three or four rows, dichotomous or alternative branches and in curved at the tip. In surface view cells elongated, 80- 135 µm long and 12- 28 µm wide. Rhizoidal filaments are distinct and 200-400 µm long. In cross section branches one central cell, 20-25 µm in diameter and 13 pericentral cells, 16- 20 µm in diameter.

**Specimens examined.**- Kalegauk I. (Apor Seik) (Thet Htwe Aung, 29.xii.2016, MMB 111083), Kalegauk I. (Pashyu Chaung) (Thet Htwe Aung, 29.xii.2016, MMB 111084), Kalegauk I. (Kyunn Pyet) (Thet Htwe Aung, 29.xii.2016, MMB 111085), Kalegauk I. (Chaytoryar Pagoda) (Thet Htwe Aung, 29.xii.2016, MMB 111086).

**Distribution.** -(i) **Local distribution - Rakhine Coastal Region** - No data; **Ayeyarwady Delta and Gulf of Mottama (Martaban) Coastal Region** - Kalegauk I.; **Tanintharyi Coastal Region** - No data.

(ii) **World distribution** - Hawaii I<sup>10</sup>.

**Ecological notes.** - Plants occur on mangrove trees in the subtidal zone.

**Potential uses.** - The uses of this species are unknown.

***Polysiphonia* sp. 1**

(Figs. 4.13. I-K, 4.14. A-F)

**Type locality.** - Unknown.

**Type.** - Unknown.

**Description.** - Thallus tufted with decumbent branches, 1-2 cm high, reddish brown in color and attached by unicellular rhizoids. Erect filaments arising prostrate axis, Cells two or five rows, secund branches and in curved. Rhizoidal filaments are 70-150 µm long and 30-40 µm broad. In surface view cells polysiphonous, 42-44 µm long and 18-20 µm broad. In cross

section one central cell, 40-44 µm in diameter surrounded by 11-12 pericentral cells, 20-30 µm in diameter. Tetrasporangia branches 350-700 µm long and 90- 100 µm broad, spirally arranged in long series in branch tips. Tetraspores are 40-50 µm in diameter.

**Specimens examined.** - Kalegauk I. (Apor Seik) (Thet Htwe Aung, 27.ix.2016, MMB 11856), Kalegauk I. (Kyunn Pyet) (Thet Htwe Aung, 27.ix.2016, MMB 11857), Kalegauk I. (Chaytoryar Pagoda) (Thet Htwe Aung, 27.ix .2016, MMB 11858).

**Distribution.** - (i) **Local distribution** - **Rakhine Coastal Region** - No data, **Ayeyarwady Delta and Gulf of Mottama (Martaban) Coastal Region** - Kalegauk I., **Tanintharyi Coastal Region** - No data.

(ii) **World distribution** - Unknown.

**Ecological notes.** - Plants grow on rocks and sometimes epiphytic on mangrove trees.

**Potential uses.** - *Polysiphonia* sp. 1 is used as fodder, drugs, fish meals, organic fertilizers<sup>12</sup>.

#### ***Polysiphonia* sp. 2**

(Figs. 4.14. G-K, 4.15. A-B)

**Type locality.** - Unknown.

**Type.** - Unknown.

**Description.** - Thallus tufted, redished brown in color, 1.5- 2 cm high and attached by unicellular rhizoids. In main branches cells three rows and commonly alternate branches. In secondary branches, cells two or four rows and alternate or secund branches. Branchlets are in curved and dichotomous branching at the tip. In surface view cells polysiphonous, 150-160 µm long and 15-20 µm in diameter and 8 pericentral cells, 10-15 µm in diameter. In main branches one central cell, 30-32 µm in diameter and twelve pericentral cells 16-20 µm in diameter. Rhizoidal filaments are 400-500 µm long.

**Specimens examined.** - Kalegauk I. (Apor Seik) (Thet Htwe Aung, 28.xii.2016, MMB 111087), Kalegauk I. (Kyunn Pyet) (Thet Htwe Aung, 28.xii.2016, MMB 111088), Kalegauk I. (Chaytoryar Pagoda) (Thet Htwe Aung, 28.xii.2016, MMB 111089).

**Distribution.** - (i) **Local distribution** - **Rakhine Coastal Region** - No data; **Ayeyarwady Delta and Gulf of Mottama (Martaban) Coastal Region** - Kalegauk I., **Tanintharyi Coastal Region** - No data.

(ii) **World distribution** - Unknown.

**Ecological notes.** - Plants grow on rocks and sometimes epiphytic on mangrove trees.

**Potential uses.** - *Polysiphonia* sp. 2 is used as fodder, drugs, fish meals, organic fertilizers<sup>12</sup>.

#### **DISCUSSION**

In the present study, salinity range and temperature regimes seawater were 26-27 ‰ and 29 ° C to 31° C in the study areas. Tin Aung Moe<sup>13</sup> et al. had firstly observed the seaweeds found around the Kalegauk Island in 1971. Regarding this study, there was only one species for genus *Polysiphonia* which were described in their study. It was *Polysiphonia subtilissima*. In relation to the present study, there were 5 species of genus *polysiphonia* which were identified from Kalegauk Island with their distinguishing morphological characters. Among them, the two species were not able to be identified up to the species level due to lack of specimens and references.

As for the seaweed resources of Myanmar, Kyi Win recorded 9 species *Polysiphonia* such as *P. rhunensis*, *P. spiralis*, *P. insidiosa*, *P. foetidissima*, *P. variegata*, *P. Brodiaei*, *P. harveyi*, *P. lanosa* and *P. urceolata*. In addition, Kyaw Soe et al had also reported 9 species of *Polysiphonia* with the species *P. sertularoides* instead of *P. urceolata*. Currently, Soe Htun<sup>11,12</sup>, Sein Moh Moh Khine<sup>3</sup>, Hlaing Hlaing Htoon<sup>8</sup>, Jar San<sup>4</sup>, Myo Min Tun<sup>5</sup>, Zayar Aung<sup>6</sup> and Ei Ei Hlaing<sup>9</sup> had observed the *P. subtilissima* and *P.sp. 1* in their studied areas. As a result, *P. atlantica* and *P. howei* were the first record for Myanmar in the present study.

Taxanonomically, Maggs and Hommersad<sup>1</sup> were described the axes of *P. atlantica* are ecorticate consisting of axial cells surrounded by four pericentral cell. Likewise four pericentral cells were found in the present study. Taylor<sup>14</sup> reported that *P. howei* was attached by frequent unicellular rhizoids and it had 10 to 12 pericentral cells. The present study was found the similar result but it was found 13 pericentral cells *P. howei*.

According to the results described by Wormersley<sup>15</sup>, *P. subtilissima* had four pericentral cells and rhodoplast discoids, scattered or in chains. These results were agreement with the taxonomic characters found in the present study as well. As for their distribution, *P. subtilissima*, *P. howei*, *P.sp.1* and *P.sp.2* were found in every stations whereas, *P. atlantica* were collected only in Kyunn Pyet or Cavendish Island.

## CONCLUSION

In relation with the present study, it can be sure that the genus *Polysiphonia* commonly grow on rocks and mangrove trees in subtidal zone and then they can be generally used as fodder, drugs and agar. Moreover, it can be inferred their distinguishing characters among the species are mainly branch systems and the number of pericentral cells. Furthermore, Kyunn Pyet or Cavendish Island in which there are not households should be record the list of algae because there can be some unrecorded algae.

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