

First Record of *Polysiphonia senticulosa* Harvey (Ceramiales: Rhodophyta) in Korea

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Polysiphonia senticulosa Harvey (Ceramiales: Rhodophyta) was recorded for the first time in Korea, and its vegetative and tetrasporangial morphologies are described. This species is characterized by the combined features of having a vegetative axial segment with 4 pericentral cells, a main axis without cortication, pseudodichotomous branching, branches with sharply pointed apical cells, flexuous branches hooked backward below, the presence of cicatrigenous branches, axillary endogenous stichidia, and the production of 1-3 tetrasporangia per stichidium. Based on this study, it is distinguished from *Polysiphonia morrowii* Harvey by its flexuous branches and the number of tetrasporangia produced per stichidium.

Key words: *Polysiphonia senticulosa*, First record, Red algae, Vegetative and tetrasporangial morphology, Korea algal flora

Introduction

The red algal rhodomelacean genus *Polysiphonia* was established by Greville in 1824. At that time, the genus included all of the segmented plants placed in Rhodomelaceae. Later, Falkenberg (1901) delimited *Polysiphonia* from other members of Rhodomelaceae based on vegetative and tetrasporangial features, such as a radially symmetrical thallus, evidently polysiphonous ultimate branches, essentially similar and indeterminate branches, most branches being exogenously produced by the diagonal division of subapical cells, and the production of one tetrasporangium per stichidial segment. Similar circumscription is currently adopted for *Polysiphonia* (Maggs and Hommersand, 1993; Silva et al., 1996; Kim et al., 2000).

Of the genera belonging to the tribe Polysiphonieae recorded in Korea, *Neosiphonia*, which was separated from *Polysiphonia* (Kim and Lee, 1999), is most similar to *Polysiphonia* in habit and having polysiphonous branches and one tetrasporangium per segment in the stichidium. However, *Polysiphonia* differs from *Neosiphonia* by having only sporadically derived lateral branches, erect determinate and indeterminate branches developing from an extensive creeping base, rhizoids in open connection with pericentral cells, trichoblasts being scarce or absent,

procarys with a 4-celled carpogonial branch, spermatangial branches born in the initial lateral branch, and tetrasporangia arranged in a straight row (Kim and Lee, 1999).

In *Polysiphonia*, 198 species are currently recognized throughout the world (Guiry and Guiry, 2011). Of these, 7 species have been recorded in Korea (Lee and Kang, 2002). In this study, *P. senticulosa* is newly added to the Korean algal flora and its vegetative and tetrasporangial morphologies are described.

Materials and Methods

The specimens examined in this study were collected from Daejin on the east coast of Korea. Morphological observations were carried out using living materials and specimens preserved in 10% formalin-seawater. For anatomical observations, the material was cleared in 5-10% NaOH in distilled water for 2-7 days and then rinsed in distilled water. Branchlets dissected from cleared materials were hand-sectioned, transferred to a slide glass with a drop of distilled water, and mounted in pure glycerin. For permanent slides, the glycerin was exchanged with 50% Karo corn syrup. In some instances, the smearing method for microscopic examination was employed. Measurements are given as length and diameter. For photomicrographs, sections were stained with 0.5-1.0% aqueous methylene blue or

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hematoxylin and pictures were taken with a digital camera (C5050; Olympus, Tokyo, Japan), coupled to as BX50 microscope (Olympus).

Results and Discussion

***Polysiphonia senticulosa* (Harvey, 1862): p. 169.**

Figs. 1 and 2.

Synonyms: *Orcasia senticulosa* (Harvey) Kylin 1941, p. 35; *Polysiphonia pungens* (Hollenberg, 1942), p. 774, Figs. 1 and 10.

Type: Lyall; BM (Womersley, 2003).

Type locality: Orcas Island, Washington, U.S.A. (Womersley, 2003).

Habitat: Epiphytic on other algae in the intertidal zone.

Korean name: Keun-bul-geun-sil nom. nov.

Specimens examined: N10070601~N10070603 (Daejin: 6.vii.2010).

Morphology: Thalli up to 20-45 cm high (Fig. 1A and 1C), decumbent; forming dense tufts, entangled with each other; coarse, very elongate, epiphytic on other algae; blackish red or black in color; cartilaginous and rigid in texture, with basal prostrate axes attached by rhizoids; rhizoids unicellular, derived from pericentral cells in open connection (Fig. 2B); 25-30 μm diameter; branching pseudodichotomous to alternate; main axis percurrent, with segments L/B 0.8-0.9, 200-300 μm diameter, without cortication (Fig. 2A); vegetative axial segment with 4 pericentral cells (Fig. 2A), same length as pericentral cells; lateral branch initially mostly exogenous, produced sporadically on axial cells, developing into monosiphonous trichoblasts or polysiphonous branches; branches (Fig. 1B) cylindrical; polysiphonous, indeterminate, or determinate growth; indeterminate branches with conspicuous and

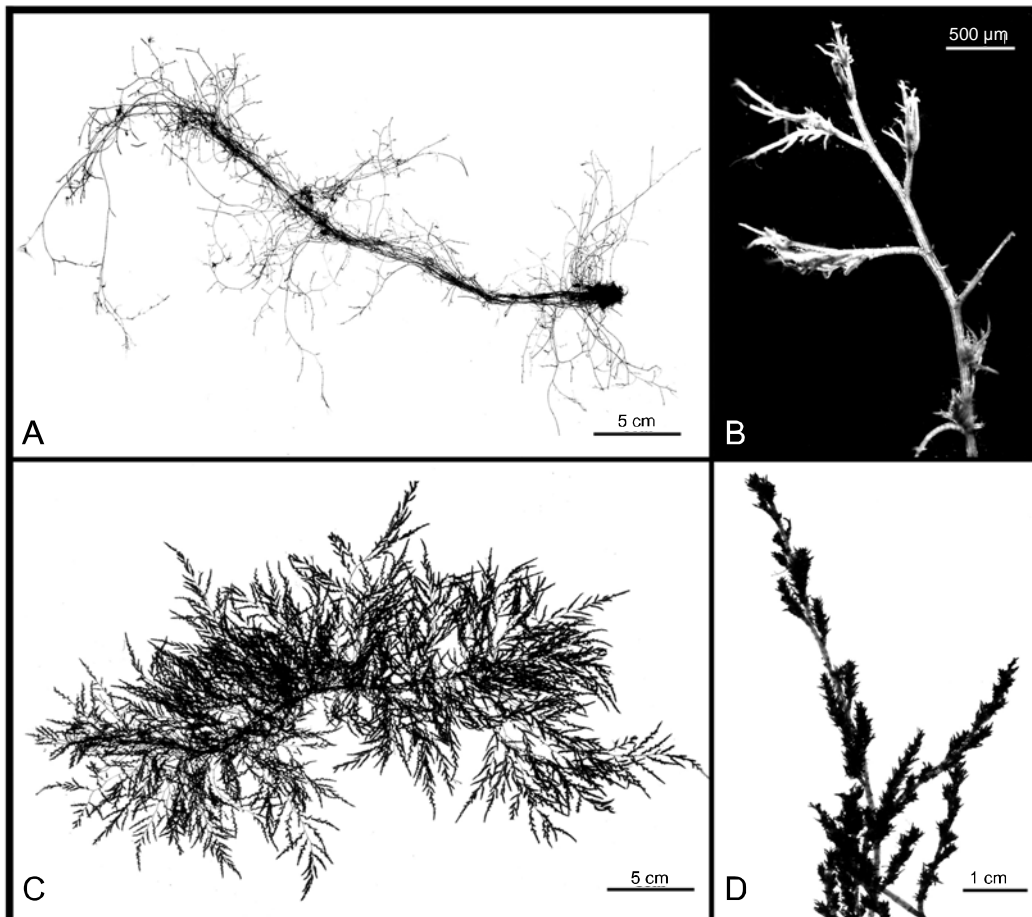


Fig. 1. *Polysiphonia senticulosa* (Harvey, 1862). (A, B) Habit (A) and details (B) of vegetative plants. (C, D) Habit (C) and details (D) of tetrasporic plants.

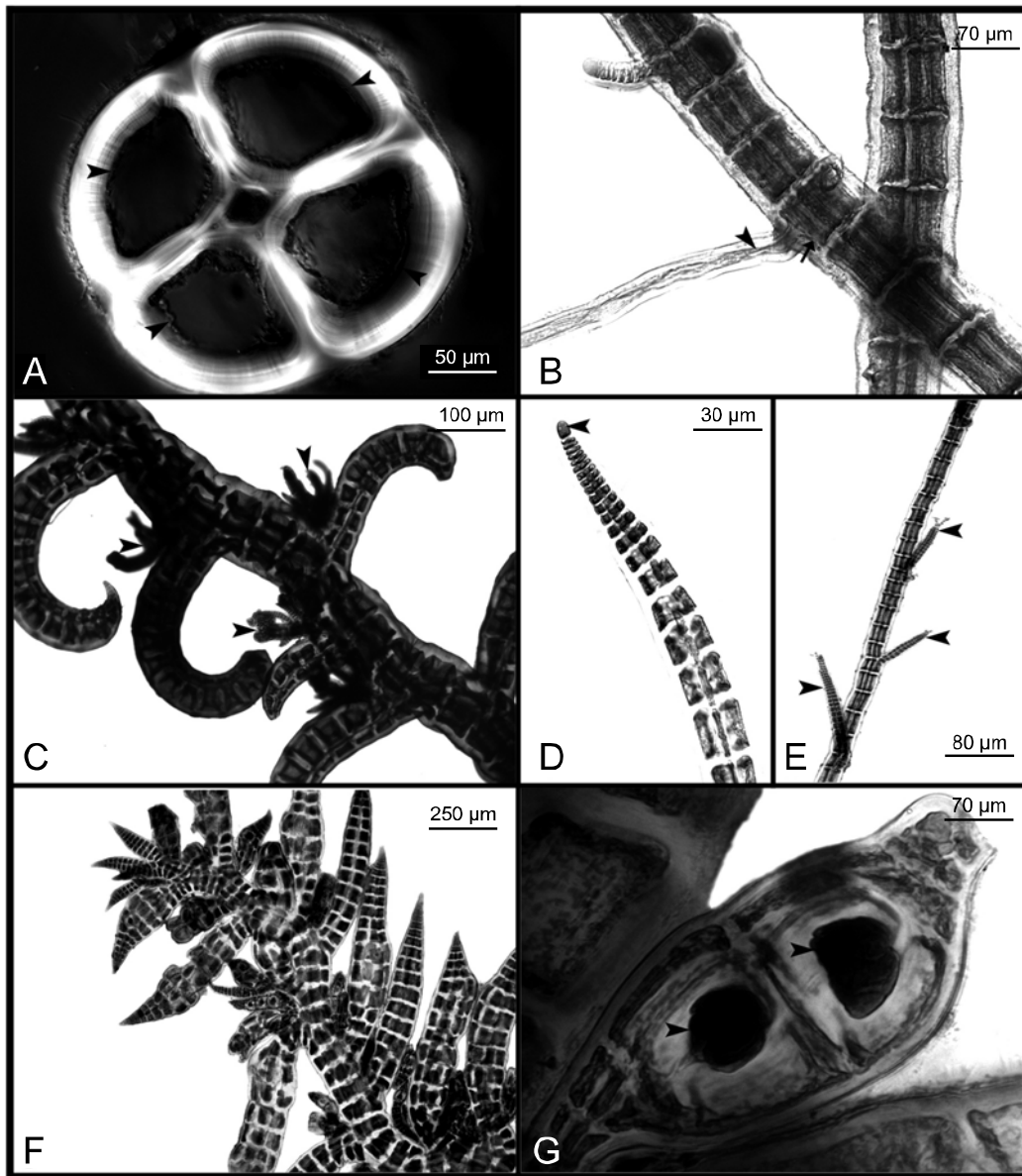


Fig. 2. *Polysiphonia senticulosa* (Harvey, 1862). (A) Vegetative axial segment with four pericentral cells (arrowheads) in transverse section of branchlets. (B) Rhizoid (arrowhead) connected with pericentral cells (arrow). (C-E) Details of vegetative branches, showing flexuous laterals hooked backward below and axillary branchlets (arrowheads) (C), dome-shaped apical cell (arrowhead) (D) and cicatrigenous branchlets (arrowheads) (E). (F, G) Details of stichidium with tetrasporangia (arrowheads) of straight arrangement.

dome-shaped apical cells 25 μm diameter (Fig. 2D); determinate branches with conspicuous and spinous apical cells 13 μm diameter, flexuous, hooked backward below (Fig. 2C); cicatrigenous branches present (Fig. 2E); trichoblasts colorless, scarcely present, usually deciduous, sometimes leaving scar cells; stichidium (Fig. 1D) arising endogenously at axil of branches (Fig. 2F), 5-6 in

one point and 1-3 tetrasporangia (Fig. 2G), with determinate growth; tetrasporangia tetrahedrally divided, borne singly in each segment in a straight row on a fusiform branch, 75-85 μm diameter. Sexual plants were not found in this study.

Remarks: As previously reported (Segi, 1951, 1960; Kudo and Masuda, 1988; Kim et al., 1994), the *Polysiphonia senticulosa* superficially resembles *P.*

morrowii. In particular, both species are very similar in some vegetative and tetrasporangial features, such as having a vegetative axial segment with 4 pericentral cells, a main axis without cortication, branches with sharply pointed apical cells, and axillary endogenous stichidia. Of these features, the production of axillary endogenous stichidia is distinct for both of the species in *Polysiphonia* (Kylin, 1941; Segi, 1951; Kudo and Masuda, 1988, 1992; Nam et al., in press). Yoon (1986) reduced *P. senticulosa* to a synonym of *P. morrowii*, but Kudo and Masuda (1988) pointed out that *P. senticulosa* differs from *P. morrowii* in having thinner thalli and 3-5 axillary tetrasporangial branchlets rather than thicker thalli and 7-8 branchlets. This taxonomic recognition is currently accepted (Guiry and Guiry, 2011) and is in agreement with this study. However, the number of axillary tetrasporangial branchlets (axillary endogenous stichidia) adopted by Kudo and Masuda (1988) seems to be variable between the two species, as reported by Kim et al. (1994).

Our plants were more similar to *P. morrowii* than *P. senticulosa* in having thicker and decumbent thalli and a pseudodichotomous branching pattern, but were distinguished from *P. morrowii* by the presence of flexuous branches and the production of 1-3 tetrasporangia per stichidium rather than 5-6 (Nam et al., in press; this study). These flexuous branch features and the number of tetrasporangia produced per stichidium are also shared by *P. senticulosa* (Segi, 1951) and seem to be significant between the two species (Nam et al., in press; this study). Therefore, the plants collected from Daejin, Korea, are identified as *P. senticulosa*.

Based on this study, *P. senticulosa* is characterized by the combined features of having a vegetative axial segment with 4 pericentral cells, a main axis without cortication, pseudodichotomous branching, branches with sharply pointed apical cells, flexuous branches hooked backward below, the presence of cicatrigenous branches, axillary endogenous stichidia, and the production of 1-3 tetrasporangia per stichidium. This is the first record of *P. senticulosa* in Korea.

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References

- Falkenberg P. 1901. Die Rhodomelaceen des Golfes von Neapel, und der Angrenzenden Meeresabschnitte. Fauna und Flora des Golfes von Neapel 26, 1-754.
- Greville RK. 1824. Flora Edinensis: or a Description of Plants Growing near Edinburgh. William Blackwood, Edinburgh, GB.
- Guiry MD and Guiry GM. 2011. AlgaeBase [Internet]. National University of Ireland, Galway, IE, Accessed 1 Jan 2011, <http://www.algaebase.org>.
- Harvey WH. 1862. Notice of a collection of algae made on the northwest coast of North America, chiefly at Vancouver Island, by David Lyall, Esq., M. D., R. N., in the years 1859-1861. J Linn Soc Lond Bot 6, 157-177.
- Hollenberg GJ. 1942. An account of the species of *Polysiphonia* on the Pacific coast of North America. 1. Oligosiphonia. Am J Bot 29, 772-785.
- Kim MS and Lee IK. 1999. *Neosiphonia flavimarina* gen. et sp. nov. with a taxonomic reassessment of the genus *Polysiphonia* (Rhodomelaceae, Rhodophyta). Phycol Res 47, 271-281.
- Kim MS, Lee IK and Boo SM. 1994. Morphological studies of the red alga *Polysiphonia morrowii* Harvey on the Korean coast. Korean J Phycol 9, 185-192.
- Kim MS, Maggs CA, McIvor L and Guiry MD. 2000. Reappraisal of the type species of *Polysiphonia* (Rhodomelaceae, Rhodophyta). Eur J Phycol 35, 83-92.
- Kudo T and Masuda M. 1988. Taxonomic notes on *Polysiphonia senticulosa* Harvey and *P. pugens* Hollenberg (Ceramiales, Rhodophyta). Jpn J Phycol 36, 138-142.
- Kudo T and Masuda M. 1992. Taxonomic features of *Polysiphonia morrowii* Harvey (Ceramiales, Rhodophyta). Korean J Phycol 7, 13-26.
- Kylin H. 1941. Californische Rhodophyceen. Lunds Univ Årsskr N F Avd 37, 1-51.
- Lee YP and Kang SY. 2002. A Catalogue of the Seaweeds in Korea. Jeju National University Press, Jeju, KR.
- Maggs CA and Hommersand MH. 1993. Seaweeds of the British Isles. Vol. 1. Rhodophyta, Part 3A. Ceramiales. Natural History Museum, London, GB.
- Nam KW, Kang PJ and Kim BH. Algal Flora of Korea. Volume 4, Number 4, Rhodophyta: Florideophyceae: Ceramiales: Rhodomelaceae: 18 Genera Including *Herposiphonia*. National Institute of Biological Resources, Seoul, KR (in press).
- Segi T. 1951. Systematic study of the genus *Polysiphonia* from Japan and its vicinity. Rep Fac Fish Pref Univ

- Mie 1, 167-272.
- Segi T. 1960. Further study of *Polysiphonia* from Japan (II). Rep Fac Fish Pref Univ Mie 3, 608-626.
- Silva PC, Basson PW and Moe RL. 1996. Catalogue of the benthic marine algae of the Indian Ocean. Univ Calif Publ Bot 79, 1-1259.
- Womersley HBS. 2003. The Marine Benthic Flora of Southern Australia. Part IIID Ceramiales – Delesseriaceae, Sarcomeniaceae, Rhodomelaceae. Australian Biological Resources Study and State Herbarium of South Australia, Canberra, AU.
- Yoon HY. 1986. A taxonomic study of genus *Polysiphonia* (Rhodophyta) from Korea. Korean J Phycol 1, 3-86.

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