J. Fish. Sci. Tech. 1(1), 1~6, 1998

Morphology and Reproduction of *Acrosorium polyneurum* and *A. yendoi* (Delesseriaceae, Rhodophyta) in Korea

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(Received April 1998, Accepted June 1998)

Morphology and reproduction of the two similar *Acrosorium* species, *A. polyneurum* and *A. yendoi*, were studied based on specimens collected from Korea. The morphology of the former species was very variable, depending on its habitat, and in some cases shown superficial resemblance to that of *A. yendoi*. Also its reproductive structures were essentially the same as those of the latter. However, the two species appear to be distinguished by some vegetative features found in fully developed stage, such as thallus size, vein structures and branching pattern. *Acrosorium polyneurum* has comparatively large thallus (6~8 cm) with three to five cell-layered macroscopic veins, together with palmately dichotomously branching, whereas *A. yendoi* is of smaller thallus (3~6 cm) with microscopic veins of one to three cell layers, and shows irregularly dichotomously or pinnately branching. This result, together with recent data based on PCR technique, suggests that the two entities are distinct.

Key words: morphology, reproduction, *Acrosorium polyneurum*, *Acrosorium yendoi*, Korea

Introduction

The frondose genus *Acrosorium* Zanardini ex Kützing (1869), a member of Delesseriaceae Broy, was established based on *A. aglaophylloides* (=*A. venulosum*). In his monographic work of the Delesseriaceae, Kylin (1924) detailed vegetative and reproductive structures of the genus, and based on this work included several species, such as *A. venulosum*, *A. reptans* (Crouan) Kylin, *A. acrospermum* (J. Agardh) Kylin, *A. corallinarum* (Nott) Kylin and *A. ciliolatum* (Harvey) Kylin. Later, Papenfuss (1939) and Mikami (1970, 1974, 1980, 1988) also made anatomical studies of some *Acrosorium* species.

In Korea, four species of this genus, *Acrosorium polyneurum* Okamura, *A. yendoi* Yamada, *A. uncinatum* (Turner) Kylin and *A. flabellatum* Yamada have been recorded in a floristic list (Kang 1966; Lee and Kang 1986). Although occurrence of these *Acrosorium* species has been frequently reported by many authors (Kang 1966; Yoo and Lee 1980; Lee and Lee 1982; Lee and Chang 1989; Nam et al. 1996), morphology and reproduction of these Korean species for the genus taxonomy have not been studied in detail. Particularly, distinguishing characters between *Acrosorium polyneurum* and *A. yendoi* are unclear because of their similarity and the overlapped variation in morpholgy, as mentioned by Mikami (1974).

This paper details comparative morphology and reproduction of these two Korean similar species, *Acrosorium polyneurum* and *A. yendoi*, with a taxonomic note.

Materials and Methods

This study was based on an examination of the following liquid-preserved material and herbarium specimens of *Acrosorium polyneurum* and *A. yendoi*: *A. polyneurum*, Pohang (?, 21.vi.1991, K001 ♀ ⊕ sterile), Yonghodong, Pusan (Kim, 14.iv.1992, K014 sterile), Hadong (Kim, 7.iii.1992, K003 ⊕ sterile), Wando (Kim, 31.v.1992, K004 ⇕ ♀ ⊕ sterile), Cheongsapo near Pusan (Kim, 26.vii.1992, K007 ♀ ⊕ sterile), Kumhodo (Park, 4.viii.1993,

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K008 sterile), Onsan (Park, 11.iv.1992, K013 sterile). *A. yendoi*, Wando (Kim, 31.v.1992, K006 ♂♀⊕ sterile), Songjung near Pusan (Kim, 10.x.1993, K015 ⊕ sterile), Kumhodo (Park, 4.viii.1993, K016 sterile), Keojedo (Kim, 14.x.1996 K020 sterile).

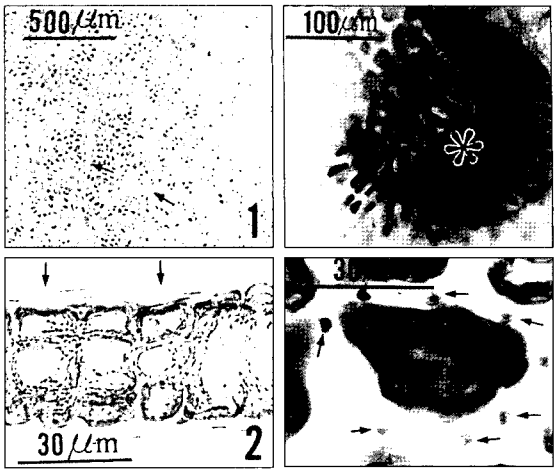
Sectioning and observational methods for microscopic examination are the same as those given in Kim and Nam (1994).

Results and Discussion

Habit: *Acrosorium polyneurum* and *A. yendoi* grow on rock, pebbles and other algae at subtidal zone. Both species have membranous blades transversed by veins in surface view and peg-like haptera from blades for attaching to substratum (Figs. 1, 3). *Acrosorium polyneurum* attains a height of 6~8 cm and a width of 3~8 mm. Its blades are palmately divided dichotomously, with blunt apices (Fig. 6). In contrast, *A. yendoi* attains a height of 3~6 cm and a width of 2~5 mm. Its blades are irregularly branched dichotomously or pinnately (Fig. 5). General habit of both species is very similar except for thallus size and branching pattern in fully developed stage.

Vegetative morphology: In *Acrosorium polyneurum*, thalli are composed of single layer of cells except for three to five cell-layered macroscopic veins, which are of narrow cells greatly elongated in lengthwise direction (Figs. 1, 2). Main branches of delicate, richly lobed fronds originate from the base of the blade. The blade laminae are composed of rectangular to polygonal cells (Fig. 2). Nearly every cell produces a 1-celled secondary filament, which is connected with adjacent cells by secondary pit connections. Most of lateral contiguous cells are linked by these pit connections (Fig. 4). However, thalli of *Acrosorium yendoi* have microscopic veins of one to three cell layers. Other features of vegetative morphology are essentially similar to those of *A. polyneurum*.

Reproduction: Spermatangial sori of *Acrosorium polyneurum* are formed in small whitish patches on both surfaces of rounded proliferations near fronds tips (Figs. 6, 7). The first step in the development of spermatangia is the formation of cortical cells on both surfaces of the central cells. The cortical cells divide anticlinally, giving rise to spermatangial mother cells. Spermatangia are formed from the outer surface of the spermatangial mother cells (Figs. 8~10).



Figs. 1~4. *Acrosorium polyneurum* Okamura
Fig. 1. Surface view of a vegetative thallus with macroscopic veins (arrows). Fig. 2. Cross section of veins (arrows). Fig. 3. Rhizoid (asterisk) formed under thallus surface. Fig. 4. Surface view of epidermal cells. Arrows indicate conjuctor cells.

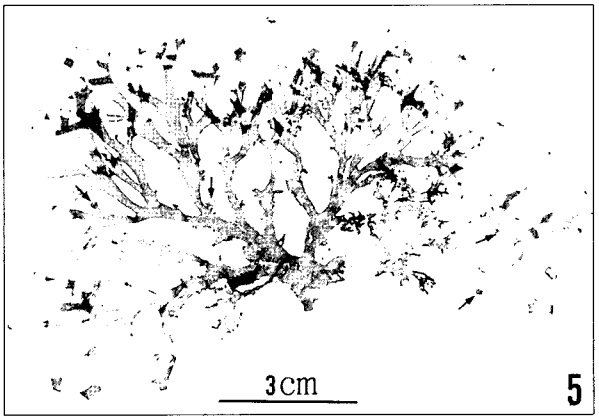
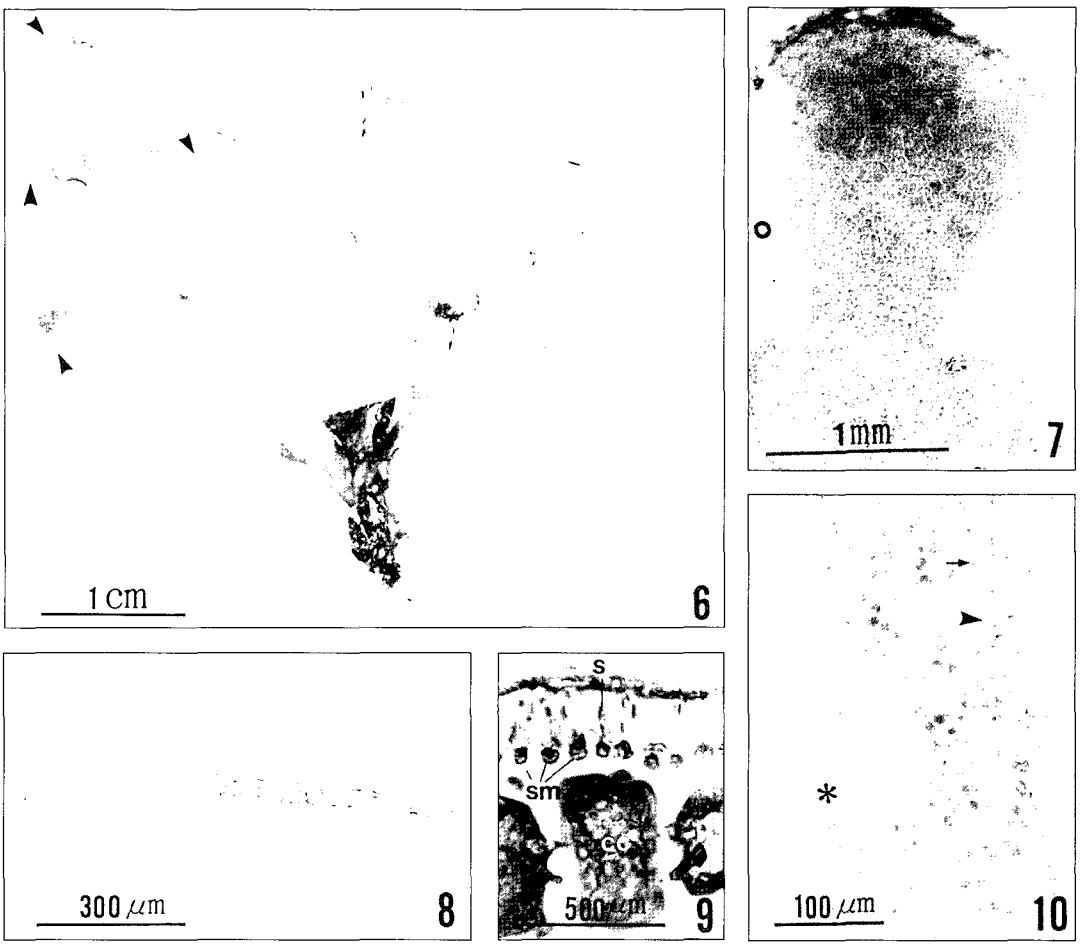


Fig. 5. *Acrosorium yendoi* Yamada: Habit of tetrasporangial plant with fertile proliferations (arrows).

Procarps are randomly formed on both thallus surfaces (Figs. 11, 12). Procarpic development initiates with formation of two fertile pericentral cells on both surfaces. Of these two fertile cells, only one usually develops into cystocarp. This pericentral cell acts as supporting cell of the procarp. It cuts off mother cell of the first group of sterile cells (Fig. 13), and then forms initial of the carpogonial branch. The carpogonial initial develops into the four-celled carpogonial branch in acropetal succession in a plane roughly parallel to the surface (Figs. 13~20). The carpogonium with trichogyne is cut off from the inner surface of the third cell of the carpogonial branch (Fig. 16). The



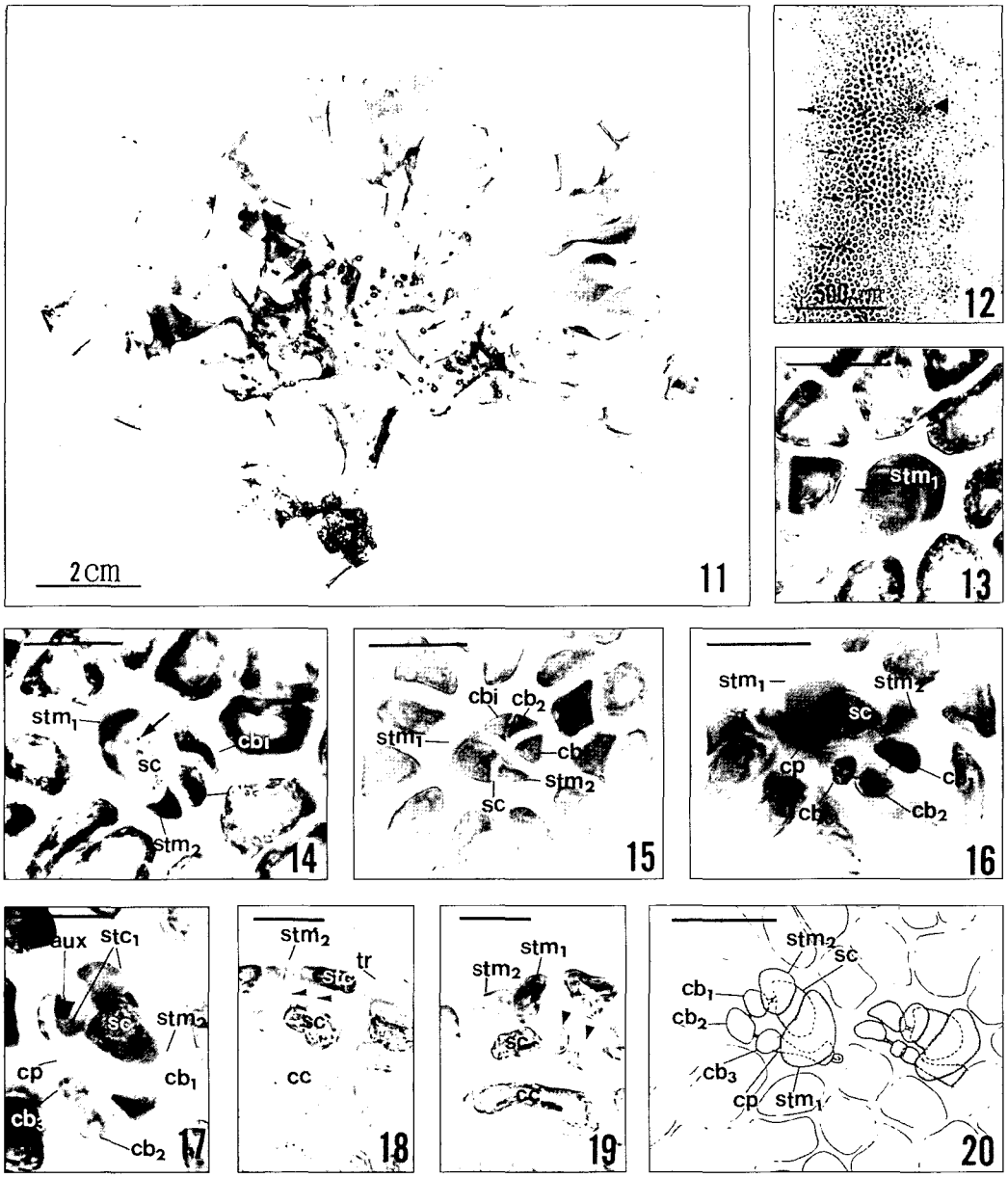
Figs. 6~10. *Acrosorium polyneurum* Okamura
Fig. 6. Habit of male plant with spermatangial sori (arrowheads). Fig. 7. Branchlet with rounded spermatangial sorus. Fig. 8. Cross section of spermatangial sorus. Fig. 9. Details of spermatangial sorus in cross section. Fig. 10. Surface view of spermatangial sorus. Asterisk, arrowhead and arrow indicate respectively central cells, spermatangial mother cell and spermatium.

trichogyne possesses a protruding tip and a median swollen part, embedded in the thallus (Fig. 18). On the other hand, the mother cell of the second sterile group is produced before the third cell of carpogonial branch is formed (Fig. 14). The mother cell of the first and second sterile group do not divide prior to fertilization (Fig. 16). At the time of fertilization, vegetative cells near the procarp continue to divide, forming a raised cortication. Auxiliary cell is cut off from the supporting cell after fertilization (Fig. 17). Gonimoblast initial is produced from the auxiliary cell. It continues to monopodial division, giving rise to many gonimoblasts. Terminal cells of the gonimoblasts are transformed subsequently into carposporangia.

Tetrasporangial sori are formed in irregular size and shape on both surfaces of rounded fertile proliferations (Figs. 21~23). In cross section of a mature sorus, tetrasporangia are arranged in two rows stretched over primary cells. The tetrasporangia are cut off from inner cortical cells, but occasionally from primary cells (Figs. 24, 25).

Reproductive features of *A. yendoi* is essentially the same as those of *A. polyneurum*.

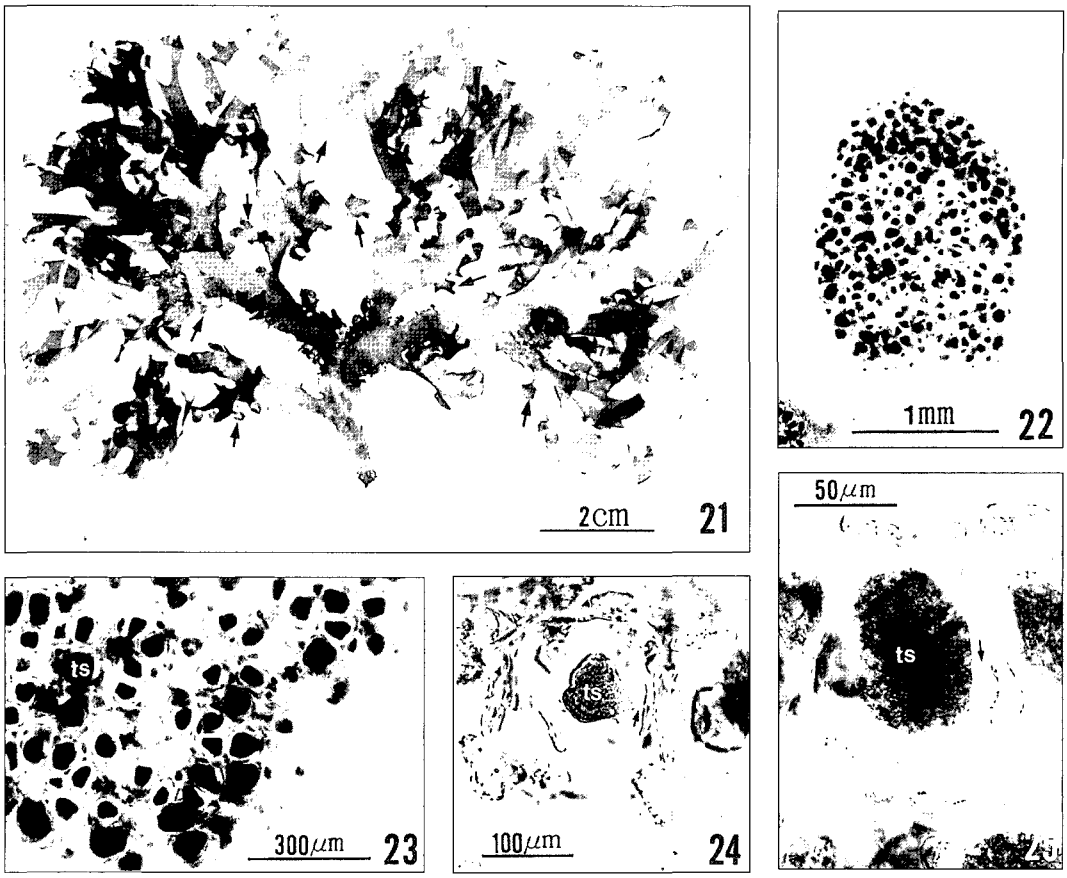
Acrosorium yendoi had been previously identified as *Nitophyllum monanthous* J. Agardh (Yendo, 1918; Yamada, 1928). Yamada (1930) established this species based on Yendo's (1918) specimens and the type examination of *N. monanthous*. Whereas, *A. polyneurum* was introduced by Okamura (1936). Later Kawashima (1957) gave some accounts on this species. According to his description, in northeastern Honshu of Japan *A. polyneurum* grows 5~7 cm high, and its tetrasporangial sori are formed in the elliptical patch near the branch apex. However, Mikami (1974) reported that tetraspora-



Figs. 11~20. *Acrosorium polyneurum* Okamura
Fig. 11. Habit of female gametophyte with numerous cystocarps (arrows). Fig. 12. Surface view of female plant with procarps (arrows) and cystocarp (arrowhead). Figs. 13~17. Various stages of procarpic development. Arrow indicates pit connection between sterile mother cell and supporting cell. Figs. 18, 19. Cross section of procarps showing development of carpogonial branch (arrowheads) and sterile cells. Arrows indicate pit connections between supporting cell and sterile cells. Fig. 20. Details of a fully developed procarp. Scale bar=20 μm for Figs. 12~20.

ngial sori in this species are produced near branch apex or on proliferations. In this study, it was observed that they are produced only on proliferations. However, as mentioned by Mikami (1974), external appearance of *A. polyneurum* is quite variable, and in some cases shows superficial resemblance to *A. yendoi*. Also its vegetative morphology and reproduction were essentially the same as those of the latter.

Even though distinguishing characters between both species were not found in essential vegetative and reproductive structures, it appears that the two species are distinct from each other based on some vegetative features found in fully developed stage,



Figs. 21~25. *Acrosorium polyneurum* Okamura
Fig. 21. Habit of tetrasporophyte. Arrows indicate small proliferations with tetrasporoangial sorus. Fig. 22. Branchlet with a rounded tetrasporangial sorus. Fig. 23. Magnification of the tetrasporangial sorus. Figs. 24, 25. Cross section of tetrasporangial sorus. Arrow indicates pit connection between tetrasporangium and its mother cell. Abbreviations in Figs. 1~25. aux, auxiliary cell; ca, carposporangium; cb, carpogonial branch; cbi, carpogonial branch initial; cc, central cell; cp, carpogonium; fu, fusion cell; pc, pericentral cell; s, spermatium; sc, supporting cell; sm, spermatangial mother cell; stc_1, first sterile cell; stc_2, second sterile cell; stm, mother cell of sterile cell; tr, trichogyne; ts, tetrasporangium; Number 1, 2 etc., formation sequence.

such as thallus size, vein structures and branching pattern. *Acrosorium polyneurum* has comparatively large thallus (6~8 cm) with macroscopic veins of three to five cell layers, together with palmately dichotomously branching, whereas *A. yendoi* is of smaller thallus (3~6 cm) with microscopic veins of one to three cell layers, and shows irregularly dichotomously or pinnately branching. Recent report (Kim et al. 1997) based on a polymerase chain reaction (PCR) technique also supports these two entities being distinct.

Acknowledgements

This study was partially supported by the research grants from Basic Science Research Institute of Pukyong National University and from Basic Science Research Institute of Chonnam National University (BSRI-97-5416).

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