

Taxonomic Notes on *Acrosorium flabellatum* and *A. venulosum* (Delesseriaceae, Rhodophyta) in Korea

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Morphological features of the two Korean *Acrosorium* species, *A. flabellatum* Yamada and *A. venulosum* (Zanardini) Kylin (Delesseriaceae, Rhodophyta) are described based on specimens collected from several localities along the coasts of Korea. *Acrosorium flabellatum* is easily distinguished from other *Acrosorium* species in lacking rhizoids in branchlets for attachment to substratum. The flabellate branching is also characteristic for this species. By contrast, *Acrosorium venulosum* is distinct from others in having the unique hooked branchlets. Taxonomic features found in the Korean *Acrosorium* species are compared, and a key to the species is provided based on this and previous data.

Key words: *Acrosorium flabellatum*, *Acrosorium venulosum*, Vegetative and reproductive morphology, Rhodophyta, Korea

Introduction

The red algal genus *Acrosorium* Zanardini ex Kützing (1869) belongs to Delesseriaceae Bory, in which thalli are of prostrate and erect or decumbent membranous blades. This genus is well represented on the shores of Korea (Kang, 1966; 1968). Since Kang (1966), four *Acrosorium* species, *A. polyneurum* Okamura, *A. yendoii* Yamada, *A. flabellatum* Yamada and *A. venulosum* (Zanardini) Kylin have been now recognized in Korean algal flora, and their occurrence has been frequently reported in floristic lists by many researchers (Lee and Kim, 1977; Kim and Lee, 1981; Lee and Lee, 1981; Lee and Lee, 1982; Lee and Kang, 1986; Nam, 1986; Song, 1986; Lee and Lee, 1988; Lee and Chang, 1989; Koh, 1990; Lee et al., 1991; Yoon and Boo, 1991; Park et al., 1994; Kim et al., 1995; Kim et al., 1997; Lee et al., 1997). Among them, the former three species are endemic to Korea and Japan (Cho

and Boo, 1998; Kim et al., 1998), and are sometimes difficult to identify except for the type species, *A. venulosum*. Recently, Kim et al. (1997, 1998) provided a taxonomic information of the two similar species, *A. polyneurum* and *A. yendoii*, based on morphological and molecular data. However, taxonomic attention for the other Korean *Acrosorium* species has not been paid.

In this paper, morphological features of *A. flabellatum* and *A. venulosum* are described, and taxonomic features found in the four Korean *Acrosorium* species are compared based on this and previous data (Kim et al., 1998). A key to the species is also included.

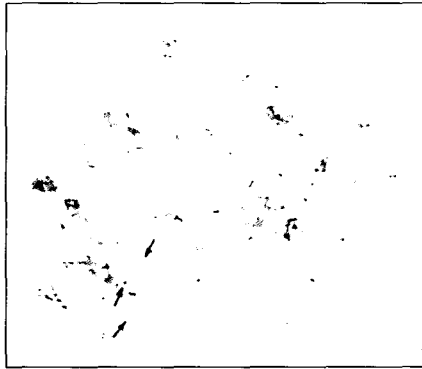
Materials and Methods

This study was based on an examination of the liquid-preserved materials. Collections for the material were made in several localities along the coasts of Korea. Sectioning and microscopic observational methods are the same as those given in Kim and Nam (1994).

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Results and Discussion

Acrosorium flabellatum Yamada (1930) (Fig. 1)



3cm 1

Fig. 1. Habit of *Acrosorium flabellatum* Yamada with tetrasporangial sori (arrows).

Okamura 1908, p. 121, pl. 26, figs. 2, 3; Okamura 1936, p. 785; Kang 1966, p. 97; Noda 1987, p. 400; Mikami 1988, figs. 1~15.

Nitophyllum uncinatum sensu Okamura 1908: 43. figs. 1~15.

Acrosorium okamurae Noda in Noda et Kitami 1971: 45. fig. 12.

Type locality: Ohara, Kazusa Prov., Japan (Yamada, 1930).

Distribution: Japan (Noda, 1987; Mikami, 1988; Yoshida, 1998); Korea (Kang, 1966, 1968).

Specimens examined: Pohang (? , 21.vi.1991, K 002⊕sterile), Yonghodon, Pusan (Kim, 4.vi.1993, K 017⊕sterile), Wando (Kim, 28.vi.1998, K021 sterile), Boreyung, (Kim, 19.xii.1998, K023sterile).

Habitat: Plants grow on the rock or on the other algae in the subtidal zone.

Korean name: Buchae-bunhongip

Description: Thallus 10~15 cm tall, composed of single layer except for microscopic veins, with a short and broad stipe, but soon divide palmately (Fig. 1); branching alternate, pinnate, forming a flabellate outline; branches bearing short spine-like branchlet disposed secundly; branchlet near apex often curved; tetrasporangia formed along margins and on small proliferations of basal parts of main branches.

Remarks: According to Mikami (1988), tetra-

sporangia in *Acrosorium flabellatum* are produced along the thallus margin. On this basis, he suggested that this alga probably belongs to *Hymenena* Greville rather than *Acrosorium* in which tetrasporangial sori are formed in elliptical patch near branch apex. However, contrary to Mikami's observation, Korean specimens of this species show typical pattern of tetrasporangial production of *Acrosorium*.

Acrosorium venulosum (Zanardini) Kylin (1924) (Figs. 2 & 3)



2cm 2

Fig. 2. Habit of *Acrosorium venulosum* (Zanardini) Kylin with hooked blades (arrowheads).

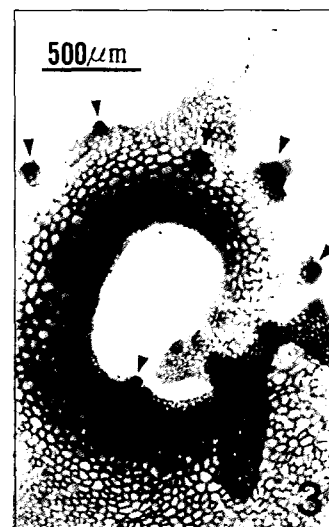


Fig. 3. Details for hooked blade with many rhizoids (arrowheads) in *Acrosorium venulosum* (Zanardini) Kylin.

Kylin 1924, p. 77, fig. 61; Okamura 1936, p. 786, fig. 379; Dawson 1962, p. 94, pl. 43, fig. 2; Kang 1966, p. 97; Abbott and Hollenberg 1976, p. 659; Noda 1966, p. 75, 1987, p. 402, fig. 297; Mikami 1980, figs. A~M.

Nitophyllum venulosum Zanardini 1865: 33. pl. 49 A.

Acrosorium uncinatum sensu Kylin 1924: 78, non *Fucus laceratus* var. *uncinatus* Turner (1808)

Nitophyllum uncinatum (Turner) J. Agardh: 1852: 654.

Type locality: Zara and Dalmatia, Adriatic Sea (Kylin, 1924).

Distribution: Adriatic Sea (Kylin, 1924); British Isles to Senegal (Maggs and Hommersand, 1993); Mediterranean Sea (Maggs and Hommersand, 1993); North Carolina to Brazil (Price et al., 1986; Schneider and Searles, 1991); Japan (Mikami, 1980; Yoshida, 1998); Korea (Kang, 1966, 1968).

Specimens examined: Hadong (Kim, 13, July 1992, K012⊕sterile), Pohang (? , 21, July 1991, K 018⊕sterile), Wando (Kim, 28.vi.1998, K022⊕sterile).

Habitat: Plants grow on the other algae in the subtidal zone.

Korean name: Galgori-bunhongip

Description: Thallus 6~10 cm tall, single layer except for microscopic vein with 3 cell-layers; fronds richly entangled, attached to other algae by rhizoids (Fig. 2); tips of branches usually attenuated or becoming into hooked blades with subacute tips (Fig. 3); tetrasporangia formed along margins and on small proliferations of main branches.

Remarks: Previously, there had been considerable confusion on *A. venulosum* (Wynne, 1989), as known as *Acrosorium uncinatum* (J. Agardh) Kylin. This problem was clarified by Wynne (1989). According to him, *A. venulosum* was described as *Nitophyllum venulosum* by Zanardini (1865) from Dalmatia and Zara in the Adriatic Sea, and based on some features, such as a sessile or stalked membranously foliose alga with rounded spines and a network of microscopic veins and a tetrasporangial sorus located subapically (refer to Zanardini's plate), he concluded that *Nitophyllum venulosum* is the earliest available name which can be applied to an alga with a world distribution that had been passing under the incorrect name *Acrosorium uncinatum*. Therefore he suggested that *Acrosorium*

venulosum (Zanardini) Kylin is the correct name for this entity.

General features of our specimens are similar to those from other areas (Mikami, 1980; Maggs and Hommersand, 1993) in having the unique hooked branchlets. Vegetative and reproductive anatomy are also very well conformed to those of the previous authors (Mikami, 1980; Maggs and Hommersand, 1993). Our specimens (6~10 cm high), however, are somewhat smaller than those (3~15 (~20) cm high) from the British Isles (Maggs and Hommersand, 1993). This alga seems to be a relatively rare member than the other *Acrosorium* species in Korean algal flora.

As commented above, *Acrosorium* is one of common genera widely distributed at low intertidal to subtidal level along the coasts of Korea (Kang, 1966). Among the four Korean species, *A. venulosum* is readily recognized by having the unique hooked branchlets. *Acrosorium flabellatum* is also readily distinguished from other species in lacking rhizoids in branchlets for attachment to substratum and in having flabellate branching. External appearance of *Acrosorium polyneurum* is quite variable, and in some cases resembles to *A. yendoii* (Kim et al., 1998). Even though distinguishing features between both species were not found in essential vegetative and reproductive structures, the two species are distinct from each other based on some vegetative features found in fully developed stage, such as thallus size, vein structures and branching pattern (Table 1). *Acrosorium polyneurum* has comparatively large thallus (6~8 cm) with macroscopic veins, together with palmately dichotomously branching, whereas *A. yendoii* is of smaller thallus (3~6 cm) with microscopic veins and shows dichotomously or pinnately branching. The distinction between both species was also supported by a recent report (Kim et al., 1997) based on molecular data.

Based on this and previous data (Kim et al., 1998), a key to the Korean *Acrosorium* species is given as follows:

Key to the Korean species of *Acrosorium*

1. Branching palmately dichotomous 2
1. Branching irregularly dichotomous or pinnate 3
2. Upper portion of branches slender, liner

Table 1. Comparison of taxonomic features found in Korean *Acrosorium* species

Features	Species			
	<i>A. polyneurum</i>	<i>A. yendoi</i>	<i>A. flabellatum</i>	<i>A. venulosum</i>
Thallus size	6~8 cm	3~6 cm	10~15 cm	6~10 cm
Veins	Macroscopic	Microscopic	Microscopic	Microscopic
Hooked branch	Absent	Absent	Absent	Present
Branching pattern	Palmately dichotomous	Irregularly dichotomous or pinnate	Flabellate	Irregular
Rhizoids	Present	Present	Absent	Present
Position of rhizoid	Under surface	Under surface	-	On hooked branchlets or margin
Stipe	Present	Absent*	Present	Absent*
References	Kim et al. (1998)	Kim et al. (1998)	This study	This study

*Rarely present

- lobes; without distinct microscopical veinlets in surface view *A. flabellatum*
2. Upper portion of branches usually rounded; with distinct macroscopical veinlets in surface view *A. polyneurum*
3. Pointed or hooked branchlets absent *A. yendoi*
3. Pointed or hooked branchlets present *A. venulosum*

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References

- Abbott, I.A. and G.J. Hollenberg. 1976. Marine Algae of California. Stanford University Press, Stanford, California, 827 pp.
- Agardh, J.G. 1852. Species genera et Ordines algarum, Vol. 2: Algas florideas complectens, Pt. 2(1/2), Pt. 3(1). Glycerup, Lund (in German).
- Cho, T.O. and S.M. Boo. 1998. Marine flora of Oeyondo Islands on the Yellow sea, Korea: III. Red algae. *Algae*, 13, 29~67.
- Dawson, E.Y. 1962. Marine red algae of Pacific Mexico. Part 7. Ceramiales: Ceramiaceae, Delesseriaceae. *Allan Hancock Pac. Exped.*, 26, 1~207.
- Kang, J.W. 1966. On the geographical distribution of marine algae in Korea. *Bull. Pusan Fish. Coll.*, 7, 1~125.
- Kang, J.W. 1968. Illustrated Encyclopedia of Fauna and Flora of Korea. Vol. 8. Marine Algae. Samhwa Publishing Co. Ltd. 465 pp (in Korean).
- Kim, L.G., H.J. Jin, Y.S. Kim, J.Y. Park, K.W. Nam and Y.K. Hong. 1997. Discrimination of two red algae *Acrosorium polyneurum* and *A. yendoi* using polymerase chain reaction technique. *J. Korean Fish. Soc.*, 30, 585~588 (in Korean).
- Kim, Y.H. and J.H. Lee. 1981. Intertidal marine algal community and species composition of Wolseong area, east coast of Korea. *Korean J. Bot.*, 24, 145~158.
- Kim, Y.H., K.W. Nam and C.H. Sohn. 1997. Intertidal benthic marine algae at Chumunjin on the east coast of Korea: Flora, distribution and community structure. *Algae*, 12, 117~130 (in Korean).
- Kim, Y.H. H.J. Yoon and J.S. Yoo. 1995. Species composition and biomass of marine algal community on the mid-western coast of Korea. *J. Plant Biol.*, 38, 389~398 (in Korean).
- Kim, Y.S., H.G. Choi, K.W. Nam, Y.K. Hong and J.H. Lee. 1998. Morphology and reproduction of *Acrosorium polyneurum* and *A. yendoi* (Delesseriaceae, Rhodophyta) in Korea. *J. Fish. Sci. Tech.*, 1, 1~6.
- Kim, Y.S. and K.W. Nam. 1994. Vegetative and reproductive anatomy of *Polyneura japonica* (Yamada) Mikami (Delesseriaceae, Rhodophyta) in Korea. *Korean J. Phycol.*, 9, 179~184.
- Koh, N.P. 1990. An ecological study on resources of marine plants in Geomundo Islands. *Korean J. Phycol.*, 5, 1~37 (in Korean).
- Kützing, F.T. 1869. *Tabulae phycologicae*. 19. Nordhausen (in German).
- Kylin, H. 1924. Studien Über die Delesseriaceen. *Lunds Univ. Årsskr. N.F. Avd. 2*, 20, 1~111 (in German).
- Lee, H.B. and I.K. Lee. 1981. Flora of benthic marine algae in Gyeonggi Bay, western coast of Korea. *Korean J. Bot.*, 24, 107~138.
- Lee, H.B. and R.H. Chang. 1989. A qualitative and quantitative analysis of seasonal change of an algal community at Padori of Tae-An Peninsula, west coast of Korea. *Korean J. Phycol.*, 4, 19~40 (in Korean).
- Lee, I.K. and Y.H. Kim. 1977. A study on the marine algae in the Kwang Yang Bay 3. The marine algal flora. *Proc. Coll. Nat. Sci., SNU*, 2, 113~153 (in Korean).
- Lee, I.K. and J.W. Kang. 1986. A check list of marine algae in Korea. *Korean J. Phycol.*, 1, 311~325 (in Korean).
- Lee, I.K., D.S. Choi, Y.S. Oh, G.H. Kim, J.W. Lee, K.Y. Kim and J.S. Yoo. 1991. Marine algal flora and community structure of Chongsando Island on the south sea of Korea. *Korean J. Phycol.*, 6, 131~143 (in Korean).
- Lee, J.W. and H.B. Lee. 1988. A floristic study on marine benthic algae of Yongil Bay and adjacent areas, eastern coast of Korea. *Korean J. Phycol.*, 3, 165~182 (in Korean).
- Lee, J.W., B.G. Oh and H.B. Lee. 1997. Marine algal flora

- and community of Padori area in the Taean Peninsula, the western coast of Korea. *Algae*, 12, 131~138 (in Korean).
- Lee, Y.P. and I.K. Lee. 1982. Vegetation analysis of marine algae in Jeju Island. *Proc. Coll. Nat. Sci., SNU*, 7, 73~91 (in Korean).
- Maggs, C.A. and M.H. Hommersand. 1993. *Seaweeds of the British Isles. Vol. 1. Rhodophyta part 3A. Ceramiales.* The Natural History Museum, London. 444 pp.
- Mikami, H. 1980. On *Acrosorium uncinatum* (Turner) Kylin (Rhodophyceae, Delesseriaceae) from Japan. *Jap. J. Phycol.*, 28, 113~116 (in Japanese).
- Mikami, H. 1988. Studies on *Acrosorium flabellatum* Yamada (Rhodophyta). *Jap. J. Phycol.*, 36, 43~47 (in Japanese).
- Nam, K.W. 1986. On the marine benthic algal community of Chuckdo in eastern coast of Korea. *Korean J. Phycol.*, 1, 185~202 (in Korean).
- Noda, M. 1966. Marine algae of the north-eastern China and Korea. *Sci. Rep. Niigata Univ. Ser. Biol.*, 3, 19~85.
- Noda, M. 1987. *Marine Algae of the Japan Sea.* Kazamashobo, Tokyo, 557 pp.
- Noda, M. and T. Kitami. 1971. Some species of marine algae from Echigo Province facing the Japan Sea. *Sci. Rep. Niigata Univ. Ser. D. (Biol.)* 8, 35~52.
- Okamura, K. 1908. *Icones of Japanese of algae.* Vol. 1, 120~146 (in Japanese).
- Okamura, K. 1936. *Nippon Kaisho-shi.* Kazamashobo, Tokyo, 964 pp (in Japanese).
- Park, S.H., Y.P. Lee, Y.H. Kim and I.K. Lee. 1994. Qualitative and quantitative analyses of intertidal benthic algal community on Cheju Island. 1. Species composition and distributional patterns. *Korean J. Phycol.*, 9, 193~203.
- Price, J.H., D.M. John and G.W. Lawson. 1986. *Seaweeds of the western coast of tropical Africa and adjacent islands: a critical assessment, III. Rhodophyta (Florideae).* 1. Genera A~F. *Bull. Br. Mus. Nat. Hist. (Bot.)*, 15, 1~122.
- Schneider, C.W. and R.B. Searles. 1991. *Seaweeds of the southeastern United States: Cape Hatteras to Cape Canaveral.* Durham, 533 pp.
- Song, C.B. 1986. An ecological study of the intertidal macroalgae in Kwangyang Bay, southern coast of Korea. *Korean J. Phycol.*, 1, 203~223 (in Korean).
- Turner, T. 1808. *Fuci; or coloured figures and descriptions of the plants referred by botanists to the genus Fucus* 1. London.
- Wynne, M.J. 1989. Towards the resolution of taxonomic and nomenclatural problems concerning the typification of *Acrosorium uncinatum* (Delesseriaceae: Rhodophyta). *Br. Phycol. J.*, 24, 245~252.
- Yamada, Y. 1930. Notes on some Japanese algae I. *J. Fac. Sci. Hokkaido Imp. Univ.*, 1, 35~36.
- Yoon, M.Y. and S.M. Boo. 1991. Flora and zonation of marine plants at littoral areas of Sapsido Island on the Yellow Sea of Korea. *Korean J. Phycol.*, 6, 145~156 (in Korean).
- Yoshida, T. 1998. *Marine Algae of Japan.* Uchida Rokakuho Publishing Co. Ltd., Tokyo, 1222 pp (in Japanese).
- Zanardini, G. 1865. *Iconographia phycologica mediterraneo-adriatica.* Vol. 2. Antonolli, Venezia (in Italian).