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Antithamnionella miharae (Tokida) Itono (Rhodophyta, Ceramiaceae) in Korea

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韓國產 紅藻 *Antithamnionella miharae* (Tokida) Itono

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ABSTRACT

Antithamnion miharae (Tokida) Itono was investigated in field and laboratory culture. The plant grows in lower littoral zone through out the year in Korea. The gland cells occur scarcely or commonly according to the populations, but the terminal hairs in the female plants are not observed. The structure of vegetative thallus and the reproductive organs in culture are similar to those of field materials, except for the number of gonimoblasts, which become five to six in contrast to one to three of the field. A typical *Polysiphonia*-type life history is repeated in culture. This species which produces tetrahedral tetrasporangia is markedly distinguished from *Antithamnion glandulifera sensu* Kylin (=*Antithamnionella glandulifera* (Kylin) Wollaston) which produces cruciate tetrasporangia, while the plants reported by Dawson (1962) and Wollaston (1971) as *A. glandulifera* seem to be conspecific with *A. miharae* by the fact that they have the tetrahedral tetrasporangia in stead of cruciate ones.

INTRODUCTION

Antithamnionella was established and distinguished from *Antithamnion* by Lyle (1922) with the characters of tetrahedrally divided tetrasporangia and three whorl-branchlets on an axial cell. He included three species in it, *A. sarniensis* nov. sp., *A. ternifolia* (Hook. *et* Harv.) Lyle, and *A. verticillata* (Suhr) Lyle. Baardseth (1941) added two new species later, and Kylin (1956) lectotypified the genus with *A. sarniensis*. Feldmann-Mazoyer (1940) however considered the genus invalid, and merged it in *Antithamnion sensu lato*.

Wollaston (1968, 1971, 1972), studied precisely on the vegetative and reproductive structures of *Antithamnion* and the related genera, resurrected *Antithamnionella* and added six more species and one variety. At present, this genus comprises fifteen species and one

variety by adding four more species thereafter (Itono, 1977; Abbott, 1979; Whittick, 1980). Among them the life history in culture has been detected only in *A. spirographidis* (Drew, 1955; Sundene, 1964).

Antithamnionella miharae (Tokida) Itono (basionym: *Antithamnion miharai* Tokida (1942)*) grows in Korea and Japan (Tokida, 1942; Kang, 1966; Itono, 1977; Lee and Boo, 1982). Tokida (1942) distinguished this species from closely resembled species, *Antithamnion glandulifera* Kylin (=*Antithamnionella glandulifera* (Kylin) Wollaston), by tetrahedrally divided tetrasporangium, paucity of gland cells and occasional presence of divided branchlets. The validity of this species, however, was still under the discussion (Dawson, 1962; Wollaston, 1971; Yoshida, 1981). In this paper a taxonomic reinvestigation of the species was carried out with the plants collected in Korea, specially dealing with the life history in laboratory culture.

MATERIALS AND METHODS

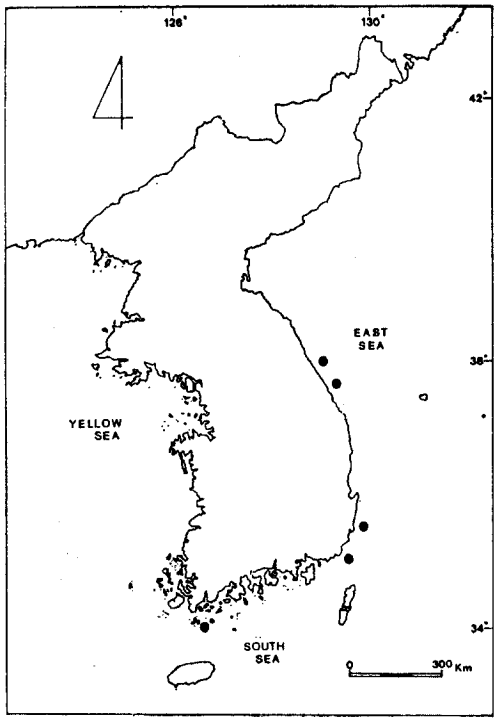

Fig. 1. Geographical distribution of *Antithamnionella miharae* (Tokida) Itono along the coasts of Korea.

Field populations of *Antithamnionella miharae* were investigated during 1982 and 1984 from east and south coasts of Korea (Fig. 1). Description and illustration were mainly based on field materials, and confirmed with the cultured plants.

Materials for culture were obtained at intertidal zone of Ilkwang (35°15N, 129°15E) in the east coast of Korea on 8 January, 1983. They were 3~4 cm high tetrasporophytes. Unialgal culture was established from excised apical tips of the indeterminate branches, which were isolated and cultured in Provasoli's enriched seawater (PES) medium at 16~19°C, under 800~1,300 lux using daylight fluorescent tubes with 16:8 photoperiod. The medium was usually changed in every two weeks.

FIELD OBSERVATION

Antithamnionella miharae grew on rock

* Yoshida (1981) corrected the specific epithet as *miharae* in accordance with the provisions of International Code of Botanical Nomenclature.

or was epiphytic on other algae. In Japan, the plants were collected at 5~11 m depth (Tokida, 1942; Yoshida, 1981). Both mature tetrasporophytes and gametophytes were collected in January at Ilkwang. In addition, from the east coast mature tetrasporophytes were found at Anin in April, at Kijang in July, epiphytic on *Ulva pertusa*, and at Kori and Sokcho in December. In the south coast, the plants were collected at Chungsando in August, and reported at Odongdo in summer by Kang (1966). As a result, *A. miharae* seems to grow through all seasons in Korea, whereas in Japan it occurs mostly in August and September (Yoshida, 1981).

MORPHOLOGICAL OBSERVATION

Vegetative thallus. The morphology of *A. miharae* was described and illustrated by Tokida (1942) and Yoshida (1981). Our plants agreed well with Tokida in description. The following was based on the plants at Kori.

The plants consist of prostrate and erect portions. The erect frond arises from the prostrate axes which are anchored on substrata by filamentous rhizoids. It is flaccid, up to 5 cm high, and bright red in color, adhering tightly to paper in drying. Rhizoids arise from the basal cells of whorl-branchlets, or are produced by elongation of lower most axial cell. They are usually 1~2 celled, terminating with multicellular pad. The rhizoids free from attachment become 2~5 celled with a blunt apex. Sometimes, single celled rhizoids are also produced in upper frond.

The main axis is developed monopodially by transverse divisions of apical cell. The axial cells are 35~45 μm wide and 380~400 μm high at the central portion of a mature thallus, making L/B be ca. 10 : 1. Each axial cell bears distichous determinate whorl-branchlets *sensu* Wollaston (1968). Three or rarely three to four whorl-branchlets also occurs occasionally on an axial cell. They are 7~9 celled and unequal in size each other (Figs. 2G, 3B). Their basal cells are similar in shape to the other cells of branchlet. The whorl-branchlets produce 2~5 celled primary pinnules adaxially, whereas 1~3 celled secondary pinnules rarely (Fig. 3B). On the other hand, the indeterminate branch replacing the determinate whorl-branchlet arises on the axial cell. It occurs alternately and is similar to the main axis in feature.

Gland cells are produced adaxially on the cells of whorl-branchlets in lower frond. They are sessile and 7~9 μm × 14~16 μm (Fig. 2H). The plants from Anin have gland cells singly or in series, whereas from Chungsando they are scarce or rare.

Apical part of an indeterminate branch curves insinuously as several early formed laterals are cut off alternately in secund pattern (Figs. 2G, 3A).

Gametophytes and carposporophyte. Spermatangial clusters are produced on the adaxial side of whorl-branchlets or on the primary pinnules (Fig. 2I). The cells of whorl-branchlet divide adaxially once or more, and become spermatangial mother cells. Two primary

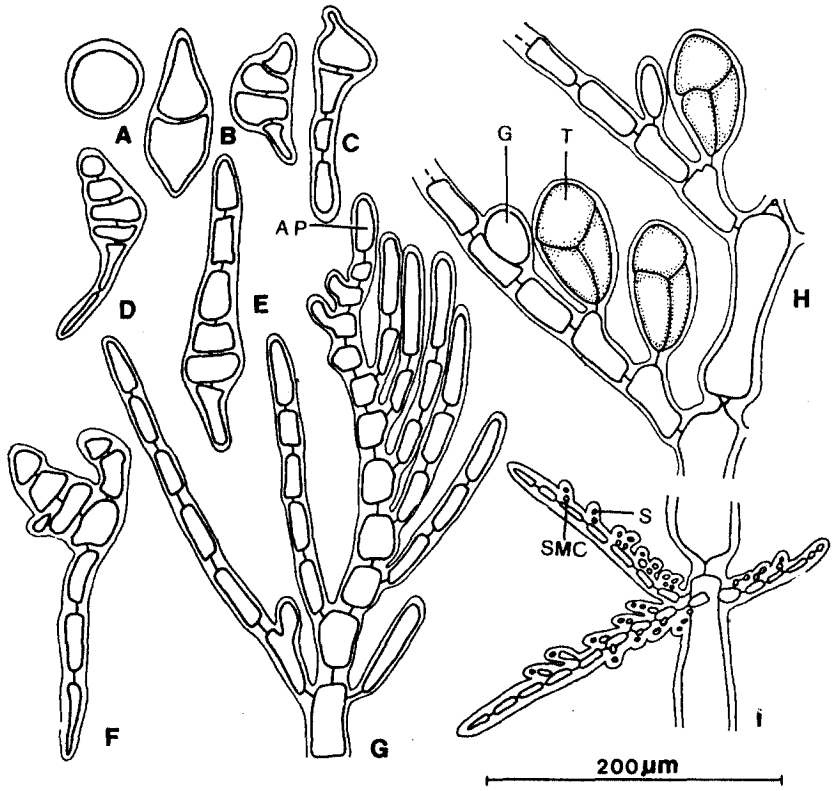

Fig. 2. *Antithamnionella miharae* (Tokida) Itono. A-F. Development of sporelings. G. Actively divided apex. H. Development of tetrasporangia. I. Development of spermatangia (AP, apical cell; G, gland cell; S, spermatangium; SMC, spermatangial mother cell; T, tetrasporangium).

spermatangia are produced subterminally on them and 3~4 μm×4~5 μm in size. Mature male gametophytes are about 1 cm high, but basically similar in shape to tetrasporophytes.

Carpogonial branches are produced singly on a supporting cell, which is the basal cell of the whorl-branchlet that is reduced to two cells (Fig. 3A), as mentioned by Wollaston (1968, 1971). An auxiliary cell is produced when the spermatium enters through the trichogyne (Fig. 3B). The auxiliary cell divides into the foot cell and central cell. The latter divides again, arising the gonimoblast initial cell, which divides several times and matures to the cystocarp. The cystocarp is terminal and surrounded by several involucral branches. The cells of gonimoblast are divided into one to three groups (Fig. 3C). Mature female plants are 20~25 mm high in the field.

Tetrasporophyte. Tetrasporangia are produced on the adaxial side of whorl-branchelets. They are first cut off from the basal cell of the branchets, and then successively from several adjacent cells (Fig. 2H). Mature tetrasporangia are sessile, tetrahedrally divided and 30~35 μm × 50~55 μm in size. Tetrasporophytes are comparatively large in 30~50 mm

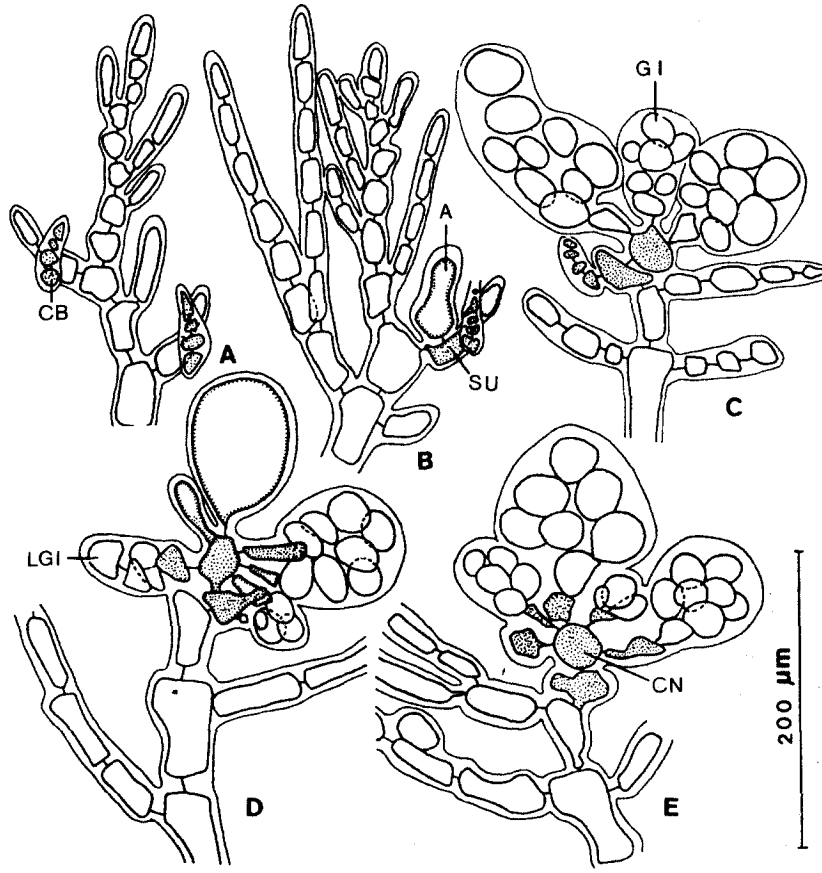

Fig. 3. *Antithamnionella miharae* (Tokida) Itono. A. Apex with carpogonial branches. B. Auxiliary cell after fertilization. C-E. Mature cystocarps with several gonimoblasts (A, auxiliary cell; CB, carpogonial branch; CN, central cell; GI, gonimoblast initial; LGI, lateral gonimoblast initial; SU, supporting cell).

height.

Laboratory culture. Unialgal culture was obtained from tetraspores. The spores soon attach to the cover glass and grow into two to four celled bipolar sporelings within a day (Fig. 2A-D). They differentiate into colorless rhizoidal portion and a pigmented upright axial portion, as seen typically in the Ceramiaceae (Dixon, 1973). The sporelings become 7~8 celled after three days, and develop branches from an axial cell in a week (Fig. 3F). Male gametophytes mature in three weeks and the female with carpogonial branches in four to five weeks. Dioecious gametophytes are crossed successfully. The post-fertilization process is similar to that of field material, except for the number of gonimoblasts, which becomes usually five to six in contrast to one to three in the field (Fig. 3D,E). Five to six gonimoblasts are not observed in Ceramiaceae.

Cystocarps mature in three weeks after fertilization. They are terminal, 150~200 μm in diam., and surrounded by two to five involucral branches in culture. Released carpospores develop into mature tetrasporophytes in two or three weeks after germination. Thus, it requires about two to three months to complete a full life cycle in culture. A typical *Polysiphonia*-type life history was repeated for several times during the culture. The vegetative and reproductive morphology of *Antithamnionella miharae* is generally identical both in laboratory and field.

DISCUSSION

Antithamnionella miharae occurs in the east and south coasts of Korea. The plants are somewhat larger than those in Japan (Tokida, 1942; Yoshida, 1981). Tokida (1942), illustrating the gland cells on the adaxial side of a whorl-branchlet, mentioned that the paucity of the cells was a noticeable character of the species. However, they occur in our plants from Anin, Kijang and Ilkwang of the east coast, but rare or scarce from Chungsando of the south coast of Korea. The culture plants isolated from Ilkwang also produce the gland cells. Thus, the occurrence of gland cell may differ among populations. Lee and West (1980) reported no gland cells in culture plants of *Antithamnion nipponicum*, eventhough they were mentioned in original description (Yamada and Inagaki, 1935) and in other populations of Korea (Boo and Lee, unpublished data).

The reproductive structures of the plants are basically similar to the previous descriptions (Tokida, 1942; Yoshida, 1981), or those of other species in the genus (Wollaston, 1968, 1971; Itono, 1977). Post-fertilization process is also similar to Yoshida's description, except for five to six gonimoblasts from a central cell in contrast to one to three gonimoblasts in field plants. Such a variation was also seen in *Antithamnion sparsum* (Boo and Lee, 1983). Neither mixed phase reproduction, nor unusual life histories, seen in culture of *Antithamnion* and related genera (Sundene, 1962, 1964; West and Norris, 1966; Rueness and Rueness, 1973; Boo and Lee, 1983) are observed in this species.

Tokida (1942) reported that *Antithamnion miharae* resembled very closely *Antithamnion glandulifera* Kylin and *A. gardneri* (Gardn.) De Toni (basionym: *A. tenuissimum* Gardner). Kylin (1925, Pl. 77, fig. 4) described and illustrated that *A. glandulifera* had the gland cells and cruciately divided sessile tetrasporangia. Smith (1944) pointed out that the tetrasporangia of *A. glandulifera* were cruciate, but often appearing as if tetrahedrally divided. Dawson (1962) mentioned that *A. miharae* should be reinvestigated in comparison with *A. glandulifera* of the Mexican plants, because the latter produced tetrahedral tetrasporangia. However, his illustration showed clearly cruciately divided tetrasporangia (Dawson, 1962, Pl. 4, figs. 5-7). Combining *A. glandulifera* with *Antithamnionella*, Wollaston (1971) reported that tetrasporangia of the species were divided cruciately or tetrahedrally, but generally appeared in tetrahedral form. She also noticed that *A.*

miharae should be reinvestigated in this point of view.

On the other hand, without any discussion on this problem, Itono (1977) combined *Antithamnion miharae* with *Antithamnionella*, and Yoshida (1981) followed the treatment. According to the present investigation, *A. miharae* is rather distinct species showing a good natural entity, and is dissimilar to *Antithamnion glandulifera sensu* Kylin (1925). As L'Hardy-Halos (1970) mentioned, cruciately divided tetrasporangia are different from tetrahedral ones by twice divisions of the initial cell in the formers and a simultaneous division of the latters. Our plants, *Antithamnionella miharae* shows distinct tetrahedral tetrasporangia in field and culture, and is different from *Antithamnion glandulifera sensu* Kylin, showing a distinct cruciate tetrasporangia. On the contrary, the plants mentioned by Dawson (1962) and Wollaston (1971) to have tetrahedral tetrasporangia are considered rather to be conspecific to *Antithamnionella miharae*.

摘 要

紅藻 애기참깃말(*Antithamnionella miharae* (Tokida) Itono: 국명 신칭)의 자연 개체군의 형태적 특징과 생육지, 계절적 소장 및 지리적 분포를 규명하고, 室內 培養을 통하여 이들의 生活史를 밝혔다. 紅藻 비단풀科의 주요 識別形質로 흔히 간주되는 腺細胞는 본 종의 경우, 개체군에 따라 달리 나타났으며, 낭과를 이루는 助胞絲의 수는 실내 배양에서 5~6個로 증가하여, 1~3개만 出現하는 자연 개체군의 경우와 구별되었다. 室內 培養에서 본 종은 *Polysiphonia*-형의 생활사를 반복하였다. 본 종의 사분포자낭은 뚜렷한 三角錐形이어서 그간 논란이 되고 있던 *Antithamnionella glandulifera* (Kylin) Wollaston과는 서로 다른 종임을 알 수 있었으며, Dawson (1962)과 Wollaston (1971)이 지적한 삼각추형의 사분포자를 갖는 *A. glandulifera*에 속한다고 생각되는 식물들은 본 종과 동일한 식물이라고 判斷되었다.

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