

Aglaothamnion callophyllidicola (Yamada) comb. nov.
(Ceramiaceae, Rhodophyta)

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A ceramiaceous red alga *Callithamnion callophyllidicola* Yamada was critically examined and compared with a related taxon, *C. minutissima* Yamada. The type and newly collected materials were found to have uninucleate vegetative cells and lobed cystocarps that link it closely with the related genus *Aglaothamnion* Feldmann-Mazoyer. The new binomial *Aglaothamnion callophyllidicola* (Yamada) comb. nov. is proposed and *C. minutissima* Yamada is here treated as a later synonym.

Key Index Words: *Aglaothamnion callophyllidicola*—*Callithamnion callophyllidicola*—*Callithamnion minutissima*—*Ceramiaceae*—*Rhodophyta*—*Taxonomy*.

Aglaothamnion was segregated from *Callithamnion* on the basis of *C. furcellariae* J. Agardh by Feldmann-Mazoyer (1940), but the genus had not been well defined (Dixon and Price 1981). The taxonomic relationship between two genera has recently been reappraised by L'Hardy-Halos and Rueness (1990), who proposed reinstatement of *Aglaothamnion* for the species of *Callithamnion* complex with only one nucleus in each vegetative cell. Thus several species previously assigned to *Callithamnion* in Europe are newly attributed to *Aglaothamnion*. In Korea and Japan three *Aglaothamnion* and nine *Callithamnion* species have been reported (Lee and Kang 1986, Yoshida *et al.* 1990), but their taxonomic positions have not been fully investigated.

Callithamnion callophyllidicola Yamada is a small ceramiaceous alga that occurs near the low water mark and in the subtidal habitats. It was first described from Enoshima in central Japan by Yamada (1932) as epiphytes on *Callophyllis crispata* Okamura and *C. japonica* Okamura. Although the diagnosis for *Callithamnion callophyllidicola* included informa-

tion on its vegetative and reproductive morphology, some described features are inconsistent with those now known to be characteristic of the genus (Segawa 1942, Boo *et al.* 1989). A reexamination of the type and newly collected materials of *C. callophyllidicola* and the related taxon, *C. minutissima* Yamada, was undertaken in order to reassess its taxonomic position.

Material and Methods

One envelope with three herbarium sheets as *Callithamnion callophyllidicola*, which were designated as types by Yamada (1932), has been housed in the herbarium of Faculty of Science, Hokkaido University (SAP). The first sheet is annotated as "Type! Enoshima, Apr. 6, 1932". Many plants are epiphytic on *Callophyllis crispata* (Fig. 1A). They are tetrasporic plants, males or females with cystocarps. The second sheet is annotated as "cotype! Enoshima, IV-1932" and has many plants epiphytic on the same host plant. The third is also annotated as "cotype! Enoshima, 6/4, 1932" and has seven plants (Fig. 1B).

The annotations were made by Y. Yamada himself.

Small fragments of dry specimens from the herbarium sheets were softened for a while in distilled water and then prepared for microscopic observation. When possible, the

preparations were stained with aniline blue/acetic acid and washed for observation.

The live tetrasporic plants were collected for staining nucleus at the low water mark in Choshi (Jan. 28, 1990), Chiba Prefecture and Kikonai (Feb. 15, 1990) of southern Hok-

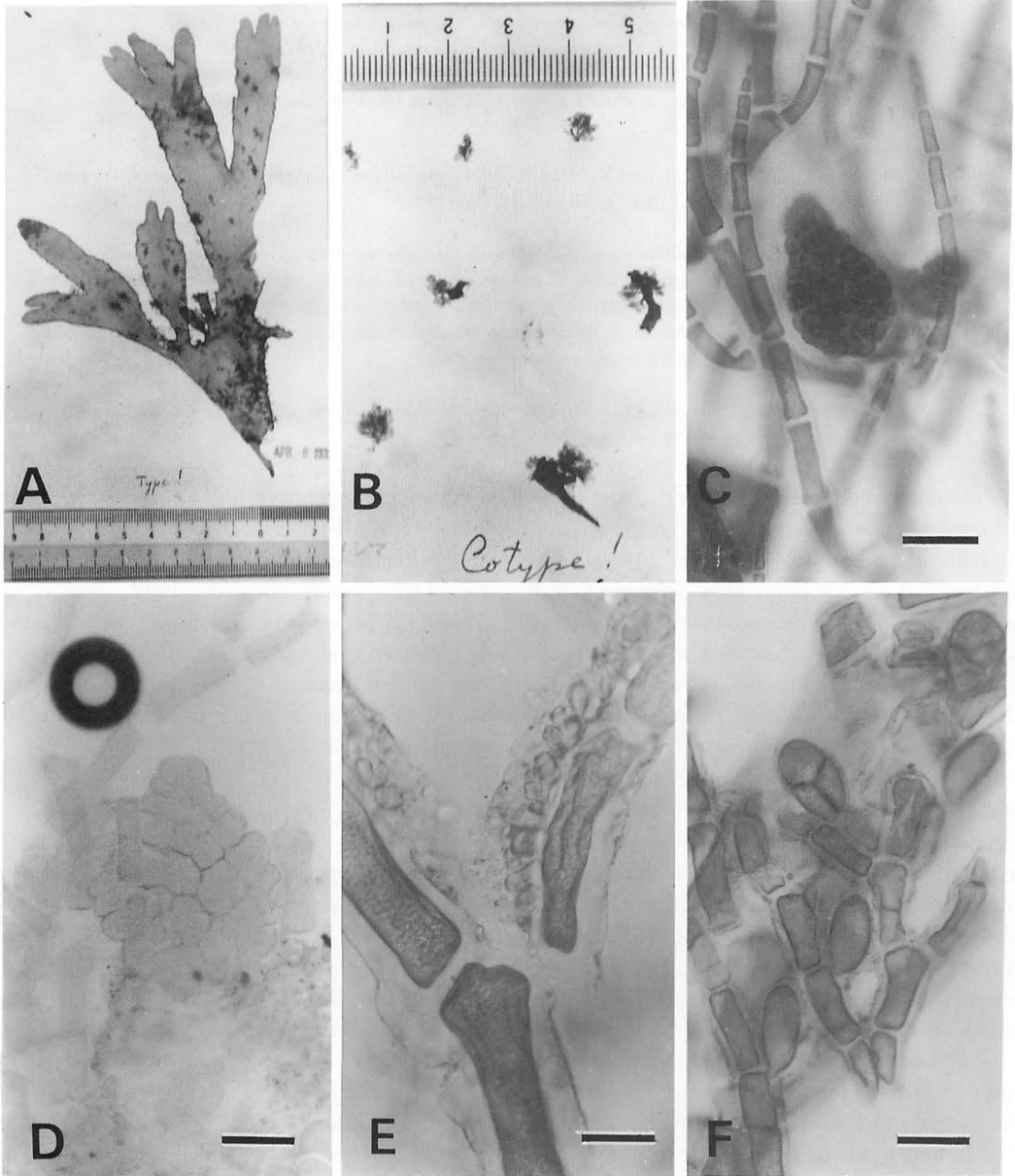


Fig. 1. *Aglaothamnion callophyllidicola*, habit and morphology. A. Holotype of *A. callophyllidicola* epiphytic on *Callophyllis crispata* Okamura (SAP 13082). B. Isotype sheet. C. Cystocarp of a female plant from Choshi. D. Cystocarp of a female plant on type sheet. E. Spermatangial branches of a male plant on type sheet. F. Tetrasporangia of a tetrasporic plant on type sheet. Scale: 50 μm for C, D, and 40 μm for E, F.

kaido. They were fixed in 2% glutaraldehyde and stained with the fluorochrome 4'-6 diamidino-2-phenylindole (DAPI, Goff and Coleman 1984) for observation under photomicroscope equipped with epifluorescence filters.

The original materials of *Callithamnion minutissima* Yamada are kept in SAP. They are mounted on slide glass and are given collection numbers of 368 and 1837.

Results

Callithamnion callophyllidicola Yamada: The plants grow with a maximal height of about 8 mm and are attached to the host by thin rhizoidal filaments which come out of the basal cells of the frond. The rhizoids are simply branched to digitate (Fig. 3B). The axial cells are formed from apical cells by oblique division and 70-90 μm broad and 200-220 μm long in the middle portion of plants, thus the L/B ratio being 2-3: 1. The branching pattern is alternate to subdichotomo-pinnate (Fig. 3A). The primary branches are derived alternately from every axial cell except lower ones (Fig. 2A). The third or fourth are usually formed similarly to the pri-

mary branches. All branches are distichous and can grow ultimately. Only one nucleus is observed in every vegetative cell of the axis and branches (Fig. 2A-B).

The gametophytes are dioecious. Spermatangial mother cells are cut off from the adaxial portion of the branches and give rise to spermatangia. Thus small spermatangial patches are seen on the adaxial portion of branches of male plants (Figs. 1E, 3D) and the branches with spermatangial patches are often curved. Carpogonial branches are formed on the axial vegetative cells in the upper portion of female plants. They are composed of four cells and are arranged in zig-zag (Fig. 3E-F). Two sterile cells are accompanied with the carpogonial branches. After fertilization young gonimolobes are formed (Fig. 3G-H), which become spherical to irregular carposporophytes and 300-500 μm long when mature (Fig. 1C-D).

Tetrasporophytes are isomorphic to gametophytes. Tetrasporangia are formed on the adaxial portion of branches (Fig. 2A). They are divided tetrahedrally and 40-55 μm \times 60-70 μm in size (Figs. 1F, 3C). The gland cells, which were described on the tetrasporophytes by Yamada (1932) and Kawashima

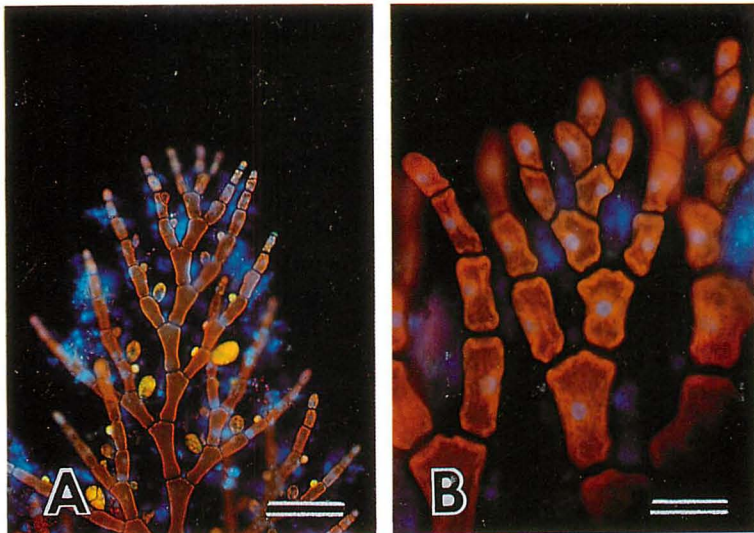


Fig. 2. *Aglaothamnion callophyllidicola* stained with DAPI. A. A tetrasporic plant from Choshi under photomicroscope equipped with epifluorescence filters. B. One nucleus in each vegetative cell. Scale: 100 μm for A and 40 μm for B.

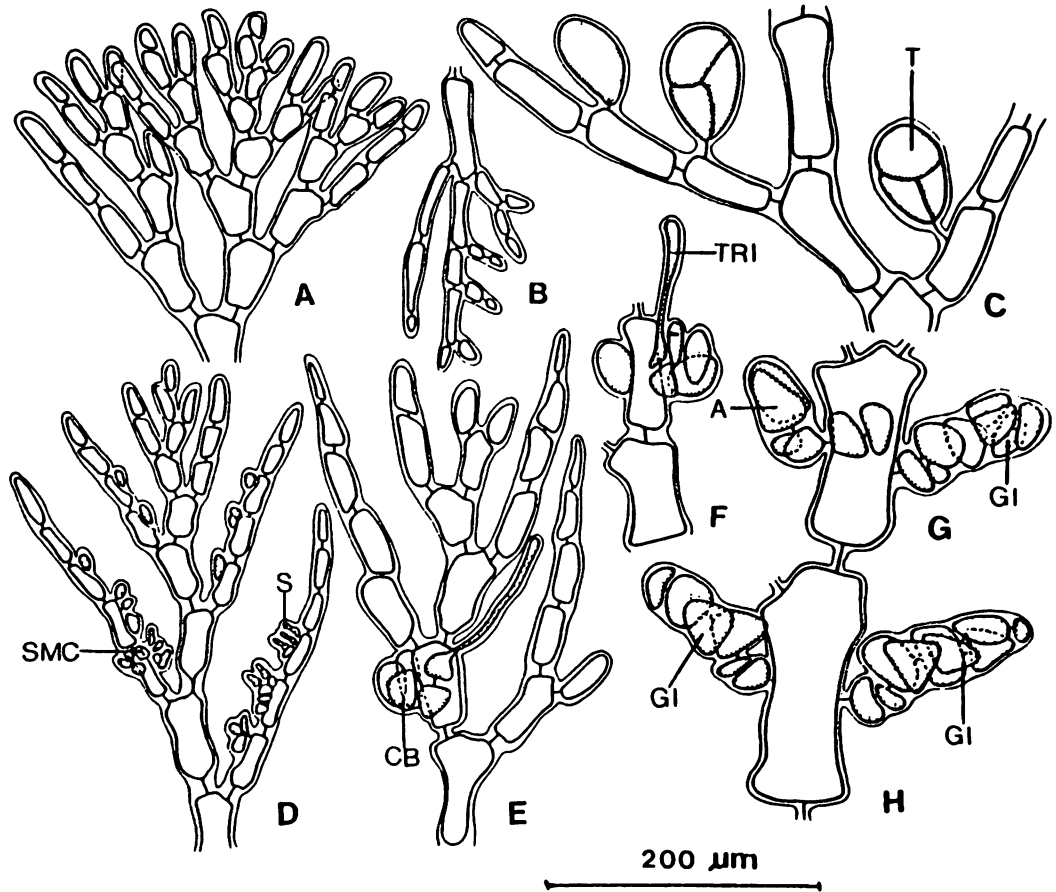


Fig. 3. *Aglaothamnion callophyllidicola*, morphology. A. Actively dividing apex. B. Digitate rhizoid. C. Development of tetrasporangia. D. Development of spermatangia. E-F. Carpegonial branches and postfertilization process. G-H. Development of gonimolobes. A; axillary cell, CB; carpegonial branch, GI; gonimolobe initial, S; spermatangia, SMC; spermatangial mother cells T; tetrasporangia, TRI; trichogyne.

(1960), are never observed in this study.

Callithamnion minutissima Yamada: The original materials are kept only on slides (Nos. 368 and 1837). They are crushed to piece and bleached, from which we couldn't observe any characteristic features. As there is no accompanying illustration in the original paper (Yamada 1944, p. 14) and the species has scarcely been reported in flora, checklist and monograph, we have no choice but to refer the original description.

Discussion

The genus *Aglaothamnion* is typified by *A. furcellariae* (J. Agardh) Feldmann-Mazoyer, which was lectotypified with Agardh Herbari-

um no. 19087 (LD) collected from Bohuslan on the Swedish west coast (L'Hardy-Halos and Rueness 1990). Although it has been circumscribed in the uninucleate vegetative cells, a zig-zag alignment of cells of the carpegonial branches and the lobed, not rounded cystocarps (Feldmann-Mazoyer 1940), the zig-zag type of the carpegonial branches occurs in multinucleate taxa like *Callithamnion corymbosum* (Smith) Lyngbye and the cystocarps of *A. byssoides* (Arnott ex Harvey in Hooker) L'Hardy-Halos et Rueness are spherical to irregular in shape. Thus, validity of *Aglaothamnion* has recently been insisted for the species with only one nucleus in each vegetative cell because of its consistency (L'Hardy-Halos and Rueness 1990).

Although there have been reports that *Callithamnion callophyllidicola* Yamada has some diagnostic characters of the genus *Aglaothamnion*, a taxonomic combination has not been made because the generic concept of *Aglaothamnion* was obscure (Segawa 1942) and type specimens had not been critically examined (Boo *et al.* 1989). Our observation on type materials of *C. callophyllidicola* agrees well to the protologue (Yamada 1932) and the previous observations (Segawa 1942, 1949, Kawashima 1960), but some features are inconsistent with them. One nucleus is found in each vegetative cell of the live plants collected in Choshi, although we could not observe nucleus from dry type materials. In addition, as our observation confirms no gland cells on type plants, Yamada must have mistaken small protuberances on branches for gland cells (Boo *et al.* 1989).

The shape of the cystocarps in the protologue is shown to be spherical (Yamada 1932, Pl. VIb), but they have been reported to be lobed (Segawa 1942, p. 208, Kawashima 1960, p. 107) and irregularly spherical (Kawashima 1960, p. 107). In this study the cystocarps of type materials present lobed forms (Fig. 1D), that is also included in the genus range of *Aglaothamnion*. Features on male and tetrasporic plants agree well to the above reports.

The foregoing sections mention that the sheet (SAP 13082) designated as type by Yamada (1932) has many individuals epiphytic on *Callophyllis crispata*. We confirmed that all specimens on the type sheet are not heterogeneous, so Yamada's type of *C. callophyllidicola* is regarded as correct according to the Article 9.1 of the Berlin code (Greuter *et al.* 1988).

It was reported that *Callithamnion minutissima* resembled *C. callophyllidicola* but was easily distinguished by its more slender frond, longer axial cells and not tapered ultimate ramuli (Yamada 1944). As is pointed out in European *Callithamnion* species (Harris 1962), Yamada's diagnostic characters are quantitative or unstable and subject to be changed in different environment (Boo *et al.* 1989).

However, since the same name was preoccupied for species of Adriatic Sea described by Zanardini (1842) and Kützing (1843 p. 371), Yamada's *C. minutissima* is an illegitimate name and should be replaced or rejected. The original materials in the herbarium of Hokkaido University (SAP) are kept so crushed in piece and bleached that we could not observe any features from them and the protologue has no illustration (Yamada 1944). The type locality, Hayama of Kanagawa Prefecture, is also situated near Enoshima, the type locality of *C. callophyllidicola*. Furthermore, as *C. minutissima* overlaps *C. callophyllidicola* in protologue (Boo *et al.* 1989, Table 1), we conclude *C. minutissima* Yamada as a later synonym.

According to Dawson (1962), *Callithamnion paschale* Børgesen is closely related to *C. minutissima*, but he did not state whether the alga had one or more nuclei in vegetative cells. Since both Dawson (1962) and Abbott and Hollenberg (1976) distinguished *Aglaothamnion* from *Callithamnion*, it seems implicit that at least *C. paschale* is a multinucleate species. *Aglaothamnion oosumiense* Itono (1971) is another related species (Boo *et al.* 1989), that needs a further study.

There are still some questions to be answered about the genus *Aglaothamnion* and its species. However, from the view discussed above, it is obvious that *Callithamnion callophyllidicola* is a distinct and an endemic species to Japan and the surrounding coasts, and includes the related taxon, *C. minutissima*. The following new binomial combination is therefore proposed:

***Aglaothamnion callophyllidicola* (Yamada), comb. nov.**

Basionym: *Callithamnion callophyllidicola* Yamada 1932, p. 270. fig. 3a-b. pl. V, VIb., Holotype SAP 13082 "Enoshima, Sagami Province, Japan, Y. Yamada, April 6, 1932" Herbarium of Faculty of Science, Hokkaido University.

Synonym: *Callithamnion minutissima* Yamada 1944, p. 14., Types SAP, collection number 368 and 1837 "Hayama, Kanagawa Prefecture, Japan" Herbarium of Faculty of

Science, Hokkaido University.

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Boo, Sung Min* · Lee, In Kyu** · Jan Rueness*** · 吉田忠生**** :

キヌイトグサ (紅藻, イギス科) について

キヌイトグサのタイプ標本および新たに採集した生材料の詳しい観察から, この種の栄養細胞は単核であり, 嚢果の外形が浅裂することを確認した。これらの特徴は近縁属であるアグラオタムニオン *Aglaothamnion* 属と一致するので, キヌイトグサに対して *Aglaothamnion callophyllidicola* の組合せを提案する。またヒナノキヌイトグサ *Callithamnion minutissima* Yamada は種のレベルで区別することができないので, キヌイトグサの異名であると結論される。(*Department of Biology, Chungnam National University, Daejeon 305-764, Korea. **Department of Biology, Seoul National University, Seoul 151-742, Korea. ***Department of Biology, Marine Botany, Oslo University, Oslo 3 Norway, ****060 札幌市北区北10条西8丁目 北海道大学理学部植物学教室)