

## Hirotohi Yamamoto: Observations on the adelphoparasite *Congracilaria babae* Yamamoto (Gracilariaceae, Rhodophyta) of the Philippines

*Key Index Words:* adelphoparasite—bisporangium—Congracilaria—Gracilariaceae—Rhodophyta.  
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Yamamoto (1986) established the monotypic genus *Congracilaria* on the basis of the materials from Okinoerabu Island in the subtropical region of Japan, characterizing it by its adelphoparasitic and bisporic nature, and deep pot-shaped spermatangial conceptacle. Its distribution has also been expected in southeast Asian regions where the host alga, *Gracilaria salicornia*, is much more luxuriant than in the type locality.

In 1988-1990, the author collected a lot of specimens growing on *G. salicornia* from various parts of the Philippines, and made detailed comparisons with the Japanese materials.

The materials in the Philippines were collected at the following sites and dates:

Luzon Island: Laoag, Jun. 1990; Batangas, Nov. 1989.

Mactan Island: Jan. 1988.

Palawan Island: Cowry Island, Jan. 1988; Barangay Tacduan, Jan. 1988; Barangay Bangkaw-bangkaw, Jan. 1988.

All specimens collected were monoecious and bisporic.

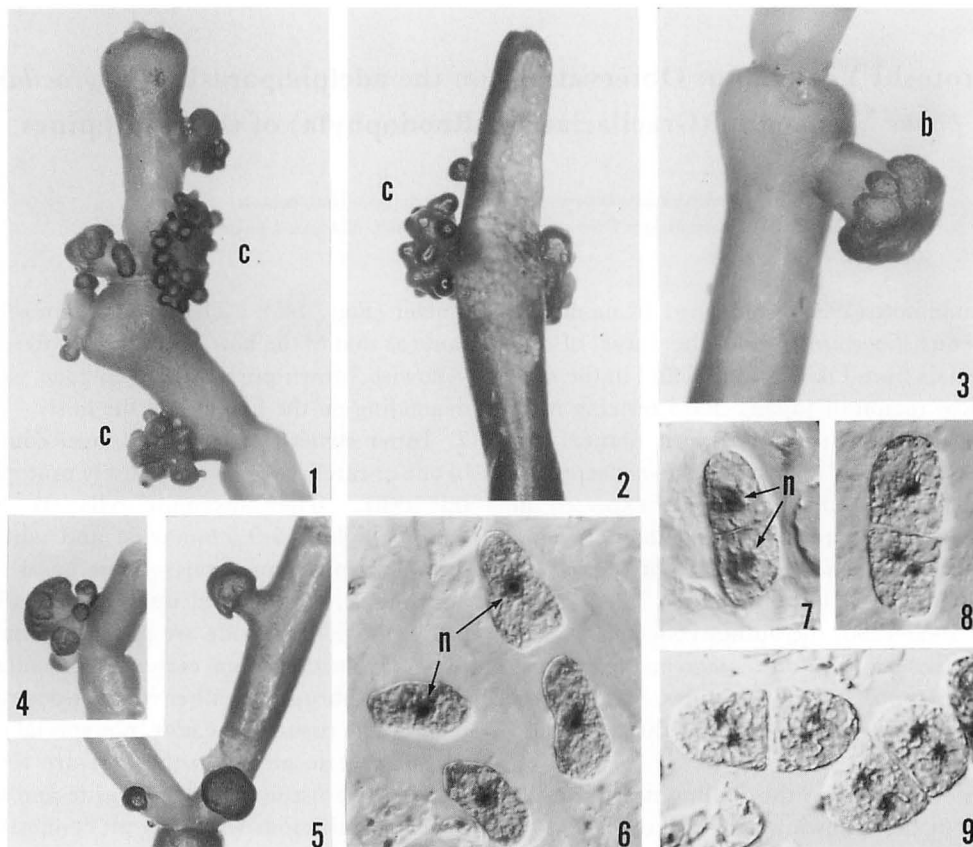
The materials were preserved in about 5% formal seawater and in ethanol acetic acid (3 : 1) fixative, and were sectioned using freezing microtome or squashed for microscopic observations. Wittmann's solution (Wittmann 1965) was used for observations on nuclei.

**1. External morphology:** The alga is parasitic on various parts of the host, *G. salicornia*. It has usually a mushroom-shaped appearance with a short stipe. The surface of the part corresponding to the cap of a mushroom is smooth, but sometimes slightly undulate or rarely lobed. The parasites are up to 3.5 mm high and 5 mm in diameter at the cap. The stipes are up to 1.2 mm high and 1.2 mm in di-

ameter (Figs. 1-5). The color is almost the same as that of the host or slightly lighter, the yellowish brown-purplish brown tone varies depending on the habitats of the host.

**2. Inner structure:** Cortical layer consists of one or rarely two rows of densely protoplasmic cells. The outermost cells are 8.0-9.5  $\mu\text{m}$  high, 5.5-9.5  $\mu\text{m}$  wide and without secondary pit connections. Hair basal cells are present, with several nuclei. Medullary cells up to 450  $\mu\text{m}$  wide are poorly protoplasmic. Transition from cortex to medulla in cell size is abrupt. Neither rhizoids penetrating into the tissue of the host, nor special cells which serve to attach to the host are recognized. The tissue between parasite and host appears continuous with only pit connections (cf. Figs. 5-7 in Yamamoto 1986).

**3. Reproductive organs:** Carpogonial branches consist of two cells and are formed all over the cap. After presumed fertilization, the cells around each carpogonial branch develop into cystocarps in the process similar to that of *Gracilaria* species. Cystocarps are dome-shaped, up to 600  $\mu\text{m}$  high and 750  $\mu\text{m}$  in diameter with an ostiole at the top. A number of cystocarps appear on a frond. Accordingly, the fronds with cystocarps show remarkably uneven or lobed appearance (Figs. 1-2). The vegetative tissue of gonimoblast consists of large cells which produce gonimoblasts and a few tubular cells. Cells close to the tips of gonimoblasts develop into carposporangia. Some of tubular cells reach the pericarp and connect with pericarp cells through several pits. Cystocarps almost always coexist with spermatangia. Spermatangia are formed in deep conceptacles up to 80  $\mu\text{m}$  deep and 60  $\mu\text{m}$  wide, and crowded in a sorus but usually separated



Figs. 1-9. *Congracilaria babae* of the Philippines.

Figs. 1-5. Various habits of *Congracilaria babae* growing on the host alga, *Gracilaria salicornia*. c: Carpophytes, showing a lot of projections of cystocarps on a single frond. b: Bisporophytes, showing smooth surface of their caps and distinguishable stalks. Figs. 6-9. Process of bisporangium formation. Fig. 6. Sporangia before cell division. Fig. 7. A sporangium transversally divided, showing a single nucleus in each cell. Fig. 8. A dividing sporangium, showing a single nucleus in upper cell and two nuclei in lower cell. Fig. 9. Binucleate bispores. n: Nucleus.  $\times 3.3$  for Figs. 1-5;  $\times 520$  for Figs. 6-9.

from each other by vegetative cells. The conceptacles appear to be the *verrucosa* type of *Gracilaria* species (Yamamoto 1975). Bisporangia are produced superficially all over the cap (Figs. 3-5) instead of tetrasporangia (cf. Figs. 6, 10-14 in Yamamoto 1986). Initial sporangia divide transversally into two cells, each of which has a single nucleus (Fig. 6). Subsequently, the nucleus of each cell divides once again without cytokinesis, resulting in binucleate cells. Sporangia are 38.4-44.5  $\mu\text{m}$  high and 18.2-22.2  $\mu\text{m}$  wide and surrounded by rows of elongated vegetative cells. Surface of the cap with sporangia is usually smooth (Figs. 3-5).

The Philippine specimens are a little larger

in frond size than Japanese ones, but there are no critical differences between the two in their external appearance, internal structures and reproductive organs (Table 1).

Bisporangium has been recognized as the most distinctive feature to characterize the genus *Congracilaria* from its related taxa. The existence of bisporangia in the materials from various parts of the Philippines proved that it is of value as a taxonomic criterion, because bisporangia are consistent structures common in populations of *Congracilaria* in Japan and the Philippines.

In addition to the similarity found in the structures and the reproductive organs between the two taxa, monoecism is prevalent.

Table 1. Comparative data on Japanese and Philippine materials of *Congracilaria babae*

	Japanese taxon	Philippine taxon
Host	<i>G. salicornia</i>	<i>G. salicornia</i>
Dimension	up to 3 mm high, up to 4.5(-5) mm diam.	up to 3.5 mm high, up to 5 mm diam.
Stipe	up to 1 mm high, up to 1.2 mm diam.	up to 1.2 mm high, up to 1.2 mm diam.
Surface	smooth, slightly or scarcely undulated	smooth, slightly undulated, rarely remarkably lobed
Color	same as host	same as host
Hair	present, but rare	present
Rhizoid	absent	absent
Outermost cell	7.9-9.6(-11.2) $\mu\text{m}$ high, 5.6-9.6(-10.4) $\mu\text{m}$ wide	8.0-9.5 $\mu\text{m}$ high, 5.5-9.5 $\mu\text{m}$ wide
Medullary cell	up to 560 $\mu\text{m}$ wide	up to 450 $\mu\text{m}$ wide
Transition in cell size	abrupt	abrupt
Carpogonial branch	two-celled	two-celled
Cystocarp	dome-shaped, single ostiole, a number of cystocarps in a single frond, up to 540 $\mu\text{m}$ high, up to 700 $\mu\text{m}$ diam.	dome-shaped, single ostiole, a number of cystocarps in a single frond, up to 600 $\mu\text{m}$ high, up to 750 $\mu\text{m}$ diam.
Tubular cell in cystocarp	present	present
Spermatangial conceptacle	<i>verrucosa</i> type of <i>Gracilaria</i> up to 50(-60) $\mu\text{m}$ deep, up to 40 $\mu\text{m}$ wide, in sorus	<i>verrucosa</i> type of <i>Gracilaria</i> up to 80 $\mu\text{m}$ deep, up to 60 $\mu\text{m}$ wide, in sorus
Sporangium	bisporangium, each cell with two nuclei, 38-50 $\mu\text{m}$ high, 18-20 $\mu\text{m}$ wide	bisporangium, each cell with two nuclei, 38.4-44.5 $\mu\text{m}$ high, 18.2-22.2 $\mu\text{m}$ wide
Coexistence of different reproductive phases	monoecious, rarely three phases coexisting	monoecious

As Yamamoto (1986) previously pointed out the result of Japanese alga which was examined by Goff's (1981) experiment, the monoecism of this alga may be a reflection of nature of binucleate bispores. During the two successive nuclear divisions in a sporangium to produce binucleate bispores, the reduction of chromosome number presumably occurs in the second division, resulting in binucleate spores which have heterogenotypic nuclei in each and may develop into a bisexual frond.

The author expects *Congracilaria babae* to be present in the regions including southern China, Indonesia, Micronesia, and possibly more widely distributed, corresponding to the broad geographical distribution of its host,

*G. salicornia* from Mauritius to Hawaii in the tropical zone.

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## 山本弘敏：フィリピン産の寄生種フシクレタケの観察

現在まで鹿児島県沖永良部島からのみ知られていた寄生種フシクレタケ (*Congracilaria babae*) が、フィリピンにも広く分布することを確認した。フィリピン産の外部形態、内部組織、生殖器官はともに日本産のものとはほぼ同じであり、この種の特徴とされている二分胞子のうと雌雄同体性は全ての採集地域からの標本で認められた。この結果、この特性は一地域（日本）の標本にのみ見られた例外的な形質ではなく、本種の特徴的な形質であることを確認した。(041-16 北海道南茅部町字白尻152 北海道大学水産学部白尻水産実験所)