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Interfertility between so-called *Gracilaria verrucosa* (Huds.) Papenfuss and *G. vermiculophylla* (Ohmi) Papenfuss in Japan[1)]

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Abstract

Reciprocal crosses between "*Gracilaria verrucosa*" from two localities, Shinori and Kikonai in southern Hokkiado, and *G. vermiculophylla* were carried out. These taxa were found to be sexually compatible, and as a result taxonomically conspecific. This suggests that Japanese *G. verrucosa* might be merged with *G. vermiculophylla* (Ohmi) Papenfuss instead of with *G. asiatica* Zhang et Xia upon a suggestion made earlier.

There has been a problem as to whether "*G. verrucosa*" of Japan is a single taxon, since it shows wide morphological variability according to localities. To answer this question, Yamamoto and Sasaki (1987) earlier attempted crossing experiments between representatives from two localities which possessed wide morphological variations. These experiments demonstrated that the variations were not genetically based, but perhaps influenced by environmental adaptations.

Gracilariopsis vermiculophylla Ohmi was first described by Ohmi (1956), and later was transferred to *Gracilaria* by Papenfuss (1966). That this plant belongs in the *Gracilaria* genus is supported by Yamamoto (1975, 1978). This species is distinguished from *G. verrucosa* by absence or scarcity of absorbing filaments in cystocarps, which have a large gonimoblast tissue of small, densely massed and protoplasmic cells, occurrence of tetrasporangial nemathecia, and somewhat vermiform morphology of upper branches. However, these criteria are not always distinct, and species identification is sometimes unsatisfactory. Therefore we performed crossing experiments between the two taxa to review their specificity. The recent world-wide reexaminations on populations of "*G. verrucosa*" that affect taxonomy are reviewed by Yamamoto and Sasaki (1987).

Materials and Methods

The gametophytes of *G. verrucosa* were initiated from tetrasporophytes collected at Shinori and Kikonai in southern Hokkaido from June to July, 1986. The gametophytes of *G. vermiculophylla* were derived from tetrasporophytes collected at

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Akkeshi Lagoon (the type locality) in July, 1986.

Sporing, culture and crosses were carried out using procedures described previously (Yamamoto and Sasaki, 1987). Self-crosses were used as controls.

Results

G. vermiculophylla showed a *Polysiphonia*-type life cycle as those of *G. verrucosa* (see Yamamoto and Sasaki, 1987). The crosses between each "*G. verrucosa*" (♀) from two populations and *G. vermiculophylla* (♂) were successful, as were the reciprocal crosses. The carpospores from resulting cystocarps developed into fertile tetrasporophytes, and the released tetraspores gave rise to both female and male gametophytes which formed fertile cystocarps after fertilization. The cycles were completed in about 7 months from the initial incubation of tetraspores. The process was the same in controls.

Cystocarps of *G. vermiculophylla* resulting from self-crosses showed a scarcity of absorbing filaments, whereas cultured *G. verrucosa* of both Shinori and Kikonai showed a moderate or small number of filaments as noted from field material. The cystocarp in reciprocal crosses of *G. vermiculophylla* × *G. verrucosa* (Shinori) possessed intermediate number of filaments, and those of *G. vermiculophylla* × *G. verrucosa* (Kikonai) had relatively few. Vermicular morphology of *G. vermiculophylla* was difficult to distinguish because closed circumstances in the incubation flasks caused considerably deformed fronds. These features tended to appear more strongly than those of Kikonai which are thinner than those from other populations. Self-crossed plants from each population retained external appearances similar to the source material. Color tended to be pale when compared with those of parents but this may result from high light intensity under culture conditions.

Discussion

The successful crosses between "*G. verrucosa*" and *G. vermiculophylla* demonstrate that they are the same species. However, Japanese "*G. verrucosa*" may be different from the British specimens, judging from descriptions of other researchers (see Bird et al. 1982; Abbott, 1985; Zhang and Xia, 1985). The chromosome number in *G. verrucosa* (Kikonai) is n=24 (Yabu and Yamamoto , 1988) which is different from n=32 in the authentic *G. verrucosa* from England (see Bird et al., 1982). If chromosome numbers are fixed, the name *G. verrucosa* cannot be used for the entities in southern Hokkaido, and the name *G. vermiculophylla* is the earliest name to be applied.

Zhang and Xia (1985) proposed a new name, *G. asiatica* for an alga known as *G. verrucosa* in China and, on the basis of a specimen from Shinori assigned *G. verrucosa* to it, also. However, since the representative from Shinori revealed sexual compatibility with *G. vermiculophylla* in this experiment, crossing experiments and comparative reexaminations need to be made with Chinese *G. asiatica*.

The Japanese taxon may be a mixture of different species. Therefore additional crossing experiments between more populations throughout Japan and detailed comparisons with the authentic specimens are still required. In our opinion, the name "*G. verrucosa*" should tentatively be continued for the Japanese

taxon.

The increase or decrease of absorbing filament numbers was found in the intercrosses. It has been demonstrated that this number is never consistent (Papenfuss, 1966; Yamamoto, 1975), but the scarcity retained in self-cross of *G. vermiculophylla* suggested that the number may be useful for segregating *Gracilaria* populations.

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