MITOSIS IN *PORPHYRA TENERA* KJELLM.

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Investigations made by Ishikawa (1921), Tseng & Chang (1955) and Fujiyama (1957) have contributed to the cytology of *Porphyra tenera* Kjellm., but, as described in a previous paper (Yabu & Tokida, 1963), the above mentioned investigators' opinions concerning chromosome number, syngamy and meiosis of this species are not in accordance with each other's results obtained through their studies. Recently I had a chance to examine the nuclear divisions in numerous leafy thalli of this alga and could ascertain the chromosome number and the fact of syngamy. The materials used in this study were collected at Pusan in Korea in April 1968 and fixed at night with aceto-alcohol solution (3:1). Wittmann's aceto-iron-haematoxylin-chloral hydrate solution was used for staining.

Results

Somatic division: In the beginning of the nuclear division, the nucleus increases up to about 7μ in diameter and the nucleolus within the nuclear cavity comes to have a vacuolated structure. At mid-prophase three chromosomes make their appearance as faintly staining threads rather thin and somewhat long, but soon they become thick and short, increasing their staining ability. In late prophase chromosomes are often seen surrounding the nucleolus. From the dividing figures of nuclei at prophase, one of the chromosomes is usually found to be longer than the other two. In metaphase chromosomes assume a rod shape in nearly the same size and are scarcely recognized to differ in size among them (Pl.I, Figs. A & B). In anaphase each chromosome group migrates to the polar position which lies in the direction perpendicular to the surface of the thallus. After the nuclear division is finished, the cell is divided into two cells by the formation of a cell wall.

Spermatium formation: Various stages of the dividing figures were easily obtained in the first and the successive divisions leading to spermatium formation. In those divisions, the nucleus in early prophase was observed to have a well stained linnen network. At this stage the nucleus occasionally contains small chromatin granules and two to several nucleoli. With the development of the process, the linnen network becomes coarser and then three chromosomes appear as somewhat long threads, one of which is always longer than the other two. As the

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shortening of the threads goes on, the chromosomes change into rod shape at metaphase. In the second and the successive divisions, nuclei in late prophase and early metaphase were found to have sometimes one or two bodies besides chromosomes, which seemed to be nucleoli in the process of degeneration. These bodies are variant in size and at times resemble chromosomes in shape and staining ability, so that in such a nucleus with those bodies the chromosomes are apt to be counted together with them and thus seem to be more numerous than nature provides.

Carpospore formation: The intrusion of spermatium and the fusion of the male and female nucleus within the carpogonium are very difficult to find. Those facts were observed only in a few preparations. When the male nucleus enters into a carpogonium, the nucleus stains better than that of the female (Pl. II, Figs. A-D). Within a carpogonium, the male nucleus takes an ellipsoidal form towards the female nucleus. The passing trace of the male nucleus in a carpogonium is seen to remain for a short while (Pl. II, Fig. A). Figs. B & C in Pl. II show the two nuclei which are going to fuse; the nucleus on the left side of the figures is of the male and the one on the right side is of the female. The fused nucleus soon enters into porphase of mitosis in the first division for carpopsore formation, and the well stained reticulum begins to appear in it. Similarly to the prophase nucleus in spermatium formation, the fused nucleus at prophase has occasionally two to several nuceoli and many small chromatin granules. Chromosomes show their outline in about mid-prophase as somewhat long threads which soon become rod shape. In the first and the following divisions leading to carpospore formation, the nucleus at late prophase and metaphase shows to have six chromosomes, two of which are occasionally found to be longer than the others in prophase.

Discussion

In *Porphyra tenera* the haploid number of chromosomes has been reported to be 3 by Ishikawa (1921), 4 by Fujiyama (1957) and 5 by Tseng & Chang (1955). According to my observation on numerous thalli of this alga, the chromosome number is always three in vegetative cells and in the formation of spermatium and six in the formation of the carpospore. Recently the karyotype in several species of *Porphyra* in Japan was shown by Yabu (1969). Referring to his study, the caryotype of *P. tenera* consisting of one long and two short chromosomes in haploid is the same as in *P. pseudocrassa*, *P. seriata* and *P. yezoensis*. In *P. tenera* it was suggested by Ishikawa and stated by Tseng & Chang that meiosis occurs in the carpogonium after fertilization, but Fujiyama reportes that carpospores are formed without meiosis. In my material it was ascertained that the male nucleus undoubtedly fused with the female one in the carpogonium and mitotic division follows without meiosis to form the carpospore. According to Migita

(1967) meiosis in *P. yezoensis* takes place at the formation of the conchospore. Further work is necessary to confirm meiosis in *P. tenera*, though it is supposed to occur in the same place as in *P. yezoensis*.

Summary

Nuclear divisions of *Porphyra tenera* Kjellm. are observed in vegetative cells and in the formation of spermatia and carpospores. In this alga, the chromosome number is three in haploid and six in diploid; two nuclei of male and female fuse within the carpogonium and carpospores are formed without meiosis.

Acknowledgement

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Explanation of Plates

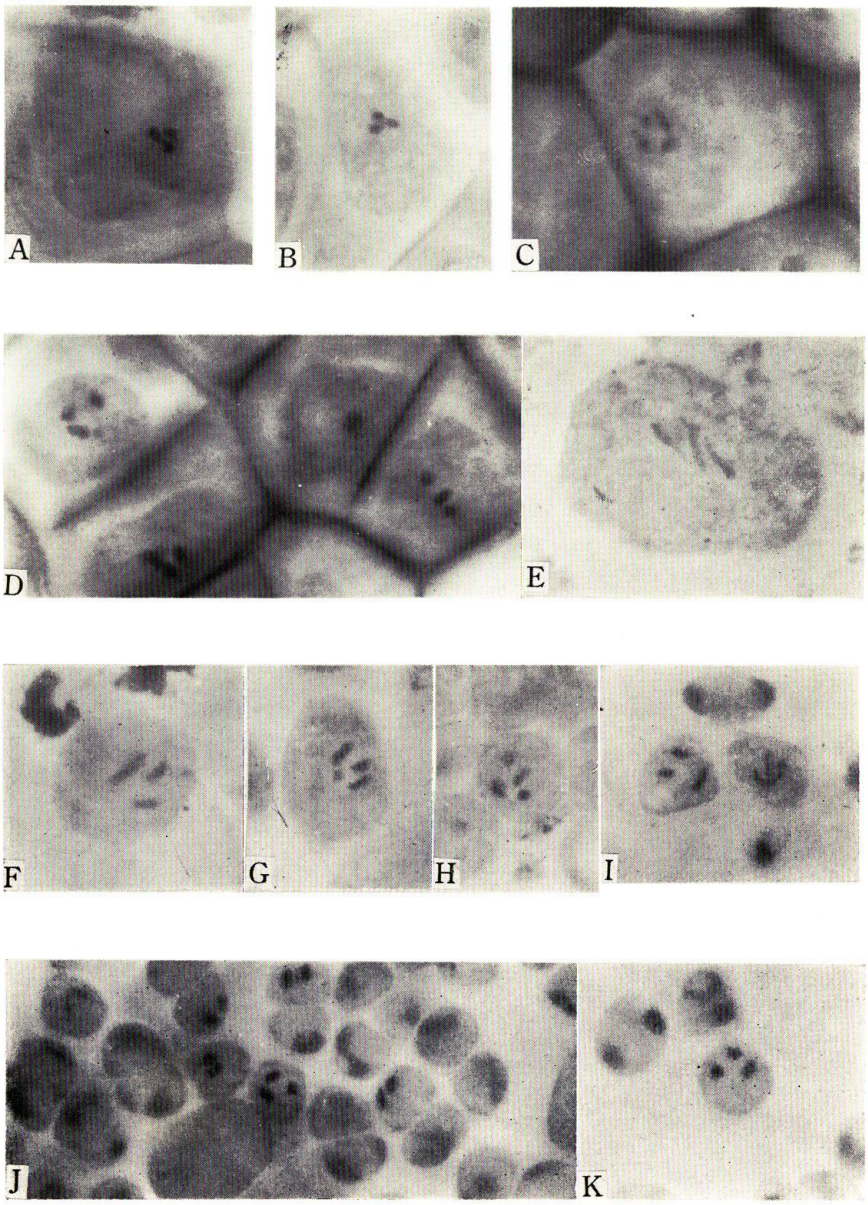
PLATE I

Porphyra tenera Kjellm.

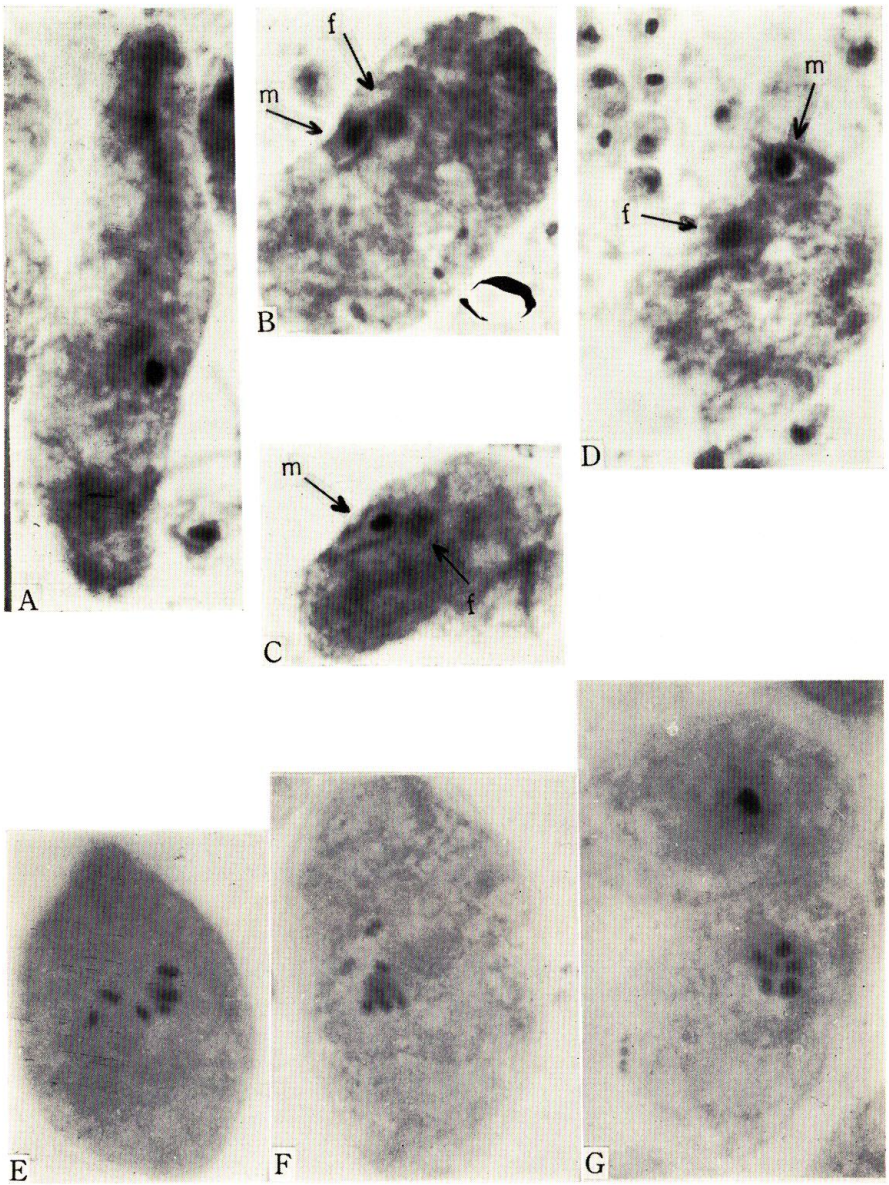
Figs. A & B. Chromosomes at metaphase in vegetative cell divisions

Figs. C-K. Chromosomes at prophase and metaphase in the divisions leading to spermatium formation. Figs. C, D, G & H show the nuclei in which the number of chromosomes can lead to miscount as 4 instead of the usual 3 by the presence of a nucleolus or chromosome-like body that seems to be a nucleolus in the process of degeneration

(Magnification: A-K, × 1,200)



H. YABU : Mitosis in *Porphyra tenera*



H. YABU : Mitosis in *Porphyra tenera*

PLATE II

Porphyra tenera Kjellm.

Figs. A-D. Female (f) and male (m) nucleus within the carpogonium just before fertilization. Passing trace of female nucleus is seen remaining within the carpogonium in Fig. A

Figs. E-G. Chromosomes at metaphase of fused nucleus in the first division leading to carpospore formation. Chromosomes in the upper cell in Fig. G. gather in a line at an equatorial plate

(Magnification: A-G. × 1,400)