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Mitosis in the gametophytes and young sporophytes of *Macrocystis angustifolia* BORY[1,2]

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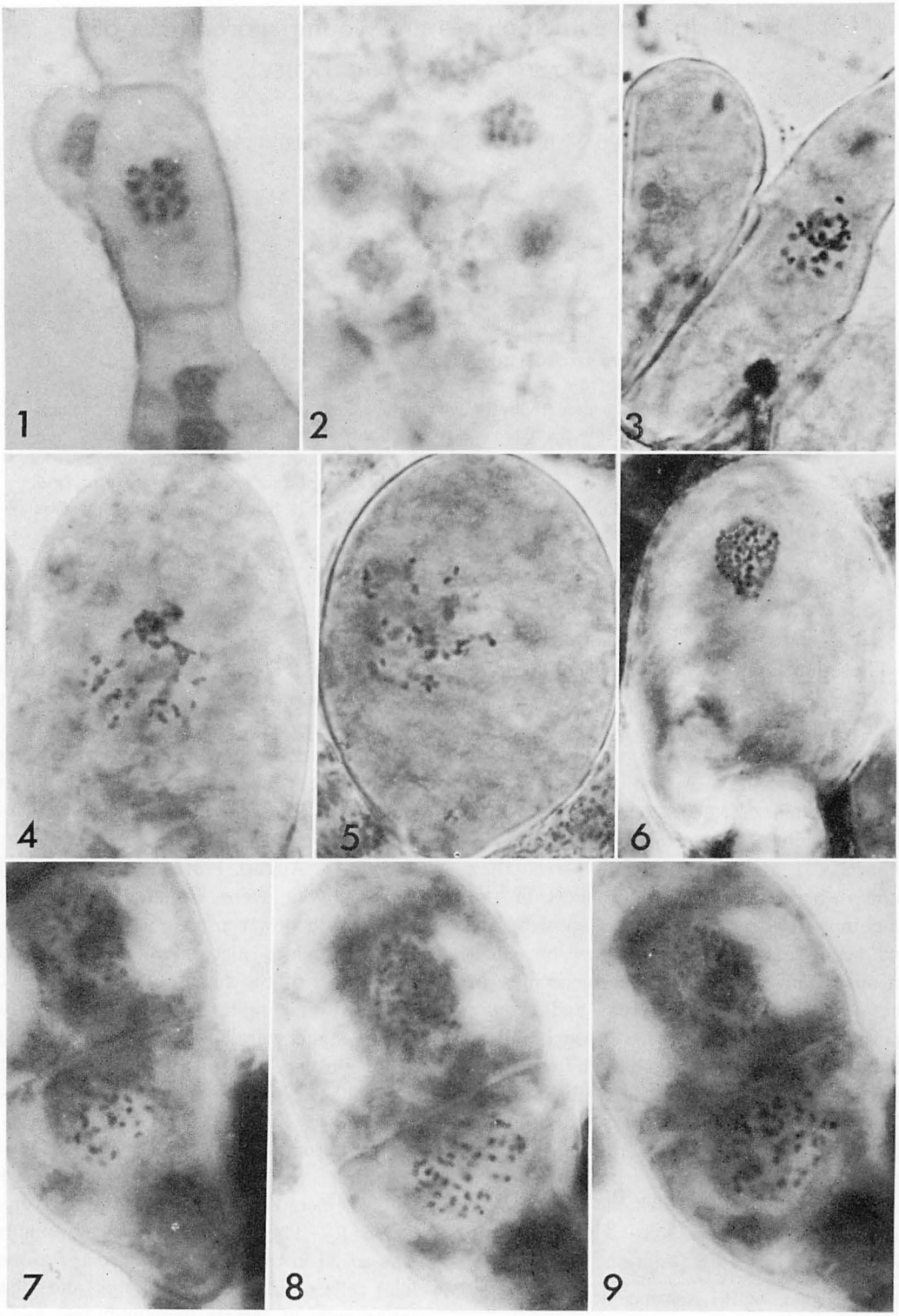
Cytological studies were carried out on the gametophytes and sporophytes of *Macrocystis angustifolia* BORY collected from southern California. The chromosome number was determined to be n=*ca* 30 in the gametophytes. There were some deviations from the counts of sporophytes with 80% of them having *ca* 60 chromosomes and 20% having *ca* 30. In a few cases single-celled sporophytes had only 16 chromosomes. The counts obtained in this study are compared with those reported previously for *Macrocystis integrifolia* (n=16, 2n=32 and n=14-16, 2n=28-32). We conclude that it is likely that the chromosome number of *M. angustifolia* is n=32 and 2n=64.

Key Index Words: *Chromosome number*; *Gametophyte*; Macrocystis angustifolia; *Sporophyte*.

The giant kelp, *Macrocystis angustifolia* BORY, (northern hemisphere phase) forms large kelp beds in southern California (NEUSHUL, 1971) and the southern hemisphere form occurs in Australia (WOMERSLEY, 1954). When SANBONSUGA and NEUSHUL (1978) studied hybridization between *M. angustifolia* and *Pelagophycus porra*, they pointed out that the chromosomes in the gametophytes of both these species had not been counted. Recently, we have had an opportunity to see the chromosomes in the cells of gametophytes and young sporophytes of *Macrocystis* from Goleta, California, U.S.A. The gametophytes of this alga being cultured at the University of California at Santa Barbara, and other freshly-isolated gametophytes were brought to the Hokkaido Regional Fisheries Research Laboratory at Kushiro, Hokkaido by the junior author in November 1983. The cells have been grown in PES solution (PROVASOLI, 1966) under 2,500 lux, 12 hr L-D photoperiod at a temperature of 15°C which does not induce the gamete formation. Once immature gametophytes were grown, they were broken into fragments consisting of a few cells and allowed to grow further. This process of vegetative propagation was repeated several times. In August 1984, a number of the gametophytes were transferred into petri dishes with newly prepared PES solution at 10°C to induce maturation. Three weeks later, most of the female and male gametophytes attained maturity. The gametophytes at this stage were fixed with acetic alcohol (3:1) and stained with aceto-iron-haematoxylin-chloral hydrate solution (WITTMANN, 1964).

Our chromosome counts were made by changing the microscope focus on well-defined metaphase nuclei, and are given in Table 1. The usual chromosome number was *ca* 30 in the both vegetative and antheridial cells of male gametophytes and vegetative cells of female gametophytes, and *ca* 60 in the cells of sporophytes (Figs. 1-9).

1) Contribution of the Hokkaido Reg. Fish. Res. Lab., B 427
2) BCP 85-II-3-3.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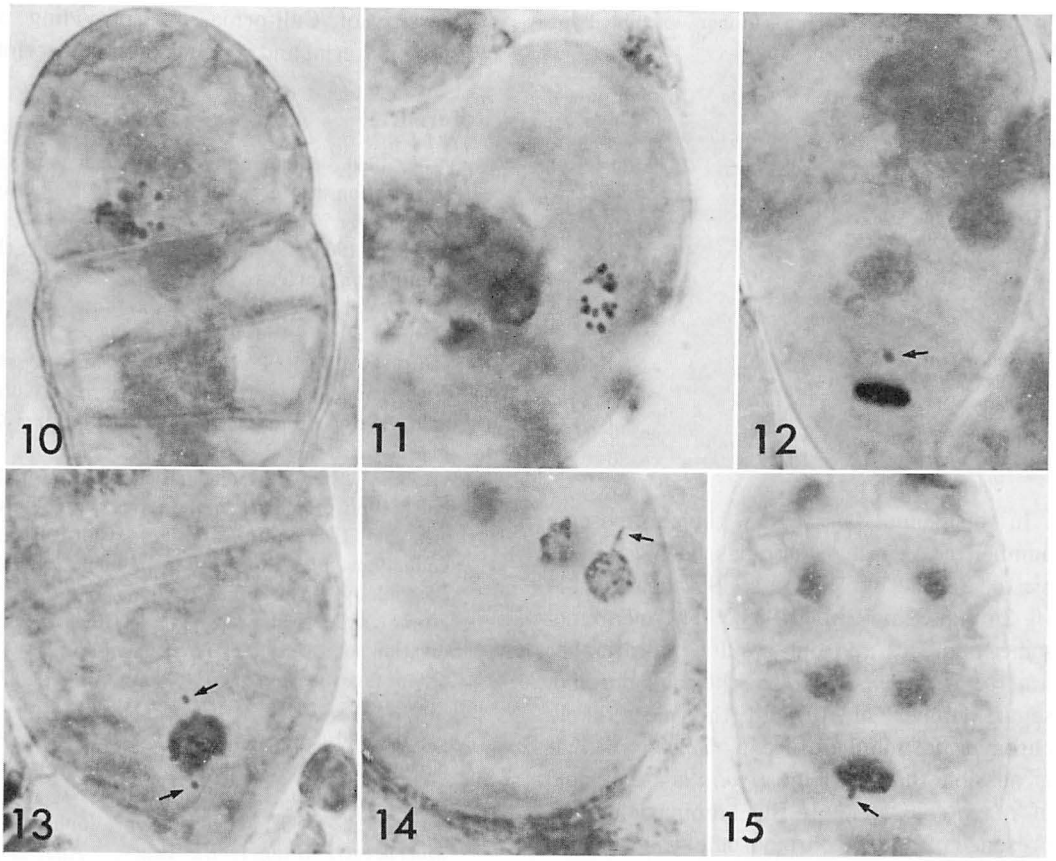

Fig. 1-15. Dividing nuclei in the cells of gametophytes and young sporophytes of *Macrocystis angustifolia* BORY 1-3, ×2,400; 4-15, ×1,600. 1. Metaphase in a vegetative cell of a male gametophyte. 2. Metaphase in an antheridium. 3. Metaphase in a vegetative cell of a female gametophyte. 4-6. Metaphase of the diploid nucleus in one-celled sporophyte. 7-9. The same sporophytic cell at three levels of focus, showing a late prophase nucleus with *ca* 60 chromosome in the lower cell. 10. Metaphase with *ca* 30 chromosomes in a cell of sporophyte which was probably derived by parthenogenesis. 11. Metaphase with 16 chromosomes in one-celled sporophyte, of which 12 chromosomes are visible in the figure and the other 4 chromosomes are out of focus. 12. Metaphase in a 2-celled sporophyte (cell wall not shown) with a precocious chromosome (indicated by the arrow) in a sporophytic cell. 13. Metaphase with two precocious chromosomes each moving toward a pole (indicated by arrows) in a sporophytic cell. A second chromosome group is out of focus. 14-15. Late anaphase in a sporophytic cell, showing the nucleus with a precocious chromosome (indicated by the arrow) associated with the chromosome group near the pole.

We frequently observed *ca* 30 chromosomes in the cell of sporophytes (Fig. 10), and very rarely counted 16 chromosomes in the one-celled sporophytes (Fig. 11); the former chromosome number might be attributed to parthenogenesis, while the latter low number might be the result of a female gametophyte being derived from a zoospore coming from a sporangium where abnormal meiosis took place. It is noteworthy that in about 70% of the mid-metaphase nuclei seen in the cells of female gametophytes and sporophytes one can see a precocious chromosome moving toward one of the poles (Fig. 12). Occasionally in the cells of sporophytes, two precocious chromosomes were seen moving to the both poles, (Fig. 13). At late anaphase, this chromosome was noticed as a small short rod associated with the chromosome group near the pole (Figs. 14 & 15).

Table 1. Chromosome number examined for *Macrocystis angustifolia* BORY.

Portion	Number of cells observed	Chromosome number
Cell of female gametophyte	26	*ca* 30
Cell of male gametophyte	8	*ca* 30
Antheridial cell	4	*ca* 30
One-celled sporophyte	84	*ca* 40-60
	21	*ca* 30
	5	*ca* 16
Cell of sporophyte	41	*ca* 40-60
	13	*ca* 30

In the genus *Macrocystis*, the chromosome number of *M. integrifolia* has been given as n=16, 2n=32 by WALKER (1952) and n=14-16, 2n=28-32 by COLE (1968). These chromosome numbers and our results indicate that *Macrocystis angustifolia* has the basic chromosome number of 16 and the most likely chromosome numbers are n=32, 2n=64. It is possible that *M. angustifolia* is a polyploid of *M. integrifolia*. In the Laminariales, the presence of a large chromosome was reported in several Laminariaceous species by EVANS (1963, 1965) and in *Cymathaere japonica* by YABU and SANBONSUGA (1981). In *Macrocystis angustifolia* studied here, no such a large chromosome could be detected and all of the chromosomes were small and dot-shaped.

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References

COLE, K. 1968. Gametophytic development and fertilization in *Macrocystis integrifolia*. Can. J. Bot. **46**: 777-781.

EVANS, I. V. 1963. A large chromosome in the Laminarian nucleus. Nature **198**: 215.

EVANS, L. V. 1965. Cytological studies in the Laminariales. Ann. Bot., N. S. **24**: 541-652.

NEUSHUL, M. 1971. The species of *Macrocystis* with particular reference to those of North and South America. Nova Hedwigia **32**: 211-222.

PROVASOLI, L. 1966. Media and prospects for the cultivation of marine algae. *In* WATANABE, A., and HATTORI, A. (Eds.) Cultures and collections of Algae. Japan Society Plant Physiology. Tokyo 63-75.

SANBONSUGA, Y. and NEUSHUL, M. 1978. Hybridization of *Macrocystis* (Phaeophyta) with other float-bearing kelp. Jour. Phycol. **21**: 214-224.

YABU, H. and SANBONSUGA, Y. 1981. A sex chromosome in *Cymathaere japonica* MIYABE et NAGAI. Jap. J. Phycol. **29**: 79-80.

WALKER, F. T. 1952. Chromosome number of *Macrocystis integrifolia* BORY. Ann. Bot., Lond. **16**: 23-26.

WITTMANN, W. 1964. Aceto-iron-haematoxylin-chloral hydrate for chromosome staining. Stain. Tech. **40**: 161-164.

WOMERSLEY, H. B. S. 1954. The species of *Macrocystis* with special reference to those on southern Australian coast. Univ. of Calif. Publ. in Botany **27**: 109-132.

藪　凞*・三本菅善昭: *Macrocystis angustifolia* BORY の配偶体と幼芽胞体に於ける核分裂**

北米カリフォルニア産の巨大海藻である *Macrocystis angustifolia* BORY の配偶体と幼芽胞体の細胞内で核分裂を観察した。その結果，通常雌雄配偶体の細胞で約30，芽胞体の細胞で約60，しばしば，芽胞体の細胞で約30，まれに1細胞期の芽胞体で16の染色体が認められた。マクロシスチス属では *M. integrifolia* で WALKER (1952) が n=16, 2n=32, COLE (1968) が n=14-16, 2n=28-32 の染色体数を報告している。これらのことから，*M. angustifolia* では基本染色体数は16であり，正常染色体数は n=32, 2n=64 と推定され，且つ，*M. integrifolia* とは倍数体の関係にある可能性が示唆された。(*041 函館市港町 3-1-1 北海道大学水産学部 **085 釧路市桂恋 116 北海道区水産研究所)