



Title	A Chromosomal Study in the Gametophytes and Young Sporophytes of <i>Eckloniopsis radicata</i> (Kjellman) Okamura (Laminariales, Phaeophyta)
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**A Chromosomal Study in the Gametophytes and Young
Sporophytes of *Eckloniopsis radicata* (Kjellman)
Okamura (Laminariales, Phaeophyta)**

Hajime YASUI* and Masahiro NOTOYA**

Abstract

Chromosome numbers of *Eckloniopsis radicata* (Kjellman) Okamura were determined to be $n=31$ for the female gametophytes and $n=31$ or $2n=62$ for the one- to three-celled sporophytes. In the haploid karyotype of the young sporophyte, a gradual decrease in size was observed from the longest ($2.5 \mu\text{m}$) to the shortest chromosomes ($0.4 \mu\text{m}$). The very large chromosomes were recognized one in the female and male gametophytes and haploid sporophytes, and two in the diploid sporophytes. These large chromosomes could be regarded as autosomes. The ratio of haploid to diploid in the young sporophytes obtained from the chromosome count showed to be approximately 3 : 5 at one-celled stage and 1 : 10 at four- or five-celled stage. This suggested that the parthenogenetic sporophytes of *Eckloniopsis radicata* were very rare in more developed stages.

Introduction

The Laminariaceous plant, *Eckloniopsis radicata* (Kjellman) Okamura is distributed along the Pacific coasts of middle and southern Japan. A few cytological studies of this alga have been observed $n = \text{ca. } 30$ in the zoosporangia (Ohmori, 1967) and $n = \text{ca. } 30$ and $2n = \text{ca. } 60$ in the young sporophytes (Migita, 1985). However, the morphological features of chromosomes have been poorly described.

The present paper reports the somatic chromosome number together with the karyomorphological observations in the gametophytes and young sporophytes of *Eckloniopsis radicata*.

Materials and Methods

The mature sporophytes collected at Tanabe Bay, Wakayama Prefecture on June 11, 1991, were brought to Tokyo University of Fisheries. The liberated zoospores from the fronds were cultured in filtered seawater with modified Grund medium (McLachlan, 1973) under $20\text{--}23 \mu\text{mol m}^{-2} \text{s}^{-1}$ (14L : 10D photoperiod), at a temperature of $15 \pm 1^\circ\text{C}$. After 25–35 days of culture, the gametophytes and the young sporophytes were both fixed by ethyl alcohol 3 : acetic acid 1 solution for 5–7 hours from the start of light-period. The staining employed for karyological observations was aceto-iron-haematoxylin-chloral hydrate solution (Wittmann,

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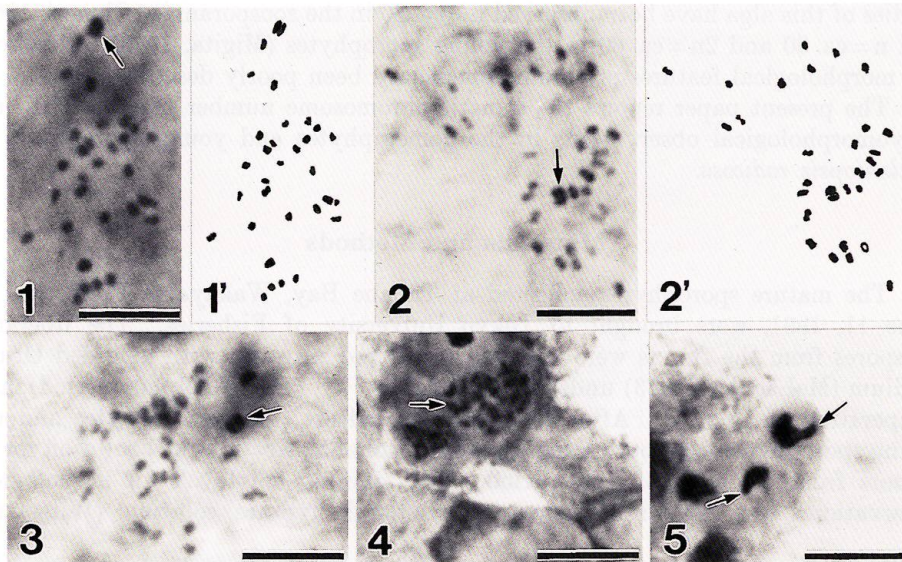
1965).

Results and Discussion

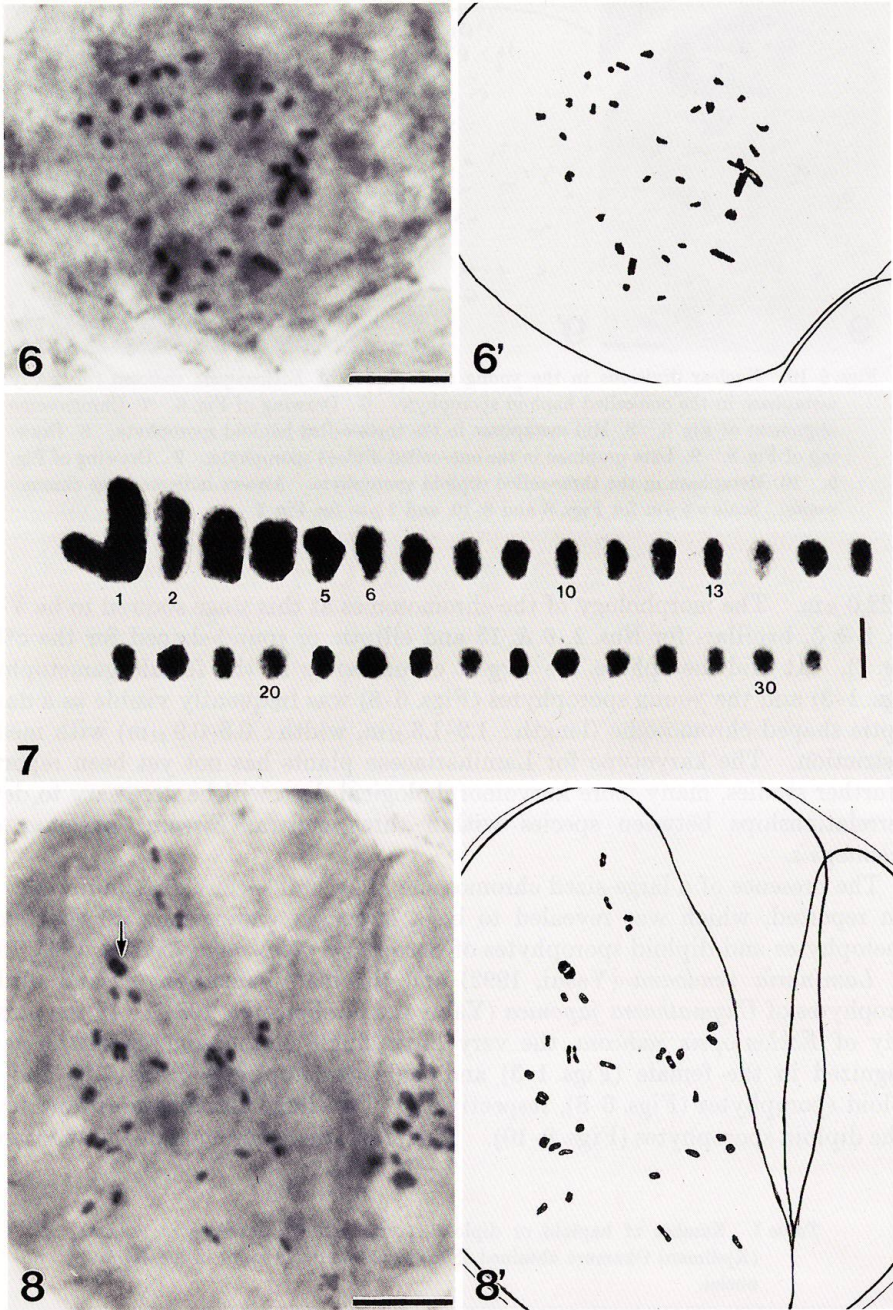
The haploid chromosome number of *Eckloniopsis radicata* was determined here to be exactly $n=31$ in the female gametophytes (Figs. 1-3) and the one- to three-celled partheno-sporophytes (Figs. 6-8') which was different from the numbers of $n=30$ in *Eisenia bicyclis* (Yabu et al., 1983), *Ecklonia cava* (Ohmori, 1967) and *Ecklonia stolonifera* (Yabu and Notoya, 1985) or $n=32$ in *Eck. kurome* (Yabu and Taniguchi, 1990), *Laminaria angustata*, *L. japonica*, *L. ochotensis*, and *L. religiosa* (Yabu and Yasui, 1991). As showed by the intermediate chromosome number ($n=31$) between $n=30$ and $n=32$, it seems that this species might have derived from natural hybridization between members of *Eisenia* and *Ecklonia*.

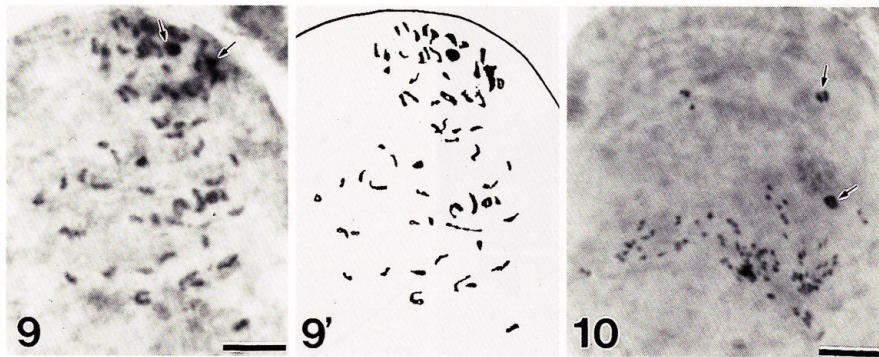
The one- to five-celled sporophytes of this alga also displayed $2n=62$ chromosomes (Figs. 9, 9'). The ratio of haploid to diploid sporophytes obtained from the chromosome count was approximately 3:5 in one-celled stage and 1:10 in three-celled stage. From one- to five-celled stages the number of haploid sporophytes gradually decreased (Table 1). In the more advanced stages, the parthenogenetic sporophytes of this species were considered to be very rare.

Among the 31 chromosome complement at early metaphase on the one-celled sporophyte (Fig. 6), the first chromosome ($2.5 \mu\text{m}$) was much longer than the others. From the second longest ($1.5 \mu\text{m}$) to the shortest chromosomes ($0.4 \mu\text{m}$), a gradual decrease in length was observed. The total length of the haploid chromosomes was



Figs. 1-5. Nuclear divisions in the gametophytes of *Eckloniopsis radicata*. 1-3. Mid metaphase in the cells of female gametophytes. 1' and 2'. Drawings of Figs. 1 and 2, respectively. 4 and 5. The cells of male gametophytes. 4. Early metaphase. 5. Anaphase. Arrows indicate large chromosomes. Scale = $5 \mu\text{m}$.





Figs. 6-10. Nuclear divisions in the young sporophytes of *Eckloniopsis radicata*. 6. Early metaphase in the one-celled haploid sporophyte. 6'. Drawing of Fig. 6. 7. Chromosome alignment of Fig. 6. 8. Mid metaphase in the three-celled haploid sporophyte. 8' Drawing of Fig. 8. 9. Late prophase in the one-celled diploid sporophyte. 9'. Drawing of Fig. 9. 10. Metaphase in the three-celled diploid sporophyte. Arrows indicate large chromosomes. Scale = 5 μm for Figs. 6 and 8-10, and 1 μm for Fig. 7.

ca. 22.0 μm . The morphology of the chromosomes at this stage showed to be V- for Nos. 1 & 5, bacillar- for Nos. 2, 6 & 13 and elliptic or round-shaped for the others (Fig. 7). At mid metaphase the largest chromosome in the female gametophytes (Figs. 1-3) and the young sporophytes (Figs. 6-8) was frequently visible as a darker elliptic shaped chromosome (length: 1.2-1.3 μm , width: 0.8-0.9 μm) with median constriction. The karyotype for Laminariaceae plants has not yet been reported. In further studies, many more karyomorphological data will be necessary to detect interrelationships between species within three genera, *Eisenia*, *Ecklonia* and *Eckloniopsis*.

The presence of a large-sized chromosome in several species of Laminariales has been reported, which was revealed to be a large sex chromosome in the female gametophytes and diploid sporophytes of *Saccorhiza polyschides* (Evans, 1963, 1965) and *Laminaria yendoana* (Yasui, 1992) and the male gametophytes and diploid sporophytes of *Chymathæra japonica* (Yabu and Sanbonsuga, 1981). In the present study of *Eckloniopsis radicata*, the very large single chromosome could be easily recognized in the female (Figs. 1-3) and male gametophytes (Figs. 4, 5) and the haploid sporophytes (Figs. 6-8), respectively. Two large chromosomes were found in the diploid sporophytes (Figs. 8-10). Therefore, these chromosomes were regarded

Table 1. Number of haploid or diploid sporophytes of *Eckloniopsis radicata* (Kjellman) Okamura obtained from the chromosome count in the dividing nuclei.

Nuclear phase	Stage				
	1-cell	2-cell	3-cell	4-cell	5-cell
Haploid	30	10	6	2	1
Diploid	49	50	60	19	25

to be autosomes.

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