NUCLEAR DIVISION IN THE ZOOSPORANGIUM OF LAMINARIA
ANGUSTATA VAR. LONGISSIMA MIYABE, AND
KJELLMANIELLA GYRATA (KJELLM.) MIYABE

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The Japanese species of the Laminariaceae which have hitherto been treated
cytologically amount to ten in number as reported by the writer in the preceding
paper (Yabu, 1964)*. To this number the writer now adds one species and one
variety by presenting the following results of one of his latest investigations.

*Laminaria angustata* var. *longissima* was collected on October 19, 1964, from
among the seaweeds cast ashore at Tokotan, Akkeshi, while *Kjellmaniella gyrata*
was collected on the same day and the following at a shallow reef near Akkeshi
Marine Biological Station, Hokkaido University. The materials were fixed in the
same way as described in the writer's preceding report (Yabu, loc. cit.) with the
mixture of Tahara's fluid and 40% formalin mixed in the ratio, 2:1.

1. *Laminaria angustata* var. *longissima* Miyabe

The zoosporangial sori are formed on both surfaces of the blade. The develop­
ment of the sporangium from the meristoderm is usually achieved in exactly the
same way as described in *Arthrothamnus bifidus* (Yabu & Tokida, 1963, p. 37).
However, the meristoderm cells in some parts of the blade divide tangentially
several times and form outward-directed rows of cells. In these cell-rows the
lower cells are more or less elongated and pale in color while the apical ones
retain the feature of the meristoderm cells or sometimes are provided with a
gelatinous thickening of the membrane at their apices (Pl. I, Figs. 1, 2 & 4; Pl. III,
Fig. 27). In the neighborhood of groups of these cell-rows, the paraphyses and
the sporangia are often found to be of an abnormal structure as shown in Pl. I,
Figs. 2 & 3. This abnormality is a new discovery in the Laminariaceae as far as
the writer knows.

The resting nucleus in a young sporangium usually contains one spherical
nucleolus, rarely two. Then a small number of chromatin granules, which soon
become filamentous, appear in the cavity of the nucleus. These chromatin threads

* In Table I of that paper, the writer has committed an error in putting “ca. 30” instead
of “22” as the haploid chromosome number of *L. angustata*. 

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form a loop in a corner of the nuclear cavity (Pl. II, Fig. 6). The nuclei in the
idiakinesis stage are shown in Pl. II, Figs. 8 & 9 and Pl. III, Fig. 21. In meta-
phase the nuclear membrane and the nucleolus disappear. In the side view of
metaphase, the centrosomes are occasionally visible at the pole of the spindle (Pl.
II, Fig. 13. Pl. III, Fig. 24). The number of chromosomes not exceeding 30 was
counted in diakinesis and in metaphase (Pl. II, Figs. 8-12). In telophase, the
nuclear membrane and the nucleolus reappear. After the first nuclear division is
finished, four successive divisions follow, and eventually 32 zoospores are formed
in each sporangium (Pl. II, Fig. 19). In the number of chromosomes, the present
variety differs from *L. angustata* (cf. Nishibayashi & Inoh, 1956).

2. *Kjellmaniella gyrata* (Kjellm.) Miyabe

The zoosporangial sori are formed in the depressions on both surfaces of the
blade. The sporangia are formed from the meristoderm in exactly the same way
as described in *Arthrothamnus bifidus* (Yabu & Tokida, loc. cit.).

The meiotic division observed in the first nuclear division of the sporangium
is shown in Pl. IV, Figs. 28-36. In the metaphase of the first nuclear division,
22 chromosomes were counted (Pl. IV, Figs. 33 & 34). In the side view of the
metaphase, the centrosomes were often visible at the pole of the spindle. After
the fifth nuclear division was finished, 32 zoospores were produced in each spo-
rangium (Pl. IV, Fig. 40).

Summary

In *Laminaria angustata* var. *longissima* and *Kjellmaniella gyrata* it has
been established that 32 zoospores are formed in each sporangium after meiosis
and four successive mitoses and that the haploid chromosome number is 30 and
22 respectively. An interesting abnormality in the structure of the zoosporangial
sori which was observed in *L. angustata* var. *longissima* is reported herein for
the first time in the Laminariaceae.

References

Nishibayashi, T. & Inoh, S. (1956). Morphogenetical studies in Laminariales, I. The develop-
ment of zoosporangia and the formation of zoospores in *Laminaria angustata* Kjellm.

Yabu, H. (1964). Mitosis in the sporangium of *Agarum cribrosum* Bory and *Alaria praelonga

Yabu, H. & Tokida, J. (1963). On the nuclear division in the sporangium of *Arthrothamnus
Explanation of Plates
PLATE I

*Laminaria angustata* var. *longissima* Miyabe

Fig. 1. Section through the cortex of blade showing abnormal activity of meristoderm

Fig. 2. Section through sporangial sorus on blade showing paraphyses, uni- and multi-cellular, and a group of cell-rows developed in the sorus from the abnormal activity of the meristoderm

Fig. 3. Section through the sorus on blade showing the abnormal paraphyses and sporangia

Fig. 4. Section through the sorus on blade showing the normal paraphyses and sporangia, and a group of abnormal cell-rows in the sorus; some of the cell-rows are provided with a gelatinous thickening of the membrane at apices

(Drawings in Pl. I and a photomicrograph (Fig. 27) in Pl. III show sections through the sporangial sori on blade; drawings and photomicrographs in Pls. II-V (except Fig. 27) show the nuclear divisions and development of zoosporangia)
H. Yabu: Nuclear division in Laminaria and Kjellmaniella
PLATE II

*Laminaria angustata* var. *longissima* Miyabe

Fig. 5. Resting stage
Fig. 6. Synapsis
Fig. 7. Spireme
Figs. 8 & 9. Diakinesis
Figs. 10-13. Metaphase
Fig. 14. Two-nucleus stage
Fig. 15. Metaphase of the second division
Fig. 16. Four-nucleus stage
Fig. 17. Eight-nucleus stage
Fig. 18. Sixteen-nucleus stage
Fig. 19. Thirty-two-cell stage of sporangium
H. Yabu: Nuclear division in *Laminaria* and *Kjellmaniella*
PLATE III

*Laminaria angustata* var. *longissima* Miyabe

Fig. 20. Spireme
Fig. 21. Diakinesis
Figs. 22-24. Metaphase
Fig. 25. Side view of the metaphase of the second division
Fig. 26. Metaphase of the third division
Fig. 27. Section through the periphery of a sorus on blade with cell-rows derived from abnormal divisions of meristoderm cells

(Figs. 20–26, ×1600; Fig. 27, ×80)
H. Yabu: Nuclear division in *Laminaria* and *Kjellmaniella*
PLATE IV

*Kjellmaniella gyrata* (Kjellm.) Miyabe

Figs. 28 & 29. Resting stage
Fig. 30. Synapsis
Fig. 31. Spireme
Fig. 32. Diakinesis
Figs. 33-35. Metaphase
Fig. 36. Two-nucleus stage
Fig. 37. Four-nucleus stage
Fig. 38. Eight-nucleus stage
Fig. 39. Sixteen-nucleus stage
Fig. 40. Thirty-two-cell stage of sporangium
H. Yabu: Nuclear division in Laminaria and Kjellmaniella
PLATE V

*Kjellmaniella gyrata* (Kjellm.) Miyabe

Figs. 41 & 42. Spireme
Fig. 43. Diakinesis
Fig. 44-46. Metaphase
Fig. 47. Metaphase of the fourth division
Fig. 48. Metaphase of the fifth division

(Figs. 41–48, ×1600)
H. Yabu: Nuclear division in *Laminaria* and *Kjellmaniella*