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

Hiroshi YABU
Faculty of Fisheries, Hokkaido University

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 development 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 mebrane 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*.

form a loop in a corner of the nuclear cavity (Pl. II, Fig. 6). The nuclei in the diakinesis stage are shown in Pl. II, Figs. 8 & 9 and Pl. III, Fig. 21. In metaphase 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 sporangium (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 development of zoosporangia and the formation of zoospores in *Laminaria angustata* Kjellm. *Biol. Jour. Okayama Univ.* **2**, 147–158.

Yabu, H. (1964). Mitosis in the sporangium of *Agarum cribrosum* Bory and *Alaria praelonga* Kjellman. *Bull. Fac. Fish., Hokkaido Univ.* **15** (1), 1–4.

Yabu, H. & Tokida, J. (1963). On the nuclear division in the sporangium of *Arthrothamnus bifidus* (Gmel.) J. Ag. *Ibid.* **14** (2), 37–39.

Explanation of Plates

PLATE I

Laminaria angustata var. *longissima* Miyabe

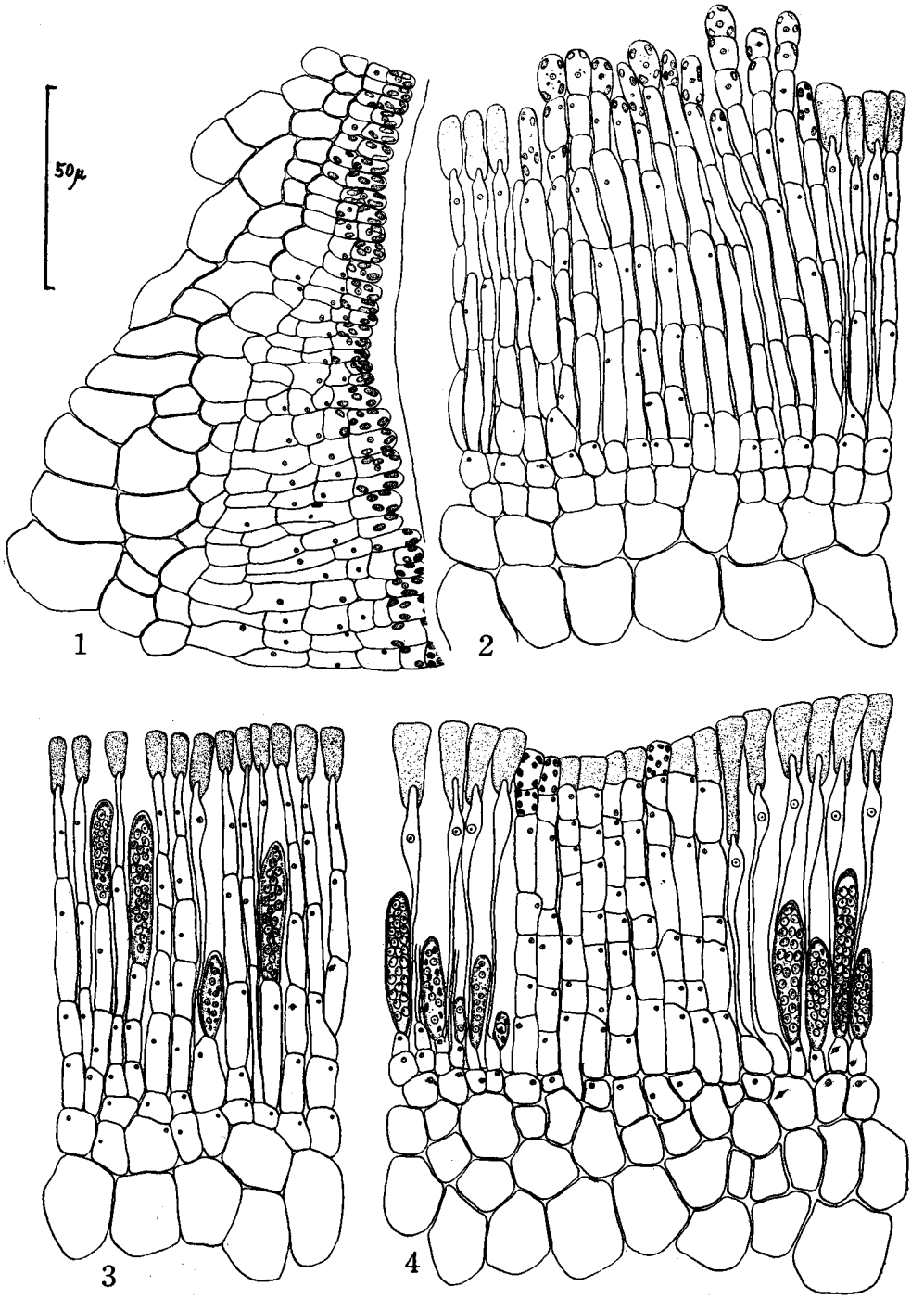
Fig. 1. Section through the cortex of blade showing abnormal activity of meristoderm

Fig. 2. Section through sporangial sorus on blade showing paraphyses, uni- and multicellular, 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)

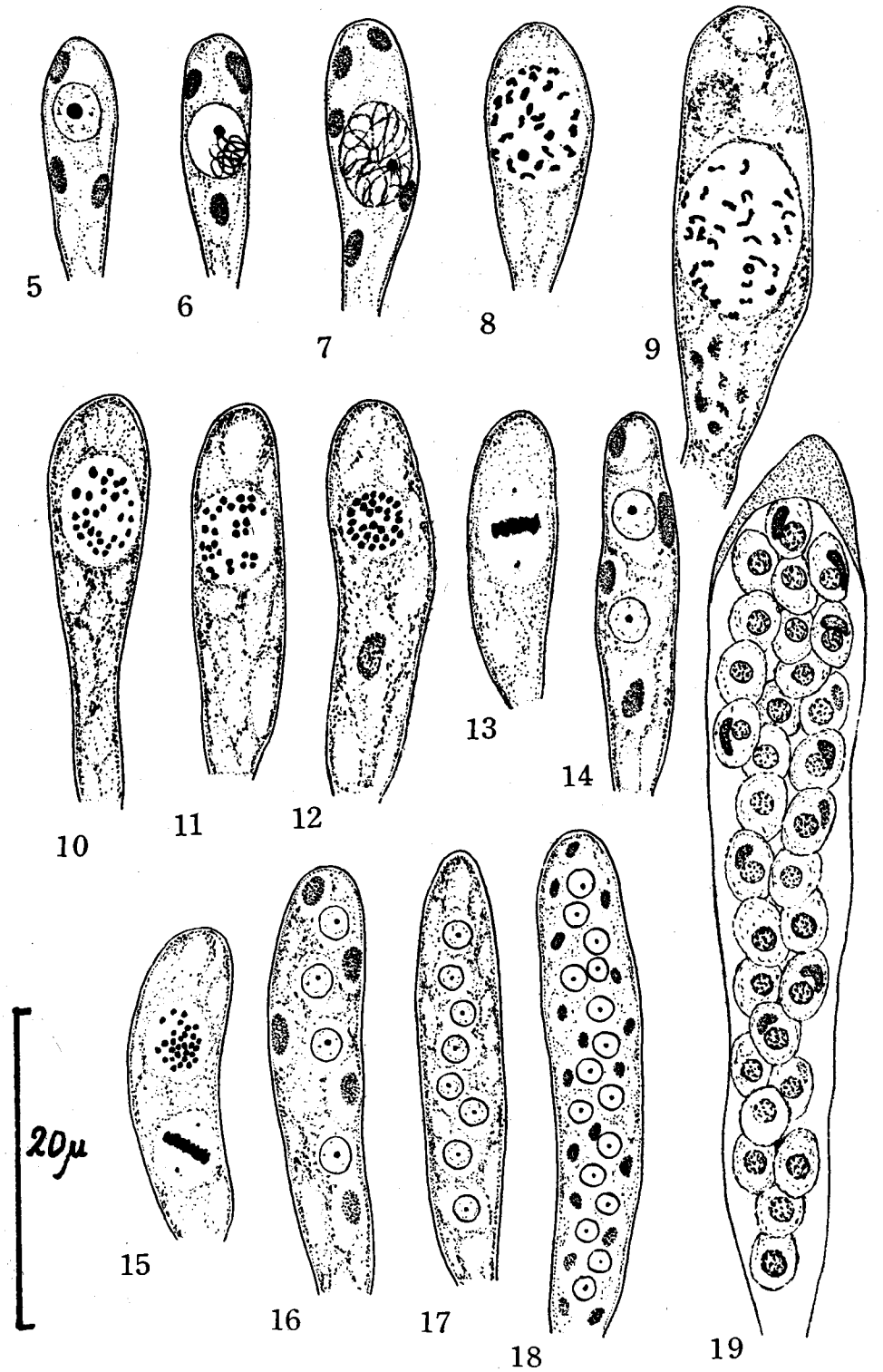


H. Yabu: Nuclear division in *Laminaria* and *Kjellmaniella*

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

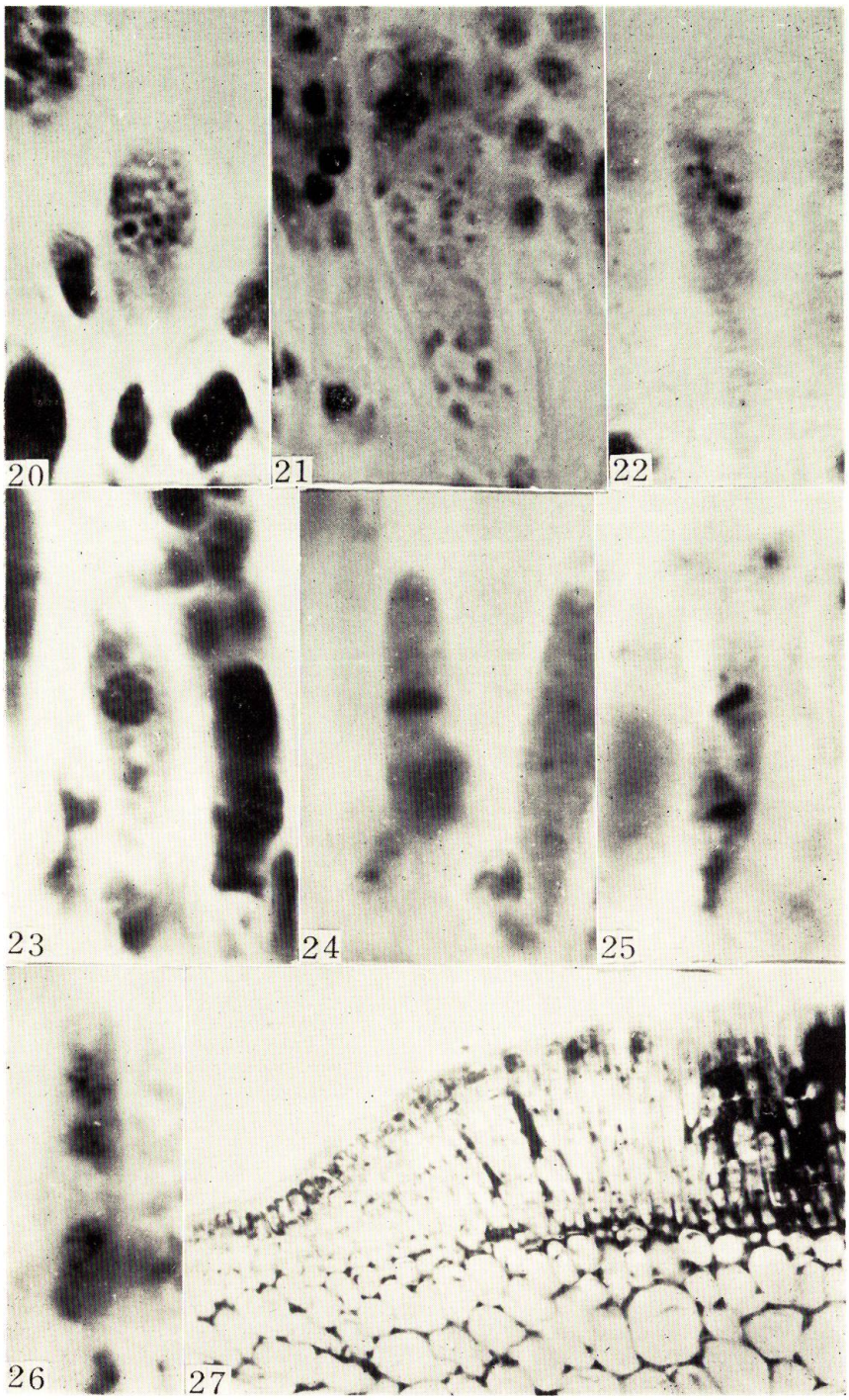
Figs. 22–24. Metaphase

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)

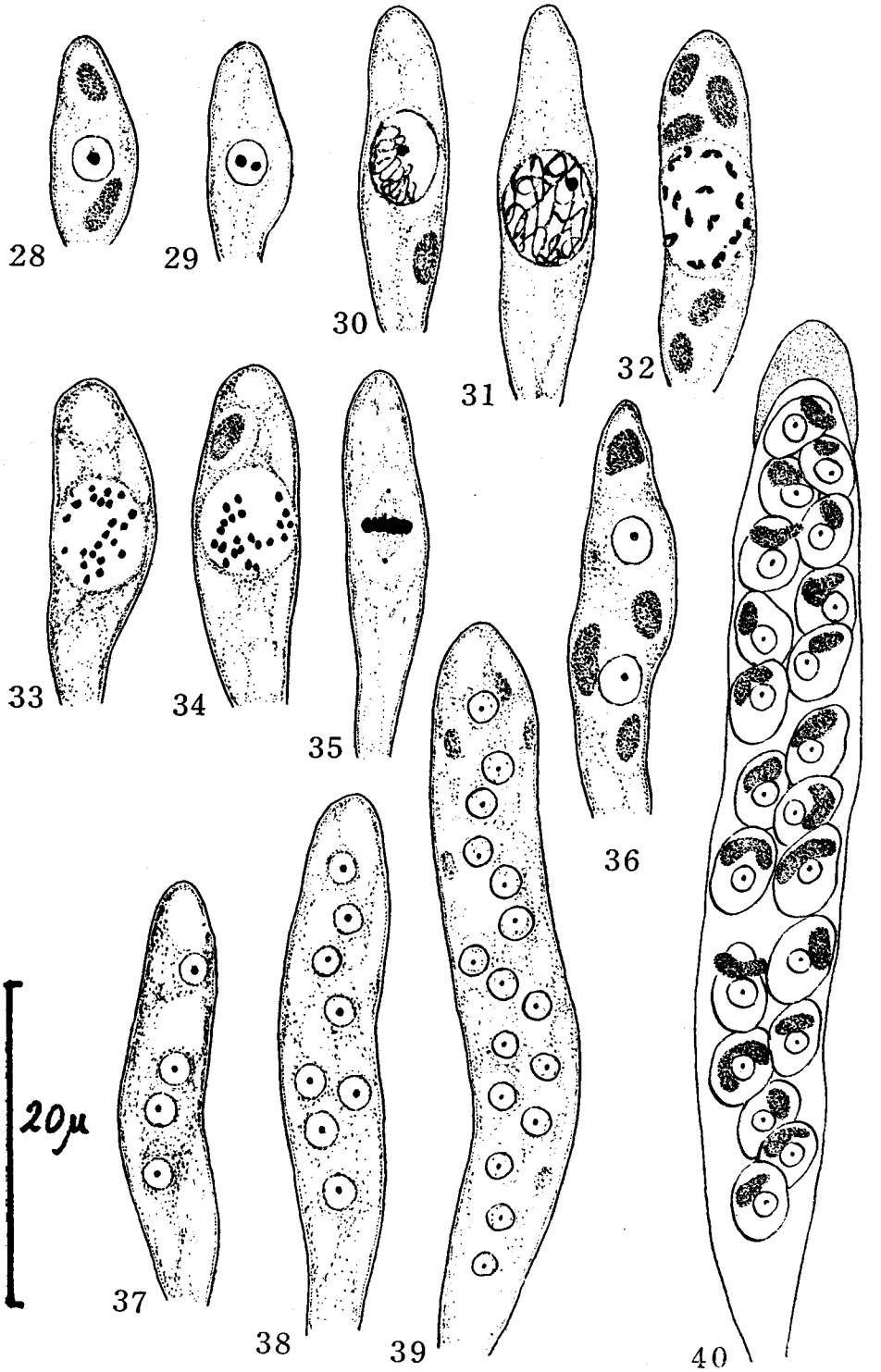


H. Yabu: Nuclear division in *Laminaria* and *Kjellmaniella*

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

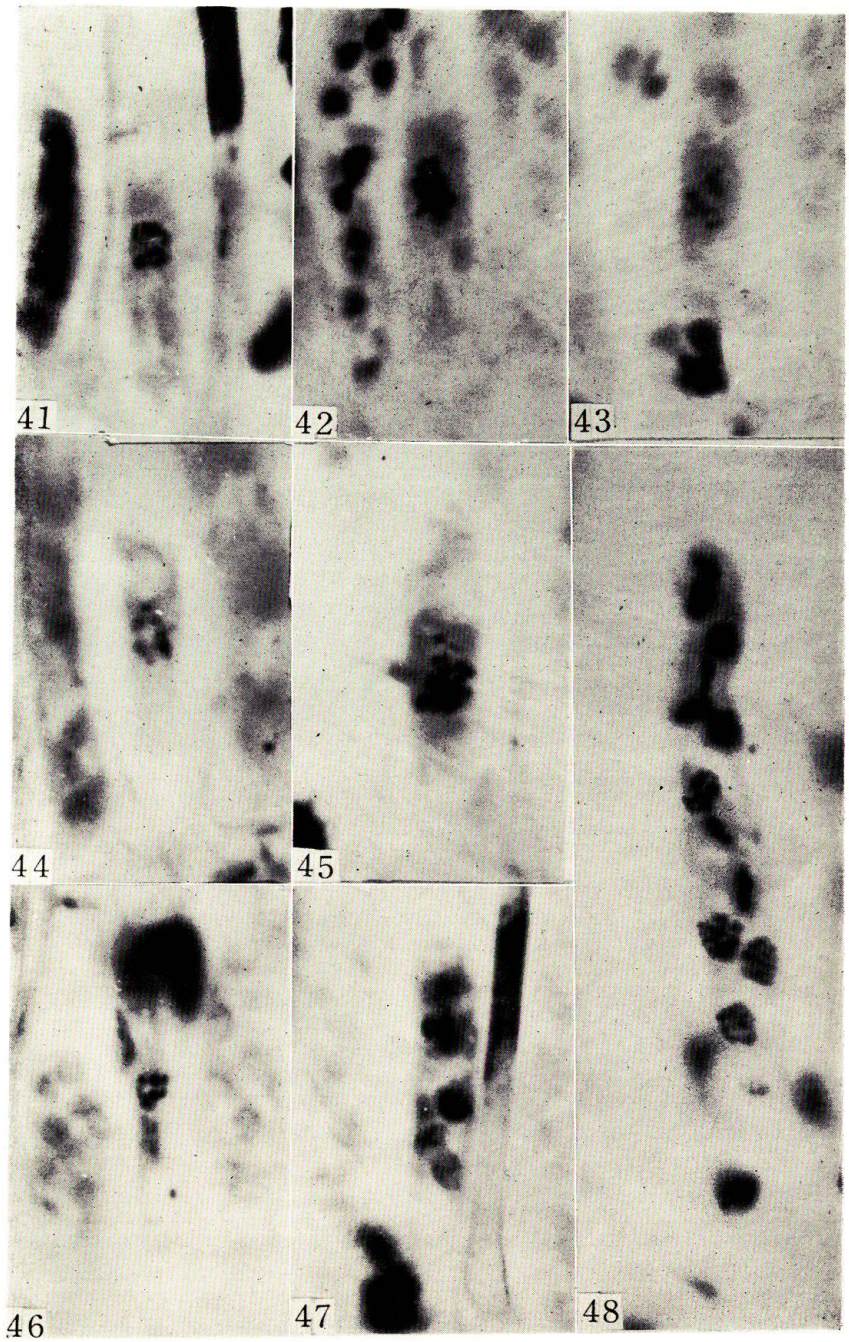
Fig. 43. Diakinesis

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*