# ON THE NUCLEAR DIVISION IN THE SPORANGIUM OF *ARTHROTHAMNUS BIFIDUS* (GMEL.) J. AG.

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*Arthrothamnus bifidus* (Gmelin) J. Agardh is widely distributed in the North Pacific Ocean from eastern Hokkaido north-eastwards as far as the Aleutian Islands. In Japanese waters it grows along the coasts of Kushiro and Nemuro Provinces. It has been studied and described by several authors such as Miyabe (1902, 1957), Yendo (1903), Kanda (1933, 1936, 1946), and Yamada (1934, 1935). However, as far as the writers are aware, there has never been published to date any report treating cytological aspects of this alga. Last February the junior writer, H. Yabu, collected a number of fertile specimens of this alga at Akkeshi, Kushiro Province, and a study on the mitosis in the sporangium was carried out. As a result, the writers could establish the occurrence of meiosis in the early development of the sporangium and the number of chromosomes of this alga as reported in the present paper.

## Material and Methods

The material was collected on the 2nd and 3rd of February, 1963, from among seaweeds cast ashore at Tokotan, Akkeshi-machi, and was fixed at midnight of the collection day after having been kept in vats filled with filtered seawater at the Akkeshi Marine Biological Station, Hokkaido University. For fixing, the material was placed in Abe's fluid (Abe, 1933) for 8–12 hours. The sections were cut 4 $\mu$ thick by paraffin method and were stained with Heidenhein's haematoxylin.

## Results Obtained

The development of the sporangium is as follows. The meristoderm cells at the surface of the blade divide tangentially into two cells, the basal cell and the upper. The upper cell elongates to become a long slender cell or a paraphysis, separated from the neighboring paraphyses by intercellular spaces. Into these spaces a protuberance grows out from the basal cell, and then the protuberance is devided at the base by a septum to become a young sporangium which contains in its center a single resting nucleus with one nucleolus. The nucleus gradually grows larger and comes to contain in its cavity a small number of chromatin granules besides the nucleolus. The nucleolus at this stage sometimes does not

stain uniformly but appears to be vacuolated. The chromatin granules soon become filamentous and are readily stained with haematoxylin. They form a loop in a corner of the nuclear cavity. Then the chromatin threads gradually spread out within the cavity and lose their affinity with the stain so that the nuclear cavity presents the appearance of the resting stage. Meanwhile the chromatin threads make their appearance again and soon grow shorter to become the chromosomes. In early diakinesis stage, slender and elongated bivalent chromosomes could be observed. They gradually become shorter and thicker. In metaphase, the nuclear membrane and the nucleolus disappeared; 22 gemini could be counted clearly. In side view of metaphase, a centrosome-like body was occasionally observed at a pole of the spindle. In anaphase, the spindle fibers were observed between two chromosome groups migrating to the poles. After the first nuclear division was finished, four nuclear divisions are repeated successively and 22 chromosomes are counted in each metaphase. After the fifth division was completed, the chromatophores which had increased in number become quite distinct and scattered one by one in close proximity to each nucleus. At this stage the cell-membrane at the apex of the sporangium is found to be thickened remarkably; it stained faintly with haematoxylin. Then small portions of the cytoplasm, each containing one daughter nucleus and one chromatophore, become bordered by a thin cytoplasmic membrane respectively to produce 32 small spherical cells which are eventually converted into the same number of zoospores in each sporangium.

## Summary

As a result of the writers' observations on the nuclear division in the zoosporangium of *Arthrothamnus bifidus* reported herein, it has been established that 32 zoospores were formed in each sporangium after meiosis and three successive mitoses and that the haploid chromosome number was 22.

## References

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## Explanation of Plates

### PLATE I

All the figures and photomicrographs in Plates I–IV, prepared by H. Yabu, show the nuclear divisions in zoosporangia of *Arthrothamnus bifidus*.

(Figs. 1–36, ×1840; Figs. 37–46, ×1780; Figs. 47–65, ×1224)

Figs. 1 & 2. Resting stage

Figs. 3–5. Synapsis

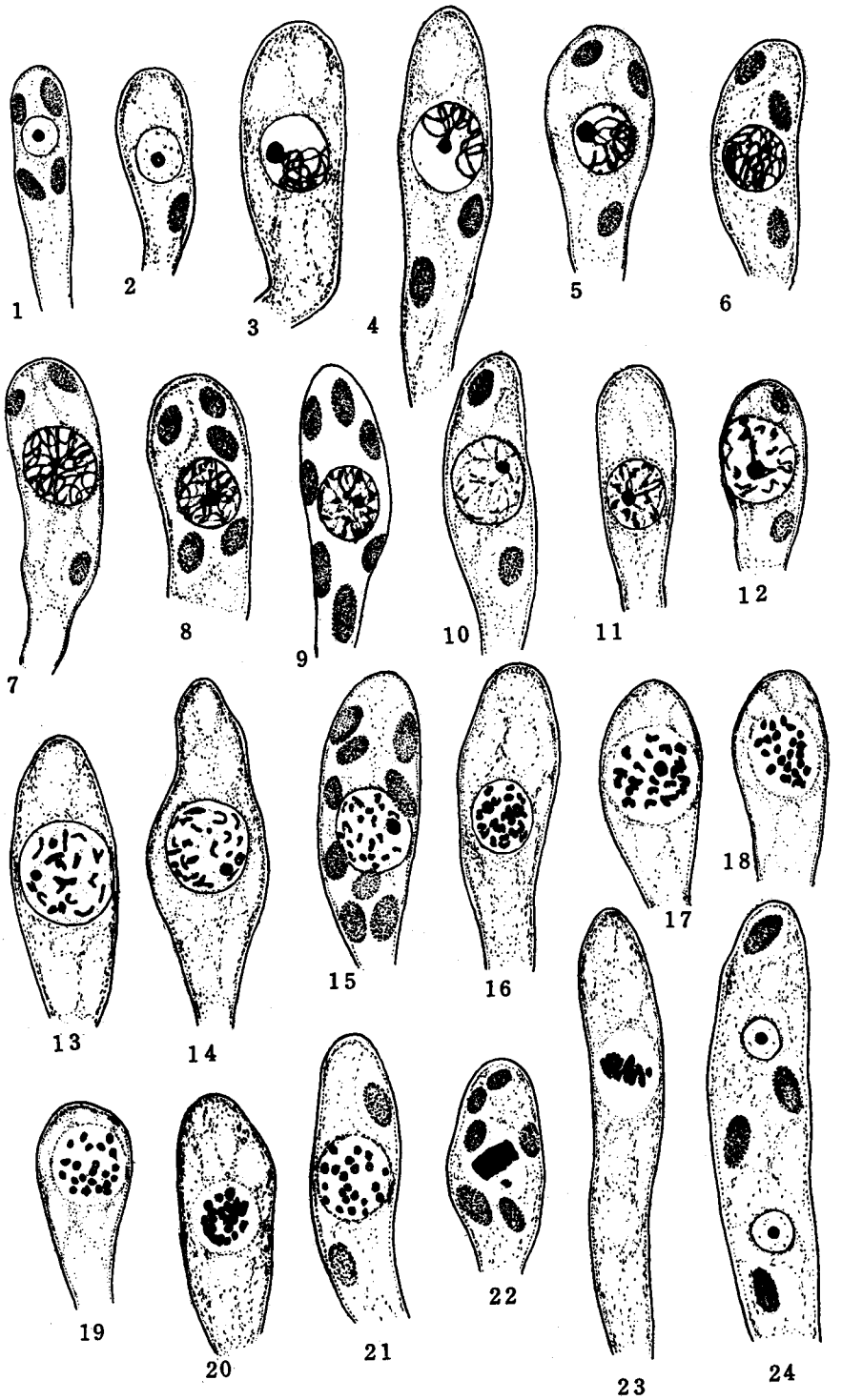
Figs. 6–9. Spireme

Fig. 10. Diffuse stage

Figs. 11–17. Diakinesis

Figs. 18–23. Metaphase

Fig. 24. Two-nucleus stage of sporangium

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## PLATE II

Figs. 25 & 26. Metaphase of the second division

Fig. 27. Four-nucleus stage

Fig. 28. Prophase of the second division

Fig. 29. Metaphase of the second division

Fig. 30. Eight-nucleus stage

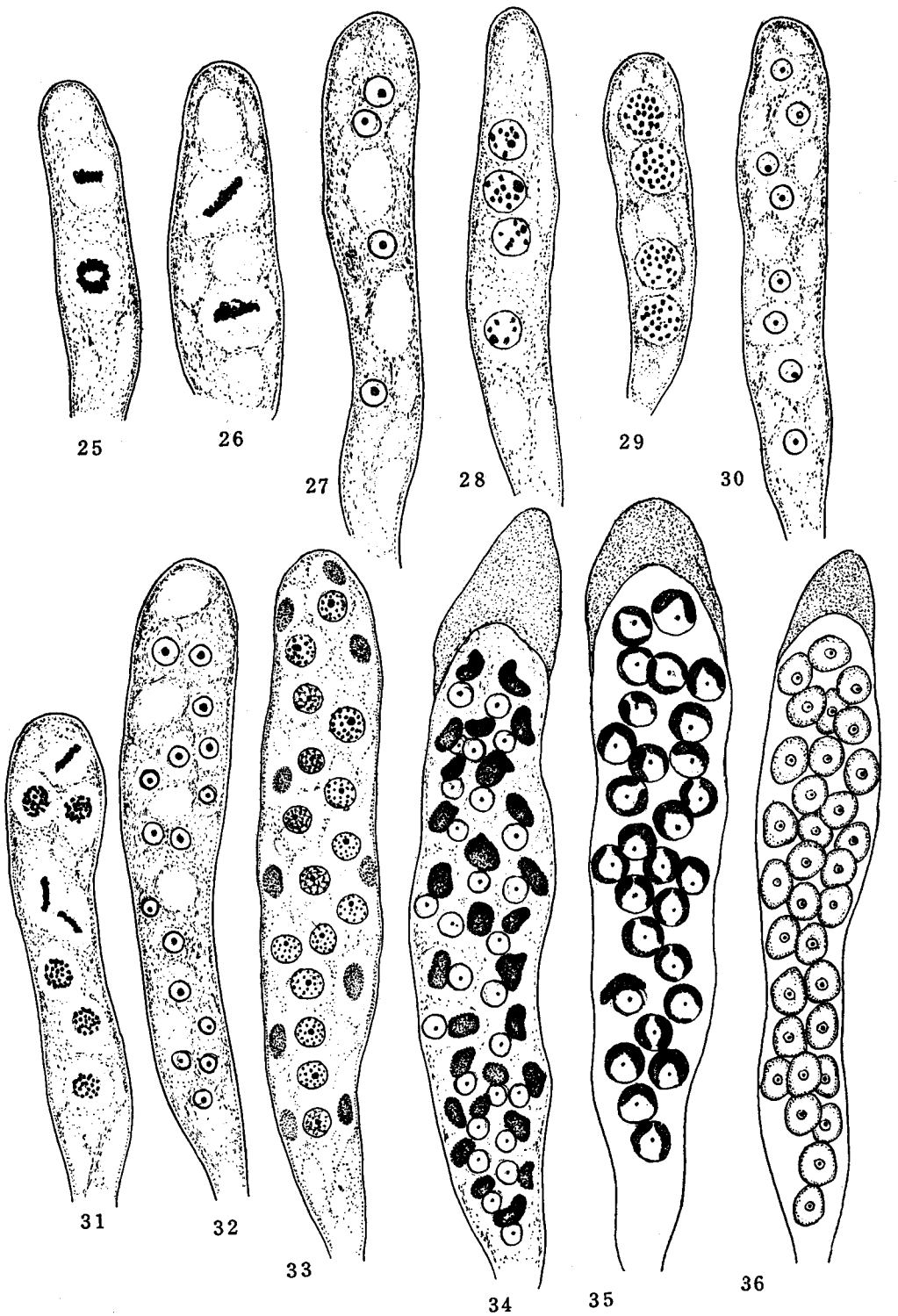
Fig. 31. Metaphase of the third division

Fig. 32. Sixteen-nucleus stage

Fig. 33. Prophase of the fourth division

Fig. 34. Thirty-two-nucleus stage following the end of the fifth division

Fig. 35. Thirty-two-cell stage of sporangium

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## PLATE III

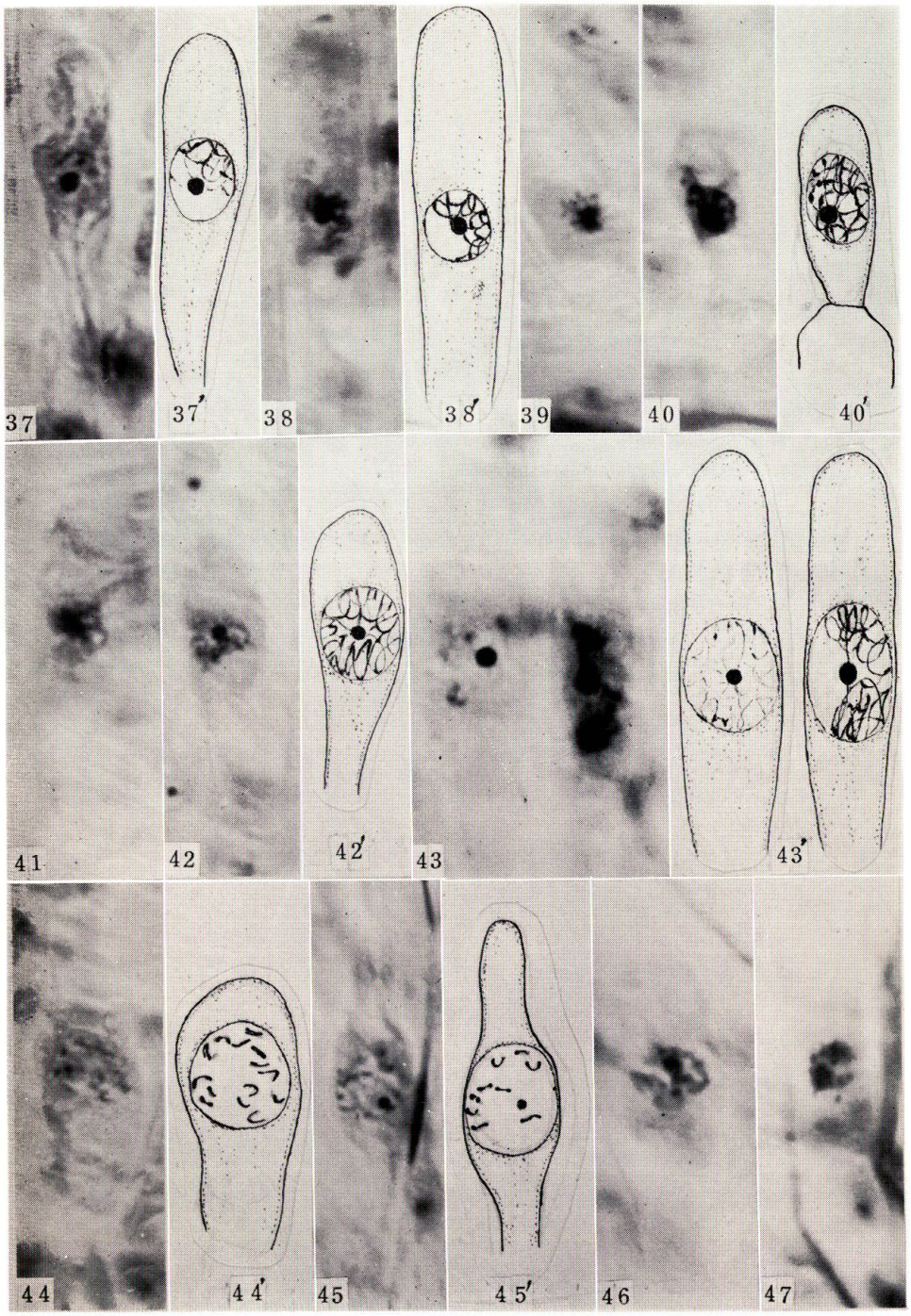
Figs. 37–38′. Synapsis

Figs. 39–42′. Spireme

Figs. 43 & 43′. Diffuse stage and synapsis

Figs. 44–45′. Diakinesis

Figs. 46 & 47. Late diakinesis

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## PLATE IV

Figs. 48 & 49. Side view of metaphase

Figs. 50–53′. Polar view of metaphase

Fig. 54. Two sporangia, one in metaphase of the second nuclear division and the other in two-nucleus stage

Figs. 55–57. Metaphase of the second division

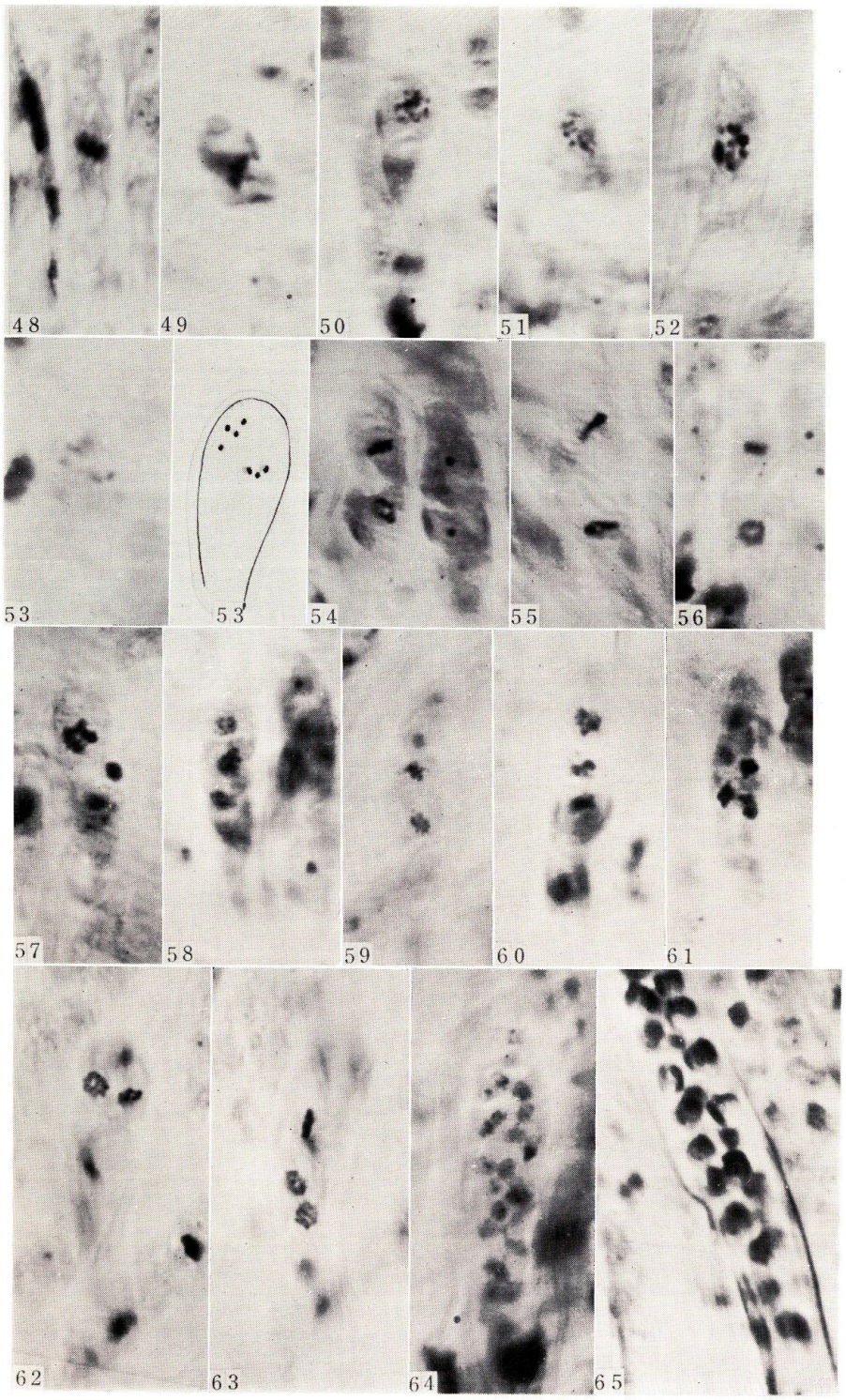
Fig. 58. Metaphase of the third division

Fig. 59–61. Metaphase of the third division

Figs. 62 & 63. Metaphase of the fifth division in one sporangium photographed by focussing at different levels

Fig. 64. Thirty-two nucleus stage

Fig. 65. Part of a nearly matured sporangium

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