

The Japanese Journal of PHYCOLOGY

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今後、再びこのような間違いのないよう努力いたす所存でございます。

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I regret the action of Gakujutsu-tosho Printing & Publishing Company to have made the misprinting on sheet between pages 174 and 175 and the careless finishing of the photoplates of issue No. 2 of Vol. 33, 1985.

This unfortunate action will not be repeated in the future.

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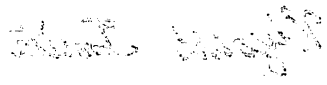


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Studies on the freshwater Rhodophyta of Brazil II. Two new species of *Batrachospermum* ROTH from States of Amazonas and Minas Gerais

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KUMANO, S. and NECCHI, O., Jr., 1985. Studies on the freshwater Rhodophyta of Brazil II. Two new species of *Batrachospermum* ROTH from States of Amazonas and Minas Gerais. Jap. J. Phycol. 33: 181-189.

Although there are minor differences among *Batrachospermum procarpum* SKUJA, *B. equisetoides*, sp. nov. and *B. cipoense*, sp. nov., concerning vegetative characteristics these three species are distinguished from the other taxa of the genus *Batrachospermum* in having the audouinelloid fascicles. A key for the above-mentioned three species of *Batrachospermum* is as follows:

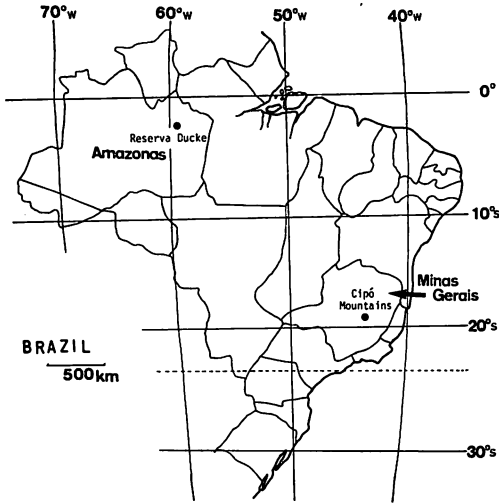
1. Gonimoblast 100-300 μm in diameter—*B. procarpum* SKUJA
1. Gonimoblast 300-900 μm in diameter.
 2. Carposporangia 13-19 μm long—*B. cipoense* KUMANO et NECCHI, sp. nov.
 2. Carposporangia 19-30 μm long—*B. equisetoides* KUMANO et NECCHI, sp. nov.

Key Index Words: Audouinelloid fascicle; *B. cipoense* sp. nov.; *B. equisetoides* sp. nov.; Brazil; freshwater Rhodophyta; taxonomy.

As regards the freshwater Rhodophyta, especially the genus *Batrachospermum*, of Brazil, SKUJA (1931) described *Batrachospermum orthostichum* and *B. procarpum* from Santa Teresa in State of Espírito Santo as a new species and SKUJA (1969) described *B. vagum* (ROTH) C. AGARDH var. *periplocum* from Rio Negro in State of Amazonas as a new variety. Recently, NECCHI and KUMANO (1984) reported three taxa of the genus *Batrachospermum* including *B. cayennense*, *B. orthostichum* and a new variety of *B. capense* from Itabaiana Mountains, Município of Areia Branca in State of Sergipe. The present paper deals with two new species of the genus *Batrachospermum* based on the specimens collected from States of Amazonas and Minas Gerais.

Specimens Examined

The specimens examined in the present study were deposited in the Herbarium of Institute of Botany, São Paulo, Brazil (SP), and in the Herbarium of Faculty of Science, Kobe University, Kobe, Japan. The specimens of *Batrachospermum equisetoides* were collected on Feb. 22 in 1978 by C. PAPE (SP-152530), on Sept. 30 in 1982 by O. YANO (SP-176239) and on Jan. 31 in 1984 by O. NECCHI Jr. (SP-187177) from Igarapé Acará, Reserva Florestal Adolfo Ducke at about 25 km from Manaus to Itacoatiara (Route AM-10), ca. 100 m alt. and situated at 2°54'S, and 59°56'W, Município of Manaus, State of Amazonas. The specimens of *B. cipoense* were collected on Feb. 7 in 1976 by L. SORMUS (SP-187192) and on Sept. 7 in 1974 by I. SAZIMA and M. SAZIMA (SP-



Map. 1. Map of Brazil showing the localities where specimens were collected.

187193) from Cipó Mountains, at about 126 km from Vespasiano to Conceição de Mato Dentro (Route MG-2), ca. 1,200 m alt. and situated at 19°10'S and 43°32'W, Município of Santana do Riacho, State of Minas Gerais. Two localities above-mentioned are shown in Map. 1.

Descriptions of Species

1. *Batrachospermum equisetoides* KUMANO et NECCHI, sp. nov. (Figs 1-5, 6-16)

Frons monoica, ca. 6 cm alta, 300-800 μm crassa, abundanter irregulariteque ramosa, parum mucosa, atropurpurea. Cellulae axiales cylindricae, 30-80 μm crassae, 140-300 μm longae. Verticilli equisetoides et distantes vel contigui. Cellulae basales globosae, cum 1 (-2) fasciculis. Ramuli primarii arcuati, audouinelloidei, unilateraliter, alterne vel opposite ramificantes, ex 7-15 cellulis constantes; cellulae fasciculorum cylindricae, 5-8.5 μm crassae, 16-48 μm longae; pili nuli. Fila corticalia bene evoluta. Ramuli secundarii rari vel sparsim evoluti. Spermatangia globosa vel obovata, 6-9 μm diametro, in ramulis primariis, rari in

ramulis secundariis, lateralibus vel terminalibus. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, ex cellulis 5-7 disci- vel doliiformibus constantes, tortuosi; carpogonium 40-55 μm longum, basi 7-8 μm crassum, apice 10-13 μm crassum; trichogyne ellipsoidea vel urniformis, distincte pedicellata. Bractee numerosae, breves, ex cellulis rotundatarum constantes. Gonimoblastus singulus, indefinitiforme, verticillis crassioribus, 300-800 μm diametro, plus minusve diffusus; fila gonimoblastorum ex cellulis cylindricis vel longis constantes, laxa agglomerata. Carposporangia globosa vel obovoidea, 15-24 μm crassa, 19-30 μm longa.

Frons monoecious, ca. 6 cm high, 300-800 μm wide, abundantly and irregularly branched, slightly mucilaginous, blackish purple. Axial cells cylindrical, 30-80 μm wide, 140-300 μm long. Whorls *Equisetum*-like and separated or touching each other. Basal cell globose, with 1 (-2) fascicles. Primary branchlets curved, audouinelloid, unilaterally, alternately or oppositely branched, consisting of 7-15 cell-stories; cells of fascicles cylindrical, 5-8.5 μm wide, 16-48 μm long; hairs lacking. Cortical filaments well-developed. Secondary branchlets rare, sparsely developed. Spermatangia globose or obovoidal, 6-9 μm in diameter, lateral or terminal on primary branchlets, rarely on secondary branchlets. Carpogonium-bearing branch arising from the basal cell of primary branchlet, consisting of 5-7 disc- or barrel-shaped cells, twisted; carpogonium 40-55 μm long, 7-8 μm wide at the base, 10-13 μm wide at the apex; trichogyne ellipsoidal or urn-shaped, distinctly stalked. Bracts numerous, short, consisting of rounded cells. Gonimoblast single, indefinite-shaped, wider than whorls, 300-800 μm in diameter, more or less diffused; gonimoblast filaments with cylindrical and long cells, loosely aggregated. Carposporangia globose or obovoidal, 15-24 μm wide, 19-30 μm long.

Holotype: O. NECCHI JR., SP-187177, 31/I 1984, Herbarium of Institute of Botany, São Paulo, Brazil.

Other specimens examined: C. PAPE, SP-152530, 22/II 1978; O. YANO, SP-176239, 30/IX 1982; J. A. STEYERMARK & J. J. WURDACK, BMP 419, 21/I 1955.

Type Locality: Reserva Florestal Adolfo Ducke, Município of Manaus, Amazonas State, Brazil.

Distribution: Type locality and Tirica River, between "La Laja" and Base Camp, Chimantá Massif, Bolivar State, Venezuela.

Habitat: Epilithic in a rivulet with limpid and current water in shaded places.

Batrachospermum equisetifolium was described from French Guiana by MONTAGNE (1850), who supplied only a poor description and no figures with detail of structures as an aid to a precise identification. Although *B. equisetoides* resembles *B. equisetifolium* in the Latin epithets and there is not enough information to judge securely, the former seems to be a different species from the latter, judging from the original description in MONTAGNE (1850) and that in SIRODOT (1884).

B. equisetoides closely resembles *B. procarpum* SKUJA in having a twisted carpogonium-bearing branch, a large gonimoblast consisting of loosely aggregated filaments and fascicles which are unilaterally, alternately or oppositely branched and containing spiral and ribbon-shaped chromatophores. However, this species differs from *B. procarpum* in the shape and size of carposporangia and gonimoblasts. The carposporangia for this species are globose or obovoidal, 15-24 μm wide and 19-30 μm long, while those for *B. procarpum* are obovoidal or pear-shaped, 8.5-9.5 μm wide and 10-13 μm long (SKUJA 1931). The gonimoblasts for this species are more or less diffused and indefinite-shaped, 300-800 μm in diameter, while those for *B. procarpum* are semiglobular and up to 300 μm in diameter (SKUJA 1931).

2. *Batrachospermum cipoense* KUMANO et NECCHI, sp. nov. (Figs 17-21, 22-31)

Frons monoica, ca. 5 cm alta, 350-700 μm crassa, abundanter irregulariteque ramosa,

parum mucosa, aeruginosa. Cellulae axiales cylindricae, 25-90 μm crassae, 70-200 μm longae. Verticilli distantes vel contigui et cylindratii vel obconici. Cellulae basales globosae, cum 1-2 fasciculis. Ramuli primarii audouinelloidei, alterne vel unilaterliter ramificantes, ex 9-19 cellulis proximalibus et distalibus constantes; cellulae distales fasciculorum doliiformes, 5.5-8 μm crassae, 12-16 μm longae; cellulae proximales cylindricae, 6.5-9 μm crassae, 20-28 μm longae; pili numerosi, unus vel duo in quoque cellula terminales. Fila corticalia bene evoluta. Ramuli secundarii abundi, in parte vetustiore frondis totum internodium obtegentes. Spermatangia globosa vel obovata, 5-8 μm diametro, in ramulis primariis et secundariis lateralia vel terminalia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, ex cellulis 4-7 disci- vel doliiformibus constantes, tortuosi; carpogonium 33-48 μm longum, basi 5-10 μm crassum, apice 7-10 μm crassum; trichogyne ellipsoidea vel claviformis, plus minusve distincte pedicellata. Bracteae numerosae, breves, ex cellulis rotundatarum constantes. Gonimoblastus singulus, globosus vel semiglobosus, 400-900 μm crassus, 400-700 μm altus, verticillis crassioribus; fila gonimoblastorum longa, plus minusve laxae agglomerata. Carposporangia globosa vel obovoidea, 11-17 μm crassa, 13-19 μm longa.

Fronde monoecious, ca. 5 cm high, 350-700 μm wide, abundantly and irregularly branched, slightly mucilaginous, green with a bluish tinge. Axial cells cylindrical, 25-90 μm wide, 70-200 μm long. Whorls obconical or cylindrical, separated or touching each other. Basal cell globose, with 1-2 fascicles. Primary branchlets audouinelloid, curved, alternately or unilaterally branched, consisting of 9-19 both distal and proximal cell-stories; distal cells of fascicles barrel-shaped, 5.5-8 μm wide, 12-16 μm long; proximal cells cylindrical, 6.5-9 μm wide, 20-28 μm long; hairs abundant, 1-2 on each terminal cell. Cortical filaments well-developed. Secondary branchlets abundant, covering all the internodes in older parts of

frond. Spermatangia globose or obovoidal, 5–8 μm in diameter, lateral or terminal on primary and secondary branchlets. Carpogonium-bearing branch arising from the basal cell of primary branchlets, consisting of 4–7 disc- or barrel-shaped cells, twisted; carpogonium 33–48 μm long, 5–10 μm wide at the base, 7–10 μm wide at the apex; trichogyne ellipsoidal or club-shaped, more or less distinctly stalked. Bracts numerous, short, consisting of rounded cells. Gonimoblast single, globular or semiglobular, wider than whorls, 400–900 μm wide, 400–700 μm high; gonimoblast filaments more or less loosely aggregated. Carposporangia globose or obovoidal, 11–17 μm wide, 13–19 μm long.

Holotype: L. SORMUS, SP-187192, 7/11 1976, Herbarium of Institute of Botany, São Paulo, Brazil.

Other specimens examined: I. SAZIMA and M. SAZIMA, SP-187193, 7/IX 1974.

Type Locality: Cipó Mountains, Município of Santana do Riacho, Minas Gerais State, Brazil.

Distribution: Known only from the type locality.

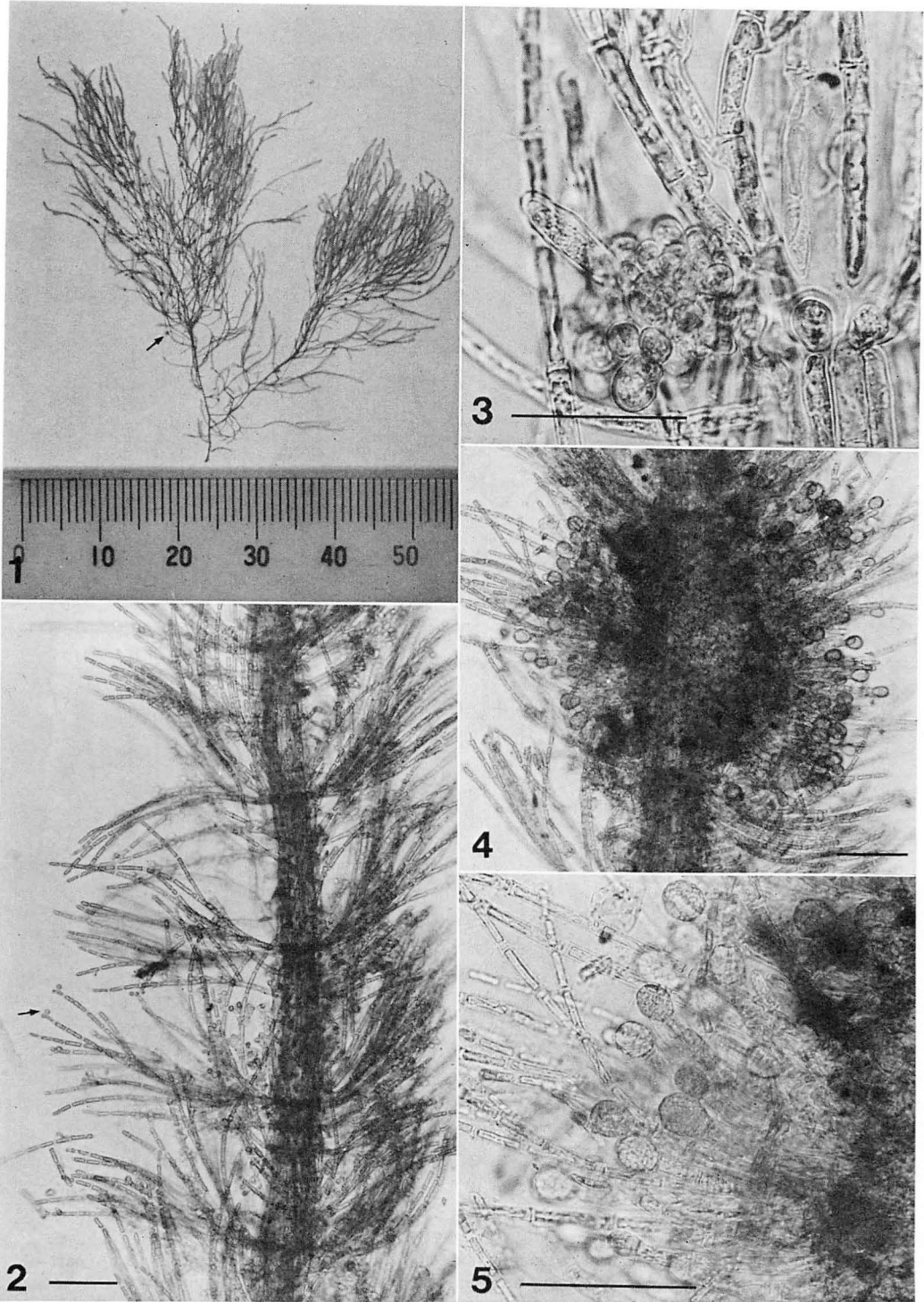
Habitat: Epilithic in a mountain rivulet with limpid and current water in shaded places.

This species resembles *B. procarpum* and *B. equisetoides* in general appearance. However, this species differs from *B. procarpum* in the shape and size of carposporangia and gonimoblasts; the carposporangia for *B. cipoense* are globose or obovoidal, 11–17 μm wide, 13–19 μm long and the gonimoblasts for *B. cipoense* are globular or semiglobular, 400–900 μm wide, while the carposporangia for *B. procarpum* are obovoidal or pear-shaped, 8.5–9.5 μm wide, 10–13 μm long and the gonimoblast for *B. procarpum* are semiglobular and up to 300 μm wide (SKUJA 1931). This species differs from *B. equisetoides* in having secondary branchlets more abundantly developed, gonimoblasts more compactly aggregated and in the size of carposporangia; the carposporangia for *B. cipoense* are 13–19 μm long, while those for *B. equi-*

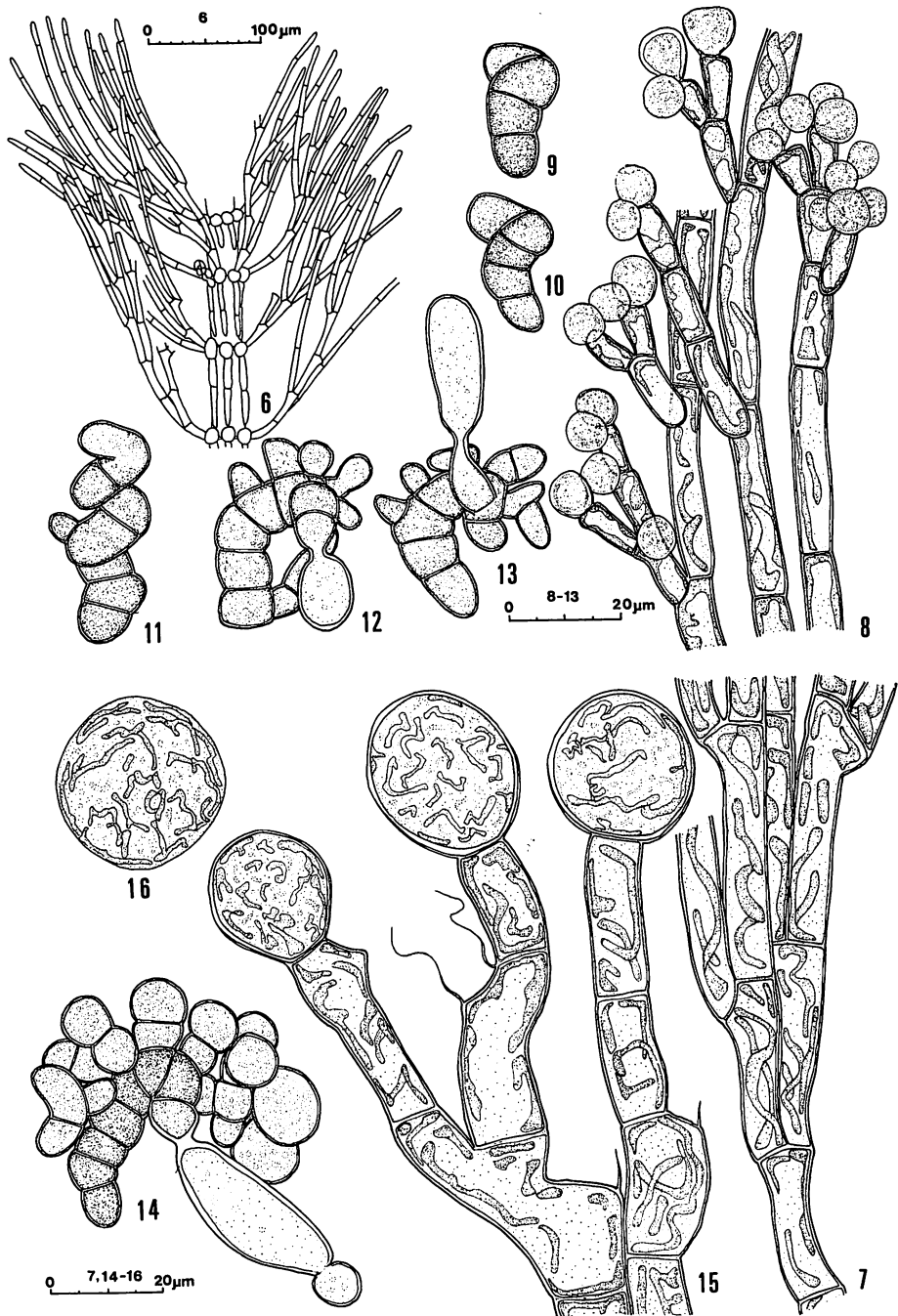
setoides are 19–30 μm long.

Discussion

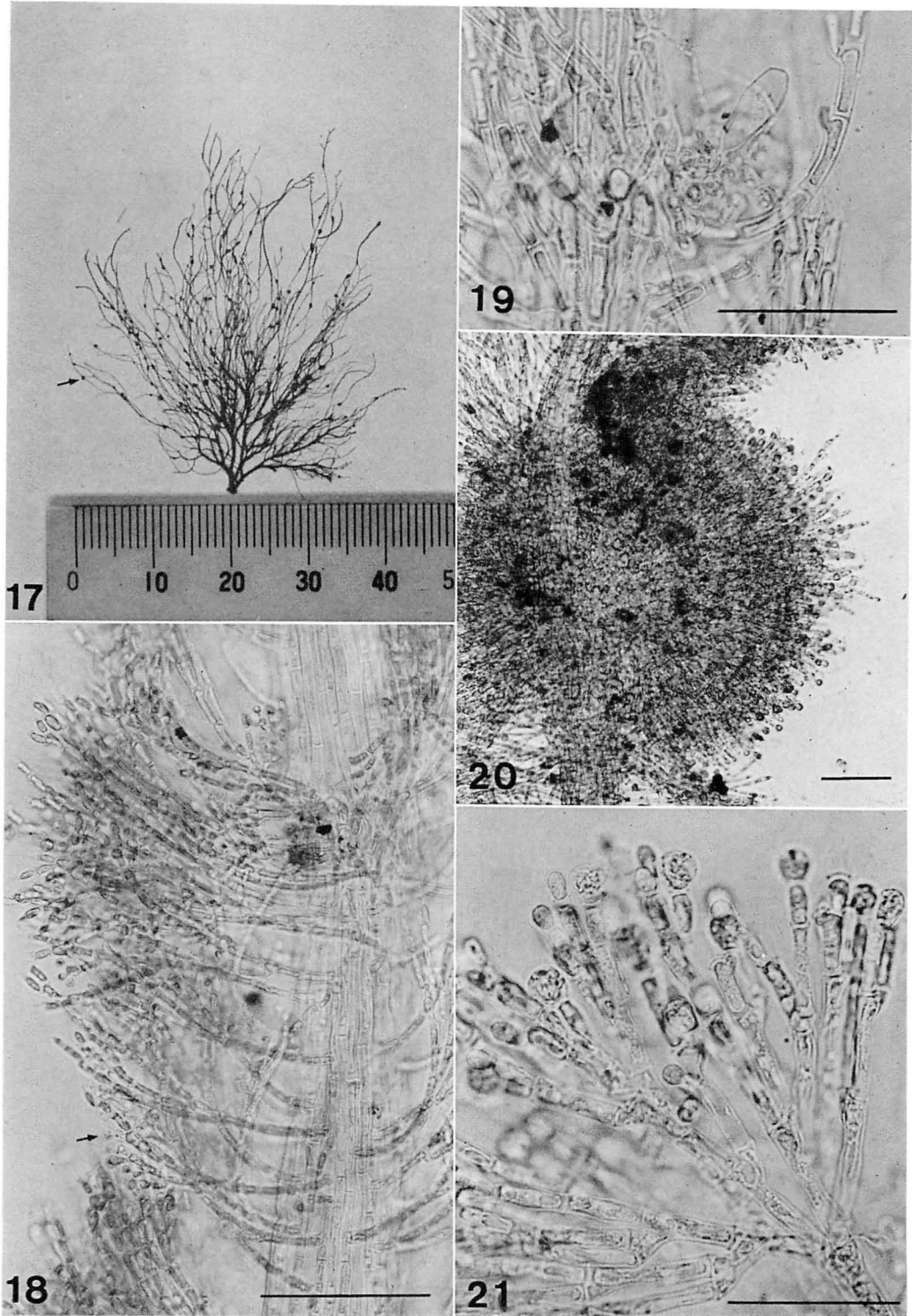
Most taxa of the genus *Batrachospermum* have the fascicles, which are di-, tri- or tetrachotomously branched laterals of limited growth, all of about the same length. These laterals are composed of small ellipsoidal or moniliform cells. However, *B. equisetoides* presents some important characteristics, which are whorls of audouinelloid fascicles with alternate, opposite or unilateral branches. *B. equisetoides* is compared with *B. procarpum*, which also has the audouinelloid branches, but is different from the latter in having the whorl of audouinelloid fascicles with opposite branches in addition to the alternate and unilateral ones found in *B. procarpum*, and strongly curved fascicles in contrast to the slightly curved ones found in *B. procarpum*. The cells of fascicles in *B. equisetoides* are perfectly cylindrical without swellings or constrictions at the cross-walls as found in *B. procarpum*. *B. cipoense* is different from *B. equisetoides* in having branches in the distal ends of the fascicles, the secondary branchlets more abundantly developed and hairs. Although there are minor differences among *B. procarpum*, *B. equisetoides* and *B. cipoense*, concerning vegetative characteristics these three species are distinguished from the other taxa of the genus *Batrachospermum* in having the audouinelloid fascicles. In this respect, it is reasonable to consider them as a definite group of species named *Batrachospermum procarpum* complex, which has a geographical distribution restricted to the American Continent up to now. On the other hand, in relation to the reproductive characteristics, there are distinct differences among these three species as shown in the Table. However, these three species have the twisted or coiled carpogonium-bearing branches as found in taxa belonging to the section *Contorta*. This section is very heterogeneous at the present, and consists of a miscellany of species that has the just mentioned



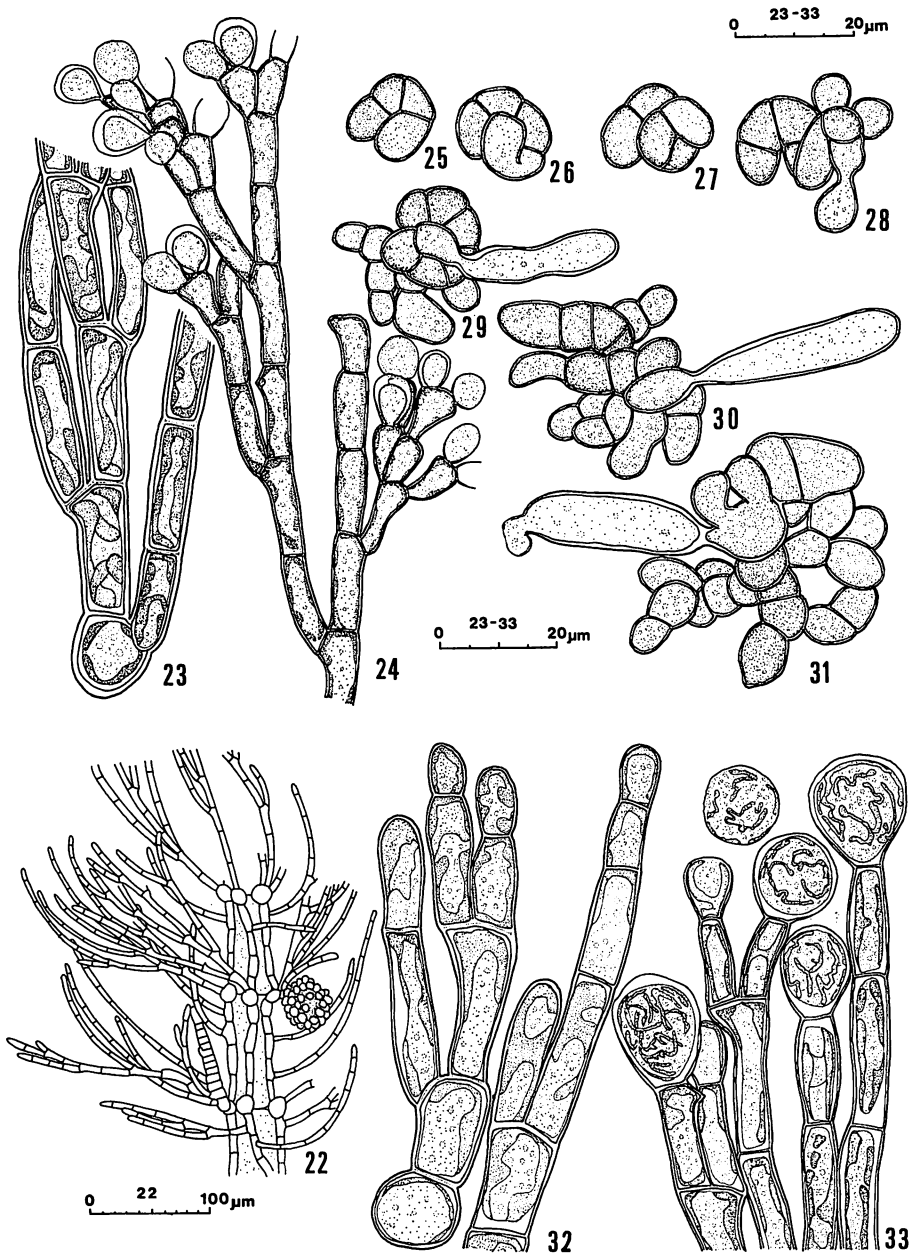
Figs 1-5. *Batrachospermum equisetoides* KUMANO et NECCHI, sp. nov. 1. Holotype, leg. O. Necchi Jr., SP-187177, 31/I 1984, several gonimoblasts are recognized (arrow); 2. A part of thallus showing well-developed cortical filaments and many spermatangia terminal or lateral on primary and rarely secondary branchlets; 3. A part of whorl showing primary branchlets, cortical filaments and a carpogonium-bearing branch surrounded by rounded cells of bracts; 4. An indefinite-shaped gonimoblast; 5. Carposporangia terminal on loosely aggregated gonimoblast filaments. (Scale bar; 100 μ m for Figs 2, 4 and 5; 50 μ m for Fig 3).



Figs 6-16. *Batrachospermum equisetoides* KUMANO et NECCHI, sp. nov. 6. A part of thallus showing axial cells, primary branchlet and a young carpegonium-bearing branch; 7. Proximal cells of primary branchlet containing spiral ribbon-shaped chromatophores; 8. Spermatangia terminal or lateral on primary branchlets; 9-11. Carpegonium-bearing branches at very early stage in development; 12. An early stage in development of a twisted carpegonium-bearing branch with a young carpegonium; 13. A carpegonium-bearing branch with a mature carpegonium; 14. A fertilized carpegonium with a spermatium; 15. Carposporangia terminal on gonimoblast filaments containing ribbon-shaped chromatophores; 16. A carpospore. (Scale bar; 100 µm for Fig. 6; 20 µm for Figs 7-16)



Figs 17-21. *Batrachospermum cipoense* KUMANO et NECCHI, sp. nov. 17. Holotype. leg. L. Sormus, SP-187192, 7/II 1976, several gonimoblasts are recognized (arrow); 18. A part of thallus showing well-developed cortical filaments and spermatangia terminal or lateral on primary and secondary branchlets (arrow); 19. A carpopogonium with a trichogyne; 20. Semiglobular gonimoblast; 21. Carposporangia terminal on gonimoblast filaments. (Scale bar; 100 μ m for Figs 18 and 20; 50 μ m for Figs 19 and 21).



Figs 22-33. *Batrachospermum cipoense* KUMANO et NECCHI, sp. nov. 22. A part of thallus showing axial cells, cortical filaments, primary and secondary branchlets and a young carpogonium-bearing branch; 23. Proximal cells of primary branchlets containing parietal chromatophores; 24. Spermatangia terminal or lateral on secondary branchlet; 25-27. Carpogonium-bearing branches at very early stages in development; 28. An early stage in development of a coiled carpogonium-bearing branch with a young carpogonium; 29-30. Carpogonium-bearing branches with mature carpogonia; 31. A fertilized carpogonium with a spermatium; 32. Gonimoblast filaments at an early stage of development; 33. Carposporangia terminal on gonimoblast filaments. (Scale bar; 100 μm for Fig. 22; 20 μm for Figs 23-33)

	Gonimoblast	Carposporangia
<i>B. procarpum</i>	semiglobular up to 300 μm in diameter	obovoidal or pear-shaped 8.5-9.5 μm wide, 10-13 μm long
<i>B. equisetoides</i>	more or less diffuse 300-800 μm in diameter	obovoidal or globose 15-24 μm wide, 19-30 μm long
<i>B. cipoense</i>	globular or semiglobular 400-900 μm in diameter	obovoidal or globose 11-17 μm wide, 13-19 μm long

characteristic in common. The other sections of the genus are generally identified mainly by reproductive characteristics, such as size and position of gonimoblasts, shape of trichogyne, size of carpogonium-bearing branches. So that, the present authors considered the reproductive characteristics as more important than the vegetative ones, and these three species should be assigned to the section *Contorta* for the present. The need for a more natural infrageneric arrangement is becoming greater every time a new species is described. Thus, a further rearrangement of the species at the infrageneric level with a review of the taxonomic criteria for those level is strongly desired.

Acknowledgements

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熊野 茂*・ネッシー O., Jr.** : ブラジルの淡水産紅藻 II. アマゾン州および ミナス ジェライス州のカワモツク属 2 新種

ブラジル アマゾン州 アドルフォ デュケ森林保護区の小流から *Batrachospermum equisetoides* が、ミナス ジェライス州 シボ山地の小流から *Batrachospermum cipoense* がそれぞれ新種として記載された。上記 2 種と *Batrachospermum procarpum* SKUJA とは *Audouinella* 状に分枝する輪生枝をもつ点でカワモツク属の他の種と区別できる。また上記 3 種を互いに区別するためのキは次の通りである。

1. 嚢果の直径 100-300 μm —*B. procarpum* SKUJA
1. 嚢果の直径 300-900 μm
2. 果胞子の長さ 13-19 μm —*B. cipoense* KUMANO et NECCHI
2. 果胞子の長さ 19-24 μm —*B. equisetoides* KUMANO et NECCHI

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Seasonal variation of desmids at a small marsh in Hiroshima, Japan*

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Seasonal changes in cell size and occurrence of desmids were studied from April 1984 to February 1985 in a small marsh in Hiroshima-ken, western Honshu, Japan. In this study, 23 species of desmids belonging to 10 genera were observed. Only *Netrium digitus* and *Euastrum montanum* showed a tendency of periodicity of occurrence. In *Netrium digitus*, the periodicity was considered to be a result of the formation of zygospores in the autumn and their germination in the spring. In *Netrium digitus*, *Closterium costatum*, *C. pseudolunula* and *Hyalotheca dissiliens*, cell width was considered to be the more reliable character for classification than cell length. Concerning the seasonal variation in cell length, all species except *Closterium costatum* showed rather large variations without any correlation to the seasonal changes, while cell width was rather stable throughout the whole year in all the species examined.

Key Index Words: Cell size; Chlorophyceae; desmids; seasonal variation.

The variation of vegetative cell characters in desmids has been studied by many investigators. However, most of them have dealt with the qualitative characters such as those of spines, warts and radiations (RAYNOLDS 1940, ROSENBERG 1944, TEILING 1957, BICUDO and CARVALHO 1969, GERRATH 1979, SOUTH 1984). Although the cell size is much used as a taxonomic criterion, the variation of cell size has been poorly studied in the laboratory (ICHIMURA and WATANABE 1976, WATANABE 1978) and still more poorly in the field. DUTHIE (1965b) and RŮŽIČKA (1971) showed that cell size of desmids was influenced by temperature under culture conditions. Therefore, it is expected that desmids may show periodical variation in cell size according to the seasonal change in temperature. In order to study this, periodical observations of desmid populations at

a fixed site in a marsh were carried out from April 1984 to February 1985. The marsh is at about 770 m altitude and is located in Iiyama, Saeki-cho, Saeki-gun, Hiroshima-ken, which is situated in the western part of Honshu, Japan. This marsh has been used as a paddy field but it has been left without cultivation of the crop for about 20 years. The vegetation at present is mainly composed of *Scirpus wichrae*, *Carex dispalata*, *Cirsium sieboldii*, *Eriocaulon iskokianum*, *Thuidium glaucinum*, etc. In August heights of the vegetation attained up to about 1 m, but the sunlight reached the surface of the water through the vegetation. During the months of January and February in 1985 this marsh was covered with snow. To show the climate of this region, monthly mean atmospheric temperatures at Yoshiwacho, which is located about 8 km northeast of the studied site are shown in Table 1.

The present study deals mainly with variations of vegetative cell size in natural popu-

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Table 1. Seasonal changes of atmospheric temperature at Yoshiwa-cho, which is located about 8 km northeast of the studied site.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Mean temp.	-0.5 ¹	0.2	4.0	10.0	14.5	18.3	23.1	23.5	19.2	12.8	7.4	2.5
Maximum temp.	3.8	4.9	9.6	16.4	20.9	23.7	27.8	28.8	24.6	19.1	13.4	7.4
Minimum temp.	-4.8	-4.4	-1.7	3.5	8.0	12.9	18.3	18.2	13.8	6.5	1.3	-2.6

¹ Degrees Celsius (°C); all data are mean values during the past 20 years.

lations of several desmids along with their seasonal fluctuation in abundance, but also with the occurrence of zygospores in the field.

Materials and Methods

Samples (ca. 20 ml) were collected by glass pipette once a month from a definite spot of about 100 cm² in the marsh. At the time of collection, pH and water temperature were measured by a pocket pH meter (Model PH51, Yokogawa Electric Works) and the data are shown in Table 2. Cells were taken out from each sample to study the morphology of chloroplasts and pyrenoids in living condition. After this, the rest of the samples were preserved in 5 percent formalin and used for the measurement of cell size. For each measurement, 25 cells per species, ex-

cept for some cases when fewer cells were available, were observed under the light microscope using the micrometer. All the samples studied were deposited in the Herbarium of Hiroshima University (HIRO).

The experiment of zygospore germination of *Netrium digitus* was carried out at about 20°C. Light was provided by cool white fluorescent tubes on a cycle of 12 hr light and 12 hr dark. Light intensity was about 2500 lux. Samples containing zygospores were kept in a refrigerator until the time of use. When the sample was set on this condition, a great number of zygospores germinated within a few days.

Results

1) Seasonal changes in desmid population

During the present study 23 species of desmids belonging to 10 genera were found and their monthly occurrences are shown in Table 3. Associated algae with these desmids were mainly diatoms, blue-green algae and other groups of green algae. Some species of diatoms were abundant during the winter, and *Eremosphaera viridis* (Chlorellales) was always dominant throughout the period of this study.

Among the desmids found in this marsh, *Microsterias denticulata* var. *angulosa* (Fig. 1j) was always dominant throughout the year. Even during the winter, many vegetative cells of this species were observed, but no zygospores were found. *Netrium digitus* (Fig. 1a), however, showed a marked contrast to this. The vegetative cells were abundant from April to October, but sudden-

Table 2. Water temperature and pH of the samples studied.

Sample No. (HIRO)	Collection date	Time	Water ¹ temp.	pH
so-934	27 iv '84	12:30	23.8	5.5
so-944	1 vi	10:10	20.5	5.7
so-949	5 vii	19:40	23.2	5.6
so-951	5 viii	12:30	32.3	5.6
so-956	5 ix	11:20	19.9	5.8
so-962	6 x	13:00	15.3	5.4
so-969	4 xi	11:00	3.9	5.8
so-974 ²	4 xii	13:00	2.5	5.9
so-980 ²	11 i '85	12:00	1.7	5.2
so-983	7 ii	13:30	3.0	-

¹ Degrees Celsius (°C). ² Marsh was covered with snow, and samples were collected from another site near the study point.

Table 3. Occurrence of desmids from April 1984 to February 1985.

Species	Apr.	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
<i>Spirotaenia condensata</i>	rr	rr	—	—	rr	rr	rr	r	rr	rr
<i>S. obscura</i>	rr	rr	—	—	rr	rr	rr	rr	r	rr
<i>Cylindrocystis brebissonii</i>	—	—	—	—	—	—	rr	—	—	—
<i>Netrium digitus</i>	c	cc	c	c	cc	cc ¹	r ¹	r ¹	rr ¹	— ¹
<i>Closterium closterioides</i> var. <i>intermedium</i>	rr	rr	c	+	r	r	—	rr	—	rr
<i>C. costatum</i>	r	r	+	+	c	r	+	+	+	+
<i>C. diana</i> var. <i>minus</i>	—	—	rr	—	—	—	—	—	—	—
<i>C. intermedium</i>	—	—	—	—	rr	—	—	—	—	—
<i>C.</i> (cf.) <i>kuetzingii</i>	—	—	rr	rr	rr	rr	rr	—	—	—
<i>C. lunula</i>	r	rr	r	rr	rr	rr	r	rr	—	r
<i>C. moniliferum</i>	—	—	rr	—	—	—	—	—	—	—
<i>C. pseudolunula</i>	r	+	+	+	+	+	r	+	r	r
<i>C. striolatum</i>	—	—	—	—	rr	—	rr	—	rr	—
<i>Tetmemorus granulatus</i> f. <i>minor</i>	—	—	—	rr	—	rr	rr	rr	—	—
<i>Euastrum luethemuelleri</i> var. <i>carniolicum</i>	—	—	—	rr	rr	rr	—	—	—	—
<i>E. montanum</i>	cc	cc	+	+	+	+	rr	rr	rr	r
<i>E. oblongum</i>	rr	—	—	—	—	—	—	—	—	—
<i>Micrasterias denticulata</i> var. <i>denticulata</i>	+	+	r	r	r	r	r	r	r	rr
<i>M. denticulata</i> var. <i>angulosa</i>	c	c	c	c	c	c	c	c	c	c
<i>Actinotaenium cucurbita</i>	—	—	rr	—	—	—	—	—	—	—
<i>Cosmarium quadratum</i>	rr	rr	rr	—	—	—	—	—	—	rr
<i>C. westii</i>	rr	rr	rr	—	rr	—	—	—	—	rr
<i>Hyalotheca dissiliens</i>	cc	c ²	+ ²	r ²	r	+	+	+	c	+

cc: Very abundant; c: Abundant; +: Common; r: Rare; rr: Very rare. ¹ Zygosporae were observed. ² Parthenosporae were observed.

ly decreased their numbers after October, when zygosporae (Fig. 1b) of this species were first observed. Although a small number of living vegetative cells were seen with zygosporae from November to January, no living vegetative cells were observed in February. Zygosporae germination was observed in the sample collected in April 1984. *Euastrum montanum* (Fig. 1h) also showed a marked fluctuation in vegetative cell number. It was abundant from April to June, and commonly seen from July to October, but rarely from November to January and very rarely in February. No zygosporae were observed throughout the year. *Closterium pseudolunula* (Fig. 1e), *C. costatum* (Fig. 1f), *C. closterioides* var. *in-*

termedium (Fig. 1g), *Micrasterias denticulata* var. *denticulata* (Fig. 1i) and *Hyalotheca dissiliens* (Fig. 1c) were observed throughout the period studied. In these four species, however, neither seasonal fluctuation in vegetative cell number nor zygosporae formation were detected. But from June to August only parthenosporae of *Hyalotheca dissiliens* (Fig. 1d) were observed. The remaining species were rare or occurred sporadically, and no zygosporae were observed.

2) Variation of cell size

As to the most frequently appearing six species, *Netrium digitus*, *Closterium costatum*, *C. pseudolunula*, *Micrasterias denticulata* var.

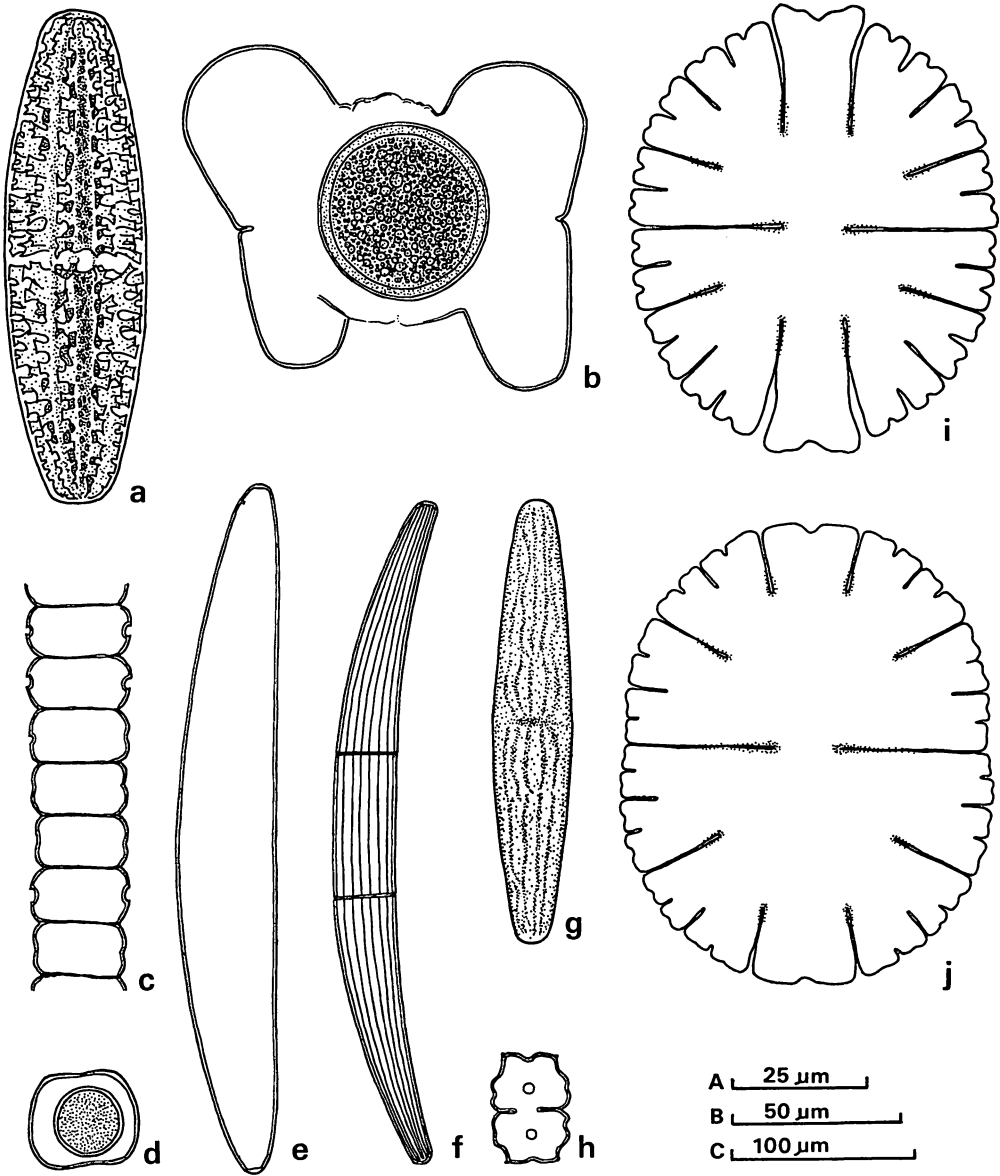


Fig. 1. Representative species of the desmids studied. a. *Netrium digitus* (RALFS) ITZIGS & ROTHE. b. Zygosporangium of *N. digitus*. c. *Hyalotheca dissiliens* RALFS. d. Parthenospore of *H. dissiliens*. e. *Closterium pseudolunula* BORGE. f. *C. costatum* RALFS. g. *C. closterioides* (RALFS) LOUIS & PEETERS var. *intermedium* (ROY & BISS.) RŮŽIČKA. h. *Euastrum montanum* WEST & WEST. i. *Micrasterias denticulata* RALFS var. *denticulata*. j. *M. denticulata* var. *angulosa* (HANTZSCH) WEST & WEST. Scale: A for h, B for c, d, g and C for others.

Table 4. Seasonal variation of coefficient of variability of cell size in six species of desmids from Hiroshima.

Month	<i>Netrium digitus</i>		<i>Closterium costatum</i>		<i>Closterium pseudolunula</i>		<i>Hyalotheca dissiliens</i>		<i>Micrasterias denticulata</i> var. <i>denticulata</i>			<i>Micrasterias denticulata</i> var. <i>angulosa</i>		
	Length ¹	Width ¹	Length	Width	Length	Width	Length	Width	Length	Width	Isthmus ¹	Length	Width	Isthmus
Apr.	13.4	9.2	11.6	2.6	7.4	2.0	8.6	4.2	5.8	3.1	3.3	2.6	3.1	5.0
June	9.8	6.1	8.2	2.6	6.9	2.5	10.0	4.5	4.4	3.6	5.2	4.0	3.6	3.8
July	9.6	2.5	10.6	2.4	6.5	1.8	9.4	3.4	2.9 ⁶	3.8	5.2	3.1	3.6	2.8
Aug.	8.4	1.9	11.4	2.9	7.0	1.8	7.5	3.8	3.1	2.7	3.7	4.2	3.4	3.3
Sep.	6.7	2.4	11.3	2.9	7.1	1.8	9.3	3.8	3.3	3.4	2.7	3.6	3.6	3.9
Oct.	6.1	1.7	9.1	2.4	8.0	1.6	7.3	3.7	3.2	3.9	3.0	4.5	4.3	2.9
Nov.	8.1 ²	3.1	10.0	2.6	7.3 ³	2.0	8.5	3.4	2.5 ⁷	3.8	3.9	3.6	4.0	4.2
Dec.	—	—	13.3	2.6	6.8	1.8	6.5	3.8	2.7	2.8	2.7	3.9	3.2	4.0
Jan.	—	—	13.7	1.9	5.0 ⁴	2.2	11.1	4.1	3.2 ⁸	1.9	1.8	4.1	4.1	3.0
Feb.	—	—	11.6	2.6	6.8 ⁵	2.2	8.1	3.8	—	—	—	4.5	3.7	3.4

¹ Coefficient of variability (%).²⁻⁷ Cell number measured. ² N=15. ³ N=19. ⁴ N=15. ⁵ N=16. ⁶ N=13. ⁷ N=14. ⁸ N=7. Others N=25.

denticulata, its var. *angulosa* and *Hyalotheca dissiliens*, variations in vegetative cell size were statistically analyzed.

a) Variation of cell size in each sample

In *Netrium digitus*, *Closterium costatum*, *C. pseudolunula* and *Hyalotheca dissiliens*, CV (Coefficient of variability: standard deviation/mean) of cell width varied in a smaller range than that of cell length (Table 4). For example, in *Closterium costatum*, CV of cell width ranged from 1.9 to 2.9, while that of cell length was from 8.2 to 13.7. Thus, the cell width is rather stable and can be considered to be a more reliable taxonomic character than the cell length. Nevertheless in *Micrasterias denticulata* var.

denticulata CV of cell width, that of cell length and that of width of isthmus were in the range from 1.9 to 3.9, from 2.5 to 5.8 and from 1.8 to 5.2, respectively. Therefore, these three characters seem to vary about equally in this desmid. The same is true for *M. denticulata* var. *angulosa*.

b) Seasonal variation of cell size

In *Netrium digitus*, CV of cell length in April and CV of cell width in April and June were considerably larger than those of other months. These higher values resulted from the presence of many small cells in the samples collected in these months. These small cells are considered to be juvenile cells appeared from germination zygospores, because all the developmental stages from small young to fully developed cell were observed with several germination vesicles in these samples (Fig. 2). It is clear from Fig. 3 that cell size variation in July, when no zygospore germination was observed, is restricted to the normal moderate range, while that in April is more widely scattered, especially toward smaller cell size. Mean values of cell size of both months were somewhat smaller than those of other months (Fig. 4a). In *Closterium costatum* (Fig. 4c),

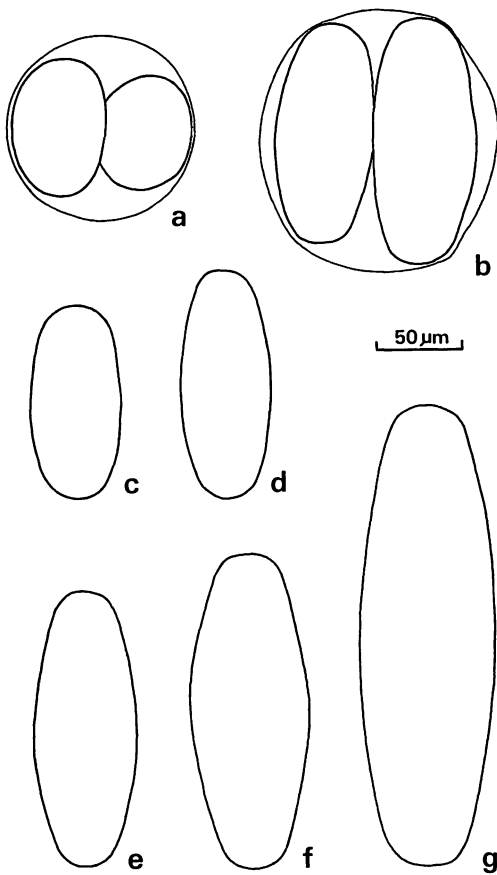


Fig. 2. Germination vesicles and developing cells of *Netrium digitus* in a sample so-934 (April). a, b. Two gones within a vesicle. c-f. Young developing cells of various sizes. g. Fully grown vegetative cell.

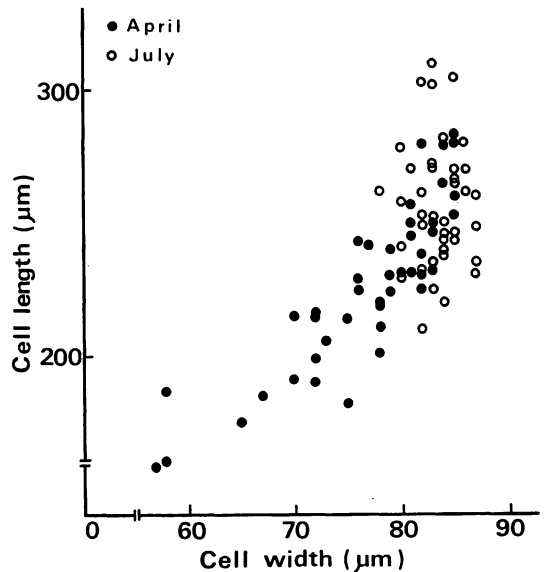


Fig. 3. Cell size variation of *Netrium digitus* in April (●) and July (○).

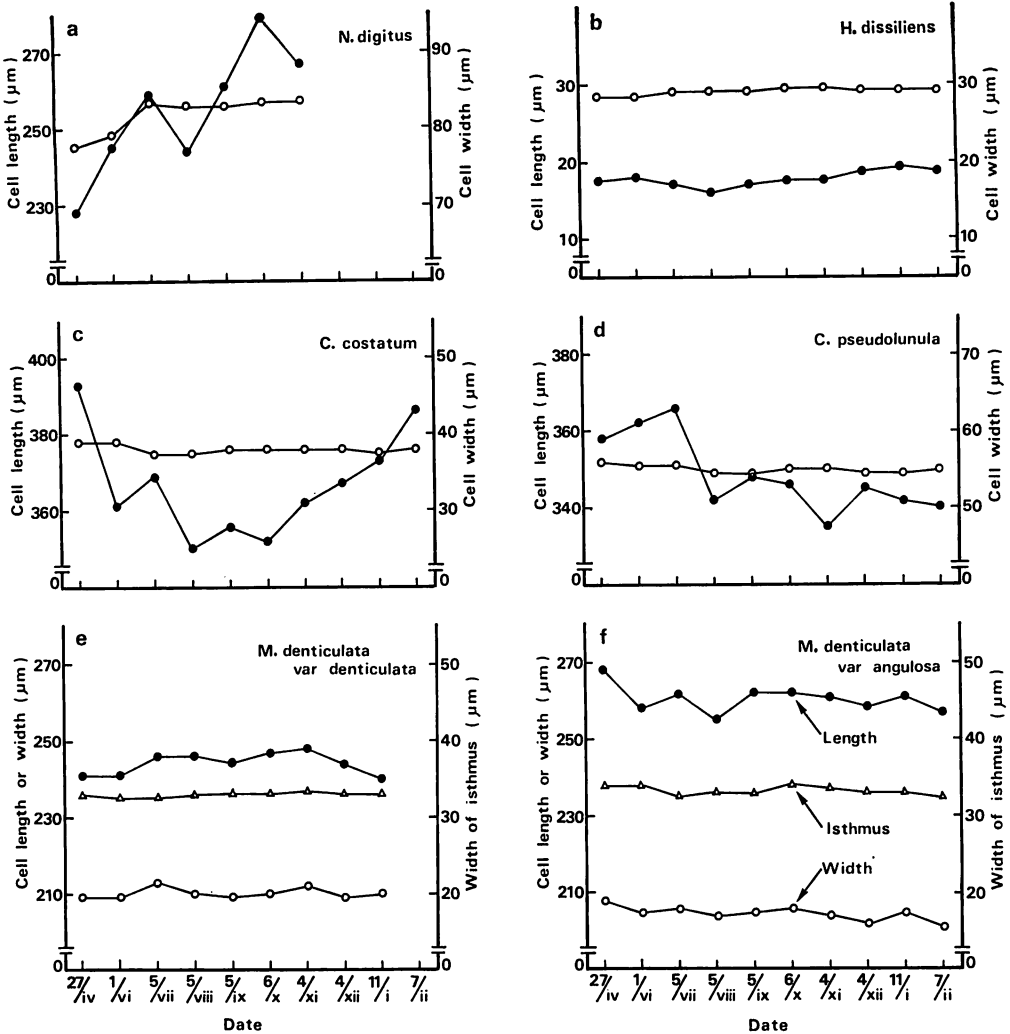


Fig. 4. Seasonal variation of cell size in six species of desmids. a. *Netrium digitus*. b. *Hyalotheca dissiliens*. c. *Closterium costatum*. d. *C. pseudolunula*. e. *Micrasterias denticulata* var. *denticulata*. f. *M. denticulata* var. *angulosa*. ●: Cell length; ○: Cell width; △: Width of isthmus.

a marked seasonal fluctuation in the cell length was observed. The cell length was significantly diminished from April to August, and increased again from August to February. In contrast, the cell width was considerably stable throughout the year. In *Micrasterias denticulata* var. *denticulata* (Fig. 4e) and its var. *angulosa* (Fig. 4f), however, both the cell width and length considerably varied throughout the year and no meaningful change was detected, while the width of isthmus was considerably stable

throughout the year. In *Closterium pseudolunula* (Fig. 4d) and *Hyalotheca dissiliens* (Fig. 4b), the cell length varied to a large extent without any correlation with the seasons, but cell width was always rather stable.

Discussion

WEST and WEST (1912) showed the clear seasonal fluctuation in planktonic desmids such as *Staurastrum jaculiferum* and *S. lunatum* var. *plancticum*. These species were abun-

dant during the summer and the autumn, but diminished in numbers during the winter months, while some other desmids were not rare or rather abundant during winter months (WEST and WEST 1912, DUTHIE 1965a). In the present study, *Netrium digitus* and *Euastrum montanum* showed the seasonal fluctuation, while *Micrasterias denticulata* var. *angulosa* did not show such a tendency, abounding throughout the year.

It is probable that, in *Netrium digitus*, the marked changes in vegetative cell number are caused by the formation of zygospores in the autumn and their germination in the spring. The zygospores of *N. digitus* seem to be resistant to the winter coldness. COESEL (1974) reported that a shallow water habitat appeared to be favorable for the formation of zygospores in certain species of desmids and considered that the formation of zygospores could be explained as a means of survival when desiccation threatens. In the present study, the zygospores of *N. digitus* were also collected from shallow water. But the sampling site was never completely dried up throughout the period of study and the water containing fresh zygospores was very gelatinous. My colleague, Dr. T. BANDO, and I have collected zygospores of *N. digitus* at several sites including the one reported in this paper during the autumn months (Oct. 30, 1977, Oct. 18, 1982, Nov. 19, 1983, Oct. 6 and 22, 1984) in the same marsh. I could observe the process of zygospore formation in two samples collected on Oct. 18, 1982 and Oct. 22, 1984. Moreover, GRÖNBLAD (1957) reported zygospores on Sep. 20, 1936 in SW Finland and BANDO (1981) on Oct. 12-15, 1979 at Kirigamine highland in Japan. On the basis of these results, the formation of zygospores in *N. digitus* seems to occur frequently in the autumn. I consider that the sexual reproduction of *N. digitus* is induced not only by desiccation but also by other factors appearing during the autumn months. Germination of zygospores was not observed from November to February, but was observed in April 1984 in the field. In the

laboratory, however, zygospores could germinate at room temperature (ca 20°C) even in January. On the basis of these results of observations in nature and the experiment in the laboratory, I consider the zygospore of *N. digitus* to be a resistant form against low temperature.

Investigating the size variation of some desmids under different temperature conditions in the laboratory, RŮŽIČKA (1971) reported that most species showed a tendency to be smaller in cell size in high temperature (30°C) than in low temperature (10°C). DUTHIE (1965b) also showed similar results on some desmids in two sets of temperature conditions of 4°C and 20°C. Although it was expected that the desmids might show clear seasonal change in cell size, most of the desmids studied did not show such changes, their cell sizes being constant throughout the whole year. RŮŽIČKA (1971) showed that the light intensity also controlled the cell size in desmids. In the field, the combination of temperature, light intensity and other factors probably controls sizes of the desmids. Further studies at different places and on other species will contribute to understanding the problem of the stability of natural populations of desmids.

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大谷修司： 広島県の小湿地におけるチリモ類の季節変化

広島県北西部に位置する小湿地において、チリモ類の出現個体数および栄養細胞の大きさの季節変化を観察した。1984年4月から1985年2月におよぶ本研究を通して23種類（優占種は *Netrium digitus*, *Closterium costatum*, *C. pseudolunula*, *Micrasterias denticulata* var. *denticulata*, *M. denticulata* var. *angulosa*, *Hyalotheca dissiliens*）のチリモ類が見出された。

Netrium digitus と *Euastrum montanum* において個体数の季節変化が観察された。前者の季節変化は春の接合子の発芽と秋の接合子形成に由来するものであった。上記の優占種6種類について、各月の標本集団中25個体の大きさの測定を行った結果、細胞の幅は長さには概して安定した形質であることが明らかとなった。各月の平均値について見ると上記6種類いずれにおいても、細胞の幅は年間を通じてほとんど変化が観察されなかったが、長さは大きく変動する傾向にあった。しかし季節と対応した長さの変化は *Closterium costatum* で観察されたにすぎなかった。(730 広島市中区東千田町 1-1 広島大学理学部植物学教室)

Ultrastructural studies on nuclear division in the sporophyte of *Carpomitra cabreræ* (CLEMENTE) KÜTZING (Phaeophyta, Sporochneales)

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MOTOMURA, T. and SAKAI, Y. 1985. Ultrastructural studies on nuclear division in the sporophyte of *Carpomitra cabreræ* (CLEMENTE) KÜTZING (Phaeophyta, Sporochneales), Jap. J. Phycol. 33: 199-209.

Nuclear division in cells of trichothallic hairs of *Carpomitra cabreræ* was studied with the electron microscope. A pair of centrioles was observed near the interphase nucleus. In early prophase, each pair of centrioles was derived from the duplication of the original, which had migrated to the poles, and the nucleus was depressed at both poles. Many microtubules radiated from electron dense material around the centrioles into the depression of the nuclear envelope. Chromatin condensed gradually and a nucleolus disappeared. In metaphase, chromosomes were arranged at the nuclear equator, and many spindle fibers were observed in the nucleoplasm, but kinetochores were not seen. The nuclear envelope was almost intact except for both polar fenestrate regions. In anaphase, separation of chromosomes was accompanied by increased distance between the poles, and disintegration of the nuclear envelope. In early telophase, the new nuclear envelope was formed around daughter nuclei in which the spindle fibers still remained. Large vacuoles were observed between daughter nuclei, and they were compressed by an increment in volume of daughter nuclei which was caused by the dispersal of chromatin and the regeneration of the nucleolus.

Key Index Words: *Carpomitra cabreræ*; nuclear division; Phaeophyta; trichothallic hairs; ultrastructure.

Ultrastructural investigations of algal mitosis have been reported recently. Some of these have suggested a phylogenetic scheme in the Chlorophyta. In the Phaeophyta, these works have been carried out in the Ectocarpales; *Pylaiella littoralis* plurilocular sporangia (MARKEY and WILCE 1975), Sphacelariales; *Sphacelaria tribuloides* apical cell (KATSAROS *et al.* 1983), Dictyotales; *Zonaria farlowii*, *Dictyopteris zonarioides*, *Padina pavonia*, *Dictyota dichotoma* apical cells (NEUSHUL and DAHL 1972), Cutleriales; *Cutleria hancockii* male gametangium (LA CLAIRE and WEST 1979), *C. cylindrica* trichothallic meristem (LA CLAIRE 1982), Fucales; *Fucus vesiculosus* antheridium (LEEDALE 1970), *F. vesiculosus* embryo (BRAWLEY *et al.* 1977),

F. serratus antheridium (BERKALOFF and ROUSSEAU 1979), and *Hormosira banksii* embryo (FORBES and HALLUM 1979). Many of these observations were limited to one or a few stages of mitosis, usually metaphase. Detailed ultrastructural investigations on the whole process of mitosis is anticipated for the Phaeophyta.

More recently, LA CLAIRE (1982) and KATSAROS *et al.* (1983) investigated nuclear division in detail in the active dividing region of the trichothallic meristem of the *Cutleria cylindrica* gametophyte and the apical cell of *Sphacelaria tribuloides*.

The assimilatory hairs of the *Carpomitra cabreræ* sporophyte grow from a trichothallic meristem (SAUVAGEAU 1926). As the case

of *C. cylindrica*, it provides a good system for investigation of nuclear division, because 1) active cell divisions occur in one region (trichothallic growth), 2) the axis of nuclear division is one direction (haplostichy), and 3) the thallus grows actively in culture. In the present study, the process of nuclear division of the *Carpomitra cabreræ* sporophyte is reported in detail from electron microscope observations.

Materials and Methods

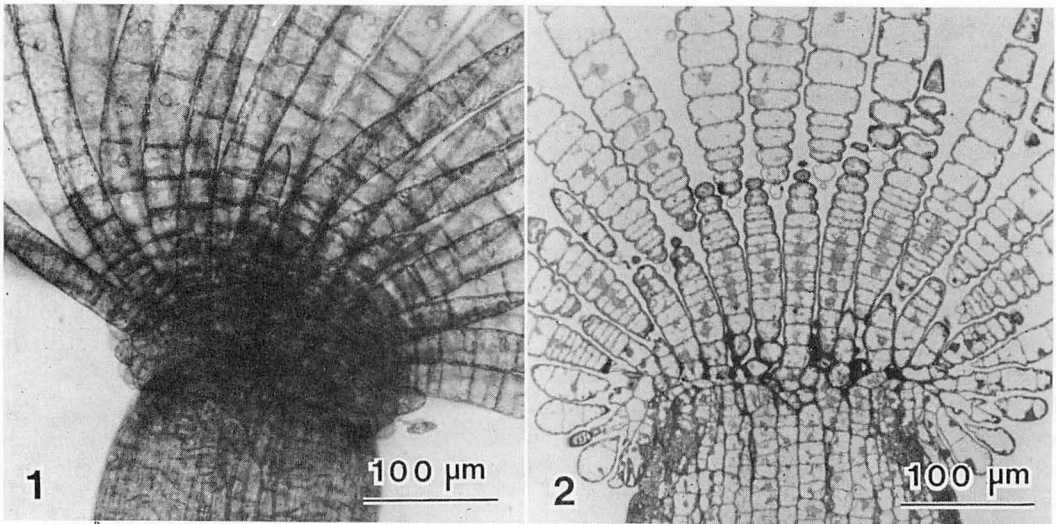
The strain used for the present observations was the same as the material used previously for the study of the life history of *Carpomitra cabreræ* (MOTOMURA *et al.* 1985). The medium used was PESI medium (TATEWAKI 1966). Vegetative gametophytes were maintained at 18°C, and illuminated with cool white fluorescent lamps (40–80 $\mu\text{mol m}^{-2}\text{s}^{-1}$), 14:10 LD cycles. These were transferred to 14°C, 10:14 LD under the same light conditions for the induction of maturation of gametophytes. After one month, monoecious gametophytes had matured and formed oogonia and antheridia.

Fertilized eggs developed into sporophytes. Juvenile sporophytes were transferred again to a 18°C, 14:10 LD incubator for conducting active growth. Afterwards, the sporophytes reached 1–2 cm in height, and the apical regions, including trichothallic hairs were used for examining nuclear division.

Methods of fixation, dehydration and embedding were identical with those previously described for *Laminaria angustata* gametogenesis (MOTOMURA and SAKAI 1984). Thin sections were prepared on a Poter-Blum MT-1 ultramicrotome using glass and diamond knives, and they were double stained with uranyl acetate and REYNOLD'S lead citrate (REYNOLDS 1963), and observed with a Hitachi H-300 electron microscope. Serial sections were placed on formvar-coated slit grids.

Results

An interphase nucleus of cells of trichothallic hairs (Figs 1, 2) usually had one nucleolus and took spherical or ovoid form (Fig. 3). The nuclear envelope was intact and several Golgi bodies were present at the



Note: Legend abbreviations: C=centriole, CH=chromosome, Ch=chloroplast, CW=cell wall, ER=endoplasmic reticulum, G=Golgi body, M=mitochondrion, Mb=microbody, N=nucleus, Nu=nucleolus, V=vacuole.

Fig. 1. Apical region of *Carpomitra cabreræ*. Note many trichothallic hairs.

Fig. 2. Longitudinal section through the apex stained with 1% toluidine blue-O in 1% borax.

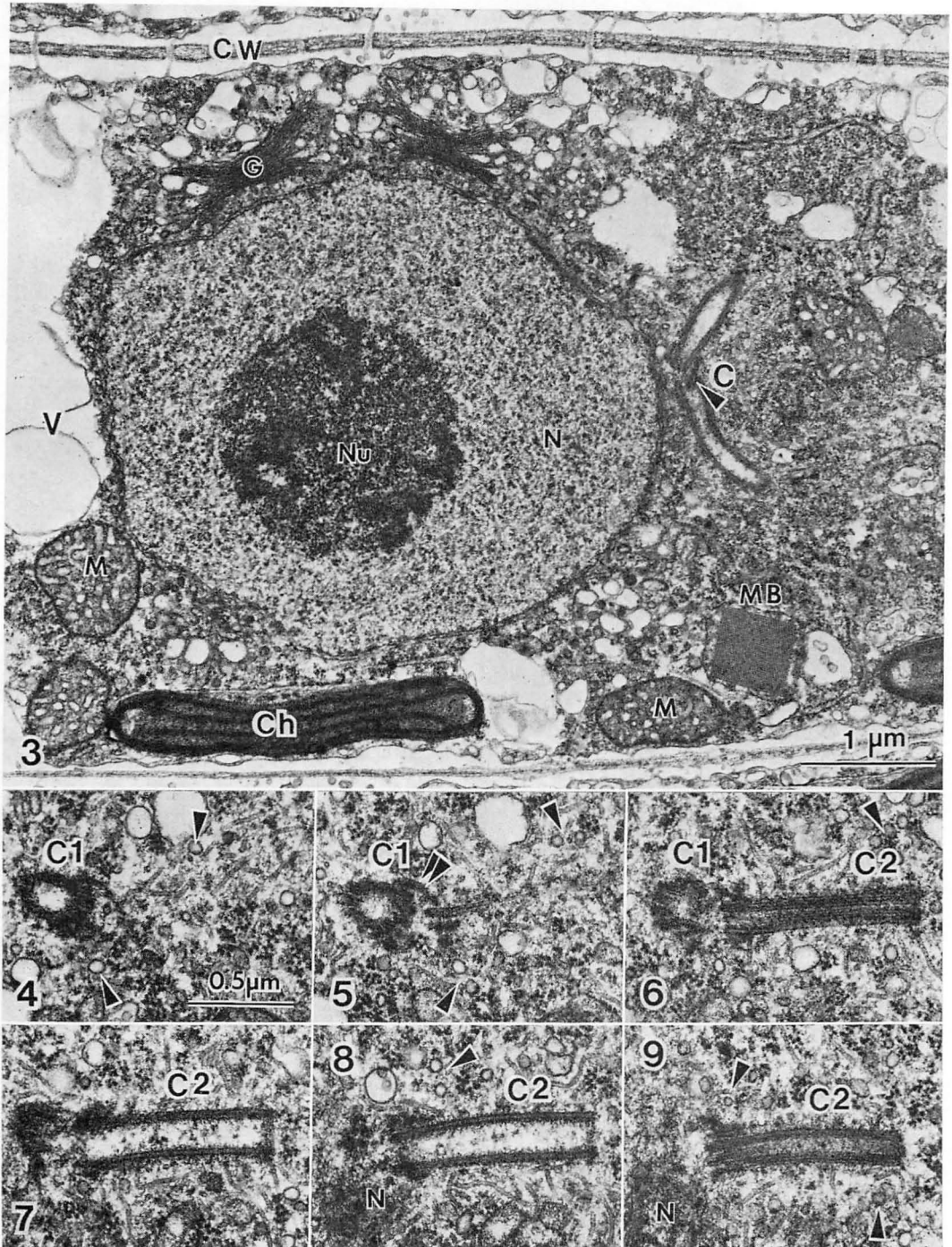


Fig. 3. Interphase nucleus with a nucleolus. A pair of centrioles exists. Arrow indicates the connecting structure between two centrioles.

Figs 4-9. Serial sections of a pair of centrioles (C1 and C2) in interphase. Note that many microtubules radiate from electron dense material around the centrioles. Small vesicles (arrow) exist around the centrioles. Double arrow in Fig. 5 indicates the connecting structure between two centrioles.

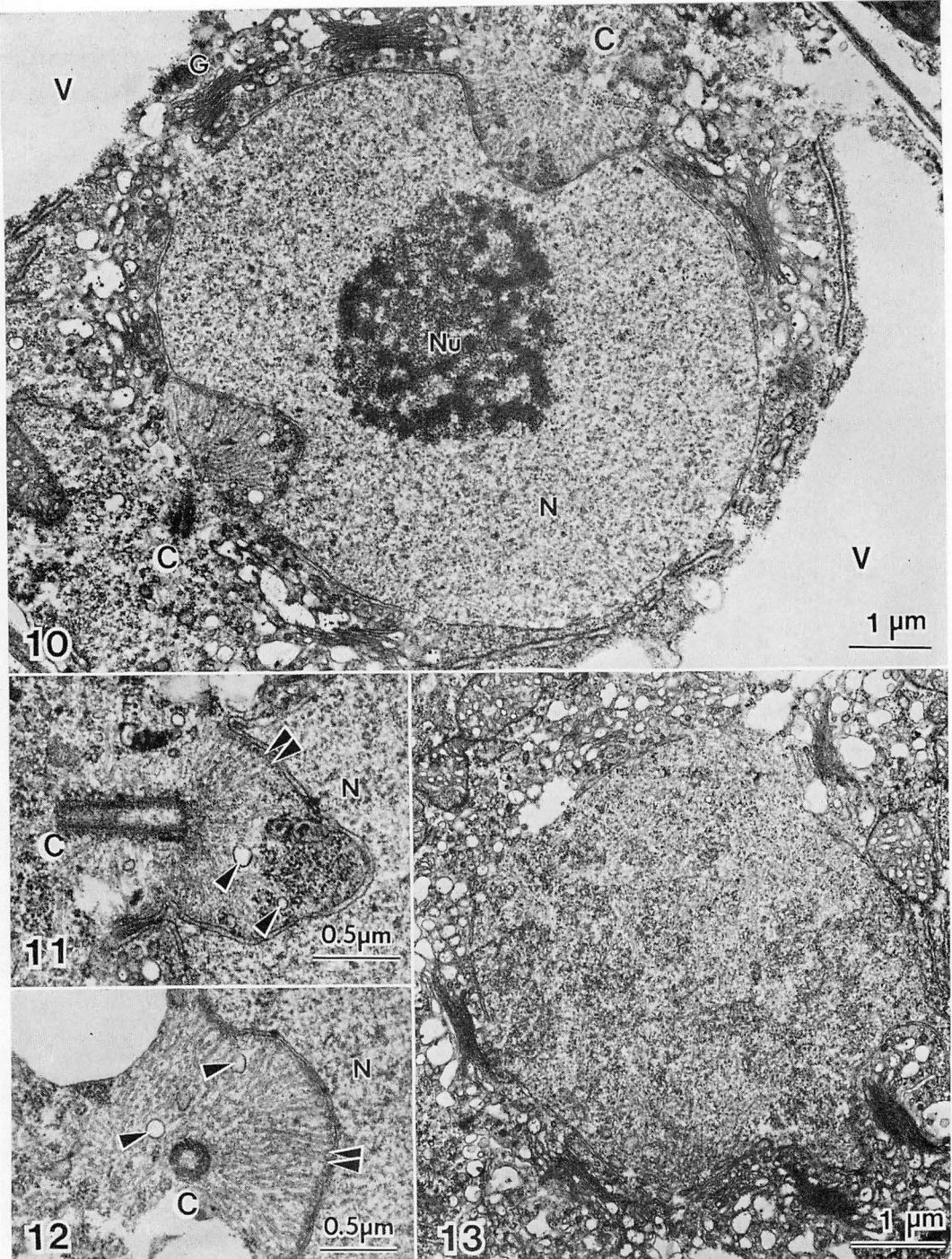


Fig. 10. Early prophase nucleus with a nucleolus. Each pair of centrioles migrates toward the both poles and the nucleus depresses at these regions.

Fig. 11. Polar depression of nucleus at the poles in prophase. Many microtubules radiate from the centriole to the nuclear depression. Electron opaque layer (double arrow) exists along the nuclear depression. Note several small vesicles (arrow) and many ribosomes in the nuclear depression.

Fig. 12. Another polar depression in prophase. Note electron opaque layer (double arrow) along the nuclear depression and several small vesicles (arrow).

Fig. 13. Late prophase nucleus. A nucleolus disappears and the chromatin condenses gradually.

perinuclear region. Examination of many thin sections of the interphase cells revealed that a pair of centrioles was situated at the side of the nuclear envelope perpendicular to the axis of nuclear division. Serial sections (Figs 4-9) showed that two centrioles were arranged at right angles to each other. Amorphous electron dense material existed either in spots or uniformly in some places around the centrioles. At the basal part of the centrioles, this amorphous material was thick. Occasionally, a structure which appeared to connect two centrioles was detected (Figs 3, 5). Many microtubules which radiated from the amorphous material were found in the cytoplasm, but not in the nucleoplasm. Small vesicles were present around the centrioles (Figs 4-9).

The first indication of early prophase must be the duplication of centrioles and their migration to the opposite poles. Although many sections were examined, these processes could not be followed in detail, therefore both processes must occur rapidly. Fig. 10 shows the early prophase nucleus. The nucleus was depressed at both poles, but the nuclear envelope was not ruptured. The nucleolus still existed. In the polar depression, many microtubules were found (Figs 11, 12). A layer of electron opaque material was present along the perinuclear region in the depression (Figs 11, 12), and microtubules terminated in this layer. The nuclear depression may be formed by the growth of microtubules. Several vesicles could be observed on the inside of the nuclear depression, and aggregation of ribosomes existed locally in the bottom of the depression (Figs 10, 11). In later prophase, a nucleolus dispersed and the chromatin began to condense. Polar fenestrae (the gap of the nuclear envelope at poles) developed, and microtubules began to enter into the nucleoplasm through the polar fenestrae (Fig. 13).

During metaphase, the nucleus turned into a spindle-shape, and chromosomes were arranged at the equator of the nucleus (Fig. 14). Polar fenestrae developed well. Many spindle fibers were observed in the nucleoplasm,

but not in the cytoplasm. There was not apparent structure of kinetochores. The nuclear envelope, except for both polar fenestrate regions, was almost intact. In this period, several vesicles appeared in the nucleoplasm. Pole-to-pole distance was ca. $5\ \mu\text{m}$, and this value was the same as in a prophase nucleus.

At anaphase, daughter chromosomes separated toward the opposite poles. Fig. 15 shows the stage in which daughter chromosomes had almost migrated to the poles. The nuclear envelope was considerably broken, but remained at the vicinity of the chromosomes. Interzonal spindle fibers developed between the groups of daughter chromosomes. Pole-to-pole distance was ca. $7\ \mu\text{m}$, which was longer than those in prophase and metaphase nuclei. In later anaphase, the daughter chromosomes appeared to disperse a little and interzonal spindle fibers between the daughter chromosomes were hardly noticeable (Fig. 16). Golgi bodies had already moved toward the poles, and ER developed well along the axis of nuclear division. The nuclear envelope was gradually reformed, and ER was present nearby (Fig. 17).

In early telophase, the nuclear envelope was completely reformed around the group of daughter chromosomes and a pair of centrioles existed in the depression of the nuclear envelope (Figs 18, 19). Microtubules radiated from the electron dense material around centrioles to the cytoplasm. The daughter chromosomes dispersed gradually, and several spindle fibers were detected in daughter nuclei (Fig. 19). Large vacuoles appeared between two daughter nuclei (Fig. 18). Afterwards, the volume of the nucleus increased concomitantly with the dispersion of chromatin and with regeneration of the nucleolus (Fig. 20). Subsequently, the two daughter nuclei approached closely to each other. In early telophase, pole-to-pole distance was ca. $7\ \mu\text{m}$, which was the same as in the anaphase nucleus, but it gradually increased during cytokinesis.

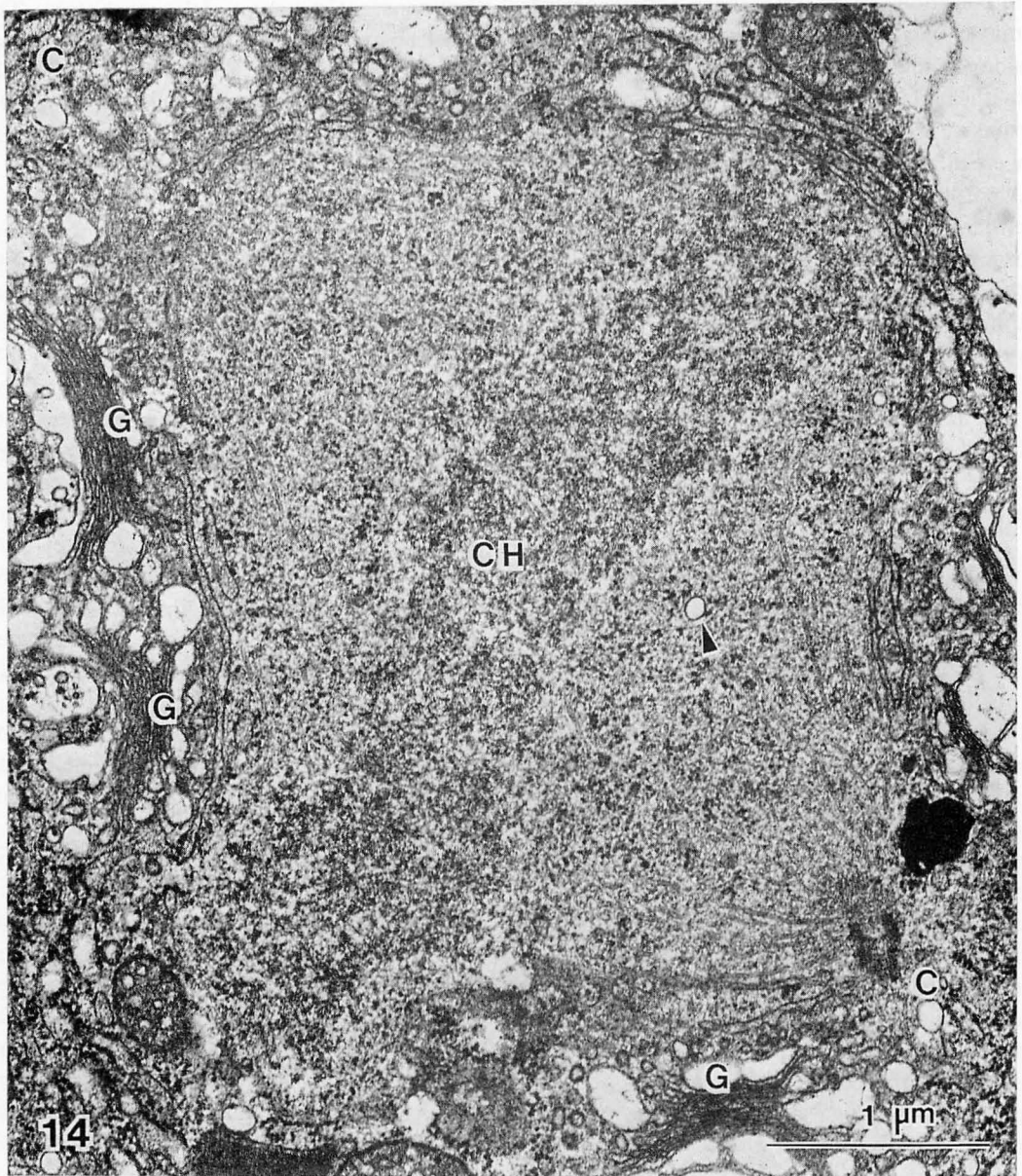


Fig. 14. Metaphase nucleus. Chromosomes arrange at the nuclear equator. The nuclear envelope seems intact except for the polar fenestrae. Many spindle fibers are noticeable from the electron dense material around the centriole to chromosomes, but kinetochores are not detected. Note several small vesicles (arrow) in the nucleoplasm.

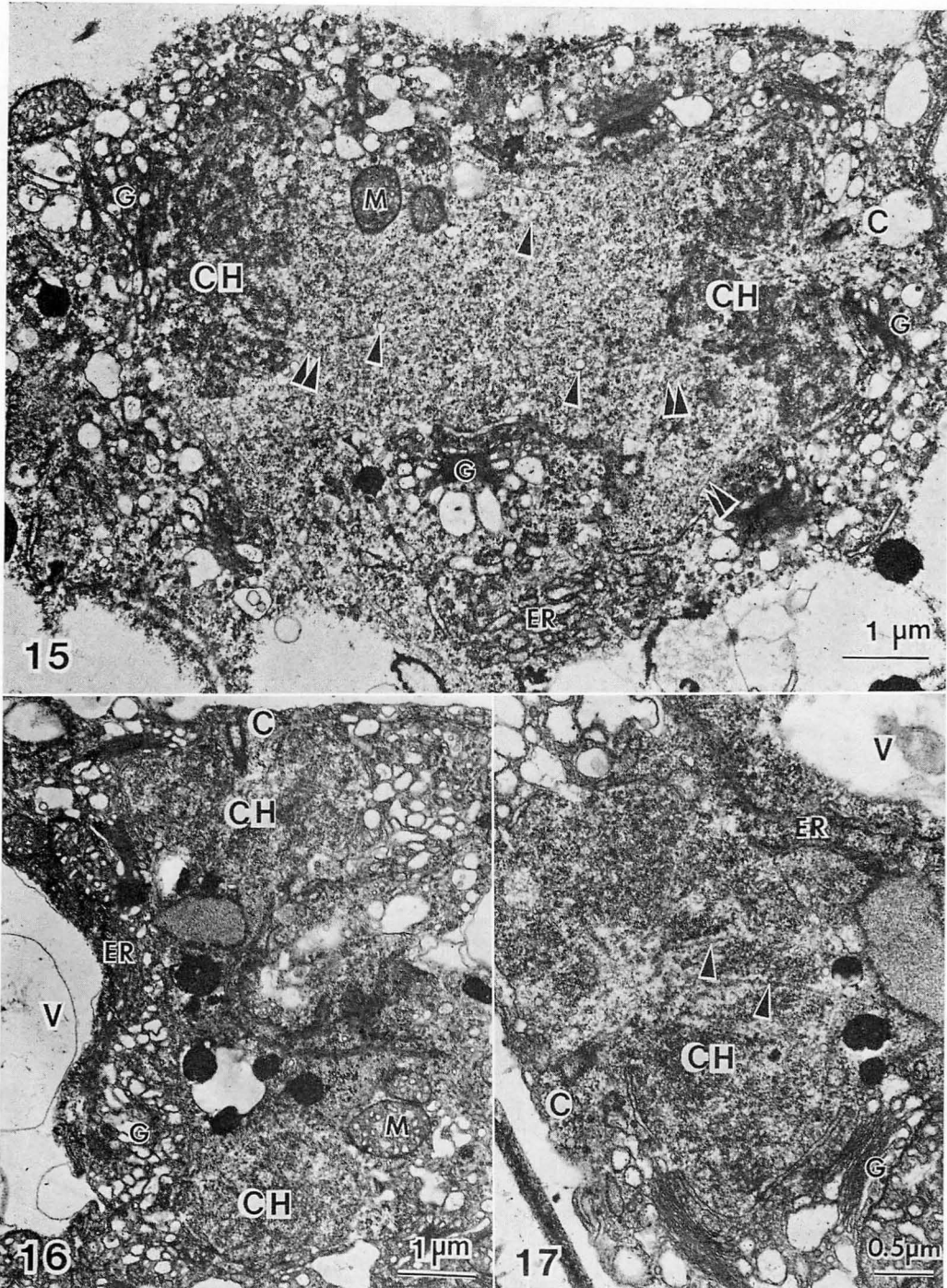


Fig. 15. Late anaphase nucleus. The mass of chromatin migrates almost to both poles. Nuclear envelope breaks down considerably. Note spindle fibers (double arrow) and small vesicles between the separated chromatin.

Fig. 16. More advanced late anaphase. ER developed well, and Golgi bodies migrate to the poles.

Fig. 17. Highly magnified figure of the upper nucleus in Fig. 16. Note spindle fibers in the nucleus (arrow).

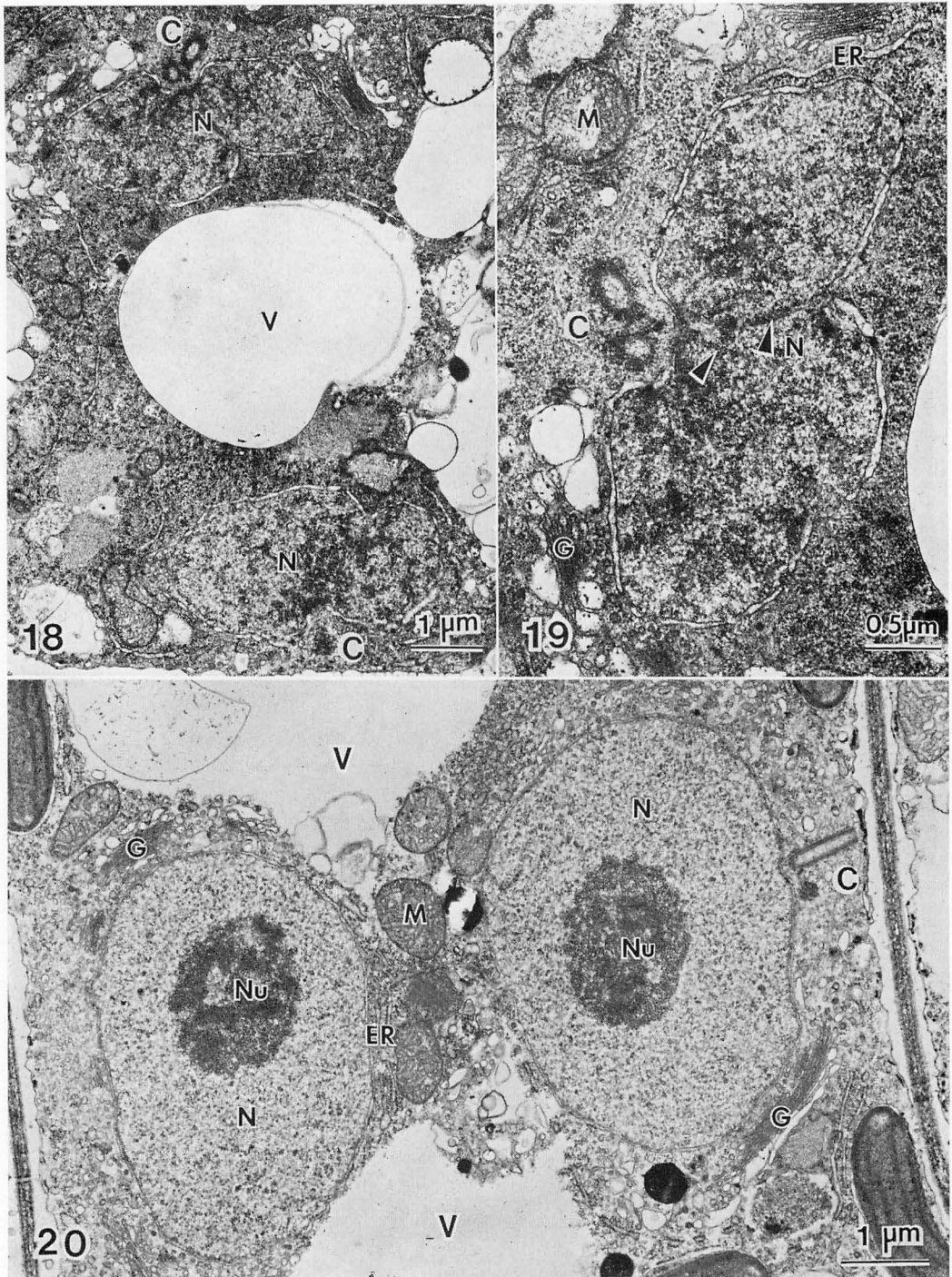


Fig. 18. Early telophase. Nuclear envelope is restored completely and condensed chromatin disperses gradually. Note large vacuole between daughter nuclei.

Fig. 19. Highly magnified figure of the upper nucleus in Fig. 18. A pair of centrioles exists at nuclear depression and several spindle fibers (arrow) are noticeable in the nucleus.

Fig. 20. Late telophase. The nucleolus regenerates in each daughter nucleus and the volume of nuclei increases with the dispersal of chromatin.

Discussion

There has been discussion as to whether a pair of centrioles existed throughout the whole cell cycle or whether they are formed *de novo* during mitosis in brown algae. According to recent studies using the electron microscope, it is evident that one pair of centrioles exists in interphase cells (LA CLAIRE 1982, KATSAROS *et al.* 1983). In *Carpomitra cabrerae*, a pair of centrioles is found easily in the interphase nucleus. The first indication of nuclear division is the duplication of centrioles and their migration to both poles. However, in the present study, the processes of duplication and migration of centrioles were not observed, in spite of observations on many sections. As suggested by LA CLAIRE (1982), these processes may be very rapid.

Polar depression of the prophase nucleus and a layer of electron opaque material along the depression have been observed in other species of Phaeophyta, *Pylaiella littoralis* (MARKEY and WILCE 1975) and *Cutleria cylindrica* (LA CLAIRE 1982). As compared with interphase, the number of microtubules increased in prophase. They radiated from the amorphous electron dense material around the centrioles to the layer of electron opaque material along the depression. The structures taking part in microtubule formation are reported as microtubule-organizing centers (MTOC) (PICKETT-HEAPS 1969, 1975), polar rings (MCDONALD 1972, SCOTT *et al.* 1980), and rhizoplast in *Ochromonas* (SLANKIS and GIBBS 1972, BOUCK and BROWN 1973) and *Tetraselmis* (= *Platymonas*) (STEWART *et al.* 1974). In several species of the Dictyotales (Phaeophyta), NEUSHUL and DAHL (1972) called the dark staining material around the centrioles the MTOC. Similar electron dense material is also observed in *Pylaiella* (MARKEY and WILCE 1975), *Cutleria* (LA CLAIRE 1982), *Sphacelaria* (KATSAROS *et al.* 1983), and *Carpomitra*. In these algae, microtubules radiated from this material, suggesting that it functions as the MTOC.

In the present observation, many ribosomes and several small vesicles are characteristically distributed in the polar depression of the prophase nucleus, although their function is not clear. With deepening of the polar depression, the number of microtubules which radiate from the electron dense material around the centrioles into the depression increases. As mentioned by LA CLAIRE (1982), it is possible that these microtubules affect the formation of the nuclear depression and the creation of the polar gap, and eventually function as the spindle fibers.

In Phaeophyta, two different types of nuclear envelope, especially in metaphase nuclei, have been reported. The first is the intact type of nuclear envelope with the polar gaps, and the other is the disperse type of nuclear envelope. The former type has been observed in *Pylaiella littoralis* plurilocular gametangium (MARKEY and WILCE 1975), *Sphacelaria tribuloides* apical cell (KATSAROS *et al.* 1983), *Zonaria farlowii*, *Dictyopteris zonarioides*, *Padina pavonia*, *Dictyota dichotoma* apical cells (NEUSHUL and DAHL 1972), *Cutleria cylindrica* trichothallic meristem (LA CLAIRE 1982), *Laminaria angustata* male gametophyte (MOTOMURA and SAKAI 1984), *Fucus* antheridium (LEEDALE 1970, BERKALOFF and ROUSSEAU 1979), and *Hormosira banksii* embryo (FORBES and HALLAM 1979). The latter type has been observed in *Cutleria hancockii* male gametangium (LA CLAIRE and WEST 1979) and *Fucus vesiculosus* embryo (BRAWLEY *et al.* 1977). In the present study, *Carpomitra cabrerae* shows the intact type of nuclear envelope in the metaphase nuclei but this disintegrates in anaphase. The behavior of the nuclear envelope in mitosis is one of the important aspects for considering phylogenetic relationships in Chlorophyta. In the case of *Fucus*, *Cutleria* and *Chara* (PICKETT-HEAPS 1967, 1968), however, the behavior of nuclear division may differ in different tissues, generations and developmental stages. ALDRICH (1969) suggested that there were two different types of nuclear division in the life cycle of *Physarum*, a genus of Myxomycetes.

However, as mentioned by LA CLAIRE (1982), in the present situation, any statements on the phylogenetic implications can not be made for Phaeophyta.

KATSAROS *et al.* (1983) are the only workers to report kinetochores in Phaeophyta (*Sphacelaria* apical cells), but other investigators have not confirmed it. In the present experiment, kinetochores could not be detected, but many spindle fibers existed near the chromosomes and some of them passed through the chromosomes.

In the ultrastructural investigations of mitosis of Phaeophyta, the stages of anaphase and early telophase have rarely been observed, because the periods of these stages progresses rapidly. MARKEY and WILCE (1975) reported that microtubules were not seen in the spindle region between the separated daughter chromosomes in *Pylaiella*. In the present study, however, the interzonal spindle fibers situated between the groups of daughter chromosomes could be detected as with the case of *Cutleria* (LA CLAIRE 1982). In early telophase, when the nuclear envelope was completely regenerated, they could not be detected. In these stages, ER developed gradually. As shown in Figs 17, 19, ER existed near the new nuclear envelope, therefore it seems to the present writers that involvement of the ER is implicated in the regeneration of the nuclear envelope.

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本村泰三・阪井與志雄：イチメガサ *Carpomitra cabreræ* (褐藻・ケヤリモ目)
胞子体の核分裂の電顕的研究

イチメガサ胞子体の頂毛細胞の核分裂を電顕的に観察した。中間期の核はほぼ球形で、その周囲に1組の中心子が存在している。前期に中心子は複製し分裂極に移動する。核は極のところでくぼみ、多数の微小管が中心子のまわりの高電子密度物質から核のくぼみに伸びている。核小体は消失し始め、染色糸の凝縮が進む。中期には染色糸が赤道面に並ぶが、動原体は観察されない。核膜は両極部分のみが開放し、中心子のまわりの高電子密度物質より紡錘糸が伸びる。後期に、核膜は徐々に破れる。両極間の距離は中期より増し染色糸は両極へと移動する。二つの娘染色体塊の間には中間紡錘糸が観察される。この時期には分裂軸に沿って核領域の近くによく発達した小胞体が観察される。終期には二つの娘核は核膜で包まれ、核小体の再生・染色糸の分散とともに核の体積が増す。(051 室蘭市母恋南町 1-13 北海道大学理学部付属海藻研究施設)

p. 225~232 の論文の和文要約.

L. ディック・R.E. ドゥブリード・D. ガーバリ：ブリティシロコンビアとカリフォルニアにおける紅藻
Iridaea cordata (スギノリ科) の配偶体と四分胞子体の出現と生活史

Iridaea cordata の配偶体と四分胞子体の出現状況を地理的分布を異にする個体群と波浪条件等を異にする個体群について調査した。両世代の藻体の識別は、藻体を含むカラゲenanのタイプを知るために Craigie と Leigh (1978) が開発した resorcinol test を著者等が改変した方法によった。カナダ・ヴァンクーヴァー島とヴァンクーヴァー港の個体群では約60%が配偶体であったが、波の荒い地点から静かな地点にかけて配偶体数比が減少する傾向を示した。アメリカ・オレゴン州からカリフォルニア州中部にかけての太平洋沿岸12点の個体群では、北部では配偶体が約11%で少かったが、南部では78~90%と増加した。しかし、この出現比は地域により、また年により例外も多く見られた。両世代の出現比の違いがどのようにして生ずるかを知るには、多くの地点において出現状況を永年に亘って調査することが必要である。

Morphological observations on *Mesoporos perforatus* (Dinophyceae)*

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TORIUMI, S. and T. NEMOTO, 1985. Morphological observations of *Mesoporos perforatus* (Dinophyceae). *Jap. J. Phycol.* 33: 210-214.

Mesoporos perforatus (GRAN) LILLICK collected from Saroma Lake in Hokkaido was examined with light and scanning electron microscope (SEM). The surface of the valves is covered with minute spines similar to those of *Prorocentrum minimum* and *P. balticum*. The margin of each valve is ornamented with one row of trichocyst pores. A few trichocyst pores are located in the middle parts of the valves. The central pore of the valves is funnel-shaped. The tip of its pore extending toward the inner part of the valve is closed.

The taxonomical relationship of the present species with other species of the genus *Mesoporos* is discussed. This is the first report for the occurrence of the genus *Mesoporos* in Japan.

Key Index Words: Dinophyceae; *Mesoporos perforatus*; Morphology; SEM; Taxonomy.

Mesoporos perforatus was originally described by GRAN (1915) from the North Sea. At that time, this species was considered to be one species of the genus *Exuviaella* of the family Prorocentraceae and was designated as *E. perforata*.

In 1918, SCHILLER described a new species of *Exuviaella bisimpresa* from the Adrea Sea. LEBOUR (1922) also reported *E. perforata* from the English Channel. She observed the flagellar pores on the species which had not been noticed until then.

In 1928, SCHILLER established a new genus *Porella* for the species which have a central pore in the central part of each valve among the species of *Exuviaella*. Then he added two new species of *Porella*, *P. adri-*

tica and *P. globulus*.

SCHILLER (1933) reported a new species under the name of *Porella asymmetrica*. This new species had been reported to be *P. perforata* in 1928 by himself. The species separated from *P. perforata* for no other reason than that there are the differences in size and form between *P. perforata* and the new species. The generic name *Porella*, however, had already been used for lichens in the plant kingdom. Therefore, LILLICK (1937) made a new genus *Mesoporos* instead of the genus *Porella* according to the International Code of Botanical Nomenclature and four species which had been known as *Porella* were transferred to the new genus.

In 1945, BRAARUD cultivated *P. perforatus* in Allen medium and observed the variation of the form. SILVA (1953, 1960) reported *M. adriaticus* and *M. globulus* from the coastal waters of Portugal. WOOD (1958) reported *M. perforatus* from Australian waters.

* This report was presented at the 6th annual meeting of the Japanese Society of Phycology in Tokyo in 1982 and was supported in part by a Cooperative Program (no. 80180) of the Ocean Research Institute, University of Tokyo.

In 1966, SUBRAHMANYAN established a new species *M. parthasarathicus* from the Indian Ocean. Lately, RAMPI and BERNHARD (1980) reported five species, *M. adriaticus*, *M. asymmetricus*, *M. bisimpessus*, *M. globulus* and *M. perforatus* from the Mediterranean Sea.

Thus, six species of the genus *Mesoporos* are found in six areas, the Atlantic Ocean, Mediterranean Sea, Indian Ocean, Australian region, North Sea and Norwegian Sea. However, the species of the genus *Mesoporos* have not been reported from Japanese coastal waters.

Materials and Methods

The materials were collected by a plankton net from Saroma Lake, Hokkaido in 1977. The materials were fixed with 2% formalin and dehydrated in an ethyl alcohol series of 30-100%. For light microscope examinations, the specimens were mounted with Pleurax. For the observations under the SEM, the materials were dried at critical point in an aluminum box using liquid carbon dioxide. The dried materials were coated with gold. SEM micrographs were taken with a JSM-35.

Results and Discussion

Cells are composed of two valves, covered with small spines. Valves are almost circular in external form. Flagellar pores lie at the front of the valve, from which two flagellar arise. A central pore of each valve is funnel-shaped in cross section. An entrance of the pore gradually opens toward the surface of the valve. The form of the entrance is almost circular in the valve view. The opposite side of the entrance become more and more slender toward the inside of the valve and its terminal end is closed. About 15 trichocyst pores are found near the margin of the valve and several other pores are scattered in the middle part of the valve. Two or more yellow-brown chromatophores are present in the valves. Length and breadth are about 20 μm .

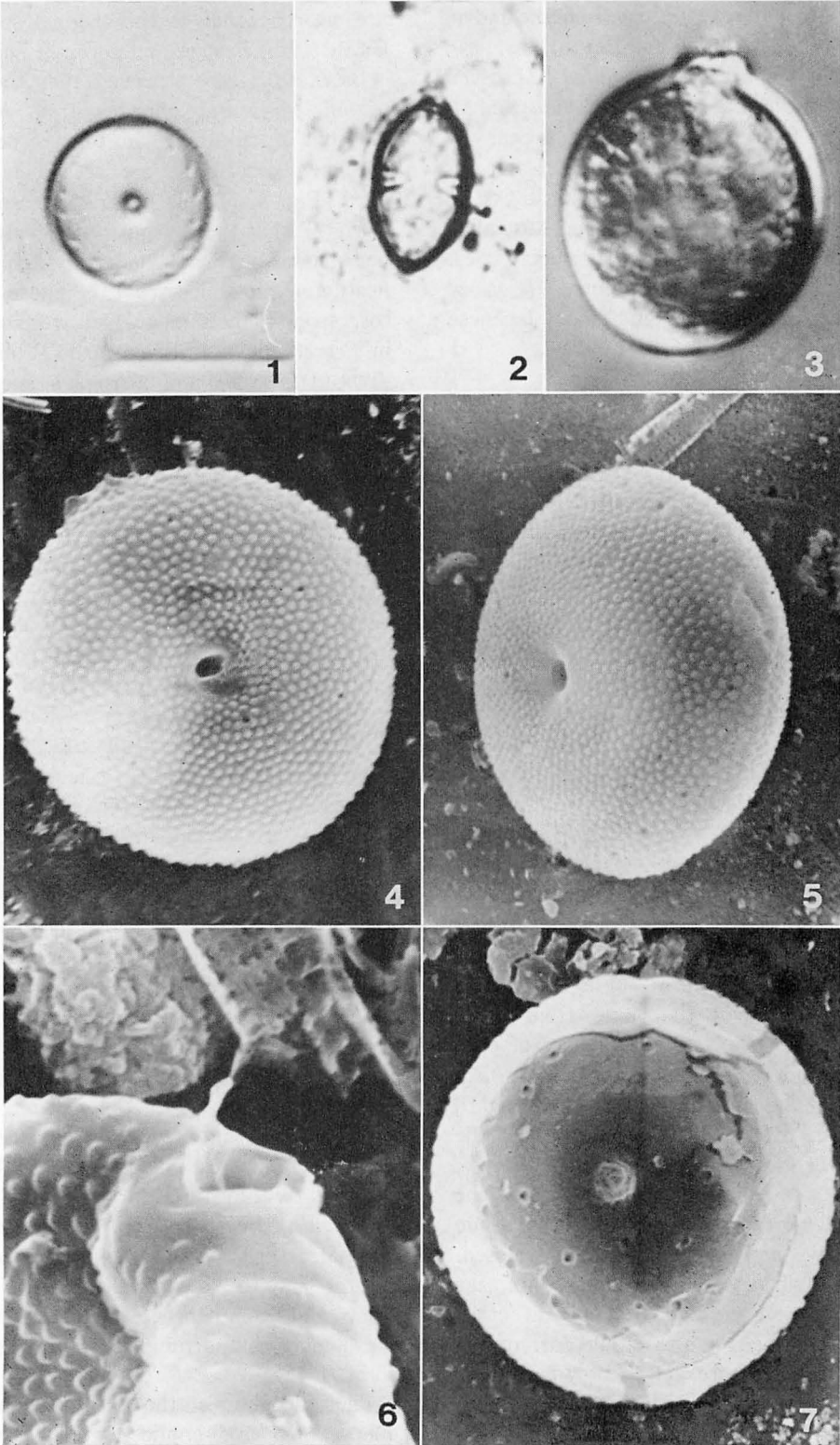
Specimens collected from Saroma Lake are nearly equal to the original species of GRAN (1915) in size and form. (Figs 1-3).

BRAARUD (1945) observed that the shape of *M. perforatus* changes from ovoid to ellipsoid in cultures. In this respect, the specimen described here resembles that of pl. 1, Fig. a, in his paper. Moreover, he observed that the margin of the valves was not smooth but wavy under a high magnification light microscope. These waves correspond to the spines which were observed in *Prorocentrum balticum* and *P. minimum* (TORIUMI, 1980) and Saroma's specimens. (Figs 4, 5). The number and arrangement of trichocyst pores of specimens from Saroma Lake slightly differ from the description of BRAARUD (1945). The number of trichocyst pores is ca. 20 on his specimens and they ring the margin of the valve. On the other hand, our specimens are distributed ca. 15 of trichocyst pores along the margin of the valve and a few pores scattered the central part of the valve (Fig. 7).

The present specimens are similar to *M. perforatus* reported by LEBOUR (1922, 1925) from the English Channel. She mentioned an interesting feature in the region of the flagellar pores. According to her, as though the two valves bite each other like two gears, they conjugate at the anterior end of the valves. But the region of the flagellar pores in our specimen looks as if it lacks such depression (Fig. 6).

Saroma specimens are more similar to *M. globulus* than the original species of GRAN in external form but differ from it in size. According to BRAARUD, the size of *M. perforatus* varies from 14 μm to 20 μm in cultures. This fact indicates that the size of *M. globulus* is within the limits of that of *M. perforatus*. However, considering from the original description of *M. globulus*, *M. perforatus* may be separated from it in size, form and some other features such as the number and arrangement of trichocyst pores.

Thus, deciding on the specific name of the genus *Mesoporos* implies several problems.



For solving these problems, it is considered that more detailed observations on many specimens collected from various localities are necessary.

Recently, DODGE (1981) concluded that the four species of *M. asymmetricus*, *M. adriaticus*, *M. bisimpresus* and *M. globulus* are all synonyms of *M. perforatus*. We agree with his opinion for the present. Therefore, the specimens collected from Saroma Lake are assigned to *M. perforatus*.

This is the first report of *Mesoporos* species from Japanese coastal waters.

Acknowledgements

We thank Dr. R. MARUMO, emeritus professor of the University of Tokyo, for his interest in this study and we also acknowledge with thanks Dr. T. ISHIMARU, Dr. S. NISHIDA and Dr. K. FURUYA of the Ocean Research Institute, University of Tokyo, for their kind advice during this study.

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Fig. 1. Ventral view of *M. perforatus*, showing the central pore and the trichocyst pores of the margin of the valve (LM). $\times 1000$

Fig. 2. Side view of *M. perforatus*, showing a funnel-shaped central pore (LM). $\times 1200$

Fig. 3. Ventral view of *M. perforatus*, showing the depression of the flagellar pore region of the valve (LM). $\times 1800$

Fig. 4. Ventral view of *M. perforatus*, showing the small spines of the valve (SEM). $\times 3500$

Fig. 5. Oblique side view of *M. perforatus*, showing the suture of the valve (SEM). $\times 3500$

Fig. 6. Flagellar pores of *M. perforatus*. $\times 9000$

Fig. 7. Reverse side of *M. perforatus*, showing the distribution of trichocyst pores. The tip of the central pore is closed (SEM). $\times 4000$

鳥海三郎*・根本敬久**： *Mesoporos perforatus* の形態観察

北海道のサロマ湖より得られた *Mesoporos perforatus* を SEM で観察した。細胞は2枚の殻板で構成され、外形はほぼ円形で、細胞の前端に鞭毛孔が存在する。細胞の表面は小刺でおおわれ、それぞれの殻板の中央に中心孔を有する。本種の中心孔は細胞の内部に向かって細くなるロウト状であるが、その先端は閉じられている。細胞の周縁に沿って刺胞孔があるほかに、細胞の中央付近にも、それは散在する。

この属に含まれる種は現在までに、北海や地中海などの6海域より6種が知られているが、これらの種を確定するには、それぞれの海域より採集される種について、鞭毛孔の構造などの詳細な観察が必要と考えられる。

この報告は、日本沿岸域より得られた *Mesoporos* 属についての最初の報告である。

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新 刊 紹 介

SPECTOR, D.L. (ed.) **Dinoflagellates** 545 pp. Academic Press, Orland, U. S. A. 1984. 邦貨約25,500円

渦鞭毛藻類について、最近の研究成果を第一線で活躍する16名の研究者が概説したもので、その内容は広く生物学全般にわたっており(生態学的な記述は少ないが)、いわば“渦鞭毛藻の生物学”といった内容の成書である。

各章はそれぞれの研究分野の歴史的背景を紹介した後に、最新の研究成果を概説するレビュー形式となっている。章の題目と内容は次のようである(カッコ内は執筆者名)。1) 渦鞭毛藻：その概要(D.L. SPECTOR)。2) 渦鞭毛藻の分類(J.D. DODGE)。題は分類であるが、分類群毎の詳しい各論はなく、分類基準に用いられる幾つかの形質の記述が行なわれ、続いて章の終りに、代表的な属の分類表と科、目の特徴が簡単に記される。3) 細胞外被(H. NETZEL & G. DÜRR) 渦鞭毛藻は他の藻群に比べ複雑な細胞外被を有し、その構造は重要な分類形質の一つとなっている。この章では細胞外被の構造変異、発生様式などが解説される。4) 渦鞭毛藻核(D.L. SPECTOR)。渦鞭毛藻核と呼ばれる特殊な核について、その特徴、染色体の微細構造、DNA や RNA に関する生化学的解析結果が総説される。5) 細胞周期と有糸分裂(R.E. TRIEMER & L. FRITZ)。細胞周期と DNA 複製のタイミング、核分裂の際の染色体、微小管等の挙動の微細構造などが述べられる。9) 有性生殖(L.A. PFIESTER)。比較的良く調べられている種類の有性生殖過程の要約と解説。なお渦鞭毛藻では、現生種約2000のうちで有性生殖が知られているのはわずかに23種に過ぎない。7) 海産有毒渦鞭毛藻(K.A. STEIDINGER & D.G. BADEN)。有毒な渦鞭毛藻の分類・生活様式・産生する毒成分やアッセイ法・毒の作用機作などの解説。8) 渦鞭毛藻の遺伝学(C.A. BEAM & M. HIMES)。遺伝的解析の最も進んでいる種類 *Cryptecodinium cohnii* の研究結果を中心に表現型の分離の様式・同胞種(交配群)の存在が詳述され、ついで GC 含量・種間のアイソザイム比較など分子レベルでのアプローチも簡単に紹介される。9) 渦鞭毛藻の生理・生化学(A.R. LOEBLICH III)。最近の研究を中心に生理学的研究と生化学的研究とに分けてその概要が紹介される。10) 渦鞭毛藻の概日リズム(B.M. SWEENEY)。概日リズム(サーカディアンリズム)は生物界に広く見られる現象であるが、渦鞭毛藻では、光合成活性や生体発光にも概日リズムが見られるという。11) 特殊な細胞含有物(D.L. SPECTOR)。主として電子顕微鏡で観察できる種々の特徴的な細胞小器官、貯蔵物質やウィルス様物質などについての総説。12) 渦鞭毛藻の培養(R.R.L. GUILLARD & M.D. KELLER)。培養技術の発達史、渦鞭毛藻の栄養摂取様式の解説、培養の具体的な方法の論述。13) 渦鞭毛藻のシスト(A.R. LOEBLICH III & L.A. LOEBLICH)。研究の歴史とシストの一般的性質の解説。14) 渦鞭毛藻の進化(A.R. LOEBLICH III)。主に細胞学的な証拠に基づき、渦鞭毛藻のグループ内での進化、特化した生物群である渦鞭毛藻の進化的位置に関する推論の提唱が行われている。ここでは *Oxyrrhis* という属が最も原始的な性質をもつ渦鞭毛藻であるとして、それをもとに進化のシェーマが展開される。

各章の執筆者が異なる為にも重複する部分も少なくないが、気になる程ではない。スペースの関係と本書が研究成果の総説であることから実際のデータや図表が充分でなく、理解しにくい点もあるが、これらは引用文献を参照することで解決されよう。各章の引用文献は充実しており、最新の研究までよくカバーしている。渦鞭毛藻に関する生物学全般にわたる研究成果を総説した本書は、この生物群の研究の現状を知る上で有用であり、時宜を得た出版物というべきである。

(筑波大学生物科学系 堀口健雄)

Fine structure of the brackish water pennate diatom *Entomoneis alata* (EHR.) EHR. var. *japonica* (CL.) comb. nov.

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OSADA, K. and KOBAYASI, H. 1985. Fine structure of the brackish water pennate diatom *Entomoneis alata* (EHR.) EHR. var. *japonica* CL. comb. nov. Jap. J. Phycol. 33: 215-224.

Observations of the fine structure of a brackish water diatom *Entomoneis alata* var. *japonica* collected from a few localities were mainly carried out using scanning and transmission electron microscopy. In addition to this, some individuals were isolated from samples collected from the estuary of Tama-gawa (Tama River) for clonal cultures, and structural variations in the clonal cultures were examined in order to distinguish stable features of this diatom. The following morphological features are apparently stable and characteristic of this taxon: 1) bisinuous junction-line, 2) wing with many fibulae on each wing-costa, 3) cingulum composed of five open bands, a valvocopula, three copulae and a pleura, 4) poroid areola closed at the external surface by a hymenate pore occlusion with regularly scattered perforations.

Key Index Words: *Brackish diatom*; *clonal culture*; *Entomoneis*; *Entomoneis alata* var. *japonica*; *fine structure*.

The genus *Entomoneis* was first described by EHRENBERG in 1845 based on a different interpretation from that of his *Amphiprora*, and typified by his *Navicula alata*. Nevertheless, a group of diatoms having a quite characteristic and conspicuous features similar to that of the type species has been called *Amphiprora*, although the type species of *Amphiprora* has already been transferred to other genus. On the other hand, REIMER (in PATRICK and REIMER 1975) have stated about so doubtful availability of the generic name, *Amphiprora*, and proposed that *Entomoneis*, should be used instead.

In some species of the genus *Entomoneis*, valves characterized mainly by the well developed sigmoid wing have been shown in electron microscopical studies of HELMCKE and KRIEGER (1962), OKUNO (1970), GERLOFF and HELMCKE (1977) and PLANCKE and BAIL-

LEUX (1976). Recently, the wing structure of the genus and allied genera has considerably elucidated by the comprehensive works of PADDOCK and SIMS (1977, 1981).

Entomoneis alata var. *japonica* was originally described from Japan as *Amphiprora alata* var. *japonica* by CLEVE (1894). Since then, only a few records on this diatom have appeared in the literature, even in Japan. However, we have samples containing a considerable number of individuals belonging to this taxon from several brackish waters. In order to clarify stable characteristics of this diatom, some individuals were isolated from fresh samples for clonal cultures.

The morphological terminology mainly employed in this investigation is that proposed by ROSS *et al.* (1979) and PADDOCK and SIMS (1981).

Materials and Methods

Materials were collected from the mud surface of the tideland of Obuchi-numa (Obuchi Bog), Aomori Prefecture on May 2, 1980 and the estuary of Tama-gawa (Tama River), Kanagawa Prefecture on June 16, 1980. According to Pringsheim's pipette-washing method, clonal cultures were introduced from the samples collected from the estuary of Tama-gawa.

The cultures were carried out in a series of test tubes containing the agar-water biphasic culture medium (OOSHIMA 1975). The medium used as a liquid medium for the liquid phase was made by adding Chu no. 10 (CHU 1942) to f-medium (GUILLARD and RYTHER 1962) to obtain a final salinity of 15–25‰. The same medium with 0.6% agar was used as an agar medium for the solid phase. All the cultures were maintained at 18°C under fluorescent lights of ca. 3000 lux intensity with a 12/12 hr light-dark cycle. Consequently, the cultures, K. E-116, K. E-213 and K. E-343, were established.

Both materials, field and culture, were cleaned by the Patrick's method (PATRICK and REIMER 1966) but some of the materials were treated with potassium persulphate which is a mild oxidizing agent proposed by MA and JEFFREY (1978) for the observation of fragile girdle structures.

For light microscopy Pleurax was used as a mountant. For SEM observation the cleaned material was dried on glass coverslips (5×6 mm²) and coated with platinum-palladium. Likewise, some of the specimens broken by a small knife were prepared for SEM observation. SEM observations were made with a Hitachi S-500 and a JSM F-15. For TEM, the specimens were dried up on grids coated with formvar and observed with a Hitachi H-500.

In order to obtain thin sections, cultured specimens were fixed for 1 hr in 2% glutaraldehyde in 0.1 M phosphate buffer (pH 7.2) and washed with the same buffer and then postfixed in 1% osmium tetroxide for

1 hr. They were washed with distilled water and embedded in 1% purified agar. Small blocks of the agar were then dehydrated slowly in ethanol and embedded in Spurr's resin. Thin sections were cut on a diamond knife. Sections were stained with uranyl acetate and lead citrate.

Results and Discussion

Frustules of this variety are strongly bilobate in girdle view because of their well developed bilobed wing (Figs 1, 6). The wing is strongly sigmoid in valve view (Fig 8) and deeply sunk at the central nodule (Figs 2, 3, 5, 7). In valve view, the valve is linear-lanceolate with acuminate ends. Valves in the field materials (Figs 1–3) are 75–150 μm long and 20–40 μm wide and the striae density on the valve face is 11–12 in 10 μm. The junction line observed in girdle view is clearly bisinuous on each side of the central nodule. In addition to these features, the other features agree quite well with Cleve's description (CLEVE 1894).

In the clonal cultures, valves in the 5-week-old cultures (K. E-343) showed the size and features similar to those of the field materials (Figs 7, 8), however, most of the valves obtained from a continued 28 weeks culture (K. E-213) showed a considerable decrease in size, being 55–80 μm in length and 18–30 μm in width (Figs 5, 6). Such smaller valves are occasionally observed in the field materials (Fig. 3). Therefore, the valve dimensions of this variety seem to vary within a wide range of 55–150 μm in length and 18–40 μm in width. In contrast, the striae density and the wing shape did not vary so markedly with the decrease of the valve size. The junction line described as one of the important characteristics of this variety by CLEVE (1894) retained bisinuous shape in all valves obtained from cultures (Figs 5–8) and field (Fig 3). Although, the distal sinuosity of the bisinuous junction line showed marked variation in shape, the proximal one kept its constant shape (Figs 3, 5, 6).

In SEM observations, it is evident that the valve has indeed a prominent bilobed wing (Figs 9, 10). Most of costae continue from the valve body to the top of the wing across the junction line (Figs 9-13). Some of these costae bifurcate more frequently in the wing than in the valve body (Figs 9, 10, 12, 13). Intercoxae viewed as striae under the light microscope are composed of two rows of pores (Figs 11-14) in the same manner with that of *Amphiprora alata* (GERLOFF and HELMCKE 1977). Each pore is a poroid areola closed by a domed occlusion at the external surface (Figs 13, 14). As seen in the TEM micrographs of the pore occlusion and its cross section, pore occlusions are of uniform thickness (Fig. 28) and are perforated by more or less elongate holes with a dimension of 6-10 nm (Fig. 27). This form of pore occlusion agreed well with that of hymenate pore occlusion proposed by MANN (1981). The type of arrangement of the perforations is the regular scatter in contrast to the centric array of the *Entomoneis alata* (MANN Fig. 19, 1981).

In each wing of the valves, linear series of dots as distinctly illustrated in Cleve's figure (CLEVE 1894) are clearly seen in the light microscope (Figs 1-3, 5, 6). REIMER (in PATRICK and REIMER 1975) have described the dots as one of the important characteristics distinguishing *E. alata* from *E. paludosa*. However, our SEM observations of the external surface of the wing could not reveal any structure except two rows of areolae constituting each stria (Figs 12-14). However, in the observation of broken valves, there are many fibulae inside the wing (Fig. 12). The wing is traversed by the fibulae arranged along on each wing-costa, so that a fibula of the wing may be observed to be a dot in the light microscope. The fibulae row on a wing costa seem to be homologous to the perforated fibulate plate of *Amphiprora* sp. (PADDOCK and SIMS 1977).

PADDOCK and SIMS (1981) have suggested that there may be no obvious morphological distinction between the fibulae immediately

adjacent to the raphe canal and the rest of the fibulae within the wing, but termed the former "primary or raphe fibulae" and the latter "secondary or keel fibulae". Moreover, they have applied the term "basal fibulae" to the fibulae arranged longitudinally along the base of the wing. In *E. alata*, so far as it appeared on the SEM micrographs of GERLOFF and HELMCKE (in HELMCKE and KRIEGER 1977), the basal fibulae are lacking from some costae. In contrast, basal fibulae in this taxon occur regularly on all costae and are situated on the border between wing and valve body (Figs 11, 12). Consequently, it is proved that the junction line obvious in the light microscopical observations is a row of basal fibulae. The perforated fibulate plate could be observed particularly near the junction line (Fig. 13).

Although the presence of a canal raphe in some *Amphiprora* species has already been pointed out by PADDOCK and SIMS (1977), this diatom also possesses the canal raphe along the apex of the keel. The raphe canal is a cavity separated by a row of raphe fibulae (Fig. 14). The raphe fissure is a plicate type as clearly seen in a trans-apical section across the raphe (Fig. 14). At each valve apex the raphe fissure terminates internally in well developed helictoglossa (Figs 9, 11). Terminal fissures curve in opposite directions at both ends of a valve (Figs 25, 26).

In the girdle view, a number of linear series of short dashes arranged parallel to the apical axis have been illustrated for *E. alata* (REIMER, in PATRICK and REIMER 1975). However, any comments on the girdle of this taxon have not been found even in the original description (CLEVE 1894). In the present study, short dashes similar to those of *E. alata* are observed in the girdle region in the light microscope, and are 20-22 in 10 μm (Fig. 4). According to the SEM and TEM observations, it is proved that each of these dashes is a poroid areola with an elongate or round inner aperture (Figs 16, 17, 22). Each areola is occluded by the hymen (MANN 1981) with randomly arranged

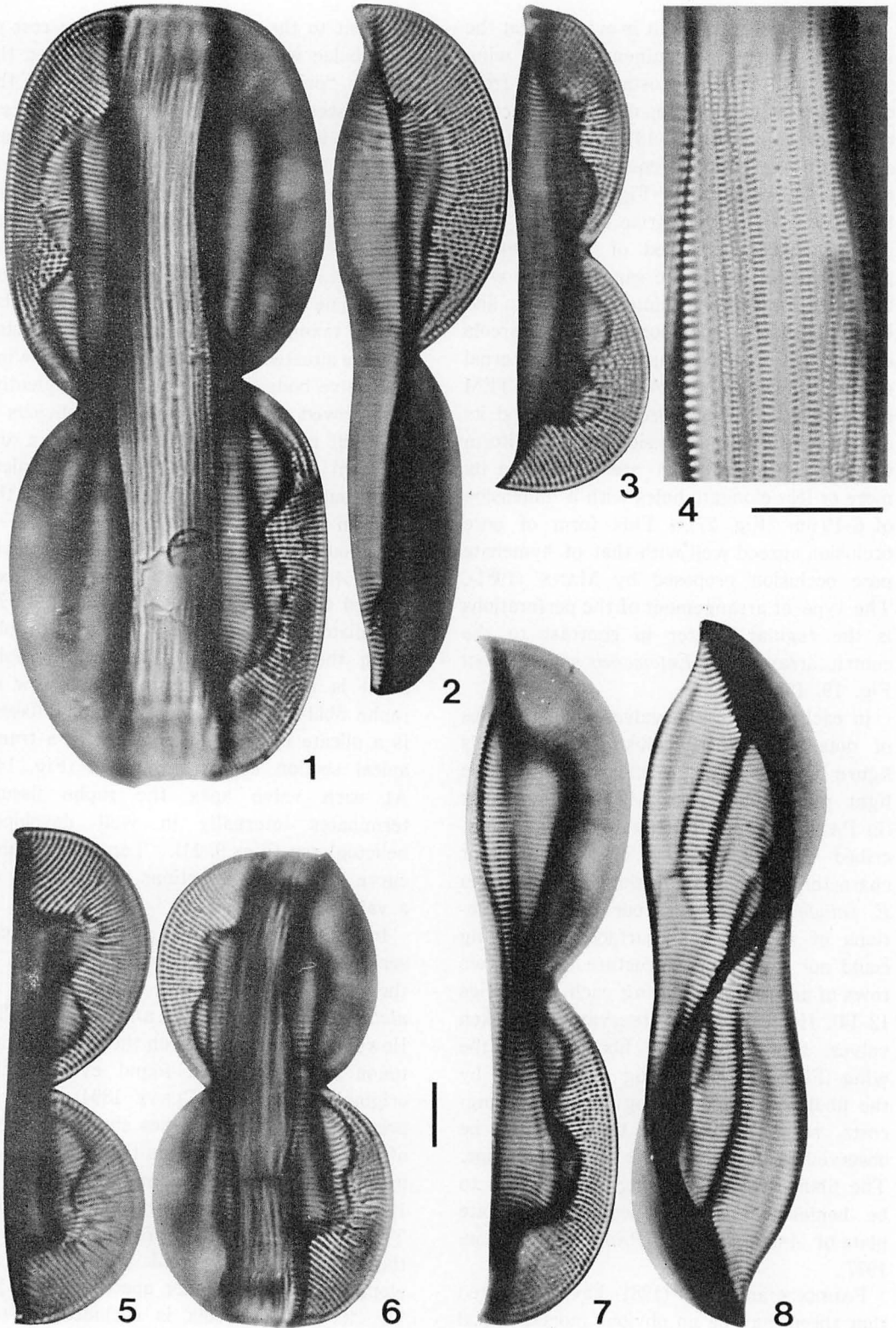


Plate 1.

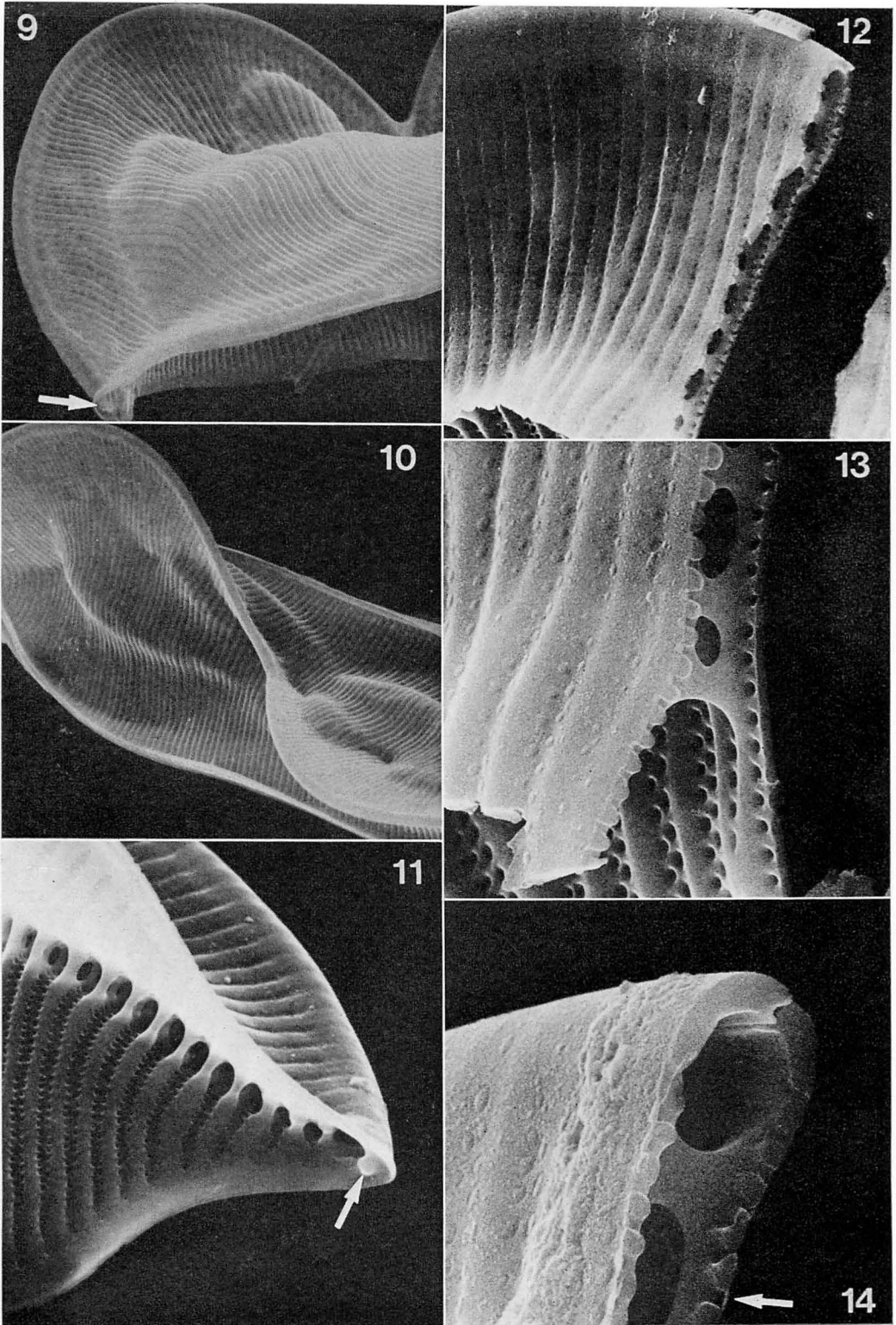


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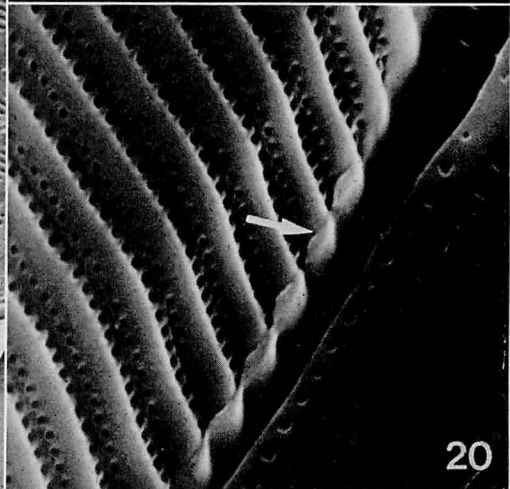
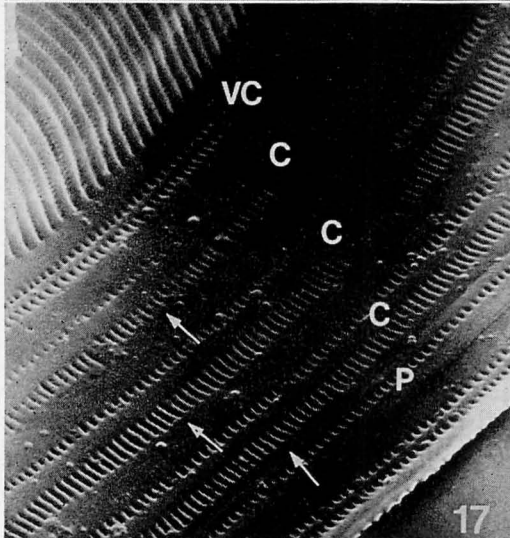
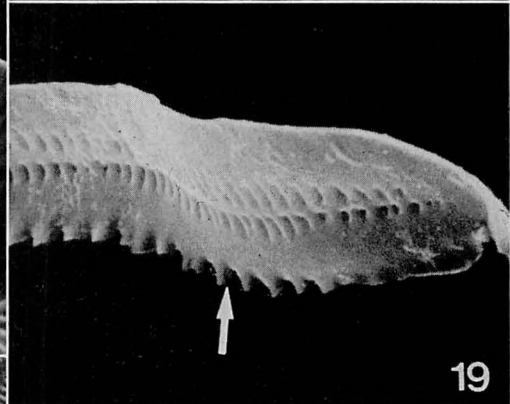
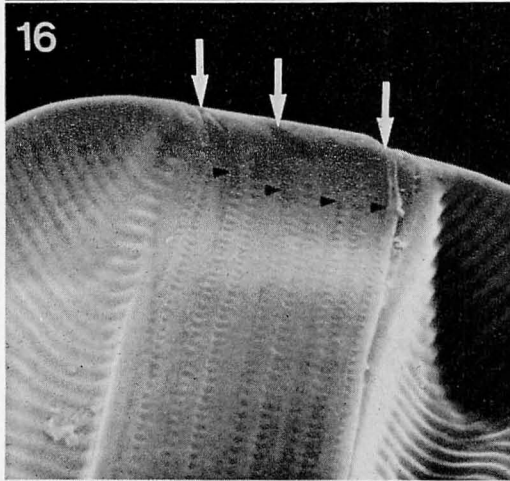
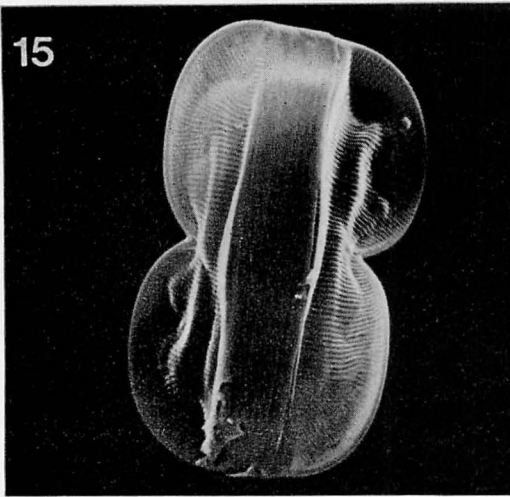


Plate 3.

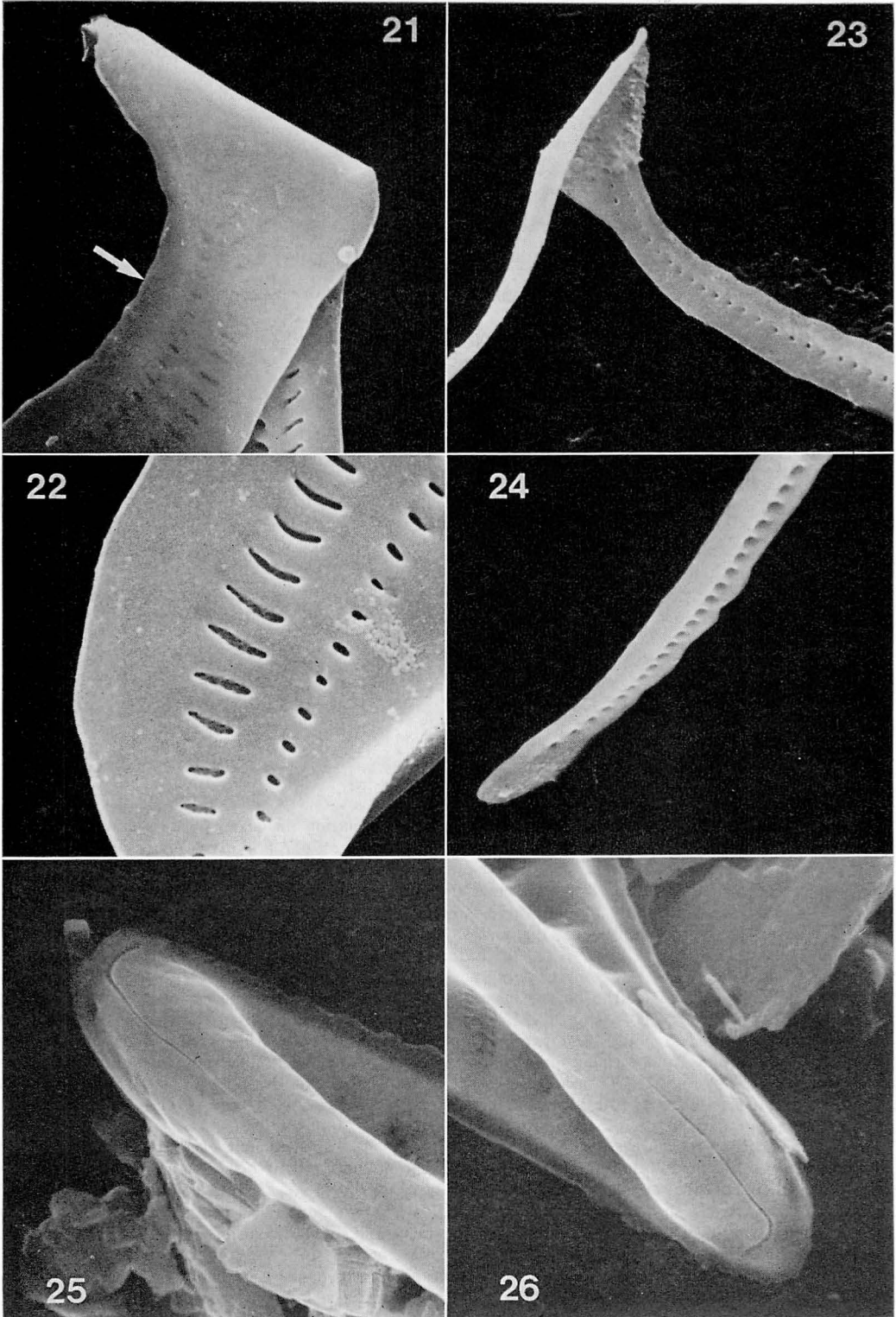


Plate 4.

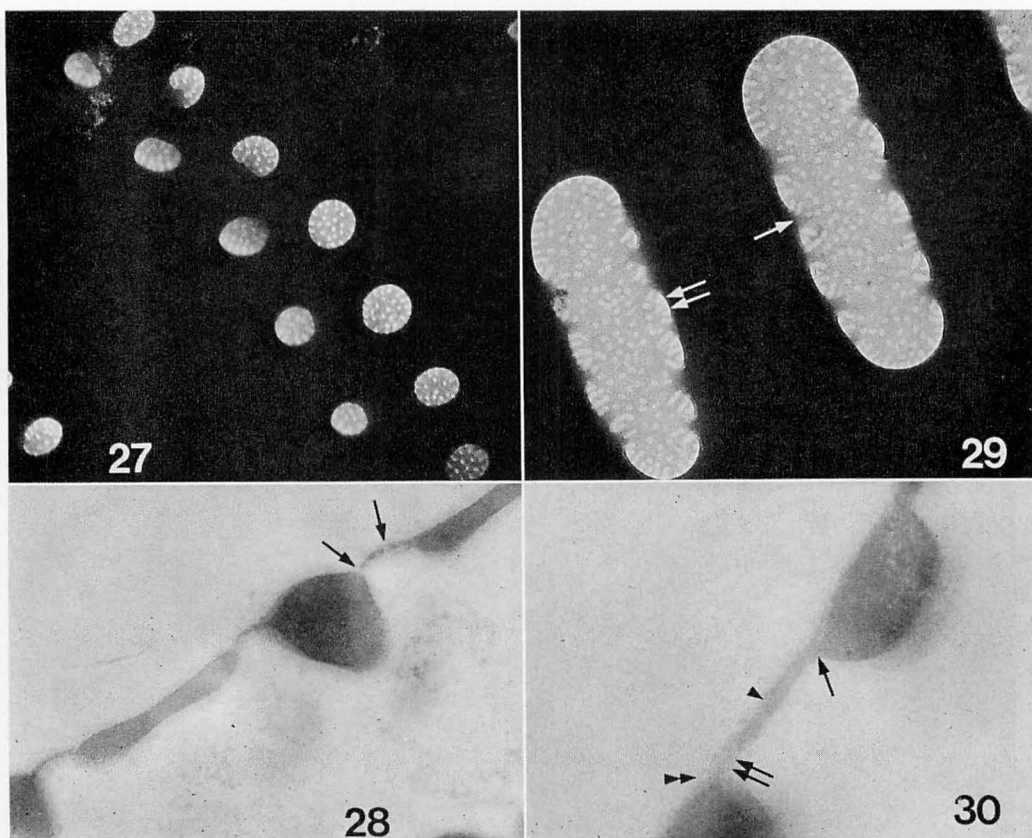


Plate 5.

Plate 1. Figs. 1-8. Light micrographs showing the variation in size. Scale bars=10 μ m; 1-3. Specimens in nature; 5,6. Specimens in 28-week-old cultures; 4,7,8. Valves and middle portion in girdle view in 5-week-old cultures, 7. Girdle view showing bilobed wing and bisinuous junction line on each side of the central nodule, 8. Valve view showing sigmoid wing.

Plate 2. Fig. 9. Oblique view of half valve showing the prominent wing with a keel at its top, bisinuosity occurred on the border between wing and valve body and a helictoglossa (arrow) on the internal surface of the valve apex. $\times 2300$. Fig. 10. External view of valve showing a sigmoid wing and costae continuous from the valve edge to the wing top. $\times 1500$. Fig. 11. Internal view of valve showing a row of basal fibulae placed on the border between the valve body and the wing and well developed helictoglossa (arrow). $\times 6000$. Fig. 12. Broken valve showing many fibulae on each costa and a few bifurcated costae. $\times 6800$. Fig. 13. Lower part of the valve shown in Fig. 12. showing the structure of perforated fibulate plate and striae composed of two rows of poroid areolae with external domed pore occlusions. $\times 17000$. Fig. 14. Transapical section of wing showing the plicate raphe fissure at the top, the raphe canal separated by the raphe fibula, and poroid areolae with pore occlusions (arrow) on the external surface. $\times 25000$.

Plate 3. Fig. 15. Frustule in girdle view. $\times 900$. Fig. 16. Enlargement of Fig. 15 showing epicingulum composed of five bands distinguishable by imbrication lines (arrow heads), and open apices (arrows) and closed apices of the bands arranged alternately. $\times 2800$. Fig. 17. Internal view of hypocingulum composed of five bands showing a valvocopula (VC) with two rows of areolae nearly equal in size, three copulae (C) with two rows composed of short and elongate areolae and a pleura (P) with a single row of areolae. Note the smooth edges of pars interior of the copulae and pleura (arrows). $\times 3000$. Fig. 18. Whole copula showing a tweezers-like open band. $\times 780$. Fig. 19. Internal view of valvocopula showing two rows of areolae and undulate pars interior (arrow). $\times 10000$. Fig. 20. Internal oblique view of valve margin showing the undulation (arrow) of the valvocopula edge overlapping valve costae and striae composed of two rows of areolae. $\times 12000$.

round holes in its thin area and radially arranged linear holes around the margin and lying near the external surface (Figs 29, 30).

The girdle region usually occupies about 1/3-1/2 of the breadth of the frustule in girdle view, and the epicingulum overlaps most of the hypocingulum (Figs 15-17). Each cingulum is composed of five bands, and each band is open at one apex (Figs 16-18). These open bands are classified into three types, a valvocopula, three copulae and a pleura, based on the structure of pars interior and the arrangement of areolae. The valvocopula has two rows of round or more or less elongate areolae nearly equal in size (Figs 17, 19) and its pars interior is undulate except a short region near the closed apex (Fig. 19). Each undulation is observed to fit closely over the inner surface of the valve costa (Fig. 20). Such a juncture between the valvocopula and the valve seems to be similar to that of *Rhabdonema arcuatum* reported in detail by POCOCK and COX (1982), except the difference in the degree of development of the pars interior. Each copula also has two rows of areolae, but each row could be distinguished by the size of areola. The abvalvar row is composed of more elongate areolae and the advalvar one is composed of short areolae (Figs 17, 21, 22). The pars interior of the copula has a smooth edge (Figs 21, 22). The fifth band in each cingulum, pleura, is observed to have basically a single row of areolae except the short region near the closed apex where two rows of areolae are present (Figs 23,

24). The opening of each band alternates between the apices of the frustules (Fig. 16). The closed apex in each band has an extension well developed in the advalvar direction (Figs 16, 18, 21, 23). The extension seems to be homologous to a ligula as seen in the bands of centric diatoms such as *Aulacosira italica* (KOBAYASI and NOZAWA 1982).

According to the present investigation using culture methods, it is considered that the following characteristics are apparently stable in *Entomoneis alata* var. *japonica*: 1) the junction line is bisinuous from the valve center to the apex. 2) the wing has numerous fibulae in its major part and has a raphe canal along its free edge. 3) the mature cingulum is composed of five open bands, i.e., a valvocopula, three copulae and a pleura. 4) poroid areolae on both valve and cingulum are closed at the external surface by pore occlusions. 5) the pore occlusion of the valve pore is a hymen with regularly scattered perforations and that of cingulum is also a hymen with scattered round perforations in its thin area and with radially arranged linear perforations along its margin.

As mentioned at the beginning of this paper, if Reimer's opinion is correct, then his taxon should have the following combination as its correct and valid name.

Entomoneis alata (Ehr.) Ehr. var. *japonica* (Cl.) comb. nov.

Amphiprora alata Kuetz. var. *japonica* Cl. Kong. Sven. Vet. Akad. Handle 26(2): 16. pl. 1. f. 2. 1984.

Plate 4. Fig. 21. Closed apex of the copula showing two rows of areolae and well developed extension and smooth edge of the pars interior (arrow). $\times 6200$. Fig. 22. Internal view of the open end of the copula showing the long and short pores forming rows. $\times 14000$. Fig. 23. Closed apex of the pleura showing well developed extension and a single row of round pores. $\times 6000$. Fig. 24. Oblique view of open apex of the pleura showing a single row of pores and smooth edge. $\times 10000$. Figs. 25, 26. External view of both apices of the same valve showing terminal fissures curved in opposite directions. $\times 12000$.

Plate 5. Fig. 27. Hymenate pore occlusions with regularly scattered perforations. TEM $\times 56000$. Fig. 28. Longitudinal thin section of wing showing pores occluded at the external surface by the domed hymen of uniform thickness and perforations (arrows). TEM $\times 84000$. Fig. 29. Hymenate pore occlusions on a band showing round holes in the thin area and radially arranged linear holes along its margin. Note the thickened portion (arrow) and thin marginal portion with radially arranged linear holes (double arrow). TEM $\times 63000$. Fig. 30. Thin section of the band parallel to the valvar plane showing thickened (arrow) and thin marginal portion (double arrow), round holes (arrow head), and a linear hole (double arrow head) of the hymen. TEM $\times 112000$.

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長田敬五*・小林 弘**：汽水産羽状珪藻 *Entomoneis alata* (EHR.) EHR. var. *japonica* (CL.) comb. nov. の微細構造

青森県小駁沼，神奈川県多摩川の汽水域から得た個体，および多摩川から採取したものから得たクローン培養を，主に TEM と SEM によって観察した。この分類群では，1) 翼と殻本体との間の 3 の字形の縫合線，2) 翼の間条線上に多数の間板をもつ翼構造，3) 1 枚の接殻帯片，3 枚の中間帯片，および 1 枚の連結帯片の計 5 枚の殻帯片からなる殻帯，4) 規則的散在型の小孔をもつ薄皮で外側を閉塞された胞紋の構造，の諸形質は天然の試料でも，また，培養の個体群の中でも，殻の変異と関係なく，極めて安定していた。(*951 新潟市浜浦町 1-8 日本歯科大学新潟歯学部生物学教室 **184 東京都小金井市貫井北町 4-1-1 東京学芸大学生物学教室)

**Life history phases in *Iridaea cordata* (Gigartinaceae):
relative abundance and distribution from
British Columbia to California***

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A rapid procedure for determining the life history stage of some (non-reproductive) red algae has been developed, based on carrageenan type. Using this methodology the life history phases of *Iridaea cordata* from five sites in Barkley Sound and from Vancouver harbour (British Columbia) showed a dominance of gametophytic blades (ca. 60% gametophytic). Within Barkley Sound there was a trend towards fewer gametophytes in areas of greater wave exposure. When about 8000 blades from 12 populations were sampled in July, 1982, from Oregon to California, the proportion of gametophytic blades was low in northerly populations (ca. 11%) and tended to be higher in more southern populations (ca. 78-90%). These data are discussed in terms of a previous life history model suggested for *Iridaea cordata* from California.

Key Index Words: Algal ecology; carrageenans; Iridaea; life histories.

Introduction

HANSEN and DOYLE (1976) and HANSEN (1977) suggested that populations of *Iridaea cordata* from California may have an *in situ* life history different from the simple *Polysiphonia*-type. In studies on the growth and population structure of *I. cordata* these authors found that tetrasporophytic blades were more abundant than male and female gametophytes in natural populations of *I. cordata*. HANSEN and DOYLE (1976) and HANSEN (1977), sampled four populations throughout the year and concluded that plants regrew primarily from long-lived crusts rather than re-establishing from spores derived from reproductively mature plants. FOSTER (1982) came to a similar conclusion

for *I. flaccida* (SETCHELL et GARDNER) SILA. Growth, reproductive maturation, and senescence of blades occurred throughout the year, but with a larger proportion of the population experiencing senescence during the winter months (HANSEN 1977, FOSTER 1982). Throughout the year tetrasporophytic blades were most common, except in spring when numbers were approximately equal.

There is an element of paradox in this model. If sexual reproduction predominates, the tetrasporangial blades should produce a large number of gametophytic plants which in turn should produce gametangial blades in the next season. However, gametophytic blades consistently made up only a minor part of the populations they studied. HANSEN and DOYLE (1976) and HANSEN (1977) proposed several mechanisms whereby dominance of tetrasporophytes could be maintained: (i) tetrasporangial crusts are hardier

* This paper is dedicated to Professor Robert F. Scagel on the occasion of his retirement (1986).

and longer lived than gametangial crusts, (ii) tetraspores have a higher mortality than carpospores, and (iii) apomeiosis. The last of these can occur in culture (KIM 1976). Apomeiosis appeared advantageous in explaining the expenditure of energy necessary to produce the large number of spores observed in *I. cordata* (HANSEN 1977).

Dominance of tetrasporophytic blades does not, however, appear to be the rule for all populations of *I. cordata* on the west coast of North America. ADAMS (1971), examined three sites in British Columbia and found gametophytic blades to be equal or greater in number than tetrasporangial blades from May to August, after which the tetrasporophytes became more abundant.

The research described in this paper was undertaken to determine if dominance of gametophytes occurs on the exposed west coast of Vancouver Island as well as in the more sheltered areas of the Strait of Georgia and Vancouver harbour. In addition, a series of samples was taken along the Oregon and California coasts to determine if changes in population structure could be observed over this range.

In order to process large numbers of plants, and to quickly separate gametophytic from tetrasporophytic blades in samples where large numbers of thalli may be sterile, a modification of the resorcinol test described by CRAIGIE and LEIGH (1978) was used. The CRAIGIE and LEIGH method tests for 3, 6-anhydrogalactose which is a constituent of K-carrageenan (YAPHE and ARSENAULT 1965). The modification we used for analysis of all samples taken in this study, involved adding reagent directly to the dried algal sample, bypassing the autoclaving step. This modification was tested for consistency and also compared to results obtained by the CRAIGIE and LEIGH methodology.

Materials and Methods

Acetal resorcinol reagent was prepared as outlined in CRAIGIE and LEIGH (1978) and added directly to excised portions of air-

dried thalli. Material was designated as tetrasporophytic if no (or only very slight) color reaction occurred, and gametophytic if the reagent mixture became pink to red. Spectrophotometric analyses were done to determine whether the revised procedure was monitoring the same color reaction as that of CRAIGIE and LEIGH (1978). The test was initially carried out on plants of *I. cordata* from British Columbia and *Chondrus crispus* STACKHOUSE from Nova Scotia, Canada.

Increase in color intensity of the reaction product with increase in biomass of the alga was measured for dry weights from 0.5 to 16 mg (Fig. 1). All reactions proceeded for 60 sec at 86°C in 2 ml of reagent diluted with an additional 2 ml of reagent prior to reading the absorbance. Increase in color intensity of the reaction product with increase in reaction time was measured at intervals from 15 to 150 sec (Fig. 2). All readings were done at 510 nm using a Perkin-Elmer UV-VIS Spectrophotometer Model 139. Complete visible spectra (350–700 nm) for the reaction products of both gametophytic and tetrasporophytic material of *I. cordata* and *C. crispus*, utilizing both the CRAIGIE and LEIGH method and our modification, were performed on a Unicam Sp 800A Ultraviolet Recording Spectrophotometer (Fig. 3).

Preliminary samples in British Columbia were taken at Dixon Island, Wizard Island, First Beach, Second Beach, and Execution Rock (Fig. 4) in Barkley Sound, Vancouver Island, and Stanley Park in Vancouver harbour during 1981. Sampling in each case was done in a 0.5 m wide belt transect located from the upper to lower intertidal zone through an area densely populated by *I. cordata*. From each blade in the transect greater than 5 cm in height, a disk 6 mm in diameter (ca. 3 mg dry weight) was removed with a single hole paper punch.

At First Beach, Barkley Sound, four sites were chosen along a wave exposure gradient. At each site three vertical transects were sampled (July 6–12, 1982) using 0.5 m² qua-

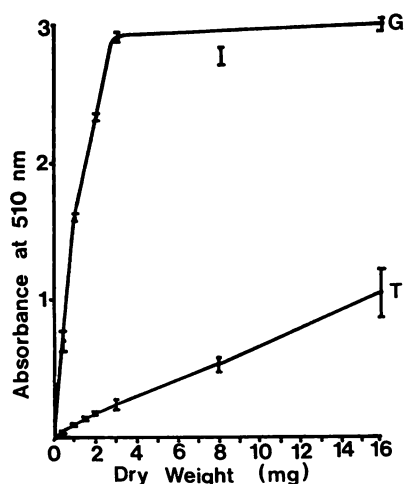


Fig. 1.

Fig. 1. Absorbance at 510 nm for modified resorcinol test in gametophytic (G) and tetrasporophytic (T) plants at different dry weights. (Mean \pm S. E., $n=6$)

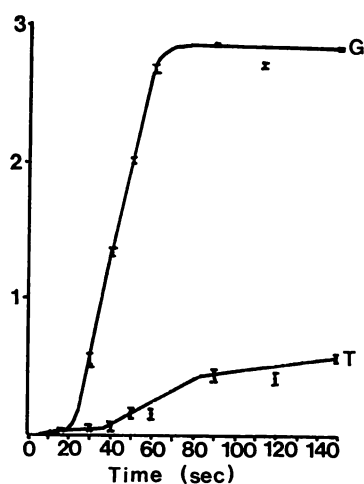


Fig. 2.

Fig. 2. Absorbance at 510 nm for modified resorcinol test in gametophytic (G) and tetrasporophytic (T) plants at different reaction times. (Mean \pm S. E., $n=6$)

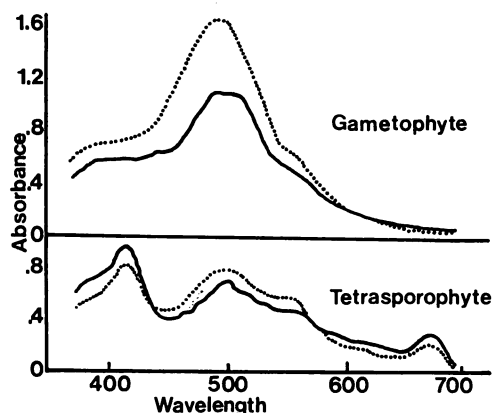


Fig. 3. Absorption spectra of reaction products of modified resorcinol test for gametophytic and tetrasporophytic plants of *Iridaea cordata* (solid line) and *Chondrus crispus* (dotted line).

drats; disks were collected from all blades in each transect. The vertical extent of the sampling varied with topography and exposure, but each transect included the lowest and highest extent of the *Iridaea* population. The lowest elevation sampled in each site was +0.2 m, the highest ranged from +1.0 m (sites 2 and 3) to +1.6 m (site

1); average sampling height was $0.66 \text{ m} \pm 0.34 \text{ m}$. After an arc-sin transformation to normalize data (SOKAL and ROHLF 1973), results were analyzed using an ANOVA to examine differences in life history stages among sites and tidal heights. At each site any quadrat with less than 30 individual blades was excluded from the analysis. Site 2 was excluded for this reason.

Twelve sites along the Oregon and California coasts were sampled between July 18-26, 1982 (Fig. 5). At each site representative areas were subjectively selected with dense growths of *Iridaea cordata*. In order to minimize bias, site selection was done from a distance before the population had been examined. At each site all blades in 4 to 10 separate 0.5 m^2 areas were punched and combined for analysis.

In April, 1983, Pigeon Point (California) was resampled. Five 625 cm^2 quadrats were placed randomly along a 50 m transect line in the upper (+67 to +39 cm above mean lower low water) extent of the *Iridaea* bed, and seven additional quadrats were placed in the same fashion in the lower (+15 to -5 cm) extent of the *Iridaea* bed. Data were

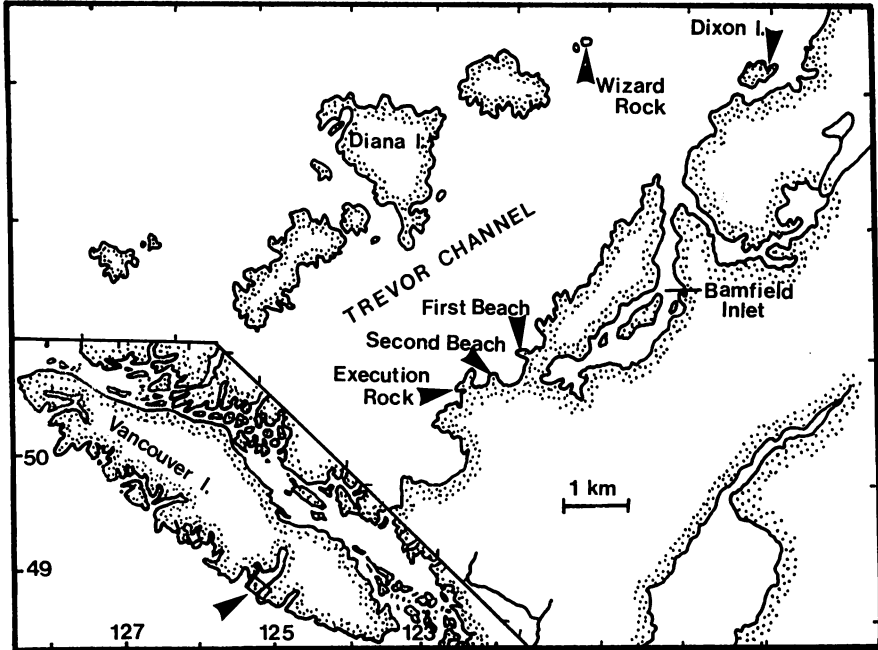


Fig. 4. Details of collection sites in Barkley Sound (arrows) with insert of Vancouver Island showing general location (box and arrow) of sampling area.

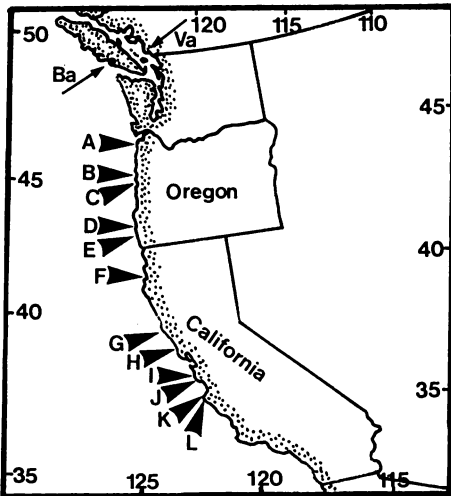


Fig. 5. Map of western North America from Vancouver Island to California indicating sampling locations: Va, Vancouver; Ba, Barkley Sound; A-E, Oregon; A, Indian Beach, Ecola State Park; B, Otter Rock; C, Seal Rock; D, Cape Arago; E, Cape Blanco; F-L California; F, Patrick's Point; G, Point Arena Lighthouse Station; H, University of California Marine Station, Bodega Bay; I, Pigeon Point; J, Davenport, California; K, Point Pinos, Pacific Grove; L, Point Joe, 17 Mile Drive.

analyzed with a one-way ANOVA to test for differences in numbers of tetrasporophytic versus gametophytic blades with respect to tidal height.

All carrageenan analyses were performed utilizing the modified resorcinol reagent test described earlier. Plants were analyzed in batches of ca. 75 disks and several disks of known life history phase were included with each batch as controls.

Note on the taxonomy of *Iridaea cordata* var. *cordata*.

The taxonomy of the *Iridaea cordata* complex in western North America is poorly understood. The bulk of the plants sampled in this study comply with concepts of *I. cordata* var. *cordata* in most modern treatments (e.g. ABBOTT 1971) and are similar to plants identified by SCAGEL (1973) from Barkley Sound. In Barkley Sound, however, plants in more wave exposed sites tended toward the morphology referred to as var. *splendens* (ABBOTT 1971), and some plants

in the upper part of the *Iridaea* zone in California may be referable to *I. flaccida*. Regardless of the potential confusion of *I. cordata* and *I. flaccida*, no differences in proportion of life history stages were recorded at different tidal heights (+0.2 to +1.6 m and -0.05 to +0.7 m) in either Barkley Sound (First Beach) or California (Pigeon Point) respectively. FOSTER (1982) suggests that there is little basis for the separation of *I. flaccida* and *I. cordata* and that these taxa may be conspecific. Our observations are consistent with this synonymy. *I. cordata* var. *cordata*, *I. cordata* var. *splendens* and *I. flaccida* form an apparent continuum in morphology.

Results

Gametophytic tissue of *I. cordata* showed a sharp increase in absorbance at 510 nm as the mass of tissue was increased from 0 to 3 mg. With greater mass there was little or no measurable increase in absorbance. Tetrasporophytic tissue showed an increase in absorbance over the entire 0 to 16 mg range used in the experiment (Fig. 1). Gametophytic tissue also showed an increase in absorbance with reaction time, from 0 to 60 sec, but with little or no increase thereafter (Fig. 2). Tetrasporophytic tissue showed an increase over the entire 0 to 150 sec range tested. Maximum separation of color intensity occurred at about 60 sec using 3 mg dry weight.

Examination of the complete visible spectra of the reaction products of gametophytic and tetrasporophytic plants of *I. cordata* showed different spectra for the two stages (Fig. 3). *C. crispus*, the plant for which the test was first used and from which the different carageenans contributing to these spectra were first isolated (McCANDLESS *et al.* 1973), also shows different spectra for the two stages. Spectra for both plants show a single broad absorption peak at 510 nm for gametophytic tissue. Tetrasporophytic tissue produced spectra with three peaks having maxima at 413, 500, and 672 nm. The absorption spectra

were the same as those generated from tissues prepared according to the methodology of CRAIGIE and LEIGH (1978).

Samples of 3 mg dry weight, when combined with the resorcinol reagent for 60 sec, produced a sufficient difference in color intensity to make visual separation of gametophytic and tetrasporophytic samples simple and consistent. All samples taken from Barkley Sound, Vancouver harbour, and Oregon and California were approximately 3 mg dry weight and were subjected to 60 sec reaction time at 86°C.

The initial survey of life history stages in Barkley Sound showed that variation occurred at the same site over time and between nearby sites at the same time. However, gametophytic blades were most common (55–90%) in 12 out of 15 samples. Similarly, four samples taken in Vancouver harbour during the spring of 1981 also showed a predominance (80%) of gametophytic blades.

Sampling done at First Beach in 1982 at sites with varying wave exposure, revealed a patchy distribution of gametophytes and tetrasporophytes. Results of ANOVA demonstrated no apparent relationship between tidal height and relative numbers of gametophytic and tetrasporophytic blades. Pooling of all the samples at a site (Fig. 6)

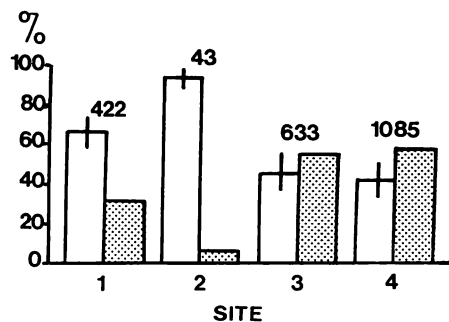


Fig. 6. Histograms showing proportions of gametophytic (clear) and tetrasporophytic (stippled) plants at four sites along a wave force exposure gradient (one is least exposed) at First Beach, Barkley Sound. Numbers above sites are the total number of plants sampled. Error bars denote \pm one standard deviation.

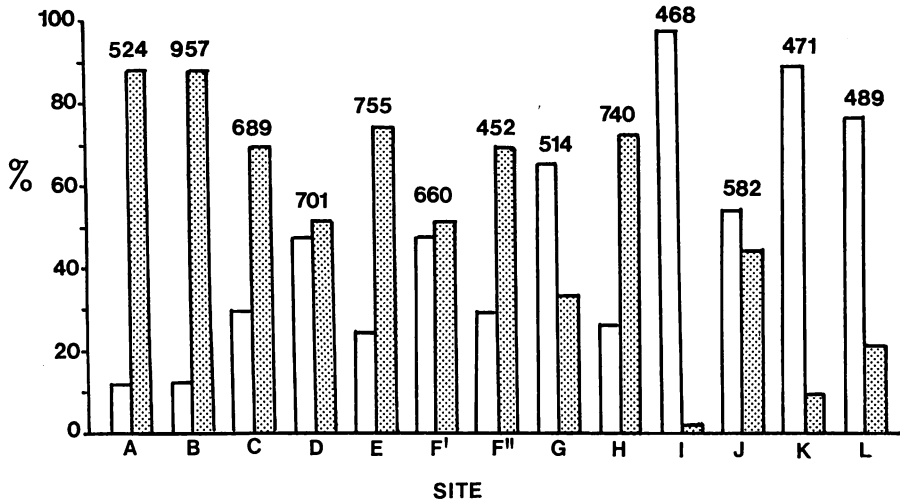


Fig. 7. Histograms showing proportions of gametophytic (clear) and tetrasporophytic (stippled) plants at sites in Oregon and California. (F', Abalone Rock; F'', Wedding Rock). See legend for Fig. 5 for other site names.

reveals an apparent trend toward tetrasporophyte dominance with increasing wave exposure. ANOVA showed a significant difference ($p=0.05$) between site 1 and sites 3 and 4.

Senescence of virtually all blades of *Iridaea* occurred late in October at First Beach, with only a few widely scattered blades overwintering. This was also reported by HRUBY (1975) for populations in Washington State, U.S.A., and by FOSTER (1982) for *I. flaccida* in California. Blade initiation occurred early in March, with rapid growth occurring for the first two or three months and then decreasing during the summer.

The populations of *I. cordata* sampled on the Oregon and California coasts from July 18 to 26, 1982 (Fig. 5) revealed unequal quantities of gametophytes and tetrasporophytes in most populations sampled (Fig. 7). Sites from Point Arena south to Pebble Beach, California (except for Bodega Bay), exhibited gametophyte dominance. Sites from Patrick's Point State Park, California north to Ecola State Park, Oregon showed tetrasporophyte dominance.

Two samples were made at Otter Rock, one of attached plants and the other of drift plants. At this site 68% ($N=188$) of the

drift blades were gametophytes whereas only 11% ($N=957$) of the attached blades were that life history stage.

In the April, 1983, samples obtained from Pigeon Point there was a mean gametophyte dominance of 86% ($N=782$). The gametophyte stage dominated in both the upper ($94\% \pm 5\%$, $N=291$) and lower ($83\% \pm 16.4\%$, $N=546$) zone. A one-way ANOVA showed no significant difference between the percent of either gametophytes or tetrasporophytes in the upper and lower zones.

Discussion

Resorcinol reagent added directly to dried, excised algal tissue proved as accurate an indicator of constituent carrageenans (and thus nuclear phase) as is the methodology outlined in CRAIGIE and LEIGH (1978). Our modification results in a large reduction in the time needed to process samples, and non-destructive (and therefore repeated) sampling is possible since only small disks are removed from blades.

The proportions of gametophytes and tetrasporophytes found in *I. cordata* populations along the Oregon and California coasts differ between sites. In their entirety the

twelve samples suggest that tetrasporophytes predominate in the north (northern Oregon) and gametophytes dominate in the south (central-California). However, large differences occurred in samples taken relatively short distances apart. An example of this is between the Pigeon Point sample, with over 80% gametophytes in 1982 and 1983, and the nearby Davenport sample, with just over 50% gametophytes. In addition, samples taken ca. 2.5 km apart at Patrick's Point State Park showed almost 25% more tetrasporophytic blades in the sample from Wedding Rock than from Abalone Rock. The presence of a strong tetrasporophyte dominance in the population of Bodega Bay, within the southern area where gametophyte dominance is most common, further supports the possibility of local variability, as do the samples taken in Barkley Sound, Vancouver Island.

Thus, such a cline of reproductive stages, if it does in fact exist, is quite different from that which was postulated at the beginning of our study on the basis of an apparent gametophyte dominance in the Strait of Georgia (ADAMS 1971) and a reported year-round (except early spring) tetrasporophyte dominance (HANSEN and DOYLE 1976) in central California. Any gradation from dominance of gametophytes in the north to tetrasporophytes in the south was certainly not shown by our samples. Instead, the pattern we found (from Oregon to California) more closely resembles that postulated by DIXON (1965) and described for *Ceramium* by EDWARDS (1973) in which gametophytes dominate the southern ranges of certain Rhodophyta, giving way to a predominance of tetrasporophytes and finally to sterile blades as one progresses northward. It should be noted, however, that our methodology employing a test for chemical differences did not test the hypothesis of DIXON (1965) who recorded reproductively mature blades. Using DIXON's methodology it is possible that equal numbers of tetrasporophytes and gametophytes are in fact present, but that only the tetrasporophytes become reproductively mature in more nor-

thern sites. Using our methodology it would be possible to score an area as having gametophyte dominance when none of the haploid blades might become reproductively mature.

Our samples taken in the Monterey area raise other questions, since they did not confirm the reported dominance of tetrasporophytes for these populations (HANSEN and DOYLE 1976). Instances of gametophyte dominance for an entire year have been reported for *Rhodoglossum affine* and *Gigartina leptorhyncos* (ABBOTT 1980) but not for species of *Iridaea*.

Our sampling at Pigeon Point revealed an 80-90% gametophyte dominance in July, 1982, and an 86% gametophyte dominance in April, 1983, different from the tetrasporophyte dominance reported from this area by HANSEN and DOYLE (1976). This suggests that the proportions of gametophytes and tetrasporophytes in a particular population may change over periods longer than a few years. Such a reversal has occurred at Pigeon Point in the nine years between the work of HANSEN and DOYLE and this study.

In re-examining some of the proposed mechanisms by which a tetrasporophytic dominance might be maintained (HANSEN and DOYLE 1976) in the light of our data, the probability of apomeiosis now seems less likely. An apomeiotic population is incapable of producing the gametophyte dominance we found at Pigeon Point. Because of the differences observed in earlier studies and in our data, the various mechanisms proposed by Hansen and Doyle do not appear important in explaining the observations.

One possibility that must be considered is that dominance of any life history stage of *Iridaea* is part of a larger cycle which takes some years before moving from one stage to another. One mechanism which could operate to produce an alternating dominance of reproductive phases is suggested here. For example, once a tetrasporophytic phase became dominant, a subsequent event which resulted in removal (grazing or very low tides combined with hot weather) would enable the spores of the remaining plants

to settle and grow into the gametophytic phase, which would then predominate until the next local catastrophe.

The results from the sampling in Barkley Sound have suggested one environmental mechanism which may contribute to an instance of tetrasporophyte dominance. Sampling at the First Beach site showed that areas of higher wave exposure had significantly more tetrasporophytes than sheltered areas.

Sampling done at Otter Rock, Oregon, showed a tetrasporophyte dominance of 89% in blades attached to rock in the intertidal zone and gametophyte dominance of 68% in a drift sample taken at the same site. This suggests that gametophytic blades are more susceptible to being stripped from rocks by wave action than are the tetrasporophytes.

The patterns of change in populations of *Iridaea cordata*, and the factors controlling these patterns, may be such that only long term studies carried out simultaneously at a large number of sites of varied geography are able to produce a satisfactory picture.

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- (和文要約は p. 209 を参照のこと)

日本産小形ステファノディスクス属 (ケイソウ類) の微細構造

2. *Stephanodiscus hantzschii* GRUN. form. *tenuis*
(HUST.) HÅK. et STOERM.*

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KOBAYASI, H., INOUE, H. and KOBAYASHI, H. 1985. Fine structure and taxonomy of the small and tiny *Stephanodiscus* (Bacillariophyceae) species in Japan. 2. *Stephanodiscus hantzschii* Grun. form. *tenuis* (Hust.) HÅK. et STOERM. Jap. J. Phycol. 33: 233-238.

Specimens collected from Waku-ike, Hachiro-gata, the brackish region of Ara-kawa and the brackish Hinuma-gawa were identified as *Stephanodiscus hantzschii* form. *tenuis* (Hust.) HÅK. et STOERM. after careful examination with TEM and SEM. Three types of valve silicification, thin, medium and thick, are distinguished being accompanied by morphological variations such as the locular structure of areolae, spine shape, and the shape of the exterior tube of the labiate process. This taxon is clearly distinguished by the features with flat valve surface, without a strutted process on the valve surface, with a single marginal labiate process open at the site of a spine and with marginal strutted processes with three satellite struts from closely related species, especially from *S. invisitatus*, occurring frequently in nature mixed with this taxon.

Key Index Words: Centric diatom; fine structure; plankton; *Stephanodiscus*; *Stephanodiscus hantzschii* form. *tenuis*.
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小形 *Stephanodiscus* 属ケイソウの識別のむずかしさは、光顕 (LM) による特徴のつかみにくさにあるが、それだけでなく、同属の他の類似種がきまって同時に出現すること、および、殻の薄い個体と厚い個体が混在して出現するので、同じ分類群のものであっても異なる種類のように見えることにある。

Stephanodiscus hantzschii form. *tenuis* (Hust.) HÅK. & STOERM. も例外ではなく、秋田県八郎潟 (N-1005, 1983年10月4日採取)、東京都荒川掘切橋 (N-935, 1984年11月27日採取)、長野県涌池 (K-2118, 1972年9月21日採取) の試料に *Stephanodiscus invisitatus* などの小形種に混じて出現した。今回は中でも比較的大量に得られた涌池と潤沼川の試料を用いて電顕 (TEM および SEM) による観察を行った。LM 観察および TEM, SEM 観察のための試料の調整および検鏡の方法などは小林・井上 (1985) と同じで

ある。

この種類は HUSTEDT (1939) により西ドイツのエムス川のパーペンブルグから上流へかけての堆積試料から独立の種として記載されたものである。しかし、ウィーン の自然史博物館所蔵の、GRUNOW が *Stephanodiscus hantzschii* を記載したときに使用したタイプ試料を調べた HÅKANSSON and STOERMER (1984) はさらに調査を広げ、ブレーメルハーフェンの HUSTEDT コレクションにある *S. tenuis* のタイプスライドを調べて *S. tenuis* を *S. hantzschii* の品種に落した。

HÅKANSSON and STOERMER (1984) の提示しているタイプの写真を計測してみると *S. hantzschii* は殻径 12~15 μm で、胞紋束は 10 μm 幅に 7~8 本あり、胞紋束は 2 列の胞紋列からなり、胞紋列を構成する胞紋は放射方向に 10 μm 幅に 16~18 個みられる。一方 form. *tenuis* のタイプスライドからの写真では、殻径 23 μm (HUSTEDT の記載は 8~28 μm)、胞紋

* 本研究は財団法人日産科学振興財団研究助成金による研究の一部である。

束は 10 μm 幅に 4~5 本、それぞれの胞紋束は 2~4 本の胞紋列からなり、胞紋列の胞紋は放射方向に 10 μm 幅に約 26 個数えることができる。すなわち、この両者は胞紋束を構成する胞紋列の数と、胞紋の粗密の 2 点で、かなり明瞭な区別ができるが、その他の点では全く区別が無い。HÅKANSSON 女史からの筆者の一人小林弘への私信によると、被殻の一方の殻が真正の *S. hantzschii* であるにもかかわらず、もう一方が *S. tenuis* の殻であるという例も見られるとのことである。筆者らは未だ、*S. hantzschii* と同定できる本邦からの個体を調べていないので断言はできないが、*S. tenuis* を *S. hantzschii* の品種とした HÅKANSSON and STOERMER (1984) の処置は当を得たものと考えられる。

観察結果と考察

Stephanodiscus invisitatus Hohn et Hell. の場合もそうであったが (小林・井上, 1985) この種類も珪酸の沈着の度合いに著しい差があり、殻が非常に薄いもの (Figs 1~9)、中間的なもの (Figs 11~13, 15~18)、非常に厚いもの (Figs 19~28) まだが連続した変異としてみる事ができた。

殻の薄いものは、LM では胞紋束は一様の幅の広い帯として見え、個々の胞紋を解像して見ることはできないが (Figs 1, 2)、中間的なもの (Figs 11, 12) ではコントラストは十分ではないが、胞紋を見分けることが可能となり、殻の厚いもの (Figs 19~22) では、かなり明瞭に点紋として見る事ができる。コントラストがついて点紋が明瞭に見えると、検鏡した時点では点紋が一見粗く配列しているように見えるが、写真に写して計測してみると全く差異は認められなかった。

この種類の殻構造の特徴を模式的に示したのが Fig. 14 であるが、殻面が平坦であること、殻面中心部に有基突起は存在しないこと、胞紋束は殻面の周辺部で 2~4 列の胞紋列で構成されるが中心部では 1~2 列になり、また周辺部ではまっ直であるが中心部に向うに従って乱れ屈曲すること、束間肋は殻面端でそれぞれ 1 本の棘 (a) をもつこと、縁辺有基突起 (b) は比較的規則的な間隔で配列し、3~4 束 (稀に 5) ごとに 1 個あること、殻套では胞紋列は平行し一様に配列すること (e) などの特徴としている。

LM でも、殻の中心部に有基突起の存在を示す遊離点紋が見られない点、殻が平坦である点、胞紋束が中心部で屈曲する点、および胞紋束の配列がやや粗い点

などに注目すると屢々同時に出現し、識別の極めて困難な *Stephanodiscus invisitatus* と区別することは不可能ではない。しかし、電顕像では区別はより明瞭である。*S. invisitatus* では縁辺棘は尖るが、この種類では殻の薄いものでは先端が扁平になり、時に広がるものも現れ (Figs 4, 6)、同一個体でも先の尖るもの (Fig. 9 矢印) と先が扁平になり切頭で終るもの (Fig. 9 矢先) の 2 種類の棘をもつものがみられた。また、殻の厚いものでは基部はより太く、先端はより細く鋭く尖る傾向があり、扁平な棘は見られなくなる。 (Figs 15, 24~27)

縁辺有基突起は殻の外側へも、内側へも、ほぼ同じ長さの管となって伸び出し、それぞれ 3 脚をもつ (Figs 4, 5, 8, 18, 25, 27) 点でも *S. invisitatus* とは異っている (小林・井上 1985)。

胞紋は殻の薄いものでは小室構造をつくらず、障子の骨と骨の間に紙、すなわち師板 (cribrum) を張ったつくりになるが (Figs 7, 8)、やや厚くなると円筒状の小室の内側を師板で閉塞する (Figs 17, 18) ようになり、さらに肥厚した殻では小室の外側の開口も一方の壁から張り出した、小孔 (hole) をもたない、帽子のつばのようなつくりの弁皮 (flap) (MANN 1980) によって閉塞され、 (Figs 26, 28)、内側は明瞭にドーム状にもり上がった小孔で穿孔された直径約 0.3 μm の師板で閉塞されるようになる (Figs 25, 27)。このような小箱構造をもつことは、殻面の断面に現れた胞紋の断面に明瞭に見ることができる (Fig. 28 矢印)。また、殻の肥厚の差は TEM 像においても明瞭な違いとなって現れる (Figs 6, 16, 23)。

唇状突起 (labiate process) は殻の縁辺に 1 個あるが、その縦裂溝は放射軸に対して直角またはやや斜めに位置する (Figs 8, 18, 27)。唇状突起の外側への開口は縁辺棘のどれかと置き換わる位置にあり、明瞭な管となるが、この管は有基突起の外管よりはやや細いが長い (Figs 7 矢印, 17 矢印)、しかし、殻の肥厚したものでは外側への開口は明瞭な外管とはならず、不完全に閉ざされた形となる傾向があり (Fig. 26)、この傾向は涌池産の個体にも、洞沼川から得た個体にも共通してみられた。

増大胞子形成直後に作られた初生殻 (initial valve) (Fig. 10) も涌池から得た試料中に見られたが、殻面が平坦でなく半円形になること、大形で明瞭なパターンセンターが見られること、束間肋が明瞭でないこと、縁辺棘が現れないこと、多数の縁辺有基突起をもつことなどは、これまでのいくつかの円心目ケイソウの観

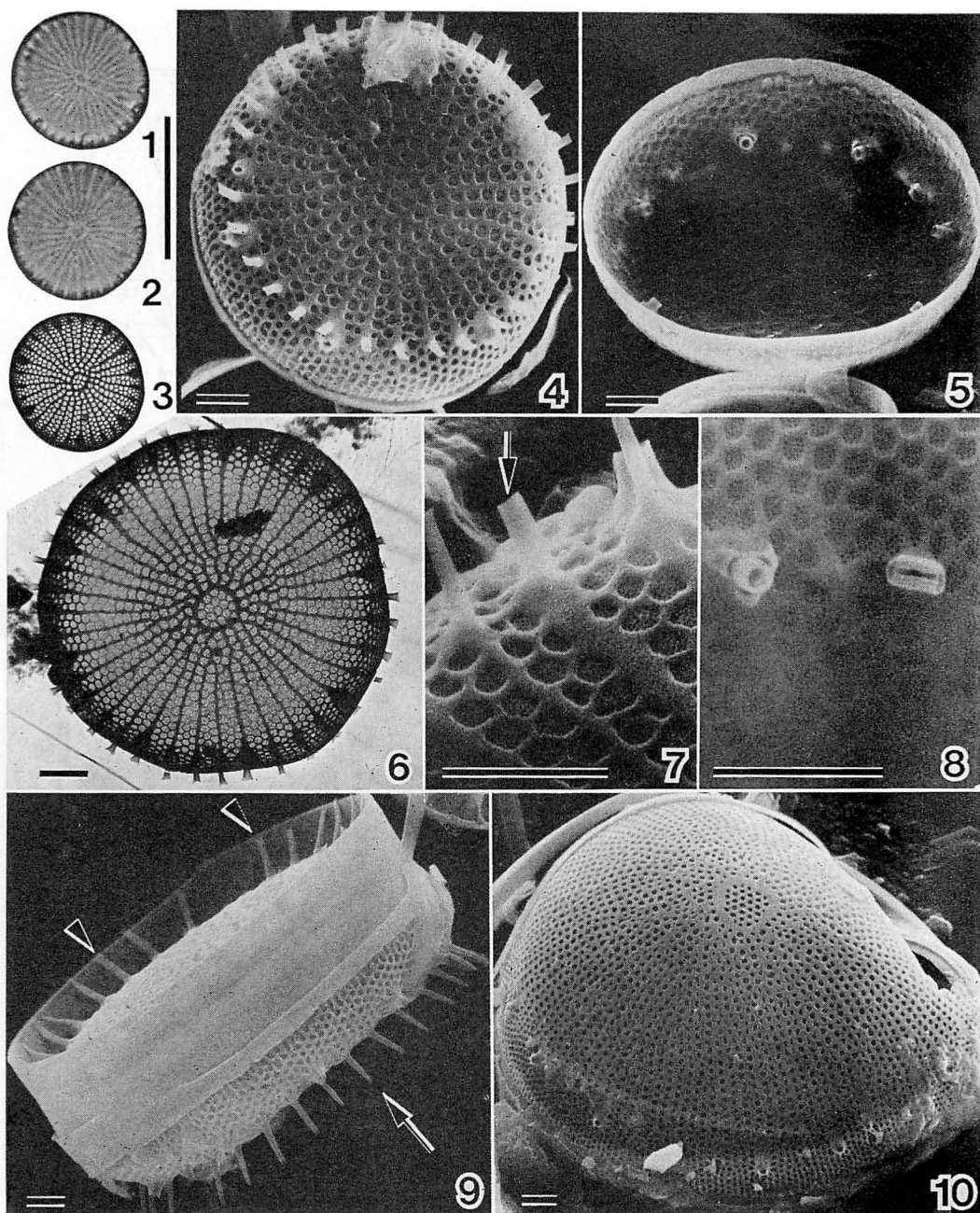


Plate 1. *Stephanodiscus hantzschii* Grun. form *tenuis* (Hust.) HÄK. et STÖRM. with thin valves. Figs 1-3. Whole valves. $\times 2000$ (bar= $10\mu\text{m}$). Figs 4, 5. Outside and inside views of valves showing flat valve surface, marginal struted processes with three struts and marginal spines with flat and broad truncate apex. $\times 7500$ (bar= $1\mu\text{m}$). Fig. 6. Valve view. TEM $\times 7000$ (bar= $1\mu\text{m}$). Figs 7, 8. Enlargement of valve margin showing the external tube of the labiate process (arrowed) and marginal struted process with three struts. $\times 24000$ (bar= $1\mu\text{m}$). Fig. 9. Side view of a frustule showing spines with acute (arrowed) and truncate (arrow head) spines. $\times 6600$ (bar= $1\mu\text{m}$). Fig. 10. Valve view of not flat but hemispherical initial valve showing large pattern center, not fasciculate areolar rows and marginal struted processes. $\times 5000$ (bar= $1\mu\text{m}$). Figs 1-10. Waku-ike (Waku Pond).

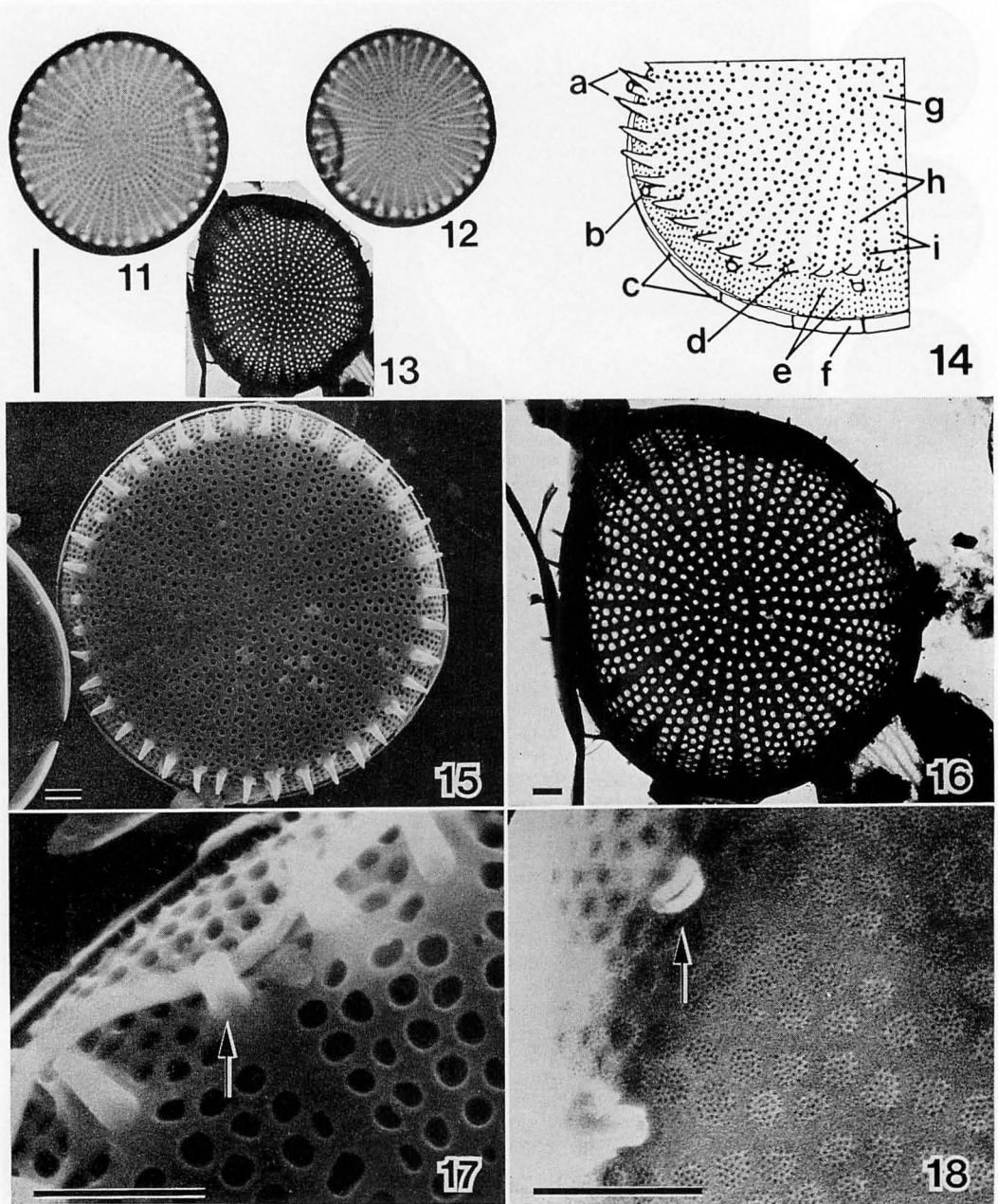


Plate 2. *Stephanodiscus hantzschii* Grun. form. *tenuis* (Hust.) HÄK. et STOERM. with mediately silicified valves. Figs 11-13. Whole valves. $\times 2000$ (bar = $10\ \mu\text{m}$). Fig. 14. Diagrammatic representation of the features of *S. hantzschii* form *tenuis*. a. marginal spines, b. marginal strutted processes, c. vertical slit-like markings of the fringe, d. outer opening of the labiate process, e. areolar rows on the valve mantle, f. fringe, g. pattern center, h. interfascicles, i. fascicles. Fig. 15. Outside view of valve. $\times 5000$ (bar = $1\ \mu\text{m}$). Fig. 16. Valve view showing fascicles on the valve surface and areolar rows on the valve mantle. TEM $\times 4000$ (bar = $1\ \mu\text{m}$). Figs 17, 18. Enlargement of outside and inside valve margins showing exterior tube (arrowed) and interior lips (arrowed) of the marginal labiate process. $\times 24000$ (bar = $1\ \mu\text{m}$). Figs. 11-18. Waku-ike.

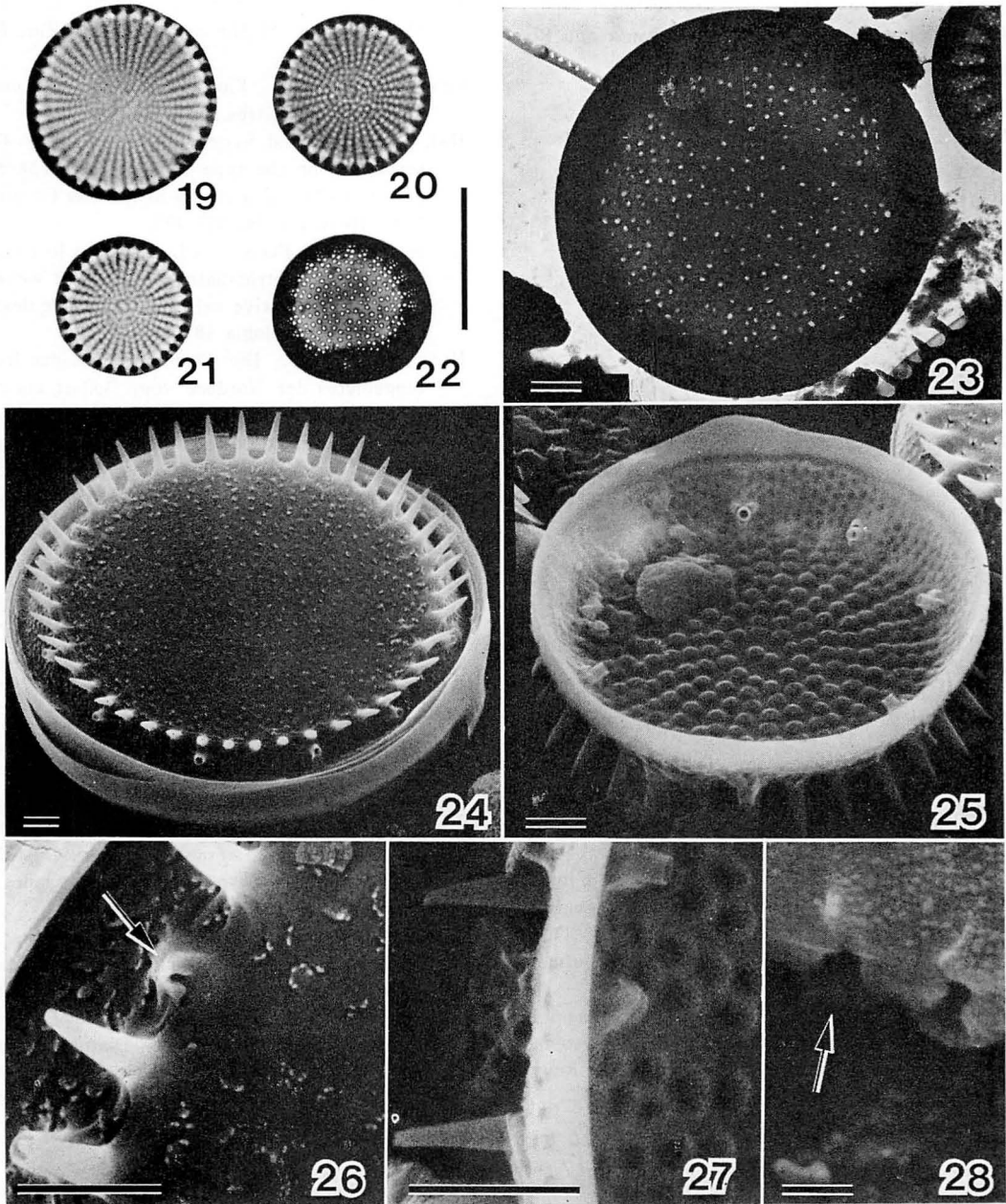


Plate 3. *Stephanodiscus hantzschii* form *tenuis* (Hust.) HÄK. et STOERM. with thick valves. Figs 19-22. Whole valves. $\times 2000$ (bar = $10 \mu\text{m}$). Fig. 23. Valve view. TEM $\times 7000$ (bar = $1 \mu\text{m}$). Figs 24, 25. Outside and inside valves showing acute marginal spines, areolae occluded by flaps externally and by domed cribra internally, and marginal strutted processes with three struts. 24. $\times 5000$ (bar = $1 \mu\text{m}$). 25. $\times 8500$ (bar = $1 \mu\text{m}$). Fig. 26. Enlargement of valve margin showing the outer opening of the labiate process (arrowed). $\times 20000$ (bar = $1 \mu\text{m}$). Fig. 27. Side view of a valve edge showing marginal spines, strutted process and labiate process. $\times 24000$ (bar = $1 \mu\text{m}$). Fig. 28. Broken valve face showing cross section of loculate areola (arrowed). $\times 50000$ (bar = $0.1 \mu\text{m}$). Figs 19-24, 26, 28. Hinuma-gawa (Hinuma River). Figs 25, 27. Waku-ike.

察結果と類似するものであった (CRAWFORD 1974, 1975, HOOPS and FLOYD 1979, ROEMER and ROSOWSKI 1980, SCHMIDT 1984)。

GENKEL and KUZMIN (1918) は *Stephanodiscus tenuis* var. *tener* を記載しているが、これは殻の薄いタイプの個体のように思われる。また、GERMAIN (1981) が *S. hantzschii* として挙げている写真のうちの多くは *S. hantzschii* form. *tenuis* と同定することができるが、GASSE (1980) が *S. tenuis* としている分類群は殻面が平坦ではなく、また *S. tenuis* form. *minor* として記載している分類群は LM 写真からは *S. hantzschii* form. *tenuis* の殻面の薄い個体のようにみえるが、同時に提示している SEM 写真では、殻套の幅が狭く、これは別の分類群と思われる。

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紅藻ウミゾウメンに内生する藍藻の生理学的研究 I. 光合成色素に与える光の波長の影響

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SUZUKI, M. and MASAKI, T. 1985. Physiological investigations of blue-green algae endophytic in the red alga *Nemalion vermiculare* I. Influence of wavelength of light on photosynthetic pigments. Jap. J. Phycol. 33: 239-244.

Absorption spectra of 90% acetone extract (chlorophyll *a* and carotenoids) were basically the same in the host alga *Nemalion vermiculare* SUR. and a mixed culture of two endophytic species of blue-green algae, *Calothrix parasitica* (CHAUV.) THUR. and *Phormidium* sp. The phosphate buffer extract (phycobiliproteins) from the host alga showed remarkable absorption at 460-580 nm, while that from the endophytes had conspicuous absorption at 550-640 nm.

During 14 days' incubation under red, blue or white light, phycobiliprotein content of a mixed culture of endophytes varied from 5.77 to 14.8% of dry weight, 3.26 to 5.69 times as high as chlorophyll *a* content. Content of phycocyanin of the endophytes increased in red light, but decreased in blue light through the culture period. However, the ratio of carotenoids to chlorophyll *a* was low and scarcely varied depending on the wavelength of light used for the culture.

Key Index Words: *Calothrix*; *endophytes*; *Nemalion*; *Phormidium*; *phycocyanin*; *phycoerythrin*.

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藻類は光の強さや波長の変化に対して含有する色素の組成を変えて適応する。これは主に光合成機能と関係して生じるものであり、光環境により、クロロフィルやカロチノイドの量が変化したり (JØRGENSEN 1969, WALLEN and GEEN 1971, JEFFREY and VESK 1977, RAMUS *et al.* 1976), フィコビリ蛋白の量比が変ること (HAXO and BLINKS 1950, MYERS and KRATZ 1955, BRODY and EMERSON 1959, JONES and MYERS 1965, MOON and DAWES 1976) が報告されている。しかし、これらは単生の藻類について行なわれたものであり、海藻に内生する藍藻の色素については、JACOB (1961) が緑藻 *Codium bursa* (L.) AGARDH に内生している *Phormidium codicola* VOUG. について報告しているほかは、ROSENBERG and PAERL (1981) が *Codium decortatum* (WOODWARD) HOWE の内生藍藻である *Calothrix* sp. の色素の特徴について僅かにふれているだけである。内生藍藻は宿主による光の吸収があるために、光環境は量

(強さ) だけでなく質的な面 (波長) から制限される。そこで本研究では紅藻ウミゾウメン *Nemalion vermiculare* SUR. とそれに内生する藍藻 *Calothrix parasitica* (CHAUV.) THUR. 及び *Phormidium* sp. の光合成色素の吸収スペクトルを調べるとともに、培養実験により、光の波長が内生藍藻の光合成色素比に与える影響を明らかにした。

材料と方法

1981年7月に北海道太平洋岸の南茅部町白尻よりウミゾウメン *Nemalion vermiculare* を採集し、ただちに函館市の北海道大学水産学部の実験室に持ち帰り、含有する色素の抽出を行った。また、ウミゾウメンに内生する藍藻ヒゲモ科の *Calothrix parasitica* と同じくユレモ科の *Phormidium* sp. (Fig. 1) を宿主より分離し、これらからも色素を抽出した。内生藍藻の一部は ESP 培地 (PROVASOLI 1966) に移し、白色螢

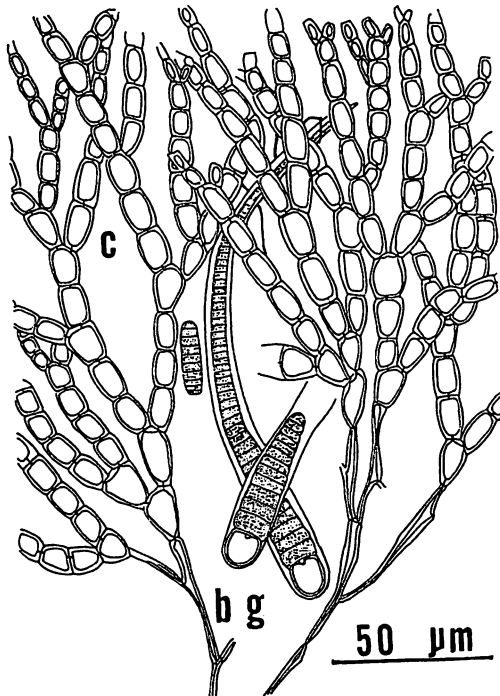


Fig. 1. Cross-section through a mature thallus of *Nematium vermiculare*, showing endophytic blue-green algae which grow in a mucilaginous interspace in the cortical region. c, cortex; bg, blue-green algae.

光灯を用いて1日12時間照明 ($0.8 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$), 20°C で2週間予備培養した後,次に示すごとく,光の波長が内生藍藻の色素組成に与える影響を調べる実験に供した。予備培養後の内生藍藻の細胞懸濁液 30 ml を ESP 培地 200 ml の入った 300 ml 容の三角フラスコに加え, Fig. 2 の装置を用いて, 白色光 ($1.20 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$), 600 nm より長波長の赤色光 ($1.28 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$), または 500 nm 付近の青色光 ($1.16 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) のもとで, 20°C , 1日12時間照明で通気しながら更に2週間培養し, 藻体が含有する色素の量とその吸収スペクトルを測定した。光源には白色蛍光灯を用い, 赤色光は M/500 エオシン水溶液, 青色光は M/1000 ライトグリーン水溶液, 白色光は蒸留水をそれぞれ Fig. 2 のビーカーに入れて, 特定の波長の光を得るためのフィルターとした。これら水溶液の光の透過特性を Fig. 3 に示した。

藻体から色素を抽出するため, 試料を 3.0 ml の pH 6.81 の磷酸緩衝液 (M/15 磷酸二水素ナトリウム溶液 5.0 ml + M/15 磷酸水素二ナトリウム溶液 5.0 ml)

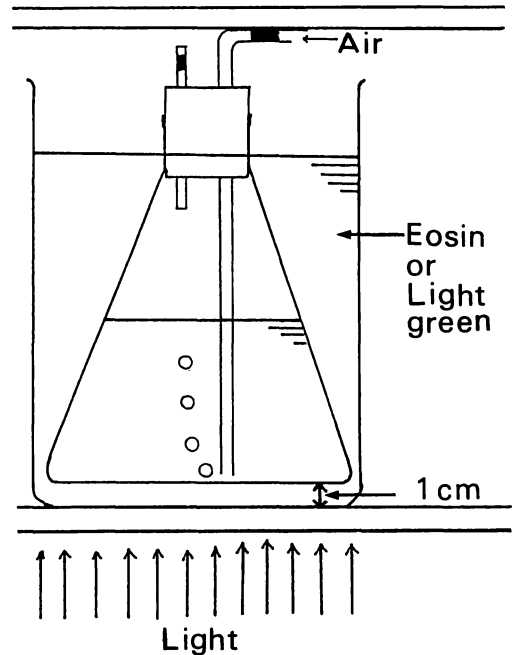


Fig. 2. Diagram of the incubation apparatus used for culturing the blue-green algae under red or blue light.

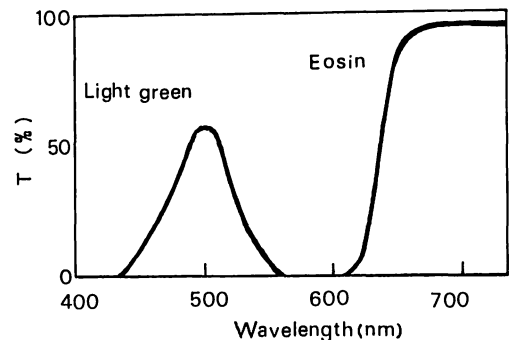


Fig. 3. Transmission spectra of 0.002 M eosin solution and 0.001 M light green solution used in the present study.

中で水で冷やしながらホモゲナイズした後, 超音波発生器で20分間処理した。次に, 冷暗所に一晚放置した後, 10,000 rpm, 4°C で1時間遠心分離した。磷酸緩衝液による抽出は計2回行い, 得られた抽出液を混合して, その吸収スペクトルを測定した。また, 残渣を90%アセトン中に懸濁させ, 無色になるまで抽出と遠心分離をくりかえし, 抽出液を混合し, その吸収スペクトルを測定した。吸収スペクトルの測定には Hitachi 100-50 形ダブルビーム分光光度計を用いた。クロロフィル a は SCOR-UNESCO (1966), カロチノイドは

PARSONS and STRICKLAND (1963), フィコビルン蛋白は藤田 (1965) の式により含有量を求めた。色素の抽出および測定は、光の影響を排除するために暗所に近い状態で行った。

結 果

ウミゾウメンとその内生藍藻の磷酸緩衝液による抽出液 (フィコビルン蛋白) と90%アセトン抽出液 (クロフィルとカロチノイド)の吸収スペクトルを Fig. 4 と Fig. 5 に示した。90%アセトン抽出液の吸収スペクトルはウミゾウメンと内生藍藻との間で著しい相違はなかったが、磷酸緩衝液では異なった吸収スペクトルが見られた。すなわち、ウミゾウメンの磷酸緩衝液の吸収スペクトルは主に460から580 nmの光を吸収し、吸収極大は565 nm付近にあったのに対して、内生藍藻のそれは550から640 nmに顕著な吸収が見ら

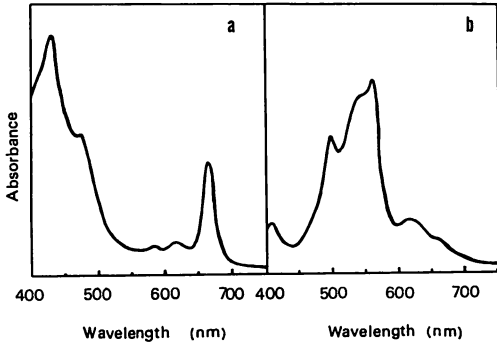


Fig. 4. Absorption spectra of 90% acetone (a) and phosphate buffer (b) extracts from *Nemalion vermiculare* with endophytic blue-green algae.

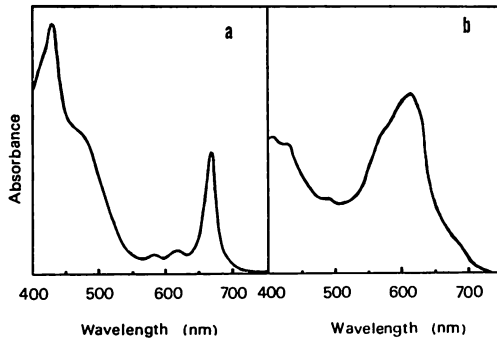


Fig. 5. Absorption spectra of 90% acetone (a) and phosphate buffer (b) extracts from mixed cultures of two endophytic blue-green algae, *Calothrix parasitica* and *Phormidium* sp. immediately after being isolated from the host alga.

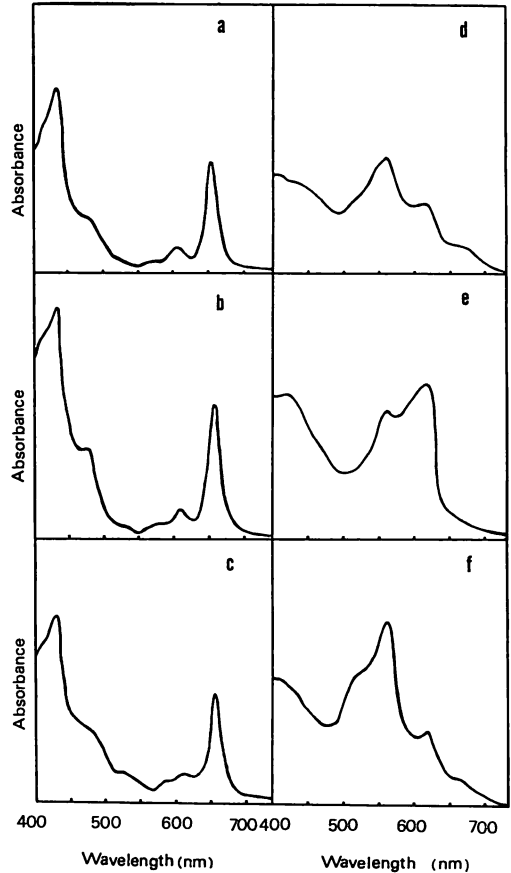


Fig. 6. Absorption spectra of 90% acetone (a-c) and phosphate buffer (d-f) extracts from a mixed cultures of two endophytic blue-green algae, *Calothrix parasitica* and *Phormidium* sp. after being incubated at 20°C with a 12:12h LD cycle for 14 days under white light ($1.20 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) (a, d), red light ($1.28 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) (b, e) or blue light ($1.16 \text{ W} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) (c, f).

れ、吸収極大は620 nm付近にあった。

白色光、青色光または赤色光を用いて2週間培養した内生藍藻の磷酸緩衝液による抽出液と90%アセトン抽出液の吸収スペクトルを Fig. 6 に示した。90%アセトン抽出液の吸収スペクトル (Figs 6a, b, c) ではいずれの光で培養した藻体も著しい違いはなかった。しかし、磷酸緩衝液による抽出液の吸収スペクトルでは若干の相違が見られた。すなわち、青色光で培養した藻体の抽出液では吸収極大が565 nm付近にあったが (Fig. 6f), 赤色光で培養した藻体のそれでは620 nm付近に吸収極大が見られた (Fig. 6e)。また、白色光の下で培養した藻体からの抽出液は青色光で培養

Table 1. Contents ($\mu\text{g}/\text{mg}$ d.w.) of chlorophyll *a* (Chl. *a*), total carotenoids (Carot.), phycocyanin (PC) and phycoerythrin (PE) in two endophytic species of blue-green algae, *Calothrix parasitica* and *Phormidium* sp. Cells were grown in mixed cultures under white light (W, $1.20 \text{ W}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$), blue light (B, $1.16 \text{ W}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) or red light (R, $1.28 \text{ W}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) for 7 and 14 days at 20°C with a 12:12 h LD cycle.

Days	Chl. <i>a</i>	Carot.	PC	PE	PC+PE
0	31.5	6.61	69.7	35.9	105.6
(W)	40.0	7.50	86.6	61.4	148.0
7 (B)	15.4	3.02	29.2	28.5	57.7
(R)	31.3	6.31	78.4	46.8	125.2
(W)	25.4	4.38	92.4	52.2	144.6
14 (B)	13.9	2.23	27.7	30.3	58.0
(R)	31.9	5.22	82.4	21.6	104.0

Table 2. The ratios of pigment contents in two endophytic species of blue-green algae, *Calothrix parasitica* and *Phormidium* sp., which were grown in mixed cultures as shown in Table 1.

Days	PC	PE	PC+PE	Carot.	PC
	Chl. <i>a</i>	Chl. <i>a</i>	Chl. <i>a</i>	Chl. <i>a</i>	PE
0	2.21	1.14	3.35	0.21	1.94
(W)	2.17	1.54	3.70	0.19	1.41
7 (B)	1.90	1.85	3.75	0.20	1.02
(R)	2.50	1.50	4.00	0.20	1.68
(W)	3.64	2.06	5.69	0.17	1.77
14 (B)	1.99	2.18	4.17	0.16	0.91
(R)	2.58	0.68	3.26	0.16	3.81

した藻体の場合と似た吸収スペクトルを示した (Fig. 6d)。

白色光, 青色光または赤色光の下で0日間, 7日間および14日間培養した内生藍藻の乾燥重量 1 mg 当りのクロロフィル *a*, カロチノイド, フィコビルン蛋白の各含有量と, クロロフィル *a* 量に対する各色素の比およびフィコシアニンに対するフィコエリスリンの量比を, それぞれ Table 1 と Table 2 に示した。クロロフィル *a* 量は, 乾燥重量の 1.39% から 4.04% を占め, 全培養期間を通して, 赤色光で培養した藻体の方が青色光で培養した藻体よりも含有量は多かった。また, カロチノイド量は培養に用いた光の波長に対してクロロフィル *a* 量と同様な傾向を示したが, 含有量は藻体乾燥重量の 1% 以下で, クロロフィル *a* に対する量比も 0.16 から 0.20 であった。一方, フィコビルン蛋白の含有量は藻体乾燥重量の 5.8% から 14.8% に

達し, クロロフィル *a* 量に対する比は 3.26 から 5.69 の間であった。クロロフィル *a* 量に対するフィコエリスリンの比は, 培養7日目ではそれぞれの光で培養した藻体とも殆んど変わらず 1.50 から 1.85 の間であったが, 培養14日目には赤色光の下で培養した藻体では 0.68 となり, 青色光の下での値 2.18 と比べて著しく低かった。クロロフィル *a* 量に対するフィコシアニンの比は, 全培養期間を通じて赤色光の下で生育した藻体の方が青色光で生育した藻体より高く, 培養7日目では赤色光下で 2.50, 青色光下で 1.90 の値を示し, これらは培養14日目になっても殆んど変わらなかった。また, フィコシアニンに対するフィコエリスリンの量比は, 赤色光下では培養7日目の藻体で 1.68, 培養14日目の藻体で 3.81 を示したが, 青色光下では全般に低く, 1.0 前後であった。

考 察

本実験において、ウミゾウメンより磷酸緩衝液で抽出した色素の吸収スペクトルでは、著しい吸収が 460 から 580 nm に見られたが、内生藍藻では 550 から 640 nm に存在した。これはウミゾウメンのフィコビルン蛋白が比較的吸収しない波長域の光を、内生藍藻のフィコビルン蛋白がよく吸収することを示している。

青色光を用いて 2 週間培養した内生藍藻から磷酸緩衝液で抽出した色素の吸収スペクトルでは 565 nm 付近に、また赤色光を用いた場合には 620 nm 付近にそれぞれ吸収極大が見られた。565 nm と 620 nm の吸収極大はそれぞれフィコエリスリンとフィコシアニンの吸収極大と一致し、これら 2 種のフィコビルン蛋白の含有量は培養に用いた光の波長により変化した。藍藻 *Tolypothrix tenuis* KÜTZ. では、緑色光はフィコエリスリン合成を促進し、赤色光はフィコシアニン合成を促進するが、クロロフィル *a* やカロチノイドではこのような変化は起らない (FUJITA and HATTORI 1960, 1962)。また藍藻 *Fremyella diplosiphon* (B. et F.) DROUET を白色光下から赤色光下に移すとフィコエリスリン合成が停止し、クロロフィル *a* 量に対するフィコエリスリン含有量は著しく低下した (BENNETT and BOGORAD 1973)。本実験においては、赤色光で培養したウミゾウメンの内生藍藻のフィコシアニン含有量は増加し、フィコシアニンに対するフィコエリスリンの含有量の比は、青色光や白色光の下で培養した藻体に比べて高くなった。一方、青色光の下ではフィコシアニンもフィコエリスリンも含有量が著しく増加することはなかった。フィコビルン蛋白は藍藻類や紅藻類の主要な光エネルギー捕獲色素であり (藤田 1981)、その含有量の変化は内生藍藻の光合成に大きく影響するであろう。緑藻 *Codium bursa* の内生藍藻 *Phormidium codicola* は 550 nm の光の下で最も高い光合成能を示すが、これは含有するフィコビルン蛋白の吸収スペクトルと密接な関係を有していた (JACOB 1961)。今回用いた内生藍藻の一種 *Calothrix parasitica* を赤色光または青色光の下で 2 週間培養した後に、培養に用いた光の下で光合成能を測定すると、青色光で培養した藻体よりも赤色光で培養した藻体の方から高い活性が得られた (鈴木・正置 1982)。これは、上述のフィコビルン蛋白の含有量の変化と密接な関係をもつものと考えられる。また、カロチノイドはフィコビルン蛋白に比べて含有量は少なく、かつ、クロロフィル *a* 量に対する含有量の比も培養に用いた光

の波長によって大きく変動することはなかったことから、内生藍藻の光の質 (波長) に対する適応には、フィコビルン蛋白ほどは貢献していないものと考えられる。

以上により、本実験に用いたウミゾウメンの内生藍藻は、赤色光を効率よく吸収するためにフィコビルン蛋白の含有量を調整する能力を持つものと考えられる。

終りに本研究に対し、御指導と御校閲をいただいた北海道大学水産学部の辻野勇教授に心から感謝の意を表する。

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第12回国際海藻会議 (The XIIth International Seaweed Symposium) 案内

第12回国際海藻会議が明年(61年)7-8月サンパウロ大学にて開催されます。その概要は次の通りです。

会 期: 1986年7月27日~8月1日

会 場: ブラジル国 サンパウロ市 サンパウロ大学

テ ー マ: 変転する世界における海藻利用の新しい発展

講 演 (研究発表): 全体講演, 招待講演 (ミニシンポジウム), 一般講演, 展示講演など。一般講演は応用藻類学に関するもので, 特に (1) 有用藻類の生物学, 分類学, 生理学, 生態学, 遺伝学 (2) 藻類及び藻類成分の化学, 生化学 (3) 商業用藻類とその製品の生産, 利用, 加工などが主な対象分野である。

公式使用語: 英語

講 演 要 旨: 所定の用紙を使って1986年2月28日までに会議事務局へ提出する。

会 議 録 (Proceedings): 発表論文は審査を受けてから掲載。原稿の作り方は 3rd Circular で案内。

参 加 費 (ホテル-会場間の運賃, 開会カクテル, 晩餐会, 会議録の経費を含む):

1986年1月31日まで (参加者) 160 USドル, (同伴者) 10 USドル。

2月1日以後 (参加者) 210 USドル, (同伴者) 10 USドル。

エクスカーション: 会期前後に9つのエクスカーションが企画されている。

締 切 日: 講演要旨提出 1986年2月28日; 参加申込及び送金 1月31日; 参加申込及び送金 (割増料金)

5月1日; ホテル予約 5月1日; 会議録用原稿提出 7月27日。

会議事務局アドレス: Secretariat, XIIth International Seaweed Symposium, Especifica S/C Ltda., Caixa Postal 51.502, 01414 Sao Paulo SP, Brasil.

申込用紙その他の案内をご希望の方は下記にご連絡ください。コピーをお送りします。

108 東京都港区港南 4-5-7 東京水産大学 有賀祐勝

紅藻ヒダトリギヌについて

三上日出夫

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MIKAMI, H. 1985. Some observations on *Apoglossum minimum* YAMADA (Delesseriaceae, Rhodophyta). Jap. J. Phycol. 33: 245-248.

Morphological studies were carried out on the vegetative thallus and procarp structure of *Apoglossum minimum* YAMADA on the basis of the original specimens. As a result, the following data were obtained: 1) a transversely dividing apical cell is present, 2) intercalary cell divisions occur in the cell rows of the second order, 3) not all the apical cells of the third order reach the thallus margin, 4) lateral pericentral cells are undivided, 5) the thallus is monostromatic except the midrib, and is branching from the midrib, 6) no lateral veins are present, 7) a central layer of large medullary cells are surrounded by many rhizoidal cells, and 8) the procarps are borne acropetally on the first order cell rows and consist of 2 sterile groups and a 4-celled carpogonial branch. These features support well the systematic position of this species in the genus *Apoglossum*.

Key Index Words: Apical segmentation; *Apoglossum minimum*; *Delesseriaceae*; procarp; *Rhodophyta*; taxonomy.

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生物学御研究所に所蔵されているヒダトリギヌは昭和15年、神奈川県葉山付近の佐島沖より初めて採集され、YAMADA (1944) により *Apoglossum minimum* として文章のみによる新種記載が行なわれたが、その後今日まで本種についての採集記録、写真及び図版などは全く示されていない。幸いにも、ごく最近になって特別に貸し出しを認められた生物学御研究所の原標本にふれることができた結果、本種についてこれまでに全く確認できていなかった幾つかの重要な性質を明らかにすることができたので次に報告する。

供試材料

現在、生物学御研究所に所蔵されている本種の腊葉標本は、このたび貸し出された1個体だけとのことであり、そのラベル上には No. 1214 (海藻標本番号)、S. 620 (相模産標本番号)、2130 a (YAMADA 同定番号) と示されている (Fig. A) が、更にこれは YAMADA (1944, p. 13) 報文中の No. 2348 に相当するもので、ごく若い雌性体であることがわかった。そこでこれを選定タイプ標本 (Lectotype) と定めて観察した。その外に本種同定の際に貸し下げられた本種の別個体に基づき YAMADA によって作製されたプレパラート標

本3枚 (北大理学部 SAP 保存) をあわせて観察に用いた。

結 果

(1) 外形: 本種の外形的特徴については YAMADA (1944) の原記載に殆んど一致している (Fig. A)。即ち、体は不規則な盤状根をもち、基部は円柱状、中肋は明瞭であるが肉眼的及び顕微鏡の側脈はない。中肋より生ずる小葉は倒卵形～楕円形である。小葉の先は一般に鈍形であるが、乾燥体ではその縁辺が内側に折れ曲がるために先が尖って見える部分も見られる。

(2) 生長点の構造: Fig. B は本種のごく若い生長点、Fig. C はそれに続く時期の生長点を示す。即ち、横に関節する頂細胞 (a) をもち介生分裂 (in) は第1位細胞列内には存在しないが、第2位細胞列に至って明らかに認められる。第2位細胞列からはしきりに第3位の細胞列を生ずるが、第3位細胞列の先端はその殆んどが体の縁辺に達することはない。Lateral 周細胞 (pc) は上下に分割されることなく、そのまま存在する。

(3) 体の内部構造: 体は中肋部を除いて1層の細胞から成り立つ。Fig. D は中肋を含む体の横断面を示

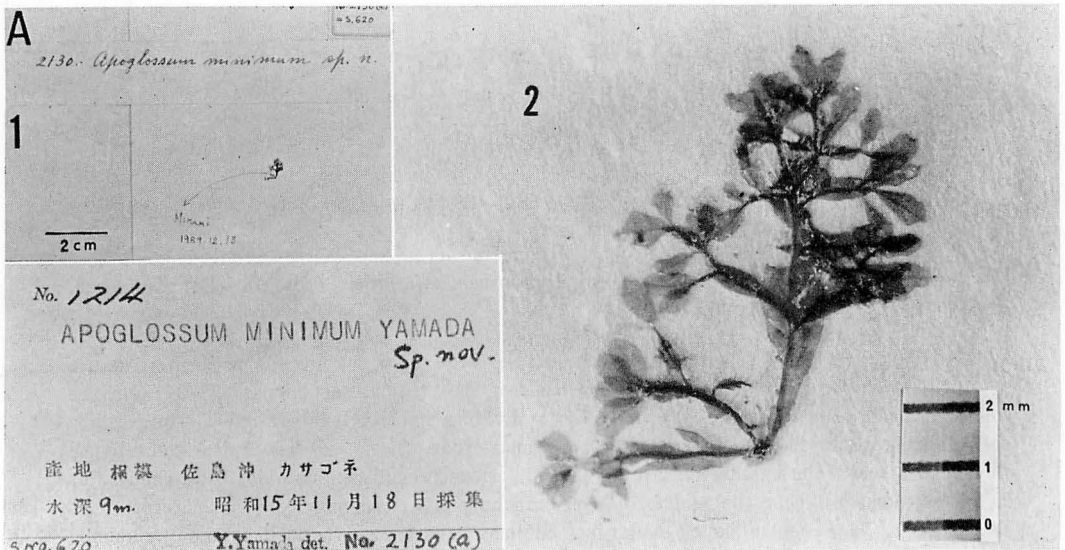


Fig. A. *Apoglossum minimum* YAMADA. 1. The lectotype specimen in the herbarium of the Biological Laboratory, Imperial Palace (s. 620); collected from Sajima-oki, near Hayama, Kanagawa prefecture on November 18, 1940. 2. The same, more highly magnified.

す。即ち、体の中央部に大型の中心細胞 (cc) と周細胞 (pc) などが並び、それらを取り囲んで小型の根状細胞が多数存在している。

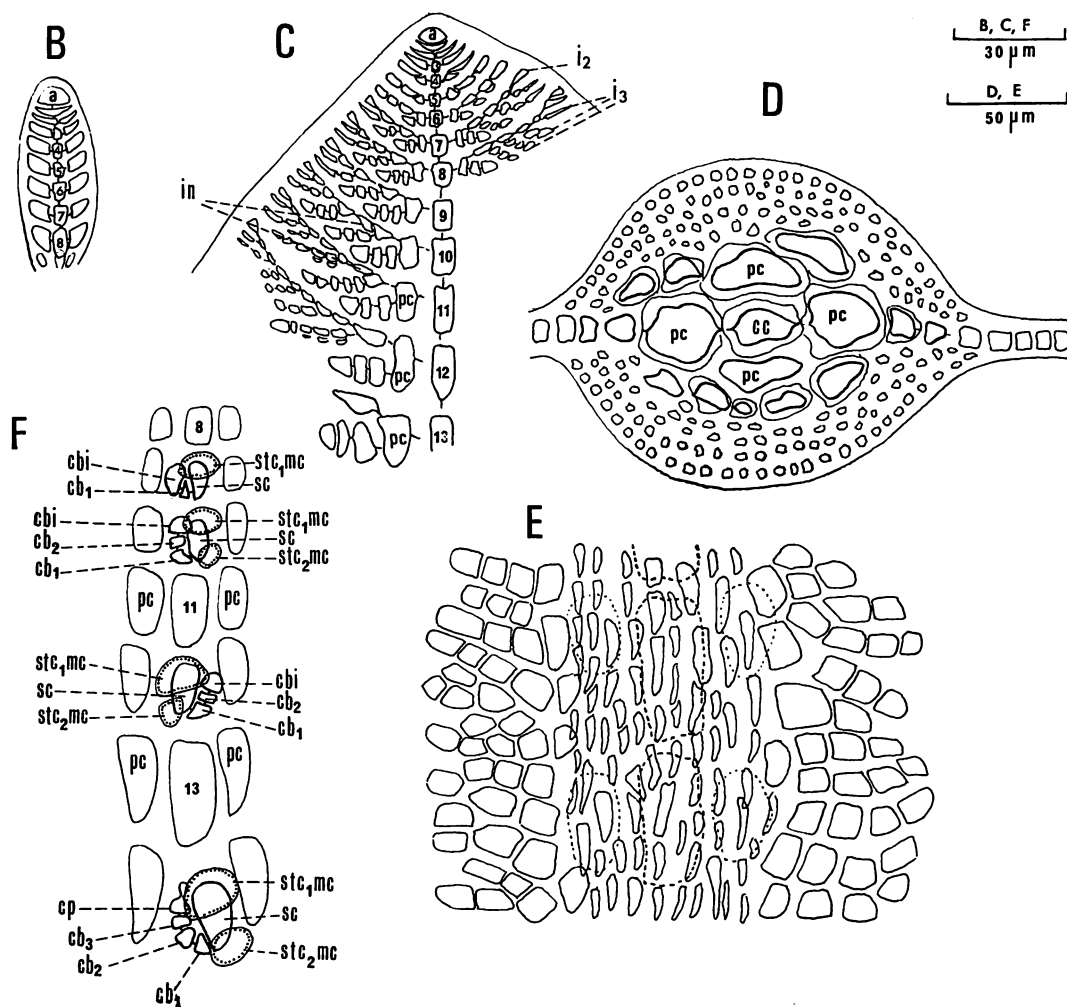
(4) プロカルブ：本種のプロカルブは生長点第1位細胞列上に求頂的に1列に並んで生ずる。Fig. F はその発生過程の一端を示す。即ち、最初のプロカルブは先端細胞より下方に数えて第9番目の位置において現われ、先ず支持細胞 (sc) より第1次の中性母細胞 (stc₁mc) を体の表側に切り出す一方、同じ支持細胞より側方に向って切り出された2ヶ細胞よりなるカルボゴン枝 (cb₁, cdi) の像が見られた。続く第10番目の位置においては、カルボゴン枝は3ヶ細胞 (cb₁, cb₂, cbi) に分割し、カルボゴン枝の第1細胞 (cb₁) と左右対称の位置に第2次中性母細胞 (stc₂mc) の発生が認められた。更に発生段階が進みほぼ完成期に近づいたと見られる像が第14番目の位置に認められた。即ち、支持細胞 (sc) から生じた4ヶ細胞より成るカルボゴン枝1組と、同じ支持細胞から生じた2組 (第1次、第2次) の中性細胞が見られ、しかも2組の中性細胞は共に母細胞のままの状態 (stc₁mc, stc₂mc) として確認された。

考 察

KYLIN (1924, 1956) は *Apoglossum* 属 (J. AGARDH 1898) に所属する世界からの種類として *Apoglossum ruscifolium* (TURN.) J. AG. (タイプ種, ヨーロッ

パ大西洋沿岸産), *A. oppositifolium* (HARV.) J. AG. (ニュージーランド産), *A. montagneanum* (J. AG.) J. AG. (ニュージーランド産) 及び *A. tasmanicum* (MÜLL.) J. AG. (タスマニア産) の4種類のみを掲げた。これに対して日本産の本種 *Apoglossum minimum* YAMADA (ヒダトリギス) は既に1944年に発表済みであり、しかも初めて太平洋海域からの発見種にもかかわらず全く KYLIN (1956) が本種に触れることを避けたのは、恐らく YAMADA (1944) の原記載に本種の写真、図版が全く用いられず、ただ文章記述のみであったためかと考えられる。

さて *Apoglossum* 属は分類上、コノハノリ科 (Delesseriaceae), コノハノリ亜科 (Delesserioideae) の中の *Delesseria* group (tribe) に置かれている。*Delesseria* group の中には現在次の9属が知られている (WYNNE 1983)。即ち, *Phrix*, *Odontolaingia*, *Pseudolaingia*, *Laingia*, *Yamadaphycus*, *Marionnella*, *Microrhinus*, *Delesseria* そして *Apoglossum* がそれである。以上9属の中で *Apoglossum* 属は *Delesseria* 属に最も近縁とみなされ、その共通点として 1) プロカルブは第1位細胞列上に1列に並んで生ずること, 2) 生長点は横に関節する頂細胞をもつ, 3) 第1位細胞列内に介生分裂が無く, 第2位細胞列に至ってそれが存在することなどが挙げられる。以上に掲げた諸性質は今回の観察を通してそれぞれを確認することができた。即ち先に述べたように先ず本種の



Figs B-F. *Apoglossum minimum* YAMADA. B. Early stage in development of frond. C. Apex of frond showing apical segmentation. D. Transverse section of thallus. E. Surface view of midrib with rhizoidal cells. F. Apical part of proliferation showing stages in development of procarp. 3-13. segments of apical cell; a. apical cell; cb_1, cb_2, cb_3 , first, second, and third cells of carpogonial branch, respectively; cb_1 . initial cell of carpogonial branch; cc . central cell; cp . carpegonium; i_2, i_3 . initial cells of cell rows of second and third order, respectively; in . intercalary cell; pc . pericentral cell; sc . supporting cell; stc_1, mc, stc_2, mc . mother cells of first and second groups of sterile cells, respectively.

プロカルブは第1位の細胞列上に1列に並んで求頂的に形成され、1組のカルポゴン枝と2組の中性細胞とから成り立っていることが Fig. F のように確かめられた。次に生長点における介生分裂の出現に関しては、Fig. C に示したように第1位の細胞列上には全く存在しないが、第1位列の先端から10番目の位置から生ずる第2位細胞列内に至って初めて現われてくること確かめられた。一方これに対して *Apoglossum* 属を *Delesseria* から区別するための重要な点として先

ずその lateral 周心細胞の性質の相違を挙げるができる (KYLIN 1923)。即ち、*Delesseria* の場合の lateral 周心細胞はそれぞれが横分裂によって上下2細胞に分割されるのに対して、*Apoglossum* の場合ではその lateral 周心細胞に横分裂のきざしが全く認められることが無く、従って各々が単一の細胞のままであることが Fig. C (pc) のように確かめられた。次に体の内部構造についての区別点として先ず *Delesseria* の場合は大型の髓細胞と小型の根状細胞とが互

いに入り混じる (KYLIN 1923, Fig. 62) のに対して *Apoglossum* では中央の大型細胞の回りを小型の根状細胞が包囲するように位置する特徴 (KYLIN 1923, Fig. 55) をもつことが本種について Fig. D のように確かめることができた。従って以上の事柄から YAMADA (1944) がヒダトリギヌを *Apoglossum* 属に当て、*A. minimum* YAMADA とした根拠並びにその妥当性がここに改めて確認される結果となった。なお、YAMADA (1944) の原記載には本種の雄性体及び四分孢子体についても同時に記載が行なわれた。そしてその後それらの標本の返還が確かに行なわれたことの記録が残されているにもかかわらず、今日の生物学御研究所には全くそれらが所蔵されていない由である。恐らく非常事態下にあった当時の輸送事情に災いされたの結果としか思われてならない。

終りにのぞみ重要な原標本の特別貸与につき御認可を賜わった生物学御研究所に対してつつしんで深謝を表します。また終始懇切な助言と御配慮をいただいた黒木宗尚北大名誉教授に対し、また標本の写真をまと

めていていただいた北大理学部植物分類学講座の川井浩史博士に厚く御礼申し上げます。

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吉田忠生*・中嶋 泰**・中田由和**：日本産海藻目録—II. 紅藻 Tadao YOSHIDA, Yasushi NAKAJIMA and Yoshikazu NAKATA: Preliminary check-list of marine benthic algae of Japan—II. Rhodophyceae.

紅藻の目 Order について最近多くの意見が出されている。ここでは *Palmariales* を除いて大部分 KYLIN (1956) の体系に従っておく、科の配列も従来通りで、属と種はアルファベット順とした。貴重な御意見を下さった札幌大学三上日出夫博士と北海道大学理学部増田道夫博士に感謝する。

RHODOPHYCEAE RABENHORST, 1863 紅藻綱
(BANGIOPHYCEAE CRONQUIST, 1960)

PORPHYRIDIALES KYLIN, 1937 ちのりも目
Goniotrichaceae G. M. SMITH, 1933 べにみどろ科
Asterocytis (HANS GIRG) GOBI ex SCHMITZ, 1896
アステロキティス属 (1)

echigoensis NODA えちごたまつなぎ, えちごたま
のいと (2)

Bangiopsis SCHMITZ in ENGLER et PRANTL, 1897
にせうしけのり属

subsimplex (MONTAGNE) SCHMITZ in ENGLER
et PRANTL にせうしけのり

[*Goniotrichum humphreyi* sensu TANAKA]

Chroodactylon HANS GIRG, 1885 たまつなぎ属
ornatum (C. AGARDH) BASSON たまつなぎ (3)

[*Asterocytis ornata*]

Colacodictyon J. FELDMANN, 1955 あみまゆだま属
reticulatum (BATTERS) J. FELDMANN あみまゆ
だま

[*Colaconema reticulatum*]

Goniotrichum KÜTZING, 1843 べにみどろ属
alsidii (ZANARDINI) HOWE べにみどろ

[*elegans*]

cornu-cervi (REINSCH) HAUCK かずのほしのいと

ERYTHROPELTIDALES GARBARY, HANSEN
et SCAGEL, 1980 エリスロペルティス目

Erythropeltidaceae SKUJA, 1939 エリスロペルテ
ィス科

Erythrocladia ROSEN VINGE, 1909 いそはなび属

irregularis ROSEN VINGE いそはなび, とげいそは

なび

[*subintegra*]

Erythrotrichia ARESCHOUG, 1850 nom. cons.

ほしのいと属 (4)

carnea (DILLWYN) J. AGARDH ほしのいと

[*biseriata*]

[*reflexa*]

incrassata TANAKA いそりぼん (5)

japonica TOKIDA ほしのおび

[*Bangia ciliata*]

parietalis TANAKA いとりぼん (5)

pulvinata NODA et HONDA in HONDA et NODA

regularis NODA

sargassicola NODA

Porphyropsis ROSEN VINGE, 1909 ひなのり属

coccinea (J. AGARDH ex ARESCHOUG)

ROSEN VINGE ひなのり

BANGIALES SCHMITZ in ENGLER, 1892

うしけのり目

Bangiaceae ENGLER, 1892 うしけのり科

Bangia LYNGBYE, 1819 うしけのり属

atropurpurea (ROTH) C. AGARDH うしけのり

(74)

[*fuscopurpurea*]

gloiopeltidicola TANAKA ふのりのうしげ

Porphyra C. AGARDH, 1824 nom. cons. あまのり属

akasakae MIURA むろねあまのり

amplissima (KJELLMAN) SETCHELL et HUS in

HUS べにたさ (6)

angusta OKAMURA et UEDA in UEDA こすじの

り (7)

bulbopes (YENDO) OKAMURA ふくろたさ

crassa UEDA あつばあまのり

crispata KJELLMAN つくしあまのり

dentata KJELLMAN おにあまのり

irregularis FUKUHARA えりもあまのり

ishigecola MIURA べんてんあまのり

katadae MIURA そめわけあまのり

kinositae (YAMADA et TANAKA) FUKUHARA

うたすつり

kuniedae KUROGI まるばあさくさのり

lacerata MIURA やぶれあまのり

moriensis OHMI かやべのり

occidentalis SETCHELL et HUS in HUS きいろた
さ

ochotensis NAGAI あなあまのり (8)

[*perforata* sensu YENDO]

okamurae UEDA くろのり

ono UEDA おおのり

[*abyssicola* sensu UEDA]

pseudocrassa YAMADA et MIKAMI in MIKAMI

まくれあまのり

pseudolinearis UEDA うっぶるいのり

punctata YAMADA et MIKAMI in MIKAMI

すなごあまのり

purpurea (ROTH) C. AGARDH ちしまくろのり

[*umbilicalis* auct. japon]

seriata KJELLMAN いちまつのり

suborbiculata KJELLMAN まるばあまのり (9)

tanegashimensis SHINMURA たねがしまあまのり

tasa (YENDO) UEDA たさ

tenera KJELLMAN あさくさのり

tenuipedalis MIURA かいがらあまのり

variegata (KJELLMAN) KJELLMAN in HUS

ふいりたさ

[*tenuitasa*]

[*uedae*]

yezoensis UEDA すさびのり (10)

NEMALIONALES SCHMITZ in ENGLER, 1892

うみぞうめん目 (11)

Acrochaetiaceae FRITSCH ex W. R. TAYLOR,

1957 アクロケチウム科

[*Audouinellaceae* WOELKERLING, 1971]

Acrochaetium NÄGELI, 1862 アクロケチウム属 (12)

immersum (ROSENINGE) HAMEL

[*Chantransia immersa*]

sargassicaulinum NODA in NODA et KITAMI

toyamense NODA et HONDA in HONDA et NODA

Audouinella BORY, 1823 オーデュイネラ属 (13)

alariae (JÓNSSON) WOELKERLING

attenuatum (ROSENINGE) GARBARY

[*Rhodochorton attenuatum*]

callithamnionoides (NAKAMURA) GARBARY

[*Rhodochorton callithamnionoides*]

codicola (BØRGESEN) GARBARY

[*Rhodochorton codicola*]

codii (CROUAN frat.) GARBARY

[*Rhodochorton codii*]

daviesii (DILLWYN) WOELKERLING

[*Rhodochorton daviesii*]

densa (DREW) GARBARY

[*Rhodochorton densum*]

[*arcuatum*]

howei (YAMADA) GARBARY みるのべに

[*Acrochaetium howei*]

[*Rhodochorton affine* YAMADA]

[*Rhodochorton howei*]

hyalosiphoniae (NAKAMURA) GARBARY

[*Rhodochorton hyalosiphoniae*]

infestans (HOWE et HOYT) DIXON in PARKE et
DIXON

[*Rhodochorton infestans*]

kurogii Y. P. LEE et LINDSTROM はねべにのいと

microscopica (NÄGELI in KÜTZING)

WOELKERLING

[*catenulata*]

[*crassipes*]

[*moniliformis*]

occidentalis (BØRGESEN) GARBARY

plumosa (DREW) GARBARY

[*Rhodochorton plumosum*]

polyspora (HOWE) GARBARY

purpurea (LIGHTFOOT) WOELKERLING

[*Rhodochorton purpureum*]

[*Rhodochorton rothii*]

radiatum JAO

rhizoidea (DREW) GARBARY

robusta (BØRGESEN) GARBARY

[*Rhodochorton robustum*]

ryukyuensis (NAKAMURA) GARBARY

[*Rhodochorton ryukyuensis*]

sanctae-thomae (BØRGESEN) GARBARY

[*Rhodochorton sanctae-thomae*]

secundata (LYNGBYE) WOELKERLING

[*Chantransia secundata*]

seriata (BØRGESEN) GARBARY

sessilis (NAKAMURA) GARBARY

[*Rhodochorton sessile*]
subimmersum (SETCHELL et GARDNER)

GARBARY et RUENESS

[*Rhodochorton subimmersum*]

terminalis (NAKAMURA) GARBARY

[*Kylinia terminalis*]

[*Rhodochorton terminale*]

Colaconema BATTERS, 1896 べにまゆだま属

furcata TANAKA よなくにまゆだま

simplex INAGAKI べにまゆだま

[*Acrochaetium japonicum*]

Rhodochortonopsis YAMADA, 1944 かいめんしぼり
 属

spongicola YAMADA かいめんしぼり

Helminthocladiaceae J. AGARDH, 1851 べにもず
 く科

[*Nemalionaceae* (FARLOW) DE TONI et LEVI,
 1886]

Helminthocladia J. AGARDH, 1851 nom. cons.

べにもずく属

australis HARVEY べにもずく

macrocephala YAMADA しまべにもずく

yendoana NARITA ほそべにもずく

Liagora LAMOUROUX, 1812 こなはだ属 (14)

boergesenii YAMADA すじこなはだ

boninensis YAMADA ぼうにんこなはだ

ceranoides LAMOUROUX

f. *leprosa* (J. AGARDH) YAMADA あおこな
 はだ

[*leprosa*]

f. *pulverulenta* (C. AGARDH) YAMADA
 こなはだ

clavata YAMADA ふくれこなはだ

farinosa LAMOUROUX けこなはだ

[*Ganonema farinosa*]

[*cheyneana*]

hawaiiiana BUTTERS

japonica YAMADA よごれこなはだ

[*cliftoni* sensu YENDO]

mucosissima YAMADA ぬるはだ

orientalis J. AGARDH ぶさこなはだ

papenfussii ABBOTT はねこなはだ

[*pinnata* sensu YAMADA]

robusta YAMADA たちこなはだ

segawae YAMADA みぞこなはだ

setchellii YAMADA いしはだ

[*valida* sensu OKAMURA]

tanakae ABBOTT

Liagoropsis YAMADA, 1944 にせこなはだ属

yamadae OHMI et ITONO

Nemalion DUBY, 1830 うみぞうめん属

multifidum (WEBER et MOHR) J. AGARDH

つくものり (15)

vermiculare SURINGAR うみぞうめん

Trichogloea KÜTZING, 1847 あけぼのもずく属

papenfussii TANAKA よごれあけぼのもずく

requienii (MONTAGNE) KÜTZING あけぼのもず
 く

[*lubrica*]

subnuda HOWE

Dermonemataceae (SCHMITZ et HAUPTFLEISCH)
 ABBOTT, 1976 かさまつ科

Dermonema HARVEY ex HEYDRICH, 1894 かさまつ
 属

divaricata OKAMURA et SEGAWA in OKAMURA

しまかさまつ

frappieri (MONTAGNE et MILLARDET)

BØRGESEN かさまつ

[*gracile*]

pulvinatum (GRUNOW in HOLMES) FAN かもが
 しらのり

[*Nemalion pulvinatum*]

Yamadaella ABBOTT, 1970 はいこなはだ属

caenomyce (DECAISNE) ABBOTT はいこなはだ

[*Liagora annulata* sensu YENDO]

[*Liagora caenomyce*]

[*Liagora rugosa*]

Galaxauraceae PARKINSON, 1983 がらがら科

[*Chaetangiaceae* KÜTZING, 1843]

Actinotrichia DECAISNE, 1842 そでがらみ属

fragilis (FORSSKÅL) BØRGESEN そでがらみ

[*rigida*]

robusta ITONO しまそでがらみ

Galaxaura LAMOUROUX, 1816 がらがら属 (16)

apiculata KJELLMAN ぎぼうしがらがら

arborea KJELLMAN ほそばがらがら

articulata TANAKA くだがらがら

- clavigera* KJELLMAN あつばがらがら
contigua KJELLMAN
cuculligera KJELLMAN つくしがらがら
cylindrica (SOLANDER) LAMOUROUX
delabida KJELLMAN もつれがらがら
elongata J. AGARDH なががらがら
falcata KJELLMAN ひらがらがら
fasciculata KJELLMAN びろうどがらがら
fastigiata DECAISNE がらがら
filamentosa CHOU in TAYLOR ふさがらがら
 [rudis]
glabriuscula KJELLMAN つやがらがら
hystrix KJELLMAN へらがらがら
kjellmanii WEBER van BOSSE さめはだがらがら
oblongata (SOLANDER) LAMOUROUX
obtusata (SOLANDER) LAMOUROUX ふくろがらがら
 ー
pacifica TANAKA ちゃぼがらがら
papillata KJELLMAN ぼびらがらがら
pilifera KJELLMAN
robusta KJELLMAN じゅずがらがら
subfruticulosa CHOU in TAYLOR もさがらがら
 [fruticulosa]
subverticillata KJELLMAN しまがらがら
verprecula KJELLMAN うすばがらがら
yaeyamensis TANAKA うしゅくがらがら
yamadae ITONO
Pseudogloiophloea LEVRING, 1955 にせふさのり属
okamurae (SETCHELL) CHIHARA にせふさのり
 [Gloiophloea okamurae]
Scinaia BIVONA, 1822 ふさのり属
japonica SETCHELL ふさのり
laticrons HOWE ひらふさのり
 [cottonii]
moniliformis J. AGARDH じゅずふさのり

Bonnemaisoniaceae SCHMITZ in ENGLER, 1892
 かぎけのり科 (17)
Asparagopsis MONTAGNE, 1841 かぎけのり属
taxiformis (DELILE) TREVISAN かぎけのり (18)
 [sanfordiana]
Bonnemaisonia C. AGARDH, 1822 かぎのり属
hamifera HARIOT かぎのり (19)
 [Asparagopsis hamifera]
Delisea LAMOUROUX, 1819 たまいただき属

fimbriata (LAMOUROUX) LAMOUROUX たまいた
 だき
 [pulchra]
okadae (YAMADA) CHIHARA ひろはたまいただき
 [Ptilonia okadae]

GELIDIALES KYLIN, 1923 てんぐさ目 (20)
Gelidiaceae KÜTZING, 1843 てんぐさ科
Acanthopeltis OKAMURA in YATABE, 1892 ゆいきり属
japonica OKAMURA in YATABE ゆいきり
Beckerella KYLIN, 1956 ひらくさ属
irregularis AKATSUKA et MASAKI ながひらくさ
subcostata (OKAMURA in SCHMITZ) KYLIN
 ひらくさ
 [Gelidium subcostatum]
Gelidium LAMOUROUX, 1813 nom. cons. てんぐさ
 属 (21)
amamiensis TANAKA et K. NOZAWA in TANAKA
 しんかいひめぶと
amansii (LAMOUROUX) LAMOUROUX まくさ (22)
decumbens OKAMURA たおれぐさ
divaricatum MARTENS ひめてんぐさ
isabellae TAYLOR へらひめぶと
japonicum (HARVEY) OKAMURA おにくさ
johnstonii SETCHELL et GARDNER つやくさ (23)
linoides KÜTZING きぬぐさ
nanum INAGAKI ひめひら
pacificum OKAMURA おおぶさ
polystichum GARDNER えぞてんぐさ (23)
pulchrum GARDNER ささめぶと
purpurascens GARDNER むらさきぶと (23)
pusillum (STACKHOUSE) LE JOLIS はいてんぐさ
 (24)
 [crinale]
pyramidale GARDNER ながとぶと (23)
subfastigiatum OKAMURA なんぶぐさ
tenue OKAMURA こひら
vagum OKAMURA よれぐさ
yamadae FAN こぶさ
 [densum OKAMURA]
Pterocladia J. AGARDH, 1852 おぼくさ属
capillacea (GMELIN) BORNET in BORNET et
 THURET おぼくさ
 [tenuis]

- densa* OKAMURA かたおぼくさ
nana OKAMURA ちゃぼおぼくさ
 Yatabella OKAMURA, 1900 やたべぐさ属
hirsuta OKAMURA やたべぐさ
- Gelidiellaceae** FAN, 1961 しまてんぐさ科
 Gelidiella FELDMANN et HAMEL, 1934 しまてんぐさ属
acerosa (FORSSKÅL) FELDMANN et HAMEL
 しまてんぐさ
ramellosa (KÜTZING) FELDMANN et HAMEL
 きっこうしまてんぐさ
- CRYPTONEMIALES SCHMITZ in ENGLER,
 1892 かくれいと目
- Dumontiaceae** BORY, 1828 りゅうもんそう科 (25)
 Constantinea POSTELS et RUPRECHT, 1840 おきつばら属
rosa-marina (GMELIN) POSTELS et RUPRECHT
 おきつばら
subulifera SETCHELL おおばおきつばら
 Dudresnaya P. L. et H. M. CROUAN, 1835 nom. cons. ひびろうど属
japonica OKAMURA ひびろうど
minima OKAMURA ひめひびろうど (26)
 Dumontia LAMOUROUX, 1813 りゅうもんそう属
contorta (GMELIN) RUPRECHT りゅうもんそう
 [*filiformis*]
 [*incrassata*]
simplex COTTON へらりゅうもん
 Farlowia J. AGARDH, 1876 にせかれきぐさ属
irregularis YAMADA にせかれきぐさ
 Hyalosiphonia OKAMURA, 1909 いそうめもどき属
caespitosa OKAMURA いそうめもどき
 Neodilsea TOKIDA, 1943 あかば属
crispata MASUDA ちちれあかば
integra (KJELLMAN) A. ZINOVA
 var. *longissima* MASUDA ながあかば (78)
tenuipes YAMADA et MIKAMI, in MIKAMI
 まるばあかば
yendoana TAKIDA あかば
 [*Dilsea edulis* auct. japon.]
 Pikea HARVEY, 1852 みちがえそう属
californica HARVEY みちがえそう
- Peyssonneliaceae** DENIZOT, 1968 いわのかわ科
 [Squamariaceae J. AGARDH, 1851]
 Cruoriella CROUAN frat., 1859 いわけしょう属
fissurata DAWSON さけめいわげしょう
 [*Peyssonnelia mariti*]
 Peyssonnelia DECAISNE, 1841 いわのかわ属
caulifera OKAMURA えつきいわのかわ
conchicola PICCONE et GRUNOW in PICCONE
 べにいわのかわ, まよいいわのかわ
 [*rubra* sensu YENDO]
distenta (HARVEY) YAMADA くだいわのかわ
dubyi CROUAN frat.
orientalis (WEBER van BOSSE) BOUDOURESQUE
 et DENIZOT あかせいわのかわ
- Hildenbrandiaceae** ROSENVINGE, 1917 べにまだら科 (27)
 Hildbrandtia NARDO, 1834 べにまだら属 (28)
rubra (SOMMERFELT) MENEGHINI べにまだら
 [*prototypus*]
 [*rosea*]
yessoensis YENDO えぞべにまだら
- Corallinaceae** LAMOUROUX, 1812 さんごも科
 Alatocladia (YENDO) JOHANSEN, 1969 やはずしころ属
modesta (YENDO) JOHANSEN やはずしころ
 [*Calliarthron modesta*]
 [*Cheilosporum anceps* var. *modesta*]
 Amphiroa LAMOUROUX, 1812 かにのて属
beauvoisii LAMOUROUX うすかわかにのて
 [*zonata*]
dilatata LAMOUROUX かにのて
echigoensis YENDO えちごかにのて
ephedraea (LAMARCK) DECAISNE まおうかにのて
fragilissima (LINNAEUS) LAMOUROUX
misakiensis YENDO ひめかにのて
pusilla YENDO ひなかにのて
rigida LAMOUROUX いそはり
valonioides YENDO いそはりがね
yendoi DE TONI みぞかにのて
 Bossiella SILVA, 1957 いそきり属
cretacea (POSTELS et RUPRECHT) JOHANSEN
 いそきり
 [*Amphiroa cretacea*]

- Calliarthron MANZA, 1937 えぞしころ属
latissimum (YENDO) MANZA
 [*Cheilosporum latissimum*]
yessoense (YENDO) MANZA えぞしころ
 [*Cheilosporum yessoense*]
- Cheilosporum (DECAISNE) ARESCHOUG in J.
 AGARDH, 1852 ひめしころ属
anceps (KÜTZING) YENDO
jungermannii RUPRECHT in J. AGARDH
 ひめしころ
- Choreonema SCHMITZ, 1889 いいほ属
thuretii (BORNET) SCHMITZ
- Clathromorphum FOSLIE, 1898 きたいしも属
circumscriptum (STROMFELT) FOSLIE きたいし
 も
compactum (KJELLMAN) FOSLIE あなあききたい
 しも
- Corallina LINNAEUS, 1758 さんごも属
confusa YENDO
kaifuensis YENDO
officinalis LINNAEUS さんごも
pilulifera POSTELS et RUPRECHT びりひば (29)
sessilis YENDO みやひばもどき
squamata (auct. japon) みやひば (79)
- Dermatolithon FOSLIE, 1898 そうはん属
canescens (FOSLIE) FOSLIE そうはん
 [*Lithophyllum canescens*]
- Ezo ADEY, MASAKI et AKIOKA, 1974 しずくいし
 ごろも属
epiyessoense ADEY, MASAKI et AKIOKA しずく
 いしごろも
- Fosliella HOWE, 1920 さび属
farinosa (LAMOUROUX) HOWE いほもかさ
lejolisii (ROSANOFF) HOWE しろもかさ (80)
minutula (FOSLIE) GANESAN ひめもかさ (80)
paschalis (LEMOINE) SETCHELL et GARDNER
 いほもかさもどき
zostericola (FOSLIE) SEGAWA in YOSHIDA
 もかさ
 [*Heteroderma zostericola*]
- Goniolithon FOSLIE, 1898 いしのみ属
mamillare (HARVEY) FOSLIE いほいしも
propinquum (FOSLIE) FOSLIE
versabile FOSLIE
- Heteroderma FOSLIE, 1909 もかさ属
sargassi (FOSLIE) FOSLIE もくごろも (30)
- Hydrolithon (FOSLIE) FOSLIE, 1909 こぶいしも属
decipiens (FOSLIE) ADEY うみさびもどき
reinboldii (WEBER van BOSSE et FOSLIE)
 FOSLIE こぶいし
- Jania LAMOUROUX, 1812 もさずき属
adhaerens LAMOUROUX ひめもさずき
 [*decussato-dichotoma*]
arborescens (YENDO) YENDO きぶりもさずき
capillacea HARVEY けひめもさずき
nipponica (YENDO) YENDO うらもさずき
pumila LAMOUROUX
radiata YENDO ひおうぎ
rubens (ELLIS et SOLANDER) LAMOUROUX
tenella GRUNOW
ungulata (YENDO) YENDO さきびろもさずき
yenoshimensis (YENDO) YENDO
- Leptophyllum ADEY, 1966 レプトフィツム属
laeve ADEY
 [*Lithothamnion laeve* f. *tenu*]
- Lithophyllum PHILIPPI, 1837 いしごろも属
absimile FOSLIE et HOWE in FOSLIE いわのさび
acanthinum FOSLIE
amplexifrons (HARVEY) HEYDRICH くさのかき
caribaeum (FOSLIE) FOSLIE
 f. *boreale* MASAKI きたにせうみさびもどき
fasciculatum (LAMARCK) FOSLIE かのこもち
grumosum (FOSLIE) FOSLIE
neoatalayense MASAKI くぼみいしごろも
okamurae FOSLIE
 f. *japonicum* FOSLIE ひらいほ
pustulatum (LAMOUROUX) FOSLIE
racemus (LAMARCK) FOSLIE
samoense FOSLIE さもあいしごろも
shioense FOSLIE みさきいしごろも
tortuosum (ESPER) FOSLIE はちのすいし
yendoi (FOSLIE) FOSLIE うみさび
yessoense FOSLIE えぞうみさび, えぞいしごろも
- Lithothamnion PHILIPPI, 1837 いしも属
aculeiferum MASON せといしも
canariense FOSLIE かなりあいしも
cystocarpioideum FOSLIE くさのかき
erubescens FOSLIE
 f. *madagascarensis* FOSLIE えだうちいしも
glaciale KJELLMAN

- intermedium* KJELLMAN
japonicum FOSLIE みやべおこし, かいふおこし
lenormandii (ARESCHOUG in J. AGARDH)
 FOSLIE あっけしいしも
membranaceum (ESPER) FOSLIE
nitidum FOSLIE
notatum FOSLIE
obtectulum (FOSLIE) FOSLIE あっけしおこし
pacificum (FOSLIE) FOSLIE あっけしいぼいし
siamense FOSLIE
simulans (FOSLIE) FOSLIE in WEBER van
 BOSSE et FOSLIE かわらいしも
sonderi HAUCK いぼおこし
spissum FOSLIE
vescum FOSLIE ひらおこし
Marginisporium (YENDO) GANESAN, 1967 へりとり
 かにのて属
aberrans (YENDO) JOHANSEN et CHIHARA in
 JOHANSEN ふさかにのて
 [*Amphiroa aberrans*]
crassissima (YENDO) GANESAN へりとりかにの
 て
 [*Amphiroa crassissima*]
declinata (YENDO) GANESAN まがりかにのて
 [*Amphiroa declinata*]
Mastophora DECAISNE, 1842 いしのはな属
pacifica (HEYDRICH) FOSLIE こしかいしも
 [*Lithoporella melobesioides sensu MASAKI*]
rosea (C. AGARDH) SETCHELL いしのはな
 [*macrocarpa*]
Melobesia LAMOUROUX, 1816 メロベシア属
pacifica MASAKI あばたもかさ
Mesophyllum LEMOINE, 1928 えだうちいしも属
nitidum (FOSLIE) ADEY
Neogoniolithon SETCHELL et MASON, 1943 いし
 みのどき属
accretum (FOSLIE et HOWE) SETCHELL et
 MASON りなきいしも
misakiense (FOSLIE) SETCHELL et MANSON
 かさねいしも
 [*Goniolithon misakiense*]
pacificum (FOSLIE) SETCHELL et MANSON
 すりばちいしも
 [*Goniolithon pacificum*]
Neopolyporolithon ADEY et JOHANSEN, 1972
 かさきのこいしも属
reclinatum (FOSLIE) ADEY et JOHANSEN かさき
 のこいしも
Porolithon (FOSLIE) FOSLIE, 1909 あなあきいしも
 属
boergesenii (FOSLIE) LEMOINE in BØRGESEN
 せといぼいし
colliculosum MASAKI とげいぼ
orbiculatum MASAKI おにはすいしも
Pseudolithophyllum LEMOINE, 1913 シュードリトフ
 イルム属
neofarlowii (SETCHELL et MASON) ADEY
 こぶいしごろも
Serraticardia (YENDO) SILVA, 1957 おおしころ属
maxima (YENDO) SILVA おおしころ
 [*Cheilosporum maximum*]
 [*Joculator maximum*]
Sporolithon HEYDRICH, 1897 スポロリトン属
schmidtii (FOSLIE) GORDON, MASAKI et
 AKIOKA
Tenarea BORY, 1832 のりまき属
corallinae CROUAN frat. ひめごろも
dispar (FOSLIE) ADEY のりまきもどき
tumidulum (FOSLIE) ADEY のりまき
 [*Dermatolithon tumidulum*]
 [*Lithophyllum tumidulum*]
Yamadaea SEGAWA, 1955 さびもどき属
melobesioides SEGAWA さびもどき

Halymeniaceae BORY, 1828 むかでのり科
Carpopeltis SCHMITZ, 1889 きんとき属
affinis (HARVEY) OKAMURA まつり (31)
angusta (OKAMURA) OKAMURA きんとき
articulata (OKAMURA) OKAMURA ふしきんとき
cornea (OKAMURA) OKAMURA つのむかで
 [*Prionitis cornea*]
crispata OKAMURA とさかまつ
divaricata OKAMURA ひとつまつ
formosana OKAMURA
maillardii (MONTAGNE et MILLARDET) CHIANG
 ちゃぼきんとき
 [*rigida*]
okamurae TH. ARWIDSSON in YAMADA ながき
 んとき
 [*elata*]

- prolifera* (HOLMES) KAWAGUCHI et MASUDA
こめのり
[*flabellata*]
- Cryptonemia J. AGARDH, 1842 かくれいと属
luxurians (C. AGARDH) J. AGARDH ひろはのか
くれいと
schmitziana (OKAMURA) OKAMURA おおばきん
とき
semiprocumbens TANAKA なんかいかくれいと
yendoi WEBER van BOSSE うすばのかくれいと
- Grateloupia C. AGARDH, 1822 むかでのり属
carnosa YAMADA et SEGAWA in YAMADA
にくむかで
divaricata OKAMURA かたのり
filicina (LAMOUROUX) C. AGARDH むかでのり
(32)
gelatinosa GRUNOW ex HOLMES
imbricata HOLMES さくらのり (33)
incurvata NODA in NODA et KITAMI げじげじ
むかでのり
jubata YENDO
kaifuensis YENDO かいふのり
latissima OKAMURA
livida (HARVEY) YAMADA ひらむかで
nipponica YENDO
okamurae YAMADA きょうのひも
[*lancifolia*]
prolongata J. AGARDH ひろはのむかでのり
ramosissima OKAMURA すじむかでのり
sparsa (OKAMURA) CHIANG ひぢりめん
[*Cyrtymenia sparsa*]
[*Phyllymenia sparsa*]
turuturu YAMADA つるつる
- Halymenia C. AGARDH, 1817 いそのはな属
acuminata (HOLMES) J. AGARDH おおむかでのり
dilatata ZANARDINI ふいりぐさ
durvillaei BORY
var. *formosa* (HARVEY ex KÜTZING)
REINBOLD in REINECKE つづれぐさ
floresia (CLEMENTE) C. AGARDH いそのはな
ioensis YAGI ひょうたんぐさ
rotunda OKAMURA まるばぐさ
- Kintokiocolax TANAKA et Y. NOZAWA, 1960
きんときやどり属
aggregato-ceranthera TANAKA et Y. NOZAWA
きんときやどり
Pachymeniopsis YAMADA in KAWABATA, 1954
ふだらく属 (34)
elliptica (HOLMES) YAMADA in KAWABATA
たんぱのり
[*Grateloupia elliptica*]
lanceolata (OKAMURA) YAMADA in KAWABATA
ふだらく
[*Aeodes lanceolata*]
- Polyopes J. AGARDH, 1849 またぼう属
polyideoides OKAMURA またぼう
- Prionitis J. AGARDH, 1851 nom. cons. ひらきんと
き属
patens OKAMURA ひらきんとき
- Gloiosiphoniaceae** SCHMITZ, 1892 いとふのり科
Gloeophycus I. K. LEE et YOO, 1979 おとひめもず
く属
koreanum I. K. LEE et YOO おとひめもずく
Gloiosiphonia CARMICHAEL in BERKELEY, 1833
いとふのり属
capillaris (HUDSON) CARMICHAEL in BERKELEY
いとふのり
- Schimmelmania SCHOUSBOE ex KÜTZING, 1849
ながおばね属
plumosa (SETCHELL) ABBOTT ながおばね
[*Baylesia plumosa*]
- Endocladiaaceae** (J. AGARDH) KYLIN, 1928
ふのり科 (35)
- Gloiopeltis J. AGARDH, 1842 ふのり属
complanata (HARVEY) YAMADA はなふのり
furcata (POSTELS et RUPRECHT) J. AGARDH
ふくろふのり (36)
tenax (TURNER) J. AGARDH まふのり
- Tichocarpaceae** (SCHMITZ et HAUPTFLEISCH)
KYLIN, 1928 かれきぐさ科
Tichocarpus RUPRECHT in MIDDENDORFF, 1851
かれきぐさ属
crinitus (GMELIN) RUPRECHT in MIDDENDORFF
かれきぐさ
- Kallymeniaceae** W. R. TAYLOR, 1937 つかさのり
科
Callophyllis KÜTZING, 1843 とさかもどき属 (77)

- adhaerens* YAMADA くろとさかもどき
adnata OKAMURA ねざしのとさかもどき
crispata OKAMURA ひろはのとさかもどき
cristata (C. AGARDH) KÜTZING ゆうそら
 [Euthora fruticulosa]
firma (KYLIN) NORRIS きぬはだ
 [Microcoelia chilensis]
 [Pugetia japonica]
 [chilensis]
hayamensis YAMADA えつきのとさかもどき
japonica OKAMURA in DE TONI et OKAMURA
 ほそばのとさかもどき
mageshimensis TANAKA なんかいとさかもどき
palmata YAMADA やつでがたとさかもどき
rhynchocarpa RUPRECHT ひめとさかもどき
Cirrulicarpus TOKIDA et MASAKI, 1956 えぞとさ
 か属
gmelini (GRUNOW) TOKIDA et MASAKI えぞと
 さか
 [Erythrophyllum gmelini]
Kallymenia J. AGARDH, 1842 つかさのり属
callophyloides OKAMURA et SEGAWA in
 SEGAWA はながたかりめにあ
crassiuscula OKAMURA あつばかりめにあ
oligonema YAMADA ひめつかさのり
ornata (POSTELS et RUPRECHT) J. AGARDH
 きたつかさのり
perforata J. AGARDH つかさあみ
reniformis (TURNER) J. AGARDH
 var. *cuneata* J. AGARDH えぞつかさのり
sagamiana YAMADA おおつかさのり
sessilis OKAMURA えなしかりめにあ
stipitata OKAMURA えつきつかさのり

Choreocolacaceae STURCH, 1926 コレオコラック
 ス科
Gelidiocolax GARDNER, 1927 てんぐさやどり属
mammillata FAN et PAPPENFUSS てんぐさやどり

 位置不明 Insertae sedis
Ethelia (WEBER van BOSSE) WEBER van BOSSE,
 1921 にくいわのかわ属
biradiata (WEBER van BOSSE) WEBER van
 BOSSE にくいわのかわ
Pseudorhododiscus MASUDA, 1976 べにごろも属

nipponicus MASUDA べにごろも
Rhodophysema BATTERS, 1900 ふちとりべに属
elegans (CROUAN frat. ex J. AGARDH) DIXON
 うすふちとりべに (37)
georgii BATTERS ふちとりべに (38)
odonthaliae MASUDA et M. OHTA ひめふちとり
 べに
Rhodophysemaopsis MASUDA, 1976 ふちとりべにも
 どり属
laminariae MASUDA ふちとりべにもどり

GIGARTINALES SCHMITZ in ENGLER, 1892
 すぎのり目
Cruoriaceae (J. AGARDH) KYLIN, 1928 クルオ
 リア科
Cruoriopsis DUFOUR, 1864 かいのかわ属
japonica SEGAWA かいのかわ

Calosiphoniaceae KYLIN, 1932 ぬめりぐさ科
Calosiphonia CROUAN, 1852 ぬめりぐさ属
vermicularis (J. AGARDH) SCHMITZ ぬめりぐさ
Schmitzia SILVA, 1959 ほうのお属
japonica (OKAMURA) SILVA ほうのお
 [Bertholdia japonica]
 [Platoma japonica]

Nemastomataceae SCHMITZ, 1892 nom. cons.
 prop. ひかげのいと科
 [Gymnophlaeaceae KÜTZING, 1843]
Nemostoma J. AGARDH, 1842 うすぎぬ属 (82)
foliaceae YAMADA ひめうすぎぬ
lancifolia OKAMURA うすぎぬ
Platoma SCHMITZ, 1889 にくほうのお属
izunosimensis SEGAWA にくほうのお
Predaea G. DE TONI, 1936 ゆるぢぎぬ属
japonica YOSHIDA ゆるぢぎぬ
Schizymenia J. AGARDH, 1851 べにすなご属
dubyi (CHAUVIN in DUBY) J. AGARDH べにす
 なご
Titanophora (J. AGARDH) FELDMANN, 1942
 べにざらさ属
palmata ITONO あまみのべにざらさ
weberae BØRGESSEN べにざらさ
Tsengia FAN et FAN, 1962 ひかげのいと属
nakamurae (YENDO) FAN et FAN ひかげのいと

[*Nemostoma nakamurae*]

Rhizophyllidaceae SCHMITZ in ENGLER, 1892

なみのはな科

Chondrococcus KÜTZING, 1847 なみのはな属

hornemanni (LYNGBYE) SCHMITZ ほそばなみの
はな

japonicus (HARVEY) OKAMURA in MATSUMURA
et MIYOSHI なみのはな

Contarinia ZANARDINI, 1843 しおぐさごころも属

okamurae SEGAWA しおぐさごころも

Polyideaceae KYLIN, 1956 ポリイデス科

Rhodopeltis HARVEY, 1863 さんごもどき属

borealis YAMADA がらがらもどき

gracilis YAMADA et TANAKA in YAMADA

ほそばがらがらもどき

liagoroides YAMADA こなはだもどき

setchellii YAMADA なんばんがらがらもどき

Furcellariaceae GREVILLE, 1830 すすかけべに科

Halarachnion KÜTZING, 1843 すすかけべに属

latissimum OKAMURA すすかけべに

parvum YAMADA こぼのすすかけべに

Neurocaulon ZANARDINI ex KÜTZING, 1849 じんよ

うのり属

japonicum SEGAWA じんようのり

Sebdeniaceae KYLIN, 1932 おかむらぐさ科

Sebdenia BERTHOLD, 1884 おかむらぐさ属

agardhii (DE TONI) CODOMIER ぬらくさ

[*Halymenia agardhii*]

okamurae YAMADA おかむらぐさ

polydactyla (BØRGESEN) BALAKRISHNAN くらぬ
らくさ

[*Halymenia polydactyla*]

yamadae OKAMURA et SEGAWA in SEGAWA

やまだぐさ

Solieriaceae J. AGARDH, 1876 みりん科

Eucheuma J. AGARDH, 1847 きりんさい属

amakusaensis OKAMURA あまくさきりんさい

arnoldii WEBER van BOSSE びやくしんきりんさい

い

[*cupressoideum*]

denticulatum (BURMAN) COLLINS et HERVEY

きりんさい

[*muricatum*]

gelatinae (ESPER) J. AGARDH かためんきりんさい

い

okamurae YAMADA おかむらきりんさい

serra (J. AGARDH) J. AGARDH とげきりんさい

striatum SCHMITZ おおきりんさい

Meristotheca J. AGARDH, 1872 とさかのり属

coacta OKAMURA きくとさか

papulosa (MONTAGNE) KYLIN とさかのり

[*japonica*]

Solieria J. AGARDH, 1842 みりん属

dichotoma YOSHIDA ひらみりん

mollis (HARVEY) KYLIN ほそばみりん

robusta (GREVILLE) KYLIN みりん

Turnerella SCHMITZ in ENGLER et PRANTL, 1896

えぞなめし属

mertensiana (POSTELS et RUPRECHT) SCHMITZ

in ENGLER et PRANTL えぞなめし

Caulacanthaceae KÜTZING, 1843 いそもっか科

[*Rhabdoniaceae* KYLIN, 1925]

Catenella GREVILLE, 1830 nom. cons. いそもっか属

caespitosa (WITHERING) IRVINE in PARKE et

DIXON いそもっか

[*opuntia*]

[*repens*]

impudica (MONTAGNE) J. AGARDH

nipae ZANARDINI

Caulacanthus KÜTZING, 1843 いそだんつう属

compressus HARVEY (39)

okamurae YAMADA いそだんつう

Rhodophyllidaceae SCHMITZ in ENGLER, 1892

あみはだ科

Rhodophyllis KÜTZING, 1847 nom. cons. あみはだ

属

capillaris TOKIDA いとあみはだ

Plocamiaceae KÜTZING, 1843 ゆかり科

Plocamium LAMOUREUX, 1813 nom. cons. ゆかり

属

leptophyllum (auct. japon.) ほそゆかり (40)

ovicornis OKAMURA ひめゆかり

[oviforme]

recurvatum OKAMURA まきゆかり
telfairiae (HARVEY) HARVEY in KÜTZING
 ゆかり (41)

Hypneaceae J. AGARDH, 1851 いばらのり科

Hypnea LAMOUROUX, 1813 いばらのり属
cenomyce J. AGARDH おおこけいばら
cervicornis J. AGARDH かずのいばら
charoides LAMOUROUX いばらのり
 [seticulosa]
chordacea KÜTZING
 f. *simpliciuscula* (OKAMURA) TANAKA
 こひもいばら
cornuta (LAMOUROUX) J. AGARDH ほしがたい
 ばらのり
esperi BORY ひめいばらのり
flagelliformis J. AGARDH すじいばらのり
japonica TANAKA かぎいばらのり
 [musciiformis sensu OKAMURA]
pannosa J. AGARDH こけいばら, むらさきこけい
 ばら
 [nidulans]
saidana HOLMES さいだいばら (42)
variabilis OKAMURA たちいばらのり
yamadae TANAKA べにいばらのり
Hypneocolax BØRGESEN, 1920 あねやかたのり属
stellaris BØRGESEN
 f. *orientalis* WEBER van BOSSE あねやかた
 のり

Phacelocarpaceae SEARLES, 1968 きじのお科

Phacelocarpus ENDLICHER et DIESING, 1845 nom.
 cons. きじのお属
japonicus OKAMURA きじのお

Sarcodiaceae KYLIN, 1932 あつばのり科

Sarcodia J. AGARDH, 1852 あつばのり属
ceylanica HARVEY ex KÜTZING あつばのり
cuneifolia YAMADA ひろはあつばのり
Trematocarpus KÜTZING, 1843 みあなぐさ属
pygmaeus YENDO みあなぐさ (43)

Gracilariaceae NÄGELI, 1847 nom. cons. おごのり科

Ceratodictyon ZANARDINI, 1878 かいめんそう属
spongiosum ZANARDINI かいめんそう
Gelidiopsis SCHMITZ, 1895 てんぐさもどき属
gracilis (KÜTZING) VICKERS
hachijoensis YAMADA et SEGAWA はちじょうて
 んぐさもどき
intricata (C. AGARDH) VICKERS もつれてんぐさ
 もどき
repens (KÜTZING) SCHMITZ てんぐさもどき
Gracilaria GREVILLE, 1830 nom. cons. おごのり属
 (44)
arcuata ZANARDINI ゆみがたおごのり
blodgettii HARVEY くびれおごのり
bursa-pastoris (GMELIN) SILVA しらも
 [compressa]
chorda HOLMES つるしらも
coronopifolia J. AGARDH もさおごのり
crassa HARVEY ex J. AGARDH たいわんおごのり,
 ふしくれのり
 [Corallopsis opuntia]
cuneifolia (OKAMURA) LEE et KUROGI きぬか
 ばのり
 [Rhodymenia cuneifolia]
denticulata (KÜTZING) WEBER van BOSSE
 とげかばのり
edulis (GMELIN) SILVA かたおごのり
 [lichenoides]
eucheumoides HARVEY りゅうきゅうおごのり
gigas HARVEY おおおごのり
incurvata OKAMURA みぞおごのり
punctata (OKAMURA) YAMADA いつつぎぬ
 [Rhodymenia punctata]
salicornia (C. AGARDH) DAWSON ときだふしく
 れのり
spinulosa (OKAMURA) CHANG et XIA
 f. *srilankia* CHANG et XIA むらさきかばの
 り
 [purpurascens]
textorii (SURINGAR) HARIOT かばのり
vermiculophylla (OHMI) PAPPENFUSS おごもどき
verrucosa (HUDSON) PAPPENFUSS おごのり
 [confervoides]
Tylotus J. AGARDH, 1876 なみいわたけ属
lichenoides OKAMURA なみいわたけ

- Phyllophoraceae** RABENHORST, 1863 おきつのり科 (45)
- Ahnfeltia FRIES, 1835 さいみ属
concinna J. AGARDH さいみ
furcellata OKAMURA ふささいみ
gracilis (YAMADA) YAMADA et MIKAMI in MIKAMI べさ
 [Besa gracilis]
paradoxa (SURINGAR) OKAMURA はりがね
plicata (HUDSON) FRIES ねつきいたにくさ (46)
yamadae (SEGAWA) MIKAMI はねさいみ, はねつのまた
- Gymnogongrus MARTIUS, 1833 おきつのり属
divaricatus HOLMES おおまたおきつのり
flabelliformis HARVEY in PERRY おきつのり
japonicus SURINGAR そええだなしおきつ
- Stenogramma HARVEY in HOOKER et ARNOTT, 1841 はすじぐさ属
interrupta (C. AGARDH) MONTAGNE はすじぐさ
- Gigartineae** BORY, 1828 すぎのり科
- Chondrus STACKHOUSE, 1797 つのまた属
crispus (auct. japon) とちゃか, やはずつのまた (47)
elatus HOLMES ことじつのまた (48)
giganteus YENDO おおぼつのまた (49)
 [ocellatus f. giganteus]
ocellatus HOLMES つのまた (50)
pinnulatus (HARVEY) OKAMURA ひらことじ (51)
verrucosus MIKAMI いぼつのまた
 [Gigartina mikamii]
 [ocellatus f. canaliculatus]
yendoii YAMADA et MIKAMI in MIKAMI ころはぎんなんそう, えぞつのまた (52)
 [Iridaea laminarioides sensu OKAMURA]
 [Iridophycus cornucopiae sensu TOKIDA]
- Gigartina STACKHOUSE, 1809 すぎのり属
intermedia SURINGAR かいのり
mamillosa (auct. japon) いかのあし (53)
teedii (ROTH) LAMOUREUX しきんのり
tenella HARVEY すぎのり
 [Chondrus filiformis]
- Rhodoglossum J. AGARDH, 1876 あかばぎんなんそう属
hemisphaericum MIKAMI いぼぎんなん (54)
japonicum MIKAMI あかばぎんなんそう (55)
 [Gigartina japonica]
 [Iridaea pulchra sensu OKAMURA]
- Petrocelidaceae** DENIZOT, 1968 いぼのり科
- Mastocarpus KÜTZING, 1843 いぼのり属
pacificus (KJELLMAN) PERESTENKO いぼのり, ほそいぼのり (56)
 [Gigartina ochotensis]
 [Gigartina pacifica]
 [Gigartina unalaskensis]
- 位置不明 Insertae sedis
- Wurdemannia HARVEY, 1853 ウルデマニア属
miniata (DRAPARNAUD) FELDMANN et HAMEL [setacea]
- RHODYMENIALES SCHMITZ in ENGLER, 1892
 まさごしぱり目 (57)
- Rhodymeniaceae** HARVEY, 1849 まさごしぱり科 (57)
- Botryocladia (J. AGARDH) KYLIN, 1931 nom. cons. はなのえだ属
leptopoda (J. AGARDH) KYLIN はなのえだ
skottsbergii (BØRGESEN) LEVRING あつかわはなのえだ
 [kuckuckii]
- Chrysymenia J. AGARDH, 1842 たおやぎそう属
grandis OKAMURA おおぬらぶくろ
okamurae YAMADA et SEGAWA はなさくら
 [kairnbachii sensu OKAMURA]
wrightii (HARVEY) YAMADA たおやぎそう
- Coelarthrum BØRGESEN, 1910 ふくろつなぎ属
boergesenii WEBER van BOSSE すじこのり
 [coactum]
lomentariae TANAKA et K. NOZAWA in TANAKA かたみのふくろつなぎ
muelleri (SONDER) BØRGESEN ふくろつなぎ
- Coelothrix BØRGESEN, 1920 にせいばらのり属
irregularis (HARVEY) BØRGESEN にせいばらのり
- Cryptarachne (HARVEY) KYLIN, 1931 ひらたおやぎ属
polyglandulosa (OKAMURA) SEGAWA ひらたお

やぎ

[*Chrysymenia polyglandulosa*]

Erythrocolon (J. AGARDH) J. AGARDH, 1896

ひめふくろつなぎ属

podagrica (HARVEY ex J. AGARDH in GRUNOW)

J. AGARDH in KYLIN ひめふくろつなぎ

Fauchea MONTAGNE et BORY, 1846 まだらぐさ属

leptophylla SEGAWA とげなしまだら*rhizophylla* TAYLOR ひめひしがたのり*spinulosa* OKAMURA et SEGAWA in SEGAWA

とげまだら

stipitata YAMADA et SEGAWA in YAMADA

えつきまだら

Gloioderma J. AGARDH, 1851 ひしぶくろ属

iyoenae OKAMURA ひめひしぶくろ*japonicum* OKAMURA ひしぶくろ

Halichrysis (J. AGARDH) SCHMITZ, 1889 ちりぼたん属

japonica SEGAWA ちりぼたん*micans* (HAUPTFLEISCH in ENGLER et PRANTL)

P. et H. HUVÉ うえばぐさ

[*Weberella micans*]

Rhodymenia GREVILLE, 1830 まさごしぼり属

adnata OKAMURA かさねいつつぎぬ*coacta* OKAMURA et SEGAWA in SEGAWA

はながさね

intricata (OKAMURA) OKAMURA まさごしぼり*liniformis* OKAMURA ほそだるす*parva* YAMADA ひめだるす*pertusa* (POSTELS et RUPRECHT) J. AGARDH

あなだるす

prostrata TANAKA しんかいひめだるす**Champiaceae** KÜTZING, 1843 わつなぎそう科

[Lomentariaceae J. AGARDH, 1876]

Binghamia J. AGARDH, 1894 かえるでぐさ属

californica J. AGARDH かえるでぐさ[*Binghamiella californica*]

Champia DESVEAUX, 1809 わつなぎそう属

bifida OKAMURA ひらわつなぎそう*echigoensis* NODA えちごわつなぎそう*expansa* YENDO うすばわつなぎそう*japonica* OKAMURA へらわつなぎそう*parvula* (C. AGARDH) HARVEY わつなぎそう*recta* NODA たちわつなぎそう

Gastroclonium KÜTZING, 1843 nom. cons. いそまつ属

pacificum (DAWSON) CHANG et XIA いそまつ[*Coeloseira pacifica*][*ovale* sensu OKAMURA]

Lomentaria LYNGBYE, 1819 ふしつなぎ属

catenata HARVEY in PERRY ふしつなぎ*flaccida* TANAKA ふさふしつなぎ*hakodatensis* YENDO こすじふしつなぎ*lubrica* (YENDO) YAMADA いとたおやぎそう*okamurae* SEGAWA ひろはふしつなぎ[*orcadensis*][*rosea* sensu OKAMURA]*pinnata* SEGAWA ひめふしつなぎ

PALMARIALES GUIRY et D. IRVINE, 1978

だるす目 (57)

Palmariaceae GUIRY, 1974 だるす科

Halosaccion KÜTZING, 1843 べにふくろのり属

firmum (POSTELS et RUPRECHT) KÜTZING

かたべにふくろのり, くだふくろのり

ramentaceum (LINNAEUS) J. AGARDH ほそべにふくろのり*yendoi* I. K. LEE べにふくろのり[*saccatum* auct. japon]

Palmaria STACKHOUSE, 1809 だるす属

marginicrassa I. K. LEE あつばだるす*palmata* (LINNAEUS) O. KUNTZE だるす[*Rhodymenia palmata*]

CERAMIALES OLTMANN, 1904 いぎす目

Ceramiaceae DUMORTIER, 1822 いぎす科

Acrothamnion J. AGARDH, 1892 りゅうのたま属

butleriae (COLLINS) KYLIN ひめくじゃくのはねも*preissii* (SONDER) WOLLANSTON りゅうのたま, くじゃくはねも[*pulchellum*][*terminale*]

Aglaothamnion FELDMANN-MAZOYER, 1940 アグラ

オタムニオン属

cordatum (BØRGESEN) FELDMANN-MAZOYER*neglectum* FELDMANN-MAZOYER*oosumiense* ITONO

Anotrichum NÄGELI, 1861 きぬげぐさ属

- furcellatum* (J. AGARDH) BALDOCK きぬげぐさ
[*Monospora tenuis*]
[*Neomonospora furcellata*]
tenuis (C. AGARDH) NÄGELI けかざしぐさ
[*Griffithsia tenuis*]
yagii (OKAMURA) BALDOCK いときぬげ
[*Monospora yagii*]
- Antithamnion NÄGELI, 1847 ふたつがさね属
amamiense ITONO
antillanum BØRGESSEN にせきぬいとぐさ
basisporum TOKIDA et INABA にれつがさね
callocladus ITONO
crispirrhizophorum TOKIDA et INABA ふさねふた
つがさね
defectum KYLIN きぬいとよつがさね, くしのはふ
たつがさね, きぬいとふたつがさね
[*sparsum*]
echigoense NODA
gardneri G. DE TONI きぬいとがさね
nipponicum YAMADA et INAGAKI ふたつがさね
percurrans DAWSON かたはのふたつがさね
plumula (ELLIS) THURET in LE JOLIS
secundum ITONO
tanakae ITONO とげきぬいとぐさ
- Antithamnionella LYLE, 1922 ほそがさね属
breviramosa (DAWSON) WOLLASTON in
WOMERSLEY et BAILEY ひなふたつがさね
[*Antithamnion breviramosus*]
miharae (TOKIDA) ITONO ほそがさね
- Balliella ITONO et TANAKA, 1973 バリエラ属
crouanioides (ITONO) ITONO et TANAKA
[*Antithamnion crouanioides*]
subcorticata (ITONO) ITONO et TANAKA なんか
いべにはねも
[*Antithamnion subcorticatum*]
- Callithamnion LYNGBYE, 1819 きぬいとぐさ属
aglaothamnioides ITONO
apicalis NODA
callophyllidicola YAMADA きぬいとぐさ
corymbosum (SMITH) LYNGBYE
echigoense NODA
furcellariae J. AGARDH
japonicum NODA in NODA et KITAMI
minutissima YAMADA ひなのきぬいとぐさ
nipponicum NODA in NODA et KITAMI
- Campylaeophora* J. AGARDH, 1851 えごのり属
crassa (OKAMURA) NAKAMURA ふといぎす (58)
[*Ceramium crassum*]
hypnaeoides J. AGARDH えごのり (59)
[*Ceramium hypnaeoides*]
japonica NODA ひめえごのり
- Carpoblepharis KÜTZING, 1843 nom. cons. カルポ
ブレファリス属
warburgii HEYDRICH おおばちりもみじ (60)
- Centroceras KÜTZING, 1841 ごのめぐさ属
apiculatum YAMADA なんかいごのめぐさ
clavulatum (C. AGARDH) MONTAGNE とげいぎ
す
distichum OKAMURA ごのめぐさ
japonicum ITONO なんかいとげいぎす
minutum YAMADA
- Ceramium ROTH, 1797 nom. cons. いぎす属
aduncum NAKAMURA まきいぎす
affine SETCHELL et GARDNER
amamiense ITONO
boydenii GEPP あみくさ
ciliatum (ELLIS) DUCLUZEAU つのいぎす (61)
cimbricum H. PETERSEN まつばらいぎす
codii (RICHARDS) MAZOYER とがりいぎす
fastigiatum HARVEY ひめいぎす (62)
fimbriatum SETCHELL et GARDNER ふさつきい
ぎす
[*flaccidum*]
gracillimum (KÜTZING) GRIFFITH et HARVEY
in HARVEY はいいぎす (63)
howei WEBER van BOSSE なんせいいぎす
japonicum OKAMURA はねいぎす
kondoi YENDO いぎす (64)
[*rubrum sensu YENDO*]
minutulum NODA et KONNO in NODA ひめはね
いぎす
nakamurae DAWSON つくしいぎす
[*equisetoides* NAKAMURA]
paniculatum OKAMURA はりいぎす
procumbens SETCHELL et GARDNER
serpens SETCHELL et GARDNER
sympodiale DAWSON さでがたいぎす
taylorii DAWSON
tenerrimum (MARTENS) OKAMURA けいぎす
tenuicorticatum KONNO in KONNO et NODA

- すかしいぎす
tenuissimum (ROTH) J. AGARDH きぬいといぎ
 す
 Corynospora J. AGARDH, 1851 はいきぬげ属
sericata (SEGAWA) YOSHIDA はいきぬげ
 [*Neomonospora sericata*]
 Crouania J. AGARDH, 1842 よつので属
attenuata (C. AGARDH) J. AGARDH よつので
divaricata OKAMURA もさよつので
mageshimensis ITONO
minutissima YAMADA ひめよつので
 Dasypbila SONDER, 1845 おきしのぶ属
plumarioides YENDO おきしのぶ
 Delesseriopsis OKAMURA, 1931 うすむらさき属
elegans OKAMURA うすむらさき
 Euptilota (KÜTZING) KÜTZING, 1849 いそしのぶ属
articulata (J. AGARDH) SCHMITZ いそしのぶ
 Gattya HARVEY, 1854 ガッティア属
obtusa ITONO
 Gordoniella ITONO, 1977 よなくにくすだま属
yonakuniensis (YAMADA et TANAKA) ITONO
 よなくにひびだま
 [*Spermothamnion yonakuniense*]
 Griffithsia C. AGARDH, 1817 かざしぐさ属
coacta OKAMURA わたげかざしぐさ
corallinoides (LINNAEUS) TREVISAN こつぶかざ
 しぐさ
 [*corallina*]
heteroclada YAMADA et HASEGAWA in
 HASEGAWA おくのかざしぐさ
japonica OKAMURA かざしぐさ
okiensis KAJIMURA おきかざしぐさ
rhizoidea NODA ねだしかざしぐさ
rhizophora GRUNOW ex WEBER van BOSSE
subcylindrica OKAMURA きぬいとかざしぐさ
tomo-yamadae OKAMURA おおかざしぐさ
venusta YAMADA たまかざしぐさ
 Gymnothamnion J. AGARDH, 1892 べにはねぐさ属
elegans (SHOUSBOE ex C. AGARDH) J. AGARDH
 べにはねぐさ
 [*Plumaria ramosa*]
 Haloplegma MONTAGNE, 1842 べにごうし属
duperreyi MONTAGNE べにごうし
 Herpochondria FALKENBERG in ENGLER et
 PRANTL, 1897 にくさえた属
corallinae (MARTENS) FALKENBERG in ENGLER
 et PRANTL にくさえた
 [*Microcladia corallinae*]
dentata (OKAMURA) ITONO こすじさえた
 [*Microcladia dentata*]
elegans (OKAMURA) ITONO さえた
 [*Microcladia elegans*]
pygmaea ITONO
 Lejoliea BORNET, 1859 レジョリア属
pacifica ITONO
 Neoptilota KYLIN, 1956 かたわべにひば属
asplenioides (ESPER) KYLIN かたわべにひば
 [*Ptilota asplenioides*]
californica (RUPRECHT) KYLIN かしわばべにひ
 ば
 [*Ptilota californica*]
 Platythamnion J. AGARDH, 1892 よつがさね属
horridum TOKIDA et INABA おにのよつばぐさ
intermedium TOKIDA ひめよつばぐさ
polyspora ITONO
yezoense INAGAKI よつがさね, よつばぐさ
 [*Antiithamnion plumula sensu OKAMURA*]
 Pleonosporium NÄGELI, 1862 nom. cons. くすだま
 属 (76)
caribaeum (BØRGESEN) NORRIS なんかいくだこ
 ぎぬ
 [*Mesothamnion caribaeum*]
dichotomum NODA ひめくすだま
elongatum NODA ほそえたくすだま
japonicum ITONO
 [*Compsothamniella japonica*]
kobayashii OKAMURA くすだま
mageshimense (ITONO) NORRIS
 [*Compsothamniella mageshimensis*]
mazeense NODA まぜくすだま
polymorphum ITONO もつれくすだま
 [*Mesothamnion polymorphum*]
pusillum YAMADA ちゃぼくすだま
segawae YOSHIDA はねくすだま
 [*pinnatum* OKAMURA et SEGAWA in SEGAWA]
tohyamanum TOKIDA et INABA とうやまくすだ
 ま
venustissimum (MONTAGNE) DE TONI こばんく
 すだま
yagii (YAMADA) NORRIS くだこぎぬ

- [*Mesothamnion yagii*]
 Plumariella OKAMURA, 1930 いとしのぶ属
yoshikawae OKAMURA いとしのぶ
 Psilothallia SCHMITZ, 1889 べにひば属
dentata (OKAMURA) KYLIN べにひば
 [*Ptilota dentata*]
 Ptilocladia SONDER, 1845 プティロクラディア属
japonica ITONO
 Ptilota C. AGARDH, 1817 nom. cons. くしべにひば
 属
serrata KÜTZING くしべにひば (65)
 [*pectinata*]
 Ptilothamnion THURET in LE JOLIS, 1863 いとひ
 びだま属
cladophorae (YAMADA et TANAKA) G.
 FELDMANN いとひびだま
 [*Spermothamnion cladophorae*]
pusillum (OKAMURA et SEGAWA in SEGAWA)
 ITONO
 [*Spermothamnion pusillum*]
 Reinboldiella DE TONI, 1895 ちりもみじ属
filamentosa ITONO
robusta ITONO
schmitziana (REINBOLD) DE TONI ちりもみじ
 [*Carpoblepharis schmitziana*]
 Rhodocallis KÜTZING, 1847 べにひばだまし属
elegans KÜTZING べにひばだまし
 Scagelia WOLLASTON, 1971 からふとよつがさね属
corallina (KJELLMAN) HANSEN et SCAGEL
 からふとよつがさね
 [*Antithamnion corallina*]
 Seirospora HARVEY, 1846 べにいそぶどう属
occidentalis BØRGESSEN べにいそぶどう
 Spermothamnion ARESCHOU, 1847 ひびだま属
echigoensis NODA えちごひびだま
endophytica OKAMURA かくれひびだま
 Spyridia HARVEY in HOOKER, 1833 うぶげぐさ属
aculeata (C. AGARDH ex DECAISNE) KÜTZING
 とげうぶげぐさ
elongata OKAMURA ながうぶげぐさ
filamentosa (WULFEN) HARVEY うぶげぐさ
tenuis NODA ほそうぶげぐさ
 Tanakaella ITONO, 1977 タナカエラ属
japonica ITONO
 Tiffaniella DOTY et MEÑEZ, 1960 ティファニエラ
 属
apiculata ITONO
codicola (YAMADA et TANAKA) DOTY et
 MEÑEZ みるひびだま
 [*Spermothamnion codicola*]
suyehiroi (OKAMURA) KANEKO すえひろひびだ
 ま
 [*Spermothamnion suyehiroi*]
tamamiru (SEGAWA) GORDON たまみるひびだま
 [*Spermothamnion tamamiru*]
 Tokidaea YOSHIDA, 1973 べにはねも属
corticata (TOKIDA) YOSHIDA べにはねも
 [*Antithamnion corticatum*]
 Wrangelia C. AGARDH, 1822 らんげりあ属
minor NODA in NODA et KITAMI ひならんげり
 あ
penicillata (C. AGARDH) C. AGARDH おおらん
 げりあ
tagoi (OKAMURA) OKAMURA et SEGAWA in
 SEGAWA たごのり
tanegana HARVEY (66)
tayloriana TSENG らんげりあ
 [*argus sensu YENDO*]
 [*japonica*]
tenuis NODA ほそいとらんげりあ
 Delesseriaceae BORY, 1828 このはのり科
 Acrosorium ZANARDINI ex KÜTZING, 1869 はいう
 すばのり属
flabellatum YAMADA やれうすばのり
okamurae NODA in NODA et KITAMI とがりうす
 ばのり
polyneurum OKAMURA すじうすばのり
uncinatum (TURNER) KYLIN かぎうすばのり
yendoi YAMADA はいうすばのり
 Apoglossum J. AGARDH, 1898 ひだとりぎぬ属
minimum YAMADA ひだとりぎぬ
 Asterocolax J. et G. FELDMANN, 1951 アステロコ
 ラックス属
denticulata (TOKIDA) J. et G. FELDMANN
 ぼりこりね
 [*Polycoryne denticulata*]
 Branchioglossum KYLIN, 1924 ひげむらさき属
ciliatum OKAMURA ひげむらさき
nanum INAGAKI ひめむらさき

- Caloglossa J. AGARDH, 1876 あやぎぬ属
adnata (ZANARDINI) DE TONI
bombayensis BØRGESEN
leprieurii (MONTAGNE) J. AGARDH あやぎぬ
ogasawaraensis OKAMURA ほそあやぎぬ
- Congregatocarpus MIKAMI, 1971 このほり属
pacificus (YAMADA) MIKAMI このほり
 [Laingia pacifica]
- Cryptopleura KÜTZING, 1843 nom. cons. かくれすじ属
hayamensis YAMADA ほそばのかくれすじ
membranacea YAMADA かくれすじ
- Delesseria LAMOUROUX, 1813 nom. cons. ぬめほり属
serrulata HARVEY ぬめほり
 [violacea]
- Erythroglossum J. AGARDH, 1898 ひめうすべに属
minimum OKAMURA ひめうすべに
pinnatum OKAMURA たちうすべに
pulchrum YAMADA くしのはうすべに
- Hymenena GREVILLE, 1830 うすばのりもどき属
tenuis YAMADA うすばのりもどき
- Hypoglossum KÜTZING, 1843 べにはほり属
barbatum OKAMURA ひげべにはほり
geminatum OKAMURA べにはほり
minimum YAMADA ひめべにはほり
nipponicum YAMADA ほそながべにはほり (67)
sagamianum YAMADA すじべにはほり
serratifolium OKAMURA のこぎりばべにはほり
- Kurogia YOSHIDA, 1979 いかだこのほり属
pulchra YOSHIDA いかだこのほり
- Marionella WAGNER, 1954 はぶたえのり属
schmitziana (DE TONI et OKAMURA) YOSHIDA
 はぶたえのり
 [Hemineura schmitziana]
- Martensia HERING, 1841 nom. cons. あやにしき属
denticulata HARVEY あやにしき
flabelliformis HARVEY ex J. AGARDH えつきあやにしき
- Myriogramme (J. AGARDH) KYLIN, 1924 すじぎぬ属
ciliata YAMADA ねだしすじぎぬ
polyneura OKAMURA すじぎぬ
variegata YAMADA ふいりぎぬ
- Neoholmesia MIKAMI, 1972 すずしろのり属
japonica (OKAMURA) MIKAMI すずしろのり
 [Holmesia japonica]
- Neohypophyllum WYNNE, 1983 ながこのほり属
middendorffii (RUPRECHT) WYNNE ながこのほり
 [Hypophyllum middendorffii]
- Nitophyllum GREVILLE, 1830 nom. cons. うすばのり属
stellato-corticutum OKAMURA ほしがたうすばのり
yezoense (YAMADA et TOKIDA in YAMADA) MIKAMI あつばすじぎぬ
 [Hideophyllum yezoense]
 [Myriogramme yezoense]
- Phycodryis KÜTZING, 1843 かしわばこのほり属
fimbriata (DE LA PYLAE ex J. AGARDH) KYLIN かしわばこのほり
radicosa (OKAMURA) YAMADA et INAGAKI in YAMADA ひめこのほり
rubens (LINNAEUS) BATTERS かしわばこのほりもどき
- Platysiphonia BØRGESEN, 1931 ひげうすば属
clevelandii (FARLOW) PAPENFUSS ひげうすば
- Polyneura (J. AGARDH) KYLIN, 1924 nom. cons. はすじぎぬ属
japonica (YAMADA) MIKAMI はすじぎぬ
 [Nienburgia japonica]
- Schizoseris KYLIN, 1924 べにやはす属
minima KANEKO et MASAKI えぞひめべにやはす
subdichotoma (SEGAWA) YAMADA ひめべにやはす
- Sorella HOLLENBERG, 1943 うすべに属
repens (OKAMURA) HOLLENBERG うすべに
 [Erythroglossum repens]
- Taenioma J. AGARDH, 1863 ひめづた属
macrourum THURET in BORNET et THURET
perpusillum (J. AGARDH) J. AGARDH ひめづた
- Tokidadendron WYNNE, 1970 らいのすけこのほり属
bullata (GARDNER) WYNNE らいのすけこのほり
 [Pseudophycodryis rainoskei]
- Vanvoorstia HARVEY, 1854 からごろも属
coccinea J. AGARDH からごろも
 [spectabilis sensu OKAMURA]
- Yamadaphycus MIKAMI, 1973 このほりもどき属 (68)

carnosum MIKAMI このほりもどき
[*Okamuraia carnosum*]

Dasyaceae KÜTZING, 1843 だじあ科

- Dasya* C. AGARDH, 1824 nom. cons. だじあ属
collabens HOOKER et HARVEY
cylindrica NODA つつがただじあ
echigoensis NODA えちごだじあ
elongata NODA ながみだじあ
minor NODA in NODA et KITAMI ひめだじあ
scoparia HARVEY ex J. AGARDH もさだじあ
sessilis YAMADA えなしだじあ
villosa HARVEY けぶかだじあ
- Dictyurus* BORY in BELANGER et BORY, 1836
あみごろも属
purpurascens BORY あみごろも
- Heterosiphonia* MONTAGNE, 1842 nom. cons.
しまだじあ属
japonica YENDO いそはぎ (69)
pulchra (OKAMURA) FALKENBERG しまだじあ
- Rhodoptilum* (J. AGARDH) KYLIN, 1956 だじもどき属
plumosum (HARVEY et BAILEY) KYLIN だじもどき
- Sympodothamnion* ITONO, 1977 なんかいさえた属
leptophyllum (TANAKA) ITONO なんかいさえた
- Rhodomelaceae** J.E. ARESCHOUG, 1847 ふじまつも科
- Acanthophora* LAMOUROUX, 1813 とげのり属
aokii OKAMURA ひめとげのり
muscooides (LINNAEUS) BORY ことげのり
sp. ifera (VAHL) BØRGESEN とげのり
[*orientalis*]
- Acrocystis* ZANARDINI, 1872 つくしほうずき属
nana ZANARDINI つくしほうずき
- Amansia* LAMOUROUX, 1809 ひおどしぐさ属
glomerata C. AGARDH きくひおどし
japonica (HOLMES) OKAMURA ひおどしぐさ
mitsuii SEGAWA うすばひおどし
scalpellata TANAKA すじなしひおどし
- Ardissonula* G. DE TONI, 1936 ひよくそう属
regularis (OKAMURA) G. DE TONI ひよくそう
[*Isoptera regularis*]
- Benzaitenia* YENDO, 1913 べんてんも属

- yenoshimensis* YENDO べんてんも
- Bostrychia* MONTAGNE in RAMON de la SAGRA, 1842 nom. cons. こけもどき属
binderi HARVEY ひがしこけもどき
flagellifera POST
hamana-tokidae POST にせたにこけもどき (70)
mixta HOOKER et HARVEY はまなこけもどき
[*dichotoma* TOKIDA]
moritziana (SONDER in KÜTZING) J. AGARDH
えだねこけもどき
radicans MONTAGNE
simpliciuscula HARVEY ex J. AGARDH たにこけもどき
[*andoi*]
[*tenuis* f. *simpliciuscula*]
tangatensis POST
tenella (VAHL) J. AGARDH こけもどき
- Chondria* C. AGARDH, 1817 nom. cons. やなぎのり属 (71)
armata (KÜTZING) OKAMURA はなやなぎ
crassicaulis HARVEY ゆな
dasyphylla (WOODWARD) C. AGARDH やなぎのり
expansa OKAMURA もさやなぎ
intertexta SILVA もつれゆな
[*intricata* OKAMURA]
lancifolia OKAMURA ささばやなぎのり
mageshimensis TANAKA et K. NOZAWA in TANAKA しんかいゆな
minutula NODA ひめやなぎのり
polyrhiza COLLINS et HERVEY
repens BØRGESEN ひめやなぎのり
ryukyuensis YAMADA べにやなぎのり
stolonifera OKAMURA つるやなぎのり
tenuissima (GOODENOUGH et WOODWARD) C. AGARDH ほそやなぎのり
- Dasyclonium* J. AGARDH, 1894 くしのは属
flaccidum (HARVEY) KYLIN くしのは
[*Euzoniella flaccida*]
ocellatum (YENDO) SCAGEL くしのはもどき
[*Euzoniella ocellata*]
- Digenea* C. AGARDH, 1822 まくり属
simplex (WULFEN) C. AGARDH まくり
- Ditria* HOLLENBERG, 1967 しのぶぐさ属
zonaricola (OKAMURA) T. et M. YOSHIDA

- しのぶぐさ
 [*Herpopteros zonaricola*]
 Enantiocladia FALKENBERG in ENGLER et
 PRANTL, 1897 あいそめぐさ属
okamurae YAMADA あいそめぐさ
 Enelittosiphonia SEGI, 1949 まきいとぐさ属
hakodatensis (YENDO) SEGI まきいとぐさ
 [*Polysiphonia hakodatensis*]
 Exophyllum WEBER van BOSSE, 1910 あつばこう
 もりのり属
wentii WEBER van BOSSE あつばこうもりのり
 Herposiphonia NÄGELI, 1846 ひめぐけ属
caespitosa TSENG いわひめぐけ
fissidentoides (HOLMES) OKAMURA ひめぐけ
insidiosa (GREVILLE) FALKENBERG かぎひめぐ
 け
parca SETCHELL くものすひめぐけ (72)
 [*tenella* auct. japon]
 [*terminalis*]
subdisticha OKAMURA くろひめぐけ
 Janczewskia SOLMS-LAUBACH, 1877 そぞまくら属
morimotoi TOKIDA もりもとそぞまくら
 [*tokidae*]
 Laurencia LAMOUROUX, 1813 nom. cons. そぞ属
brongniartii J. AGARDH そぞのはな
 [*grevilleana*]
capituliformis YAMADA まるそぞ
cartilaginea YAMADA かたそぞ
ceylanica HARVEY せいろんそぞ
composita YAMADA きくそぞ
filiformis (C. AGARDH) MONTAGNE なんてんそ
 ぞ
 [*heterocladia*]
hamata YAMADA かぎそぞ
intermedia YAMADA くろそぞ
intricata LAMOUROUX もつれそぞ
japonica YAMADA おもてそぞ
majuscula (HARVEY) LUCAS あかそぞ
 [*obtusa* var. *majuscula*]
mariannensis YAMADA ふくれそぞ
nidifica J. AGARDH みなみそぞ
nipponica YAMADA うらそぞ
 [*glandulifera* sensu YAMADA]
obtusa (HUDSON) LAMOUROUX まぎれそぞ
okamurae YAMADA みつでそぞ
papillosa (C. AGARDH) GREVILLE ぱびらそぞ
pinnata YAMADA はねそぞ
surculigera TSENG いわかがり
undulata YAMADA こぶそぞ
venusta YAMADA ひめそぞ
yamadae HOWE しまそぞ
 [*amabilis*]
yendoi YAMADA きたそぞ
 Lenormandiopsis PAPANFUSS, 1967 すじなしぐさ属
lorenzii (WEBER van BOSSE) PAPANFUSS
 すじなしぐさ
 [*Aneuria lorenzii*]
 Leveillea DECAISNE, 1839 じゃばらのり属
jungermannioides (HERING et MARTENS)
 HARVEY じゃばらのり
 Lophocladia SCHMITZ, 1893 よれみぐさ属
japonica YAMADA よれみぐさ
lallemandii SCHMITZ
minima ITONO なんかいよれみぐさ
 Lophosiphonia FALKENBERG in ENGLER et
 PRANTL, 1897 はいいとぐさ属
hayashii SEGAWA はいいとぐさ
 Murrayella SCHMITZ, 1893 ながみぐさ属
pericladus (C. AGARDH) SCHMITZ ながみぐさ
 [*squarrosa*]
 Neorhodomela MASUDA, 1982 ふじまつも属
aculeata (PERESTENKO) MASUDA ふじまつも
 [*Rhodomela larix* auct. japon]
munita (PERESTENKO) MASUDA いとふじまつ
 [*Rhodomela subfusca*]
oregona (DOTY) MASUDA あつけしふじまつも
 Neurymenia J. AGARDH, 1863 いそばしょう属
fraxinifolia (MERTENS ex TURNER) J.
 AGARDH いそばしょう
nigricans TANAKA et ITONO くろいそばしょう
 Odonthalia LYNGBYE, 1819 nom. cons. のこぎりひ
 ば属
annae PERESTENKO ありゅうしゃんのこぎりひば
 [*aleutica* auct. japon]
corymbifera (GMELIN) GREVILLE はけさきのこ
 ぎりひば
kawabatae MASUDA しこたんのこぎりひば
macrocarpa MASUDA おおのこぎりひば
yamadae MASUDA あつけしのこぎりひば
 [*kamtschatica* auct. japon]

Placophora J. AGARDH, 1863 はいこざね属

binderi (J. AGARDH) J. AGARDH はいこざね*japonica* TANAKA かばいろはいうすば

Polysiphonia GREVILLE, 1823 nom. cons. いとぐさ属 (73)

abscissa HOOKER et HARVEY さんぼういとぐさ*akkeshiensis* SEGI あっけしいとぐさ*bicornis* OHTA*brodiaei* (DILLWYN) GREVILLE おおいとぐさ*codiicola* ZANARDINI in KÜTZING ばらいとぐさ*crassa* OKAMURA ふといとぐさ*cystophyllicola* NODA ひふみいとぐさ*decumbens* SEGI りぼんいとぐさ*echigoensis* NODA えちごいとぐさ*elongata* (HUDSON) HARVEY in HOOKERf. *schuebelerii* (FOSLIE) ROSENVIINGE*ferulacea* SUHR ex J. AGARDH ぼういとぐさ*fragilis* SURINGAR くろいとぐさ[*forcipata* sensu SEGI]*grateloupeoides* NODA*harlandii* HARVEY たいわんいとぐさ*japonica* HARVEY きぶりいとぐさ*latiovalis* NODA うすむらさきいとぐさ*morrowii* HARVEY もろいとぐさ[*senticulosa* sensu SEGI]*nipponica* SEGI にっぽんいとぐさ*notoensis* SEGI のといとぐさ*novae-angliae* TAYLOR ながつぼいとぐさ*obsoleta* SEGI ほそいとぐさ*ohmaensis* OHTA おおまいとぐさ*porrecta* SEGI ながいとぐさ*richardsonii* HOOKER もつれいとぐさ*saczensis* NODA さどいとぐさ*savatieri* HARIOT ひめいとぐさ[*aggregata*]*scopulorum* sensu SEGI おわりいとぐさ (81)*siretokensis* YAMADA in YAMADA et TANAKA

きたいとぐさ

sphaerocarpa BØRGESEN ひないとぐさ[*pulvinata* sensu SEGI]*spinosa* (C. AGARDH) J. AGARDH とげいとぐさ*subtilissima* MONTAGNE きぬこまち*tapinocarpa* SURINGAR けいとぐさ*teradomariensis* NODA えちごひめいとぐさ*tokidae* SEGI うすいとぐさ*tongatensis* HARVEY ex KÜTZING べにぼつす*upolensis* (GRUNOW) HOLLENBERG*urceolata* (DILLWYN) GREVILLE しょうじょうけ
のり*yendoii* SEGI えんどういとぐさ*yonakuniensis* SEGI よなくにいとぐさ

Pterosiphonia FALKENBERG in ENGLER et

PRANTL, 1897 はねぐさ属

arctica (J. AGARDH) SETCHELL et GARDNER

いなぼぐさ

bipinnata (POSTELS et RUPRECHT) FALKENBERG

いとやなぎ

fibrillosa OKAMURA けはねぐさ*pennata* (C. AGARDH) FALKENBERG はねぐさ

Rhodomela C. AGARDH, 1822 nom. cons. せいよう

ふじまつも属

lycopodioides (LINNAEUS) C. AGARDHf. *tenuissima* (RUPRECHT) KJELLMAN

みやびふじまつも

sachalinensis MASUDA からふとふじまつも[*macracantha* sensu TOKIDA]*teres* (PERESTENKO) MASUDA ほそばふじまつも[*gracilis* YAMADA et NAKAMURA]

Symphyocladia FALKENBERG in ENGLER et

PRANTL, 1897 こざねも属

latiuscula (HARVEY) YAMADA いそむらさき[*gracilis*]*linearis* (OKAMURA) FALKENBERG ほそこざねも*marchantioides* (HARVEY in HOOKER)

FALKENBERG in ENGLER et PRANTL こざねも

pennata OKAMURA ひめこざね

Tolypocladia SCHMITZ in ENGLER et PRANTL,

1897 いとくずぐさ属

glomerulata (C. AGARDH) SCHMITZ in ENGLER

et PRANTL いとくずぐさ

[*Roschera glomerulata*]

Vidalia LAMOUROUX ex J. AGARDH, 1863 nom.

cons. かえりなみ属

obtusiloba (MERTENS ex C. AGARDH) J.

AGARDH かえりなみ

Wrightiella SCHMITZ, 1893 らいちえら属

loochooensis YENDO らいちえら

紅藻に関するノート

- (1) *Asterocytis* 属は *Chroodactylon* 属の異名とされているので、この属に含まれている種については命名上考慮が必要である。
- (2) *f. simplex* が区別された。
- (3) *f. simplex* の区別されている。
- (4) HEEREBOUT (1968) は培養実験の結果からこれまで記載された多くの種を少数にまとめた。日本産の種もこの観点から再検討しなければならない。
- (5) HEEREBOUT (1968) はこの種の独立性に疑問を持っている。
- (6) *f. crassa* アツバベニタサ, *f. elliptica* マルバベニタサ, *f. lanceolata* ナガバベニタサが区別された。
- (7) 有性生殖をしない *f. sanrikuensis* ニセコスジノリが岩手県より知られている。
- (8) *f. lanceolata* ナガバアナアマノリが区別された。
- (9) *f. latifolia* ヒロハマルバアマノリが区別された。
- (10) *f. coreana* が区別された。*P. palleola* サツキノリはこの種の異名と思われる。
- (11) Nemaliales の綴りが文法的には正しいとされている。
- (12) Acrochaetiaceae アクロケテウム科にいくつかの属を認めるか意見が一致していない。*Auduinella* 一属のみを認める立場をとれば、*Acrochaetium*, *Colaconema* 属等に入れられている種は *Auduinella* に移されるべきであろう。
- (13) *Auduinella* の綴りがしばしば用いられている。BORY のもとの綴りを用いるのが正しい。
- (14) 岡村 (1936) が記述している *Liagora fragilis*, *L. viscida* はその後確認されていない。
- (15) ヨーロッパではこの種は *N. helminthoides* と同種であるとされている。
- (16) ガラガラ属に KJELLMAN (1900) は多くの種を記載したが、その後の検討によりもっと少数の種にまとめられる方向にある。例えば PAPANFUSS et al. (1982) によれば
G. rugosa=cuculligera, glabriuscula, pacifica
G. marginata=clavigera, veprecula
 のようで、生活史の研究を含めて今後詳しく調べなければならない。
- (17) Bonnemaisoniales とする考えもある。
- (18) 四分胞子体は *Falkenbergia rufolanosa* である。
- (19) 四分胞子体は *Trailiella intricata* である。
- (20) DIXON and IRVIN (1977) はこの目を認めず、ウミゾウメン目の中に入れている。
- (21) *G. corneum* var. *pulchellum* リュウキュウブトが瀬木 (1957) により報告された。DIXON and IRVIN (1977) によれば *G. corneum* は *G. sesquipedale* の異名とされているので、日本産の種は検討を要する。
- (22) *f. elatum* ヒゲクサ, *f. elegans*, *f. teretiusculum* が区別されている。
- (23) 瀬木 (1954, 1955, 1957) の報告によるものであるが、分類学的再検討をしなければならない。
- (24) var. *conchicola* ケスジハイテングサ, *f. foliaceae* ヒロハハイテングサが記載されている。
- (25) *Acrosymphyton* sp. が吉崎・千原 (1974), *Gibsmithia* sp. エツキヒビロウドが糸野 (1971) により日本に産することが報告されている。
- (26) *Thuretellopsis japonica* SEGAWA et ICHIKI ミシミヒビロウドは多分この種の異名であろう。
- (27) 目のランクに上げて Hildenbrandiales とする人がある。
- (28) 綴りにいくつかの異なったものがある。ここに用いたものが正しい。科名とは綴りが違うので注意を要する。
- (29) *f. filiformis*, *f. intermedia*, *f. sororia* が区別された。
- (30) *Pneophyllum* という属名を用いるべきことが CHAMBERLAIN (1983) によって示された。*P. sargassi* (FOSLIE) CHAMBERLAIN となる。*f. parvula* ソゾゴロモが区別されている。
- (31) *f. minuta* が区別された。
- (32) 変異が多い種で, var. *porracea* ウツロムカデ, *f. lomentaria* が区別されている。
- (33) *f. flabellata* が区別された。
- (34) アカハダ *Pachymenia carnosa* sensu YENDO については学名が正式に発表されていない。
- (35) *Endocladia yasudae* YENDO が記載されたが、その後報告がない。
- (36) *f. coliformis*, *f. intricata* が区別された。
- (37) *f. polystromatica* が区別されている。この属は PUESCHEL and COLE (1982) によればダルス目に入れられる。
- (38) *f. fucicola* モツキフチトリベニが区別されている。

- (39) 原記載以後採集記録がない。
- (40) 学名については検討中である。
- (41) *f. uncinatum* が区別された。
- (42) *f. gracilis* コサイダイバラが区別されている。
- (43) *var. elongata* ホソミアナグサが区別された。
- (44) シンカイカパノリ *Gracilaria sublittoralis* YAMADA et SEGAWA, nomen nudum については取扱いを検討中。
- (45) *Phyllophora japonica* YENDO は記載以後採集記録がない。
- (46) *var. tobuchiensis* イタニグサが区別される。
- (47) 学名について検討を要する。
- (48) *f. latus* ヒロハノコトジが区別された。
- (49) *f. flabellatus* ウチワツノマタが区別された。
- (50) *f. aequalis* ヤセツノマタ, *f. crispoides* トチャカダマツ, *f. nipponicum* マルバツノマタ, *f. parvus* ヒメツノマタが記載された。
- (51) *f. armatus* トゲツノマタ, *f. ciliatus*, *f. flabellatus* ウチワツノマタ, *f. longicornis* ハサミヒラコトジが記載されている。
- (52) *f. fimbriatus* フサツノマタ, *f. subdichotomus* エダツノマタが区別されている。
- (53) 学名については増田(未発表)が検討中で, *Mastocarpus* イボノリ属の1種である。
- (54) *f. oblongo-ovatum* トカチギンナンが区別された。
- (55) *f. divergens* エダウチギンナンが区別された。
- (56) 四分孢子体は *Petrocelis* 属とされていた。
- (57) ダルスを *Palmariales* に移すと, この目および *Rhodymeniaceae* の和名を変えなければならなくなった。
- (58) *f. australis*, *f. borealis*, *f. cymosa*, *f. elongata* が区別される。
- (59) *f. hamata* が区別される。
- (60) *Reinboldiella* 属に移されるべきものであろう。
- (61) *var. robustum* が区別されている。
- (62) *f. flaccida* が区別されている。
- (63) *var. byssoideum* が区別された。
- (64) *f. abbreviatum*, *f. ambiguum*, *f. trichotomum* が区別されている。
- (65) *pectinata* の種小名が使えないので, *serrata* が正しい。コバシクシベニヒバ *P. pectinata f. litoralis* について検討を要する。
- (66) 記載以後採集記録がない。
- (67) *H. tortilis* ヨレベニハノリはこの種に含まれるであろう。
- (68) *Okamura* ZINOVA の名前が早く発表されているが, 当初同定の間違いに基いているので規約上問題があり, *Yamadaphycus* を用いる。
- (69) *f. nipponica*, *f. pacifica* が区別される。
- (70) *f. morii* が区別された。
- (71) *C. atropurpurea*? とされているものについては *C. decipiens* との関係を調べる必要がある。
- (72) クモノスヒメゴケには *H. tenella* の学名が用いられて来た。SEGI (1954) はヨーロッパのものと違うということで *H. terminalis* と命名したが, HOLLENBERG (1968) は SEGI の種と *H. parca* が同一だという意見で, ここではそれに従っておく。
- (73) イトグサ属は大きい属で, ここにリストした以外にも *P. cancellata*, *P. elongella*, *P. flabellulata*, *P. stimpsonii*, *P. violacea*, *P. yokoskensis* などの記録がある。今後の研究によって明らかにされるであろう。
- (74) GEESINK (1973) は実験的に淡水産と海産のものが同一種であると結論した。
- (75) この2種は別属 *Devaleraea* に移すべきという考え方をもっている人もある (GUIRY 1982)。
- (76) NORRIS (1985) は *Mesothamnion* BØRGESEN と *Compsothamniella* ITONO を *Pleonosporium* から区別する理由がないとして, この3属を纏めた。
- (77) *Callophyllis laciniata* の報告もあるが, ここには収録しなかった。
- (78) LINDSTROM (1985) によれば, *N. integra* は *Dilsea* の種であるから, ナガアカバは *Neodilsea* 属で *Neodilsea longissima* (MASUDA) LINDSTROM と呼ぶべきである。
- (79) ミヤヒバに *C. squamata* の学名が当てられて来たが, ヨーロッパの種と異なるようで, 分類学的に再検討が必要である。
- (80) シロモカサ *Pneophyllum lejolisii* (ROSA-NOFF) CHAMBERLAIN, ヒメモカサ *Pneophyllum confervicolum* (KÜTZING) CHAMBERLAIN の学名が正しいという。
- (81) オワライトグサの学名は検討を要する。
- (82) *Nemastoma* という綴りがこれまで用いられてきた。

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日本産海藻目録-I 緑藻と褐藻 正誤表と補遺

ページ	行	誤	正
58右	上 3	コツクム目	コックム目
60左	上 5	えとじゅずも	ふとじゅずも
61左	下 4	van-bosseae	van-bosseae
63左	上10	ひめいちょうもども	ひめいちょうもどぎ
65左	下 1	Lithodermataceca	Lithodermataceae
69左	上23	GRETELOUP	GRATELOUP
69右	上 6	OLTMANN'S, 1922	KYLIN, 1917
70右	上 3	papenfusii	papenfussii
71左	下20	OLTMANN'S, 1922	KYLIN, 1917
71左	下 2	(36)	(37)
71右	上11	(37)	(36)
73左	下14	葡萄根	葡萄根

68ページ。ハバモドキ属について研究した太田雅雅 (1984, 学位論文) によれば, *P. chartacea* auct. japon は *P. occidentalis* SETCHELL et GARDNER とすべきであり, ノート(19)で触れた YENDO の *P. rubescens* は *P. plantaginea* である。

最近日本に産することが報告されたものに *Protectocarpus speciosum* (BØRGESEN) KORNMANN がある (田中次郎, 藻類 33: 93. 1985)。また伊豆半島から *Myelophycus cavum* J. TANAKA et CHIHARA, Phycos 23: 153. 1984 が記載された。

INDEX TO GENERA

(細字の頁数は当該属が異名 synonym として記されている頁, またはノート欄に記されている頁を示す。)
 (属名をイタリックで示したものは, synonym としてのみ用いられているもの, あるいはノート欄だけに記されているものである。)

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御園生拓：モスクワ大学生物学部について Taku MISONO: On the Faculty of Biology, Moscow State University

筆者は機会を得て、ソ連邦モスクワ大学生物学部大学院に1980年秋より留学し今春帰国した。そこで、ふだんあまり知られることのないソ連邦の生物学研究システムについて簡単に紹介したい。

日本では大学は教育とともに学術研究の中心でもあるが、ソ連では大学はあくまでも教育を主とした機関であり、研究も合わせて行なっている大学は全国でもそう多くはない（モスクワ大学、レニングラード大学等）。主に研究活動を行なう機関は大学とは別の科学アカデミーの研究所である。これらの研究所は専門分野によってかなり細かくわかれており（植物生理学研究所、微生物学研究所、光合成研究所等々）、それぞれ第一線級の学者が研究を行なっている。

筆者が籍をおいていたモスクワ大学はソ連邦最大の大学で、主に大学・専門学校の教員を養成することを目的としている。学部は5年、大学院は3年（外国人留学生は4年）で、学部卒業時に修士号、大学院修了時には博士候補（対外的には Ph. D.）の称号を与えることになっている。ソ連の博士号（Dr.）は日本とは異なり、博士候補を持つ者が研究職に就いて何年か研究活動を行ない、ある大きなテーマについての総説的な論文をまとめ、改めて審査を通してから与えられる。尚、生物学は学科ではなく学部としてまとめられており、その中に植物生理学科、生化学科、下等植物学科等の学科がおかれている。

生物学部内でも教育と研究はかなり切りはなされており、教員（教授・助教授・講師）と研究者（上級研究員・下級研究員・実験助手）は別系統の資格である。尚、教授・助教授は博士号、研究員は博士候補の資格を必要とする。もっとも、研究員は講義等は行なわないが、教員は多かれ少なかれ研究活動も行なっており、また科学アカデミーの著名な学者はたいてい教授の肩書きを持っていて大学等で講義を行なっている。地方大学の教員も科学アカデミーの研究所やモスクワ大学等に出張、または内地留学して研究を行なうことができる。

研究テーマは多岐にわたっており、全国的にみれば現代生物学のほぼ全ての分野をカバーしているといえる。そのテーマの決め方が実にソ連的である。例えば、研究も同時に行なっているモスクワ大学生物学部では、まず各学科でいくつかの大きなテーマを決め、そのテ

ーマに即したより細分化されたテーマを各研究室毎に決め、さらにそれらを具体化したテーマを各研究員が選ぶというシステムをとっている。そしてそれぞれのテーマについて、大学とは別の組織である「科学者ソビエト」（大学内外の専門の学者より成る委員会）の審査・承認を受けなければならないのである。これは科学アカデミーの研究所でも同様である。尚、この委員会は博士候補及び博士号論文の審査も行なう。

これらの審査においては、そのテーマの科学上の意義と同時にその研究の社会的意義が問題となる。一般にソ連ではこの点が重視されており、論文や学会発表の際などにも必ず社会への還元に触れているようである。

もっともこのようなテーマの決め方は、学科内の複数の研究者がまとまって一つのテーマに集中できる点では優れている。しかし、個々の研究者のテーマ選択の幅が日本などに比べて狭くなったり、研究者からのテーマに関する新しいアイデアがとりあげられにくいというような欠点があるように思える。

とはいえ、世界的な生物学の動向にはたいへん敏感である。世界の主要な学術雑誌はレーニン図書館等によくそろっており、研究者はそれぞれ世界の最新の情報をとり入れて仕事を進めている。

研究室の実験装置・器具などは日本と比べると貧弱であるという印象は否めない。特にガラス器具や薬品類などの消耗品は常に手にはいるわけではなく、ものによっては何ヶ月も品切れで研究者間で乏しいストックをやりくりするという状況もみられる。しかしこのような背景があるとはいえ、学部内に修理・技術部、ガラス細工部等があって、壊れた器具の修理や種々の実験装置・器具の製作を行なっている点は、あまりに使い捨ての感のある日本とひき比べて大いに考えさせられた。

研究者の健康には多大の注意がはらわれている。年一回の健康診断の他、有機溶媒等の有毒物質を扱う者には毎日牛乳の支給（0.5l）がある。また他の労働者と同じく年24日間の休暇があり、日曜・祭日には特別な場合を除き研究室には鍵がかけられてはいれなくなる。年中無休の日本の研究室も、少しは見習って余裕を持ってよいのではないだろうか。（184 小金井市貫井北町 4-1-1 東京学芸大学・生物）

高橋永治*, 榎本幸人*, 熊野 茂*, 坪 由宏**: 広瀬弘幸先生の御逝去を悼む
Eiji TAKAHASHI, Sachito ENOMOTO, Sigeru KUMANO and Yoshihiro Tsubo:
Hiroyuki HIROSE (1912-1985)



神戸大学名誉教授、藻類学会名誉会員、農学博士、広瀬弘幸先生は去る昭和60年3月28日、73才で御逝去になりました。

先生は、大正元年8月12日、姫路市に生まれ、昭和10年北海道帝国大学理学部植物学科を卒業後、同年4月同大学副手、昭和15年5月同大学助手（農学部）、同23年4月北海道大学講師（農学部）を経て、昭和24年8月に教授として神戸大学文理学部姫路分校に就任されました。文理学部理科は改組に伴って、理学部となり、また昭和40年には大学院理学研究科が新設されました。その間、先生は、担当された系統学講座の充実と発展に尽くされ、昭和51年4月停年退官されました。

先生は、北海道大学在任中は、藍藻類の分類と生態の研究に従事され、北海道淡水産藍藻と東北、中部及び関東地方の温泉水に生育する藍藻を明らかにされ（1937-1949）、昭和24年1月、『日本の中部、関東及び東北地方に於ける温泉水性藍藻の分類学的及び生態学的研究』と題する論文により北海道大学から農学博士の学位を受けられました。神戸大学に着任されてから、淡水藻、温泉藻、土壌藻、淡水植物プランクトン及び海藻と広く藻類全般を研究の対象にされました。そして、イデユコゴモ (*Cyanidium caldarium*) が紅藻であること、新属・新種の寄生性緑藻の発見、藍藻と紅

藻の類縁関係の解明、数種の淡水プランクトンの発見、紀伊水道、瀬戸内海及び日本海西沿岸の海藻相の調査、海産緑藻の生活史における新発見など、多くの成果を挙げられました（1950-1981）。これらは52篇の原著論文として発表され、草創の時期にあった日本の藻類学の地位を高揚されました。そして、このような広範な研究成果に博い学識を加えられて、藻類の体系を平易に解説された『藻類学総説』を昭和34年に出版されました。また、日本の藻類学研究の高い水準を広く世界に示すお考えから、御自身を加えて22人の論文を集め、昭和50年にドイツ国、Gustav Fischer社から『Advance of Phycology in Japan』を出版されました。さらに日本産淡水藻の図鑑の刊行を企画され、10名の協力者と御自身の分担執筆を加え、13年の歳月を費やして、これまで公表された日本産淡水藻の全種を網羅した『日本淡水藻図鑑』を昭和52年に刊行され、日本淡水藻の分類学的研究の集大成を後世に残されました。

先生は、長らく日本植物学会と日本藻類学会の会員として活躍され、得られた新発見を弁舌さわやかに御発表されたり、総会での会費値上げに就いての質疑応答などを、柔らかくまとめられる御人柄でした。日本植物学会の評議員及び近畿支部長を歴任されたほか、古くは日本藻類学会、近年では国際藻類学会の設立発起人の一人として尽力され、また会長として両学会の発展に寄与されました。昭和46年8月、第7回国際海藻学会議が札幌市で開催されるにあたり、会長として尽力されました。また同50年12月には、藻類の分類に関する日米科学協力セミナーを企画され、これを神戸市で開催され、世界の藻類学者の交流と藻類学の進展に大きく寄与されました。昭和57年の日本藻類学会30周年記念講演では、日本藻類学会と日本の藻類研究の歩みについて講演されましたが、これが私共への最後の御講演となりました。また先生は、学術審議会専門委員や生物科学研究連絡委員会委員などの各種委員を歴任され、さらに兵庫県自然保護協会設立に努力されて初代理事長を勤められるなど、学外でも活躍されました。学内では、神戸大学附属臨海実験所の設立に奔走され、昭和38年に淡路島岩屋に設置されてから御退官までの13年間、所長として、その管理、運営、充実に尽力されました。このように藻類学研究の進展や生物学教育の振興など多方面に顕著な功績を残されたの

であります。これらの御功績に対して勲三等旭日中綬章が授与されました。

終りに先生の主要論文を紹介し、心から御冥福を御祈り申し上げます。

(*657 神戸市灘区六甲台町 1-1 神戸大学理学部, **同神戸大学教養部)

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舟橋説往： 川端清策先生の御逝去を悼む Setsuo FUNAHASHI: Seisaku KAWABATA
(1906-1985)



日本藻類学会会員，元高崎経済大学長川端清策先生は昭和60年4月11日札幌市において，クモ膜下出血のため御逝去になりました。享年78歳でした。御葬儀は4月13日札幌市中央区南11条西13丁目大有寺でとり行われました。

先生は，明治39年8月31日群馬県伊勢崎市に生れ，大正13年3月県立太田中学校を卒業，翌年4月群馬県佐波郡豊受尋常高等小学校代用教員を振出しに，昭和60年3月末日，道都短期大学長，同大海洋生物研究所長の兼職を最後として退任されるまで，60余年の永きに亘り，研究・教育の道を歩まれました。

先生の御履歴は次のようであります。上述の代用教員時代，郷里群馬県より翌大正15年4月北海道に転じ空知郡志文尋常小学校に奉職，昭和2年1月軍隊に入営のため退職，同3年4月第2高等学校入学，同6年4月北海道帝国大学理学部植物学科に入学，同10年3月同大学を卒業されました。卒業研究では，後に日本藻類学会の初代会長となられた山田幸男教授の御指導で，色丹島の海藻フロラを研究されました。後述の業績目録の最初の論文がその研究成果であります。昭和10年大学卒業後，直ちに東海高等女学校に教諭として就職され，その後，昭和12年3月茨城師範学校教諭に転じ，さらに同15年3月日立製作所教員，同21年3

月夕張市立中学校教諭，同23年4月北海道立夕張高等学校教諭，同25年4月北海道立夕張北高等学校教諭，同年8月北海道岩見沢西高等学校教諭，同27年4月北海道学芸大学助教授をへて，同31年4月同大学教授となり，同45年3月停年退職，同年4月高崎経済大学教授，同47年3月停年退職，同49年1月高崎経済大学長に就任，同51年1月任期満了退職，同年2月道都短期大学教授，同年4月同短期大学副学長，同53年4月道都大学副学長，同57年3月停年退職，同年4月道都大学名誉教授，同59年4月道都大学海洋生物研究所長，同年8月道都短期大学長，同60年3月31日勇退されました。この学長御退任の10日後に御急逝となりました。

先生の研究・教育のひとつの道は，60年余に及び，正に激動の昭和史と軌を一にされた様に思います。先生は60余年間の教育・研究活動の前半を初等・中等・高等教育に尽力されましたが，後半の30余年は大学教育と大学運営に力を注がれると共に御専攻の海藻の分類学の分野で，後述のように，業績を多数学界に発表されました。特に「日本産ムカデノリ科の系統学的研究」は先生の代表的な御業績で，この研究により北海道大学より昭和37年2月理学博士の学位を授与されました。また日本植物学会会員，日本藻類学会会員，国際藻類学会会員，日本理科教育学会理事として活躍されました。以上の様な多年の先生の御功績が認められ，昭和53年11月文化の日に，勲三等旭日中綬章を叙贈されました。さらに先生は多趣味の方で魚釣り，囲碁，園芸をたのしまれました。

先生は，大学運営の御業績からもわかりますように，卓抜した先見性と決断力をお持ちでした。しかも人格は円満で清潔であり，常に温情溢れる人間味と後進への思いやりに満ちておりました。先生を知る人々はいつまでも敬慕の念を抱き続けることであらう。

茲に，ありし日の先生を偲び，御履歴および御業績を略述し，心より御冥福をお祈りいたします。本文のために先生の御写真を提供下さいました札幌市円山の千代夫人に厚くお礼を申し上げます。

(370 高崎市上並榎町 1300 高崎経済大学)

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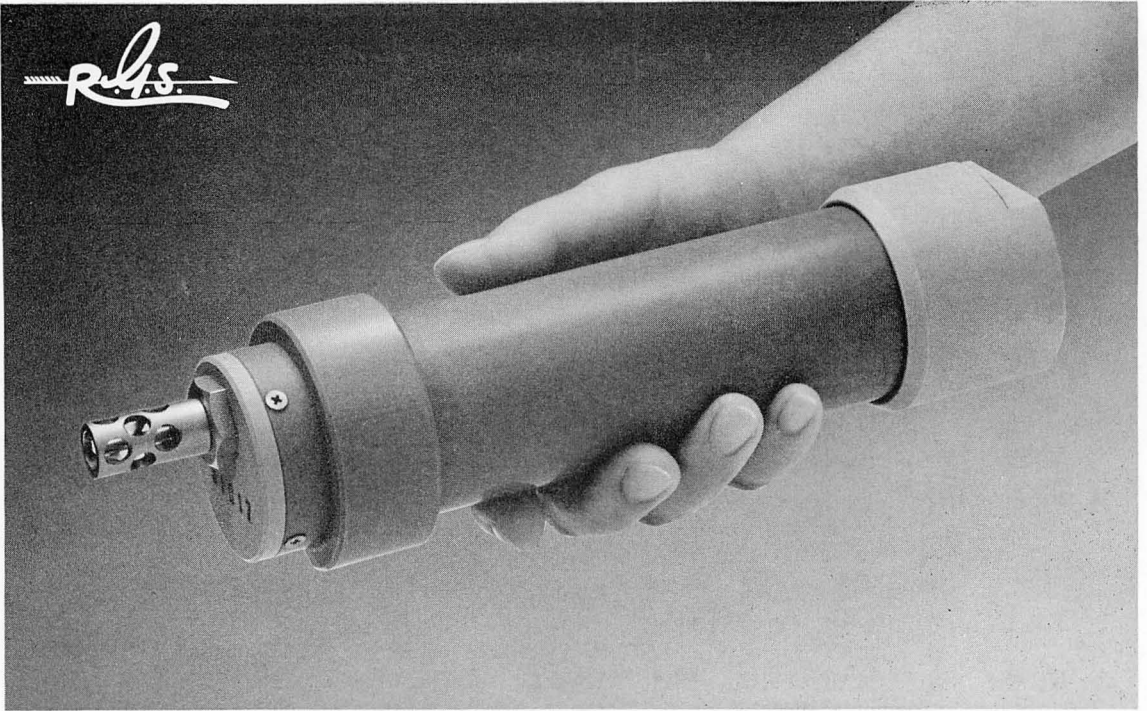
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住 所 変 更

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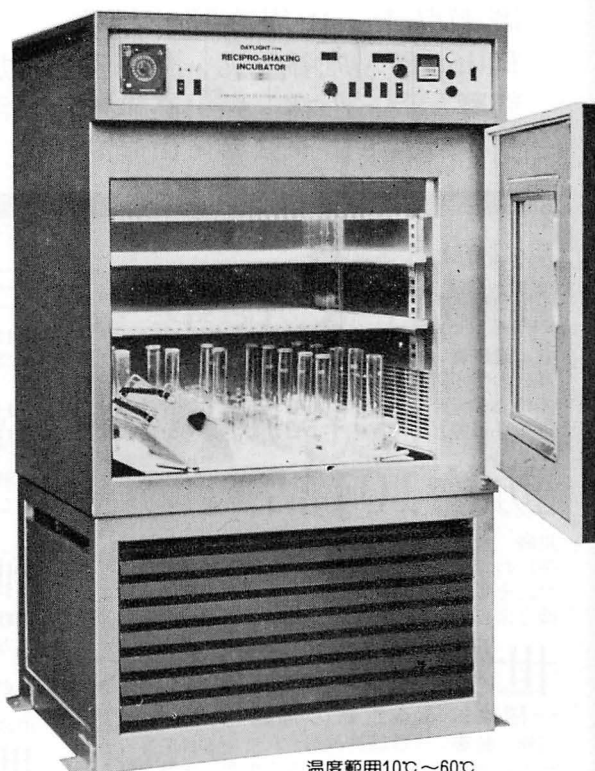
デイライトタイプ レシプロシエーキング インキュベーター

光源として20W蛍光灯、プラントルクス等が10本取付け可能で、最大10,000ルクスの照度が得られ、スイッチにより半分の点灯も可能です。さらに、24時間タイマーと連動させて、最小15分から最大24時間まで自由な照射条件が作れます。

レシプロの振盪機構はつまみひとつで自由に速度が可変でき、回転数もデジタル表示します。振盪パネルはワンタッチで交換可能、オプションとして御要望に合せたどのようなパネルも作成いたします。

恒温機構も10℃から60℃の広帯域で使用でき、恒温振盪培養機としての使用はもちろんのこと、陽光恒温器としても使用でき、藻類の増殖試験等に最適です。長時間試験にも充分使用できるようデジタル設定の運転用タイマーを備え、経時後自動OFF、または自動ONが可能です。さらに高温防止器などの安全装置も装備していますので無人運転等多様な運転操作が安心して行えます。

※この外にも各種振盪培養機があります。カタログ御請求ください。



温度範囲10℃～60℃

仕様

- 外 法: W900×D780×H1,520mm
- 器内有効内法: W720×D650×H 520mm
(ランプ無し 660mm)
- 振盪パネル: 600×600mm(500ml坂口フラスコ25本掛、その他試験管、フラスコ、パネル等任意取付可)
- 振盪巾: 70mm
- 振盪数: 30～200R.P.M.(回転計付)
- 温度範囲: 10℃～60℃
- 温度分布: ±1℃ 温度精度: ±0.5℃
- 安全装置: ヒーター断線、センサートラブル、異常高温を
警報加熱・冷却装置 自動カット機構付

理化学機器 トーマスハンディクーラー・全自動式恒温水槽(P.A.T) 低温、高温、恒温装置・乾燥器・電気炉・振盪機

トーマス科学器械株式会社

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■藻類の全体像の顕微鏡写真を中心に、拡大写真、線図を加え1種1頁を原則に収録、解説は和英両文で種名・文献、藻類の性状、寸法、分布、類似種との比較等を記載している。各巻100シートで2000～3000種を目標に刊行する。

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