Female Reproductive Morphology and Taxonomy of Rhodopeltis Harvey(Polyidaceae, Rhodophyta) II. R. gracilis Yamada et Tanaka, R. liagoroides Yamada and R. setchelliae Yamada

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journal or publication title	鹿児島大学理学部紀要. 地学・生物学
volume	25
page range	137-147
別言語のタイトル	紅藻スギノリ目ガラガラモドキ属の分類学的研究 II. ホソバガラガラモドキ, コナハダモドキとナンバガラガラモドキについて
URL	http://hdl.handle.net/10232/00006951

Rep. Fac. Sci., Kagoshima Univ. (Earth Sci. & Biol.)
No. 25, 137-147, 1992.

Female Reproductive Morphology and Taxonomy of *Rhodopeltis* Harvey (Polyidaceae, Rhodophyta)

II. *R. gracilis* Yamada et Tanaka, *R. liagoroides* Yamada and *R. setchelliae* Yamada

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(Received Sept. 14, 1992)

The female reproductive morphology of *Rhodopeltis gracilis, R. liagoroides,* and *R. setchelliae* is described and illustrated. These three species differ from *R. australis* (type of the genus) and *R. borealis* in several features. The cortex is composed of 4 or 5 layers of elliptical cells rather than 7-9 layers of round cells as in *R. australis* and *R. borealis.* Carpogonial branches are initiated by inner cortical cells rather than by surface cells. The auxiliary cell is an undifferentiated cell in a nemathecial or rarely cortical filament rather than part of a specialized filament. Nemathecial filaments are initiated by cortical cells only after the initiation of carpogonial branches rather than before. Only terminal cells of gonimoblast filaments become carposporangia rather than most cells. Thus, a new genus, *Stenopeltis,* is created for these species, and three new comninations are proposed: *Stenopeltis gracilis* (Yamada et Tanaka) comb. nov. *S. liagoroides* (Yamada) comb. nov., and *S. setchelliae* (Yamada) comb. nov.. Although *Stenopeltis* gen. nov. is retained in the Polyidaceae (Gigartinales) on the basis of carpogonial branch and auxiliary cell features and early postfertilization events, it differs from *Polyides lumbricalis,* the type of that family, in having a calcified thallus, tetrasporangia possibly occurring on heteromorphic stages in its life cycle, and carposporangia terminal on loosely fasciculate carposporogenous filaments. The phylogenetic relationship of *Stenopeltis* is discussed, especially with reference to members of the Nemaliales with a diffuse type of gonimoblast.

This report is the second concerning little-known, predominantly tropical and subtropical, western north Pacific species of *Rhodopeltis.* Part I (in preparation) treats the morphology and taxonomy of *R. australis,* the type of the genus, and *R. borealis.*

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Materials and Methods

The following collections, all made by the former auther, have been examined:
A. *Rhodopeltis gracilis*. Marbo, Guam (Sept. 7, 1977), 2-3 m below low tide level, on vertical face of rock platform.
B. *R. liagoroides*. Mageshima, southern Japan (May 28, 1979), 3-5 m below low tide level, from submarine terrace. Kikaijima, southern Japan (May 26, 1979), from tide pool at low tide level.
C. *R. setchelliae*. Mageshima, southern Japan (May 28, 1979), 3-5 m below low tide level, from submarine terrace.

The materials were preserved in 4% Formalin/sea-water. Detailed studies of the female reproductive anatomy were made on liquid-preserved specimens. Sectioned materials were stained on the slide with aniline blue and then acidified with a drop of 1 N hydrochloric acid until enough stain had been absorbed. The sections were washed while on the slide and then mounted with corn syrup (Karo brand) preserved with thymol.

Observations

Rhodopeltis gracilis Yamada et Tanaka

Carpogonial branches (Fig. 1, cb) are borne singly on outer cortical cells, usually slightly below the two cartical filaments that also arise from supporting cell, but with mature carpogonial branches tending to assume a more lateral position on the supporting cell. Occasionally, a carpogonial branch may replace one of the cortical filaments on the supporting cell, and, in this case, the carpogonial branch appears to be terminal on the supporting cell. This situation suggests that carpogonial branches are homologous with vegetative filaments of the outer cortical layer. Supporting cells are not differentiated, either in size or staining properties, from the vegetative cells that occupy a homologous position.

Mature carpogonial branches generally consist of three cells (Fig. 2, cp, hy, bc), but sometimes four-celled carpogonial branches may be found (Fig. 1, cb). Both three-celled and four-celled carpogonial branches have been seen to initiate carposporophyte development. The carpogonium is more or less cortical and terminates in a long slender trichogyne. The other two or three cells of the carpogonial branch are subcylindrical. In the young carpogonial branch, all cells stain in a similar manner, but subsequently their staining properties become differentiated. The carpogonium and subhypogynous cell stain more deeply, whereas the other cells lose their staining properties. In some carpogonial branches, however, it is the carpogonium and the hypogynous cell that stain more deeply. This is suggests that the subhypogynous cell, or rarely the hypogynous cell, acts as the nutritive auxiliary cell in the carpogonial branch.

In both fertilized and unfertilized carpogonial branches, the carpogonium and nutritive auxiliay cell sometimes initiate sterile filaments (Figs. 4, 6, st) that closely resemble the vegetative cortical filaments.

Nemathecial filaments in *R. gracilis* are initiated only after the production of the carpogonial branches, and when fully grown they surround mature carposporophytes (Fig. 9, nf). Fully grown

nemathecia are uncalcified and appear as red spots measuring about 0.5 mm in diameter on the thallus.

Presumed fertilization of the carpogonium results in the separation of the trichogyne from the carpogonium at the cytoplasmic constriction between these two structures. Subsequently, the carpogonium divides by a longitudinal or oblique septum, cutting off a small cell (Fig. 2, pcon) which protrudes and finally fuses with a cell below the carpogonium in the carpogonial branch. The cell that established a primary connection with the carpogonium functions as a nutritive auxiliary cell (Figs. 3-6, naux) and, as mentioned above, it may either be the subhypogynous cell (Figs. 3 and 4) or, more rarely, the hypogynous cell (Fig. 6). The primary connection between the carpogonium and nutritive auxiliary cell is initially an open fusion (Figs. 3, 4 and 6), but later the connecting tube forms a pit connection near the auxiliay cell (Fig. 5), which produces several secondary connecting filaments.

Up to five separate secondary connecting filaments have been observed emerging from a single nutritive auxiliary cell (Fig. 5, scon). At this time, the cells in the carpogonial branch, other than the nutritive auxiliary cell, lose much of their darkstaining contents. In Fig. 5 the carpogonium and hypogynous cells have disappeared from the branch system, while in Fig. 6 the cells below the nutritive auxiliary cell have lost their contents, leaving only their walls.

Auxiliary cells are borne in the outer dichotomies of cortical filaments (Fig. 6, naux) or in the proximal parts of nemathecial filaments (Fig. 7, naux). The detection of these auxiliary cells is difficult unless they have fused with a connecting filament. The connecting filaments become densely packed with dark-staining cytoplasmic contents and are capable of growing beyond the first auxiliary cell fusion to effect further unions with other auxiliary cells. As the connecting filament extends through the nemathecium, its attached auxiliary cells begin to stain slightly more strongly that the surrounding vegetative cells, but their size is not conspicuously differentiated.

Secondary connecting filaments divide by septa several times, and each segment usually produces one or two carposporogenous filaments (Fig. 8, cf) towards the thallus surface. The carposporogenous filaments are branched a few times by transverse or oblique divisions and stain more deeply than the segment of connecting filament. Carposporangia develop terminally and range in shape from subcylindrical to clavate (Figs. 8 and 9, ca). At maturity, each sporangium releases its carpospore through a terminal pore. The old sporangial wall (Fig. 8, cw) remains and subsequent carposporangial proliferation occurs. Several carposporogenous filaments are produced from the connecting filament between its junctions with the auxiliary cells (Figs. 8 and 9), at positions remote from the auxiliary cells, which in the present species are consequently not generative.

Rhodopeltis liagoroides Yamada

Carpogonial branches are borne singly on inner cortical cells, usually slightly below the two cortical filaments that also arise from the supporting cell. When mature, the carpogonial branches appear to be lateral on their supporting cell. The supporting cells are not differentiated from the vegetative cells of the inner cortex either in size or staining properties.

After the initiation of carpogonial branches in the inner cortex, the filaments of the outer cortical layers extend longitudinally, forming uncacified nemathecia. Fully mature nemathecia appear as red spots on the thallus surfacees and measure about 1 mm in diameter.

The mature carpogonial branch is five-celled, the cells being cylindrical, and the carpogonium projects into a trichogyne that passes directly towards the thallus surface. Three-celled or four-celled carpogonial branches that are already provided with a long trichogyne (Figs. 10-13) are frequently found. These carpogonial branches, however, are apparently immature, and their terminal cell subsequently elongates and divides transversely (Figs. 11, 13) to form normal five-celled branches. In fully developed carpogonial branches, the carpogonium and the two cells immedaiately below it stain darkly with aniline blue, but the basal two segments do not stain so strongly. The carpogonium and the subhypogynous cell stain most deeply, the latter acting as a nutritive auxiliary cell (Figs. 14 and 15, naux). Nemathecial filaments are initiated only after the production of the carpogonial branches, and when fully grown they surround mature carposporophytes.

After presumed fertilization, the trichogyne is cut off from the carpogonium at the narrow cytoplasmic bridge between the two structures. Subsequently, all traces of the trichogyne disapper. The carpogonium then divides longitudinally into two cells. One cell acts as a primary connecting filament (Figs. 14 and 15, pcon), extending towards and making contact with the subhypogynous cell (Figs. 14 and 15, naux). There is no direct fusion between the primary connecting filament and the nutritive auxiliary cell, the connection being made by way of a secondary pit-connection. At the same time, the remaining segment of the devided carpogonium (Figs. 14 and 15, cp) loses its cellular contents and finally disintegrates.

In the absence of fertilization, most of the trichogyne is shed, and the hypogynous cell of an abortive carpogonial branch sometimes produces sterile filaments (Fig. 19, st) which resemble ordinary cortical filaments.

After the establishment of a connection with the nutritive auxiliary cell (Fig. 14, naux), the connecting filament extends towards the cortex and divides by septa several times (Fig. 15, scon). This secondary connecting filament fuses laterally with an auxiliary cell in the outer cortex (Fig. 15, naux). In this study I was unable to find a filament that continues beyond the first union with an auxiliary cell.

Among the nemathecial filaments (Figs. 16 and 17, nf), however, deeply staining filaments (Fig. 16, scon) that extend parallel to the surface of the thallus are frequently observed. Although these filaments could not be traced back to a carpogonial branch, they are presumed to be secondary connecting filaments. They divides by sepata several times and fuse with numeous auxiliary cells (Figs. 16 and 17, naux) in the proximal parts of the nemathecial filaments. These fusions occure more frequently than those of *R. gracilis* described earlier in the paper, almost every segment establishing a fusion. Detection of the gametophytic cells that will fuse with the secondary connecting filaments is almost impossible prior to fusion, since they neither stain deeply with aniline blue nor differ in size from ordinary nemathecial cells.

After the establishment of union with gametophytic cells, the secondary connecting filaments produce carposporogenous filaments (Figs. 16 and 17, cf) towards the thallus surface. The initiation of carposporogenous filaments occurs from the secondary connecting filament close to its points of fusion with auxiliary cells (Fig. 16), which thus do not have a generative function.

Carposporogenous filaments stain more deeply with aniline blue than either the connecting filaments or the nemathecial filaments, and they branch di-or trichotomously. Only the terminal cells

become carposporangia (Fig. 17, ca). Mature carposporangia are obovate and immersed entirely among the nemathecial filaments.

Rhodopeltis setchelliae Yamada

The cortical filaments of this species are combined more solidly, especially in the lower segments of the branches, and the internal observations were made from preparations of branch tips, which yield more readily to the squash technique.

Carpogonial branches (Fig. 20, cb) are four-celled and are produced singly on cells of the outer cortex, usually slightly below the two cortical filaments that also arise from the supporting cell. Occasionally, carpogonial branches seem to occupy positions homologous to these of the vegetative laterals (Figs. 21-23). Carpogonial branches may be straight or slightly curved, and their orientation is towards the thallus surface, with the long trichogyne passing straight through the outer cortical layers.

At the three-celled stage, the terminal cell is already provided with a long trichogyne and stains deeply with aniline blue, while the subterminal cell may or may not stain deeply. At maturity, the carpogonium and hypogynous cell stain strongly, but the basal two segments of the four-celled carpogonila branch stain more lightly. The supporting cell is not differentiated from the ordinary vegetative cells its staining properties, but it is conspicuously smaller than the vegetative cells that are borne in similar positions. The mature carpogonium is hemispherical, and its terminal trichogyne stains densely with aniline blue.

After presumed fertilization of the carpogonium, the trichogyne is lost and carpogonium itself cuts off a short cylindrical cell, which establishes a connecting with the subhypogynous cell (Fig. 21, pcon). This primary connection of the carpogonium and subhypogynous cell seems to depend on a secondary pit-connection, as in *R. liagoroides*. If the subhypogynous cell (Fig. 21, naux) acts as a nutritive auxiliary cell, as in other species of the genus, its could be expected to stain darkly, but the fact that it does not exhibit any special staining properties suggests that it is a nutrient-poor cell. For this reason, it seems doubtful that the subhypogynous cell acts as a nutritive auxiliary cell.

Three-celled carpogonial branches that appear to have been fertilized are occasionally seen. The carpogonium setablishes a connection with the hypogynous cell by a cylindrical cell (Fig. 23, pcon), which is also provides with a sterile filamnt (Fig. 23, st) that resembles ordinary cortical filaments. In the present study, it has not been ascertained whether such carpogonial branches function in subsequent carposporophyte development. Few nemathecia were found and they are produced only after the production of the carpogonial branches, as in the case of *R. gracilis* and *R. liagoroides*.

Large numbers of carpogonial branches were observed, but auxiliary cells were rare, since the materials used in this study are too young to reveal the complete development of carposporophytes. Auxiliary cells may be intercalary in ordinary cortical filaments or in nemathecial filaments. Only once did we observe an intercalary cell of a cortical filament that had established a union with a connecting filament (Fig. 22). This intercalary cell stained slightly more strongly than the ordinary vegetative cells, but the detection of auxiliary cells is almost impossible until they establish a union with a connecting filament. No differentiated auxiliary cell branch was found in the present study. Subsequent development of the carposporophyte was not observed.

Discussion

Nozawa (1963, 1970) studied the morphology and taxonomy of *Rhodopeltis,* suggesting that this genus could be divided into two groups based on differences in their vegetative and reproductive structures. The results obtained in the present study lead to the same conclusion. Despite this agreement, the two studies differ in their descriptions of some features of the female reproductive structures and carposporophyte development in *R. gracilis, R. liagoroides,* and *R. setchelliae.* For example, Nozawa described unbranched auxiliary cell filaments for *R. liagoroides* and *R. setchelliae* resembling those of *R. australis* and *R. borealis,* and branched auxiliary cell filaments for *R. gracilis,* with the gonimoblasts in these three species arising directly from fertilized auxilary cells. She was thus of the opinion that the auxiliary cell is generative in these taxa. In contrast, from the present observations it is evident that the auxiliary cells are intercalary in cortical or nemathecial filaments and the carposporogenous filaments are produced directly from secondary connecting filaments. We were unable to observe the full development of carposporophytes in *R. setchelliae,* but the structure of its auxiliary cells is quite the same as those in the other two species. The auxiliary cells in these three species are thus typical of Gigartinalean algae, and their function is only nutritive. In the absence of fertilization, or even in early post-fertilization stages, the carpogonial branches in these species sometimes develop branchlet that resemble ordinary cortical filaments, and the unbranched auxiliary cell branches described by Nozawa for *R. liagoroides* and *R. setchelliae* probably represent misidentifications of these abortive carpogonial branches. Similarly, the branched auxiliary cell branches described by Nozawa in *R. gracilis* are thought to be a misunderstanding of the normal cortical filaments, which possess intercalary auxiliary cells.

Rhodopeltis gracilis, R. liagoroides and possibly *R. setchelliae* show the following taxonomic features: thallus cylindrical or compressed, without a distinct cartilaginous stipe, being similar in external features to members of the *Liagora*-complex; carpogonial branches consisting of three to five cells, produced laterally or sometimes appearing terminal on the outer cortical cells; in the absence of, or even after fertilization, some carpogonial branches producing sterile filaments that resemble ordinary cortical filaments; auxiliary cells intercalary in critical or nemathecial filaments, and indistinct prior to their union with secondary connecting filament; presumed fertilization of the carpogonium resulting in a primary connection with the nutritive auxiliary cell in the same carpogonial branch and, subsequently, this nutritive auxiliary cell initiating septate secondary connecting filaments that extend towards and fuse with the spatially distinct auxiliary cells; carposporogenous filaments arising from the connecting filaments at points close to or some distance away from its fusion with the auxiliary cells, with only the terminal cells sporogenous filaments becoming carposporangia; nemathecial filaments initiating after the development of female reproductive branches in the cortex.

In contarast to the Cryptonemialean features seen in *Rhodopeltis australis* and *R. borealis* (Itono and Yoshizaki 1992), several features typical of Gigartinalean algae are exhibited by *R. gracilis, R. liagoroides,* and *R. setchelliae.* A new genus, *Stenopeltis,* is proposed for these species.

Stenopeltis gen. nov.

Thalli erecti, subdichotome ramosi, leviter calcificati, exhaptero parvo pulvinato orientes,

multiaxiales, medulla filis tenuibus laxe despositis parce ramosis, cortice filis dichotome ramosis moniliformibus. Fila carpogonialia 3-5 cellularum, portata in cellulis fulcrantibus quae in partibus nematheciorum elevatorum interioribus ad apices ramulorum ponuntur, carpogonio fecundato cum cellula subhypogyna quae cellula auxiliari nutrienti fungitur plerumque conjugenti. Fila conjunctiva ex cellula auxiliari nutrienti orientibus; cum pluribus cellulis auxiliaribus, quae in filis corticalibus nemathecialibusque intercalarem et ante diploidizationem haud distinctam sunt, in serie conjugant. Carposporangia terminalia in filis ramosis, quae ex filo conjunctivo et versus superficiem thalli crescunt, in nematheciis elevatis aggregata. Spermatangia per divisiones cellularum matricalium spermatangialium superficialium obliquas formantibus.

Thallus erect, subdichotomously branched, lightly calcified, arising from a small pulvinate holdfast, multiaxial; medulla of slender, loosely desposed, sparsely branched filaments; cortex of dichotomously branched moniliform filaments. Carpogonial filaments of 3-5 cells, borne on supporting cells located in the inner parts of raised nemathecia at the branch appices; the fertilized carpogonium generally fusing with the subhypogynous cell, which functions as a nutritive auxiliary cell. Connecting filaments arising from the nutritive auxiliary cell and fusing with many auxiliary cells that are intercalary in the cortical and nemathecial filaments and are indistinct before fertilization. Carposporangia terminal on branching carposporogenous filaments which grow from the connecting filaments and towards the thallus surface through the raised nemathecia. Spermatangia formed by oblique divisions of spermatangia mother cells.

Type: *Stenopeltis gracilis* (Yamada et Tanaka) comb. nov.

Tetrasporophytic plants of *Rhodopeltis,* with irregularly zonate tetrasporangia, have been described by Yamada (1935, *R. setchelliae,* Inoh (1947, *R. gracilis*), and Nozawa (1963, 1970, *R. setchelliae* and *R. liagoroides*). However, we were unable to find any plants bearing tetrasporangia among a large number of collections of these species. Nozawa (1963, 1970) mentioned that tetrasporangial nemathecia closely resemble cystocarpic nemathecia, and she illustrated tetraspoangial nemathecia produced in a position similar to those of the gametophytes. In the present study, we frequently confused cytoplasmic streaks in the carpospores with the cleavages of irregularly zonate tetrasporangia, and it seems doubtful that these species produce an isomorphic tetrasporophyte. Thus we have given the generic diagnosis without mention of tetrasporangia.

The following new combinations are proposed for this genus: *Stenopeltis gracilis* (Yamada et Tanaka) comb. nov.

Basionym: *Rhodopeltis gracilis* Yamada et Tanaka in Yamada, 1935: 30, pl. 15-2, text-fig. 1.
Stenopeltis laigoroides (Yamada) comb. nov.

Basionym: *Rhodopeltis liagoroides* Yamada, 1935: 32, pl. 16, text-fig. 2.
Stenopeltis setchelliae (Yamada) comb. nov.

Basionym: *Rhodopeltis setchelliae* Yamada, 1935: 33, pl. 15-1, text-fig. 3 ("*setchellii*", but commemorates Mrs. W.A. Setchell and hence is correctable to the femine form).

The female reproductive morphology of *Stenopeltis,* as mentioned previously, is typical of the Gigartinales, showing important similarities with that of *Polyides* C. Agardh, a genus which, together with *Rhodopeltis,* was segregated by Kylin (1956) from the Rhizophyllidacea to a new family, Polyidaceae.

Rao (1956) observed that in *Polyides lumbricalis* (the type of the genus, as *P. caprinus*), each of the fertilized carpogonia produces a single connecting filament directly, without an initial fusion with cells of the carpogonial branch, and stated that occasional fusions between the fertilized carpogonium and cells in the same branch occur late in carposporophyte development. Thuret & Bornet (1878), however, illustrated carpogonial branches is which the carpogonium has established a union with each of to cells below it, and according to Kylin (1923) such a union is typical of the species. Secondary connecting filaments are initiated by the fusion cell and grow through the nemathecium, their tips uniting with auxiliary cells, which are intercalary in nemathecial (vegetative) filaments. A gonimoblast develops from the connecting filament close to its union with an auxiliary cell, although according to Rao (1956) they are subsequently produced at points more remote from these unions. Only terminal cells of the gonimoblast become carposporangia.

Postfertilization events in *Stenopeltis* are similar to those on *Polyides*. In all species a union is established between the fertilized carpogonium and a nutritive auxiliary cell in the same branch. In *S. gracilis* several connecting filaments are produced by this nutritive auxiliary cell, whereas in *S. liagoroides,* and possibly in *S. setchelliae,* one of the two cells resulting from a longitudinal division of the fertilized carpogonium acts first as a primary connecting filament and then, after making contact with the subhypogynous cell, continues growing towards the outer cortex as a secondary connecting filament. In *S. gracilis* numerous diffuse carposporogenous filaments are produced by the connecting filament between its points of union with nutritive auxiliary cells, whereas in *S. liagoroides* diffuse carposporogenous filaments are produced by the connecting filament only at a point of union.

Contrasting with these similarities are some important differences. In *Polyides* the thallus is uncalcified, cruciately divided tetrasporangia develop from cells of the inner cortex of isomorphic tetrasporophytes, carpogonial branches develop from superficial cells, and the spore-producing gonimoblasts become almost spherical. In *Stenopeltis,* by contrast, the thalli are lightly calcified, tetrasporangia are not known for certain and may occur on heteromorphic stages in the life history, carpogonial branches are produced from inner cortical cells, and the carposporogenous filaments are loosely fasciculate. These differences, however, seem to be of taxonomic value at the generic, but not the familial level.

The fact that the auxiliary cell of *Polyides* and *Stenopeltis* is an undifferentiated cell of a vegetative filament supports the placement of the Polyidaceae in the Gigartinales, as proposed by Papenfuss (1966). When Papenfuss made this proposal, he didn't suggest any affinities between the Polyidaceae and other families of the order. The results obtained from the present study and from a survey of the literature on *Polyides* suggest relationships with some taxonomically isolated entities.

The calcified thalli of *Stenopeltis* are fundamentally similar to those of the *Liagora*-complex in the Liagoraceae (Nemaliales), being multiaxial and having cortical filaments that exhibit a precisely dichotomous appearance due to a lack of secondary pit-connections between adjacent cells. *Stenopeltis* is also similar to the *Liagora*-complex in having carpogonial branches which are lateral to the supporting cell and which, in the absence of fertilization, occasionally develop into cortical filaments, an event described in some species of *Liagora* (Boergesen, 1915; Yamada, 1938), *Helminthocladia* (Doty & Abbott, 1961; Womersely, 1965), and *Polyides* (Rao, 1956).

In his discussion of the taxonomic relationships of *Schmitzia* (as *Bertholdia,* Calosiphoniaceae),

Feldman (1954) called attention to *Sirodotia* (Batrachospermaceae) and *Dermonema* (Dermonemataceae). *Schmitzia, Sirodotia, Dermonema,* and *Cumagloia* (Dermonemataceae) all possess a diffuse type of gonimoblast, as does *Stenopeltis*. Fritsch (1945) was of the opinion that the possession of diffuse gonimoblasts, whether or not they receive nutrients from gametophytic cells, does not reflect taxonomic relationships among genera. Fan (1961), however, assigned an important phylogenetic role to diffuse gonimoblasts, postuating that generative auxiliary cells may have arisen by the union of random vegetative cells with filaments of a diffuse gonimoblast, such unions being occasional in the beginning but evolving into a regular occurrence. According to such a hypothesis, *Stenopeltis* would seem to be a link between the Nemaliales and the Gigartinales. We believe that *Schmitzia* and *Stenopeltis* are primitive members of the Gigartinales and probably are derived from a common ancestral stock in the Nemaliales.

Acknowledgments

We particularly thank the late Dr. Munenao Kurogi for his encouragment. Sincere thanks are extended to Dr. Paul C. Silva for critically reading the manuscript and making invaluable comments. We thank Dr. Peter Robins for the Latin translation of the *Stenopeltis* diagonosis.

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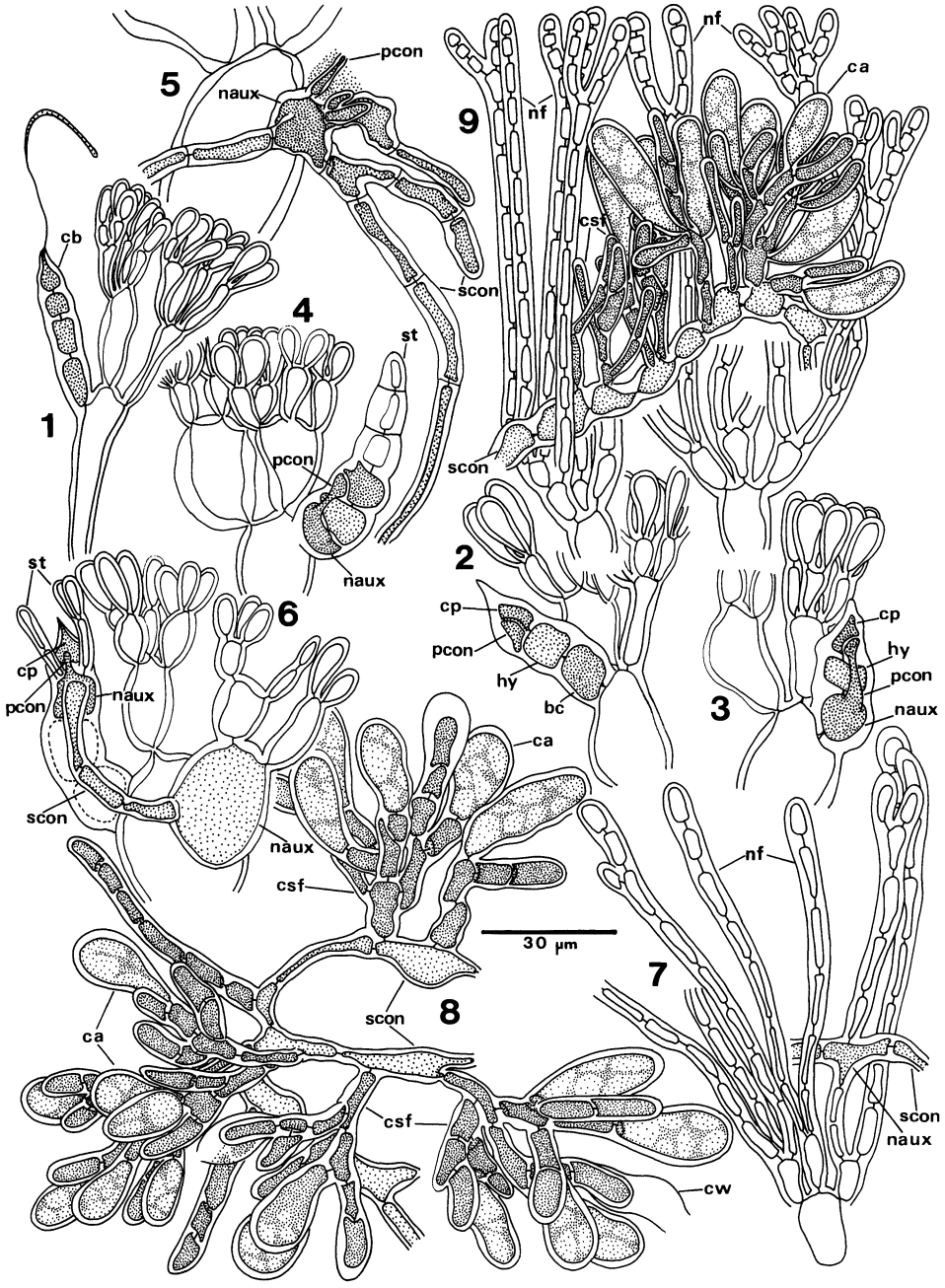
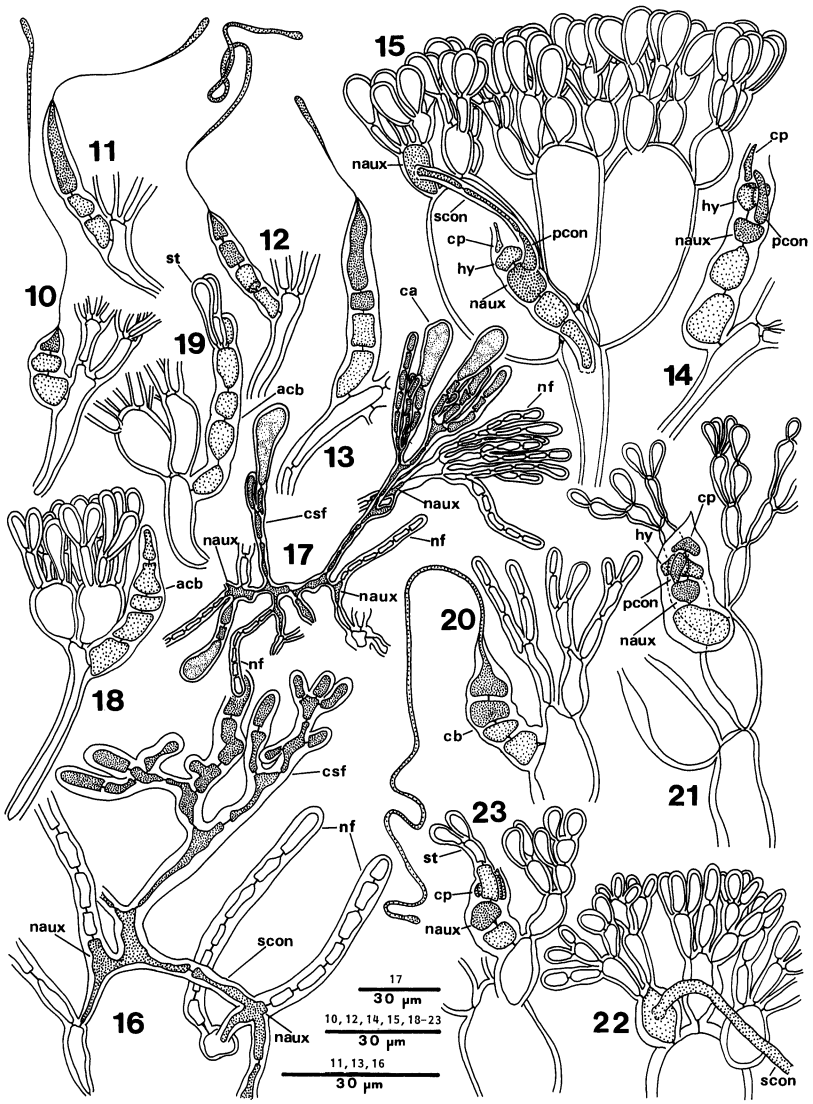


Figs. 1-9. *Rhodopeltis gracilis* Yamada et Tanaka.
Fig. 1. Carpogonial branch borne on cell of inner cortex. Fig. 2. Carpogonial branch cutting off primary connecting cell from posterio-lateral side. Figs. 3, 4. Carpogonial branches with connecting cells that have established a union with the nutritive auxiliary cell. Fig. 5. Nutritive auxiliary cell producing several connecting filaments. Fig. 6. Four-celled carpogonial branch that has established a union with the hypogynous nutritive auxiliary cell, with a secondary connecting filament extending towards an auxiliary cell that has fused with a connecting filament. Fig. 8. Connecting filament with several carposporogenous filaments fearing terminal carposporangia. Fig. 9,. Transverse section of a nemathecium, showing nemathecial filament and the outward development of carposporogenous filaments borne on the connecting filament.



Figs. 10-19. *Rhodopeltis liagoroides* Yamada.
Figs. 10-13. Young carpogonial branches borne on inner cortical cells. Fig. 14. Carpogonial branch that has cut off a tubular connecting cell towards the nutritive auxiliary cell. Fig. 15. Carpogonial branch producing a connecting filament towards the auxiliary cell intercalary in the cortical filament. Fig. 16. Young carposporogenous filament borne on connecting filament. Fig. 17. Carposporogenous filament bearing terminal carposporangia. Figs. 18-19. Abortive carpogonial branches.

Figs. 20-23. *Rhodopeltis setchelliae* Yamada.
Fig. 20. Four-celled carpogonial branch. Fig. 21. Carpogonial branch with connecting cell directed towards the nutritive auxiliary cell. Fig. 22. Connecting filament contacting auxiliary cell. Fig. 23. Three-celled carpogonial branch with fertilized carpogonium and primary connecting cell bearing sterile filament.

Abbreviations of the Figures: acb=abortive carpogonial branch; bc=basal cell of carpogonial branch; ca=carposporangium; cb=carpogonial branch; cp=carpogonium; csf=carposporogenous filament; cw=empty carposporangial wall; hy=hypogynous cell; naux=nutritive auxiliary cell; nf=nemathecial filament; pcon=primary connecting cell; scon=secondary connecting filament; st=sterile filament.