Korean Jour. Botany
Vol. 17, No. 1, 36—52(1974)

Some Members of *Rhodochorton* (Rhodophyta) in Korea*

Lee, In Kyu and Yong Pil Lee
(Department of Botany, Seoul National University)

紅藻 Rhodochorton 屬의 分類學的 硏究

李 仁 圭·李 龍 弼
(서울大學校 文理科大學 植物學科)

ABSTRACT

Nine members of *Rhodochorton* appearing in coastal waters of Korea were investigated diagnostically. Among them, *Rh. densum*, *Rh. magnificum*, *Rh. robustum* and *Rh. codicola* were identified previously, while *Rh. terminale*, *Rh. sancti-thomae*, *Rh. daviesii*, *Rh. hyalosiphoniae*, and *Rh. rhizoideum* were identified and described for the first time in this country.

Introduction

Rhodochorton is one of the common micro-red algae found easily in coastal waters of Korea. In 1861 Naegeli established the genus *Rhodochorton* and also the related genus *Acrochaetium*. However, the generic relationships among *Rhodochorton*, *Acrochaetium*, and the early known genus, *Chantransia* remained as one of the interesting problems to be solved. In 1928 Drew clarified it with an excellent monographic study of the genera, and unified them into a single genus *Rhodochorton*, emending the genus character.

Recently, Woelkerling(1971) made a new generic conception on these filamentous micro-red algae, and used the generic name, *Audouinella* Bory for the members of which sexual stage was known, and *Colaconema* Batters for the members of which sexual stage was unknown in their life histories. To adopt these generic names for our plants, however, would remain some problems, as remarked by Woelkerling himself, that "many of these taxa are probably conspecific with species described earlier and it seems best, therefore, not to suggest new nomenclatural combinations until the status of each taxon has been re-examined carefully".

On the other hand, the members of *Rhodochorton* -complex are investigated in life historical view point for clarify their taxa by recent workers (Swale & Belcher, 1963; Knaggs, 1964, 1966; Knaggs & Conway, 1964; West, 1968, 1969, etc.). For further study on Korean species of *Rhodochorton*-complex, it is attempted in this paper that 9 members identified up to now are investigated only in diagnostic view point. The generic name *Rhodochorton* is adopted here until the Korean species are re-examined with the above mentioned criterion.

Key to Species of *Rhodochorton* in Korea

Plant epiphytic.

Hair-like prolongation absent

Erect filament consisting of about 15 cells, monosporangia terminal on erect filament ..... *Rh. terminale*

* This work is partly supported by the grant of Ministry of Education, 1973.

Erect filament more than 30 cells of elongate barrel or clavate shape·····*Rh. densum*

Hair-like prolongation present

Hair-like prolongation unicellular, developing on branches and branchlets···*Rh. sancti-thomae*

Hair-like prolongation multicellular, developing mostly on branchlets·····*Rh. daviesii*

Plant endophytic partly or fully

Endophytic partly with small penetrating filaments

Cells of erect filament more than 50μm long ·····*Rh. magnificum*

Cells of erect filament less than 30μm long

Penetrating filaments short, poorly developed·····*Rh. robustum*

Penetrating filaments multicellular, well developed·····*Rh. hyalosiphoniae*

Endophytic fully with well developed penetrating filaments

Endophytic filament hyaline, uppermost cells of branches containing chromatophores densely ·····*Rh. codicola*

Endophytic filament pigmented, a few cells below apex in erect filament almost hyaline ·····*Rh. rhizoideum*

Rhodochorton terminale Nakamura

(Text-fig. 1)

Nakamura(1944) p. 99—101, fig. 1

Korean Name: 청자상투붉은털 (nom. nov.)

Plant epiphytic, caespitose, 100—150μm high, consisting of creeping and erect filaments; basal creeping filaments extended radially and roundly on host surface, coherent loosely forming disc of unistratose pseudoparenchyma, cells of creeping filament polygonal to irregular, 2.5—4μm broad, 5—8μm long; erect filaments numerous, arising singly from basal cell as well as daughter cells of spore, simple or rarely branched, almost similarly thick or slightly attenuate both at apex and base, straight or slightly curved, obtuse at apex, branches arising once or a few times from middle to upper portion of main axis, subdichotomous, trichotomous or irregular with acute angle, similarly thick to main axis, cells of erect filament moniliform, 4.5—5.5μm broad, 7—8μm long at lower, 5.5—6.5μm broad, 6.5—8μm long at middle, 4.5—5.5μm broad, 6.5—8μm long at upper portions of main axes, 1—1.5μm thick-walled; hair-like prolongations not found; chromatophores parietally lobed with large

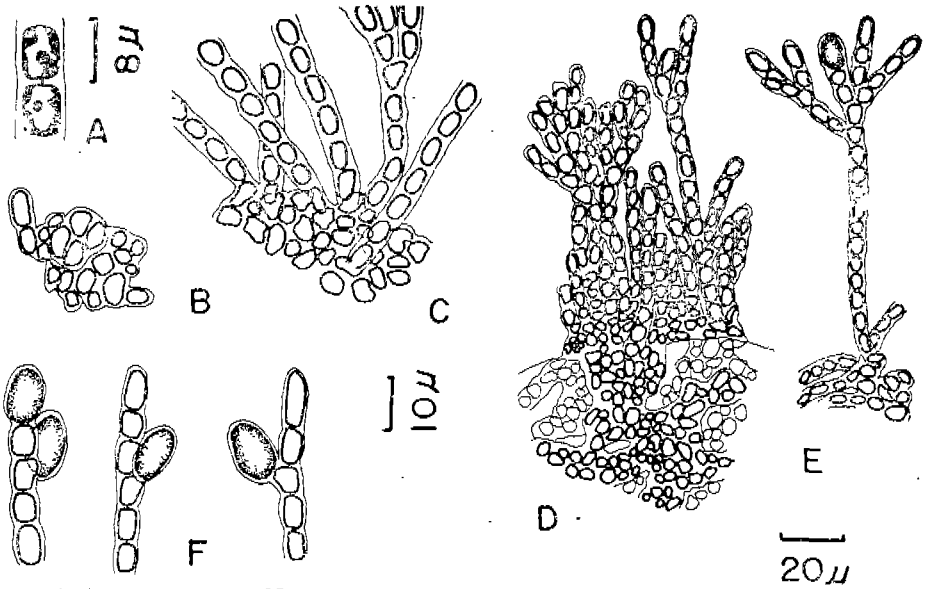

Fig. 1 *Rhodochorton terminale* Nakamura
A, cells of erect filament; B, germination stage;
C, basal structure; D-E, mature plants;
F, terminal and lateral monosporangia.

central pyrenoid; monosporangia terminal on erect filament, not rarely subterminal and lateral, sessile, elliptical, 6.5—8μm broad, 9.5—12μm long: color purple.

Habitat: Epiphytic on the utricles of *Codium* spp. at littoral zone.

Material: Gapado, Jaeju-island (May 12, 1972)

The plants were found on the utricles of *C. contractum*. They made dark red spots on the host thalli, recognized easily with naked eyes. Originally the species was found on the apex of *C. saccatum* by Nakamura(1944). According to his original description, the plants have axial stellate chromatophores in the formalin-preserved material, and have rarely the hyaline hairs. However, the plants at hand have rather parietal chromatophores and no hair at all. Except for such differences our plants accord quite well in diagnosis with the type species, such as the formation of monosporangia terminally, the germination of spore dividing into four daughter cells, and the branches arising a few times at middle to upper portion of main axis, etc. The vegetative cells and monosporangia also coincide well in shape and size with the ones shown in the original description.

In addition to the terminal sporangia, it is found not rarely the subterminally or laterally developed sporangia, not mentioned by Nakamura. The plants seem to be one of the smallest members of *Rhodochorton* appearing in Korean waters. They have erect filaments consisting of only about 15 cells.

Rhodochorton densum Drew

(Text-fig. 2)

Drew(1928) p. 168, Pl. 38, figs. 17—24; Nakamura (1944) p. 101, fig. 2; Kang(1966) p. 59.

Korean Name: 애기붉은털 (nom. nov.)

Plant epiphytic, caespitose, extended broadly on host surface, 200—300μm high, consisting of creeping and erect filaments; basal creeping filaments stretching irregularly at first, confluent later forming unistratose pseudoparenchyma, cells of creeping filament elliptical, round, oblong, or irregular, 4—8μm in size; erect filaments arising from basal cells, branched not commonly once or a few times from middle to upper portion, frequently curved slightly, constricted at septa, obtuse at apex, branches mostly short (composed of 3—5 cells), secund, alternate or irregular; cells of erect filament elongate barrel-shaped, clavate especially in fructiferous part, 4—5μm broad, 8—9μm long at lower, 5—7μm broad, 10—12μm long at middle, 5—6μm broad, 8—12μm long at upper portions of erect filament; hair-like prolongations wanting; chromatophores parietally lobed, surrounding whole surface of cell with small fenestrations; pyrenoid single, located at central portion; monosporangia terminal or lateral on main axes and branches, sessile or pedicellate (1-celled), single or secundly seriate, ovoid to elliptical, 5—7μm broad, 12—15μm long: color purple.

Habitat: Epiphytic on the surface of other algae in littoral zone

Material: Gapado, Jaeju-island(May 12 and Aug. 8, 1972) Baegryeongdo-island (Jun. 14, 1973)

The plants were found on *Hizikia fusiforme* at Gapado, and on *Sargassum confusum* at Baegryeongdo(Lee, 1973). They were found also on *Myriogramme* sp. by Kang(1966) from the southern coast of Korea. The plant is characteristic in that the germinating spore divides into two equal cells, which grow out into creeping filaments.

According to Drew, in his original description, the erect filaments usually consist of about 10 cells. However, the plants at hand and the ones shown by Nakamura (1944, fig. 2, A, B) consist of about 30 cells in fully grown erect filaments. In the present investigation, such a significant difference as to divide the present species into two forms, shown by Nakamura, is not found.

The chromatophores of monospore is not stellate as like as Drew's, but quite similar to Nakamura's one; it is more or less lobed apical plate in form. The constriction of the cell septa, the development of monosporangia, and the formation of unistratose pseudoparenchymatous basal layer, etc., accord quite well with the ones shown by Nakamura.

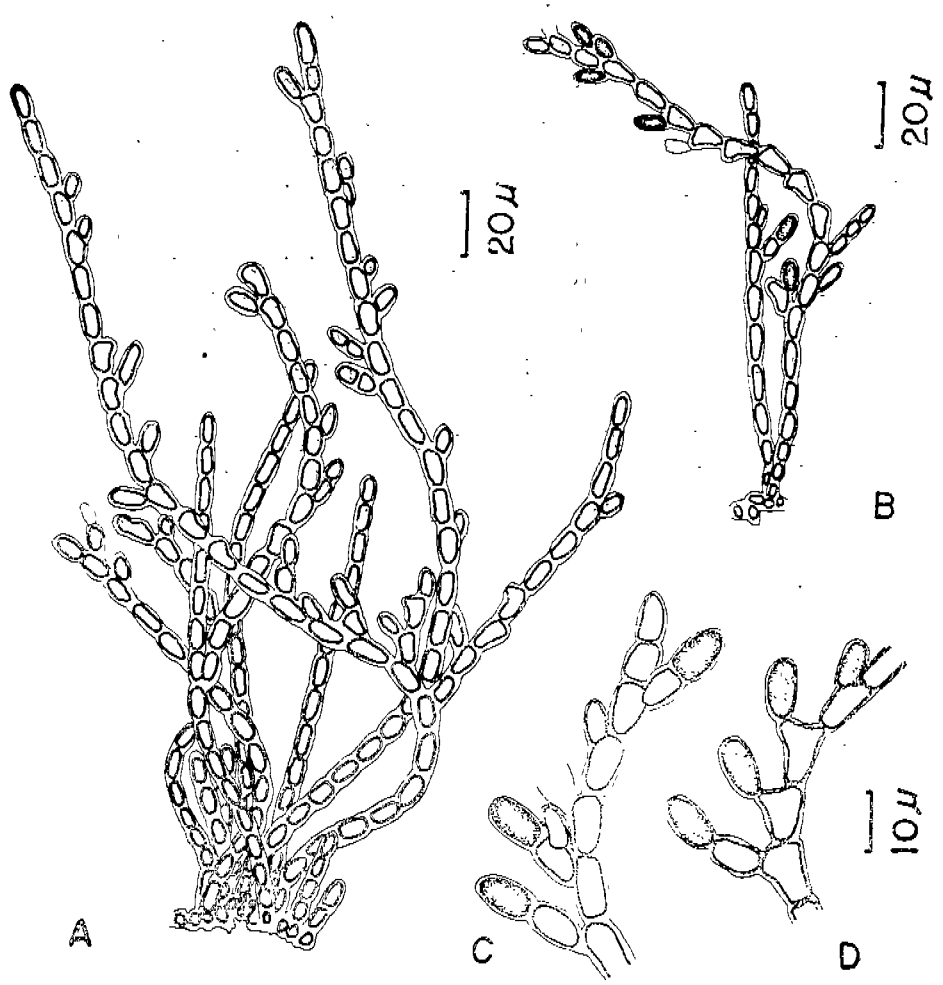

Fig. 2 *Rhodochorton densum* Drew
A, mature plants; B, monosporangia bearing plant; C—D, monosporangia.

Rhodochorton sancti-thomae(Bφrgesen) **Nakamura** (Text-fig. 3)

Nakamura(1941) p. 280—282, figs. 5—7

Acrochaetium sancti-thomae Børg. (1915) p. 30, figs. 23—24

Korean Name: 꼬티털붉은털 (nom. nov.)

Plant epiphytic, caespitose, 200—600μm high, composed of creeping and erect filaments; creeping filaments irregularly branched, confluent one another forming unistratose pseudoparenchymatous disc, cells of creeping filament irregular in shape from above, tri- to quadrangular from side, about 5μm in size, pigmented; erect filaments arising from cells of creeping filament, branched once or twice secundly and alternately, seldom simple, attenuated at apex and slightly at base, constricted at septa, terminate with hair-like prolongation, cells of erect filament cylindrical-obovate, 1—2μm thick-walled, 5—7μm broad, 10-12μm long at lower, 6—8μm broad, 12—15μm long at middle, 4—6μm broad, 13—16μm long at upper portions of erect filament; hair-like prolongations arising at top of main axes and branches, unicellular, hyaline, up to 160μm long; chromatophores parietally lobed, with single large pyrenoid; asexual reproduction

by monospores and tetraspores; monosporangia elliptical to ovoid, often seriate in all directions, sessile or pedicellate (1-celled), about 5μm broad, 10μm long; tetrasporangia pedicellate (1—2-celled), often sessile, divided cruciately, 8—10μm broad, 11—14μm long; color red violet.

Habitat: Epiphytic on the surface of other algae in littoral zone

Material: Gapado, Jaeju-island (May 10 and Aug. 8, 1972; Apr. 1, 1973)

The plants were found on *Hizikia fusiforme* in May, 1972 and on *Myelophycus caespitosus* in August, 1972 and April, 1973 from above mentioned places respectively. The plants collected in April and May were slender and large with almost cylindrical cells, while the ones collected in August were much smaller in size and had rather barrel-shaped cells.

The sample collected in May showed abundant asexual reproductive organs than the other samples collected.

On the pyrenoid in erect filament, Børgesen mentioned that it was lying near the middle of the cell. In our plants, however, the pyrenoid is large and distinct especially in the material collected in April and in May. On the other hand, the hair-like prolongations are found often by Børgesen and rarely by Nakamura while they occur rather commonly in all the materials at hand. Sometimes, two hairs are found on the same apical cell subterminally.

The monosporangia accord well with the ones

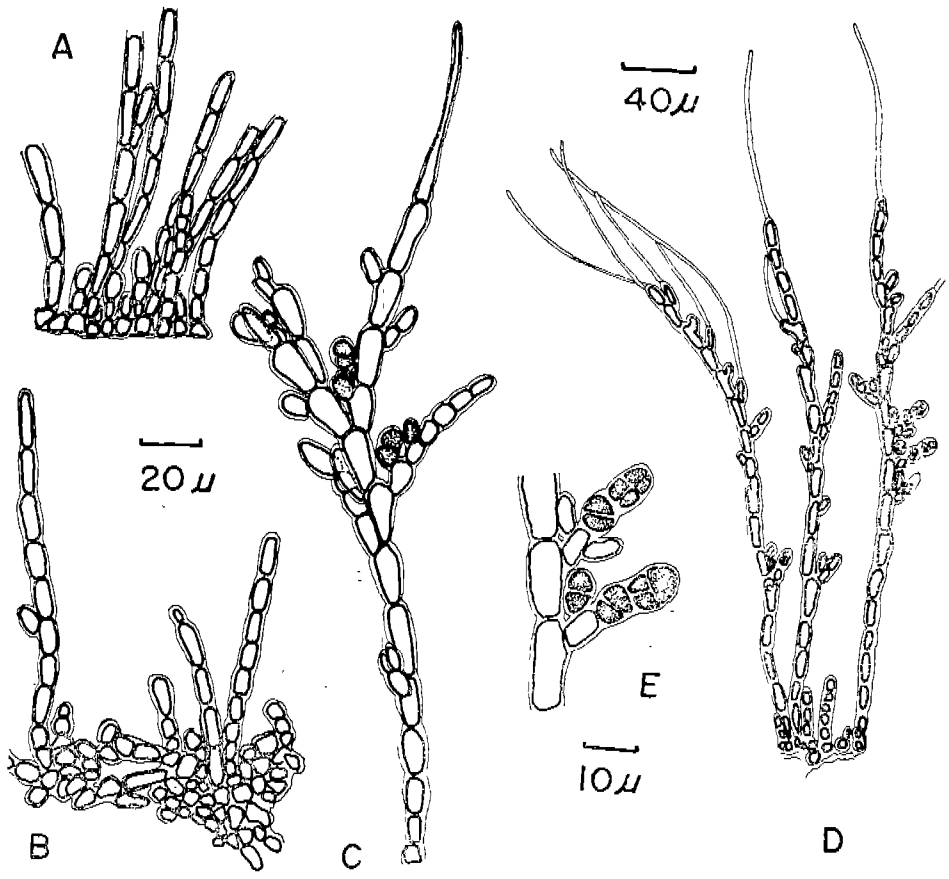

Fig. 3 *Rhodochorton sancti-thomae* (Børgesen) Nakamura
A—B, basal structure; C—D, sporangia bearing filaments; E, bi- and tetrasporangia developed seriately.

shown by Børgesen both in size and occurrence on the branches. In addition to them, the bi- and tetrasporangia are found on the same thalli that bear the monosporangia. The mode of development of tetrasporangia is similar to that of monosporangia, though the tetrasporangia are larger than the monosporangia in size. Sometimes, both the monosporangia and tetrasporangia are found on the same pedicell, or the two tetrasporangia are developed on the branches one on the other seriately (Fig. 3, E).

The bisporangia seem to develop into tetrasporangia. The plants collected in August resemble to *Rh. densum* especially in the characteristics of the erect filament, cell shape, and basal system, etc. However, the both species are distinguished by the hyaline hairs developed in *Rh. sancti-thomae*, and not developed in *Rh. densum*. The tetrasporangium formation in the former is also one of the noticeable characters of the present species.

Rhodochorton daviesii (Dillwyn))Drew
(Text—fig. 4)

Drew(1928) p. 172—173; Nakamura(1944) p. 106, fig. 5

Conferva daviesii Dillwyn(1809) p. 73

Acrochaetium daviesii (Dillwyn) Naegeli(1861) p. 171, figs. 26, 27; Rosenvinge(1909) p. 104, fig. 34

Korean Name: 송이붉은털 (nom. nov.)

Plant epiphytic, caespitose, 1—1.5mm high, consisting of creeping and erect filaments; basal creeping filaments developed irregularly, multicellular, confluent tightly one another forming pseudoparenchymatous disc, cells of creeping filament almost round to irregular in shape, 8×12.5μm in size; erect filaments arising from creeping ones, branched 3—4 times alternately and secundly, almost straight, slightly attenuate to apex, thick-walled, branches issuing mostly from middle to lower portion of main axes, 15—30° at sinus, attenuate to apex, terminating into hair-like prolongation, cells of erect filaments cylindrical, scarely constricted at septa, 10—13.5μm broad, 16-22μm long at lower, 9.5—11μm broad, 17—24μm long at middle, 7—7.5μm broad, 12—18μm long at upper portions of main axes, cell wall 2—3μm thick; hair-like prolongations multicellular, hyaline, 2μm thick at apex, up to 80μm long; chromatophores parietally lobed, poor in content, with single prominant pyrenoid at central portion; monosporangial branchlets developing from branches and branchlets, ramifying repeatedly forming fan-shaped fascicle; monosporangia pedicellate (1-celled), terminal or lateral in occurrence, ovate to elliptical, 8—9μm broad, 12.5—15μm long: color purple.

Habitat: Epiphytic on the surface of other algae in littoral zone

Material: Gapado, Jaeju-island (May 12, 1972)

This species was found on *Hizikia fusiforme*. Since the plants were known as *Conferva* by Dillwyn, it has been recombinated several times into the other genera such as *Callithamnion*, *Ceramium*, *Trentepohlia*, *Acrochaetium*, *Chantransia*, *Rhodochorton*, and *Audouinella* by several investigators (cf. Woelkerling, 1971), and some remarkable characters of the species were described by Rosenvinge(1909), Hamel(1927), Drew(1928), Nakamura(1944), and Woelkerling(1. c.), etc.

According to Nakamura, the thick-walled and short-celled filaments, and the fasciculated sporangia-bearing branchlets are the striking characteristics of this species. Our plants accord well with those in diagnosis. The basal creeping filaments are interwoven irregularly and from a pseudoparenchymatous disc, though the cell branches are scarcely distinguishable one the other, except for the marginal ones. The erect filaments are almost straight. Most of the branchlets terminate in hair-like prolongation, which is hyaline and septated. The base of the branches or branchlets are slightly constricted. The cells of erect filaments are generally one and a half length longer than broad. Sometimes, the cell wall becomes up to 3.5μm at thicker portion.

The material at hand bears monosporangia only, as described by Rosenvinge, Drew, and Nakamura. The monosporangia are developed in a fan-shaped

fascicle. Sometimes, they arrange seriately on the branchlet with 1-celled pedicell. The regeneration of monosporangia is observed frequently within the empty sporangial wall. In addition to this, it is found not rarely that the sporangia are divided into two spores within the common sporangial wall.

Recently, Woelkerling(1. c.) reported the tetrasporangia and the both sexual reproductive organs from the present species under the name, *Audouinella daviesii*. According to him, the tetrasporangia are ovoid to subglobose, cruciately divided and (13—) 15—18 μm broad, 17—21μm long. The spermatangia are ovoid to spherical, and 3μm broad, 4μm long, borne terminally or laterally. On the other hand, the carpogonia are terminal on unicellular stalks. The carposporangia are ovoid, occurring terminally, and 8—10μm wide and 16—20μm long.

Rhodochorton magnificum Drew

(Text—fig. 5)

Drew(1928) p. 180—181, Pl. 41, figs. 38-40; Kang(1966) p. 60

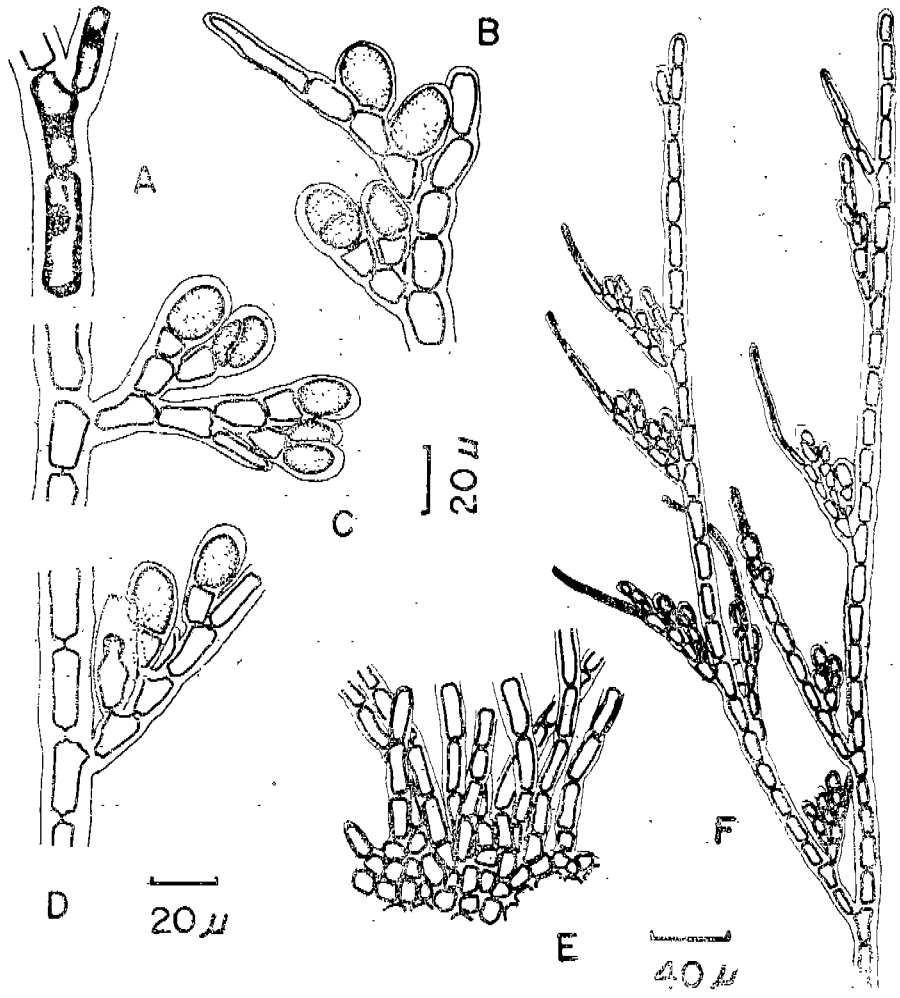

Fig. 4 *Rhodochorton daviesii* (Dillwyn) Drew
A, cells of erect filament; B—D, monosporangia, some of them divided into two; E, basal structure; F, part of erect filament, bearing multicellular hair-like prolongation.

Korean Name: 긴꼬리붉은넓(nom. nov.)

Plant epiphytic, partly endophytic, caespitose, 3—5mm high, consisting of basal creeping to penetrating and erect filaments; basal filaments multicellular, creeping on and partly penetrating into cortical cells of host, simple or irregularly branched, with round, cylindrical or irregular cells of 10—20μm in size; erect filaments arising from creeping filament, richly branched in a few to several times, attenuate outwards, scarcely constricted, branches and branchlets issuing secundly, opposi ely and alternately, terminate in hair-like prolongation, cells of erect filament cylindrical, becoming slenderer and elongated outwards, 12—15μm broad, 40—60μm long at lower, 10—12μm broad, 50—70μm long at middle, 6—8μm broad, 80—100μm long at upper portions of erect filament; hair-like prolongation multicellular, almost hyaline, 4—6μm broad, more than 100μm long; chromatophores parietal band, not so abundant; with single pyrenoid(?): monosporangia elliptical to ovoid, developing laterally on branches and branchlets, pedicellate (1-celled), 18—20μm broad, 25—30μm long; spermatangial branchlets developing laterally on branches and branchlets, divided repeatedly forming ramuli of cluster, spermatangia subterminal in occurrence, elliptical to ovoid, 5×7μm in size; carpogonia terminal on 2- to 3-celled lateral branchlets, bottle-shaped, with 30μm long trichogyne, carposporangia elliptical to ovoid, about 10×20μm in size.

Habitat: Epiphytic and partly endophytic on other algae in littoral zone

Material: Yokchido-island

With the cordial kindness of Prof. Dr. J. W. Kang of Pusan Fisheries College, this plant could be loaned from his herbarium (no. 41532) and investigated. It was found on *Dictyota dichotoma*. In the original description of the species, Drew mentioned that the most important difference separating this plant from the other similar ones such as *Rh. daviesii*, etc., was the presence of endophytic filaments. On the other hand, Woelkerling(1971) insisted the present species would be probably conspecific with *Rh. daviesii*(=*Audouinella daviesii*) by the fact that the latter developed also the endophytic filament. However, he concluded that *Rh. magnificum* was maintained as a distinct species, until the type species could be examined.

Unfortunately, it is very difficult to investigate the basal system comlpetely with the herbarium specimen at hand. On the other hand, comparing with the other plants, especially with *Rh. daviesii* occurring in Korean waters, *Rh. magnificum* is rather distinct species. In the present species, almost all the branches and branchlets become slender and feeble at the terminal portion and are modified into the hair-like prolongation.

We could account fortunately both the male and female sexual organs.

Comparing with those of *Rh. daviesii*(=*Audouinella daviesii*) by Woelkerling (l.c., fig. 7), the carposporangia of our plant are almost similar in shape and size to them, while the spermatangia are slightly larger. However, the development of gonimoblast, one of the important characters to discern the species, was not detected unfortunately in *Rh. daviesii*. Therefore, in order to detect the specific character to compare the both species in developmental anatomical view point of the cystocarp is remained still for study.

According to the material at hand, the spermatangial branchlets are developed laterally at the upper corner of the cells of branches and branchlets, and divided into several ramuli with a stalk(?) cell. The spermatangia occur subterminally on these ramuli, the spermatangial mother cells. The carpogonium, on the other hand, is developed laterally from the branches and branchlets in similar manner to the male organ. It is formed terminally on one- or two-celled branchlets with homogeneous content. After the fertilization(probably), the carpogonium and the cells of carpogonial branch are divided repeatedly, forming a gonimoblast of elliptical to obovate shape in outline. Almost all the cells of the gonimoblast seem to convert into the carposporangia.

The monosporangia occur commonly with the

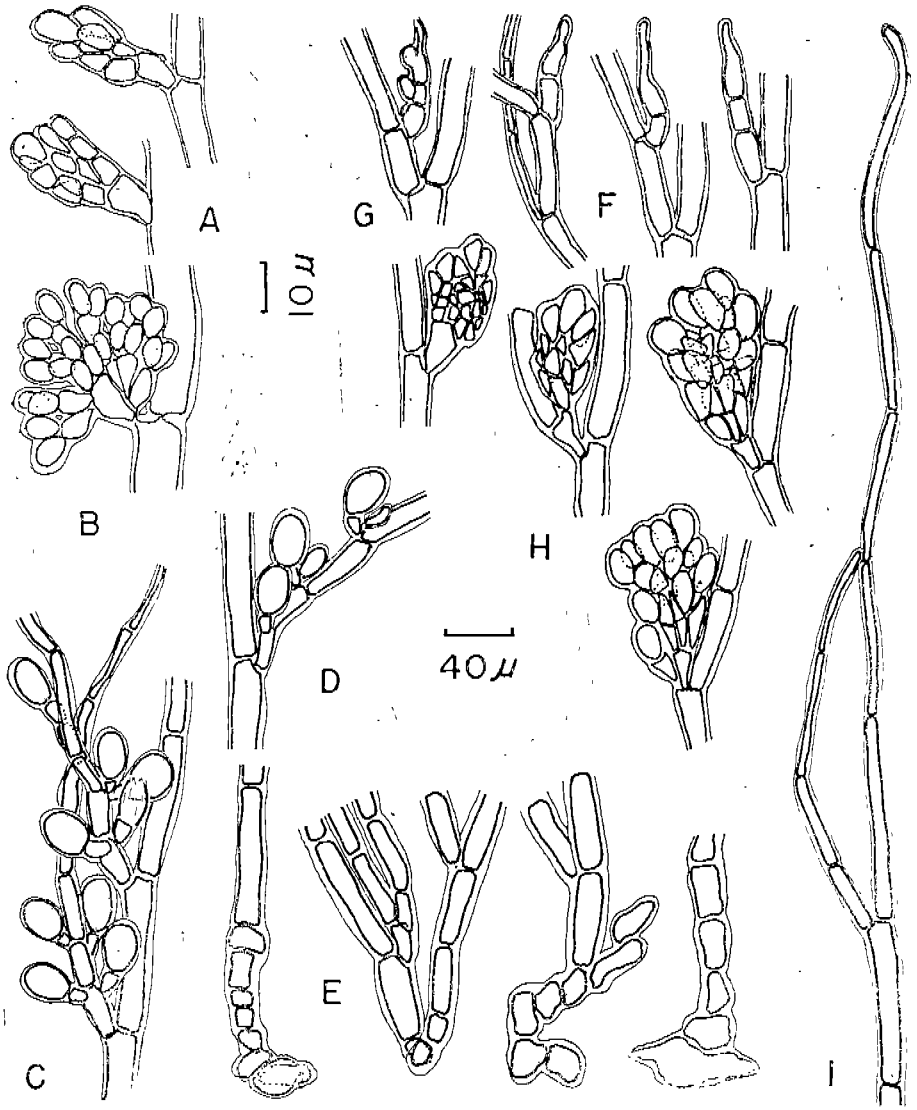

Fig. 5 *Rhodochorton magnificum* Drew
A—B, development of spermatangia;
C—D, monosporangia;
E, basal structures;
F, carpogonia with trichogyne;
G, post-fertilization;
H, development of cystocarps;
I, hair-like prolongation.

both sexual reproductive organs on the same branchlets.

Rhodochorton robustum **(Bφrgesen) Nakamura**

(Text—fig. 6)

Nakamura(1941) p. 284—287, figs. 10—13; Kang(1966) p. 60

Acrochaetium robusta Børgesen(1915—20) p. 40, figs. 38—40, *et* p. 449, fig. 418

Korean Name: 긴가지붉은털 (nom. nov.)

Plant epiphytic, partly endophytic, caespitose, 0.8—1.2mm high, consisting of basal creeping to penetrating and erect filaments; basal filaments multicellular, branched, creeping on and partly penetrating into host cortex, forming pseudoparenchymatous disc, cells of basal filament irregular

in shape, 6—8μm broad, 10—20μm long; erect filaments arising from basal filament, branched unilaterally or irregularly a few times from lower part of main axes, almost straight, with short branchlets, gradually attenuate to upper portion, scarcely constricted at septa, obtuse at apex, cells of erect filament cylindrical, becoming slightly longer to apex, thick-walled, 8—12μm broad, 20—25μm long, 3—4μm thick-walled at lower, 10—12μm broad, 24—26μm long, 2—3μm thick-walled at middle, 8—10μm broad, 30—40μm long, 1.5—2μm thick-walled at upper portions of erect filament; hair-like prolongation very rarely observed, multicellular, hyaline, 2—3μm broad, up to 160μm long; chromatophores parietally lobed, with large pyrenoid; monosporangia scattered along erect filament on branchlets, pedicellate (1—2-celled), terminal or lateral in occurrence, arranged more often seriately, elliptical to ovate, 10—12μm broad, 13—15μm long; spermatangial branches developed on branchlets or terminal portion of branches, secund, opposite or alternate in occurrence, spermatangia arranged in secund series on inner-side of branchlets, round, 5—6μm in diam. carposporangia not found.

Habitat: Epiphytic and partly endophytic on other algae in littoral zone

Material: Samtchok, eastern coast of Korea

We could also be able to investigate this plant with the cordial kindness of Prof. Kang. It was found on *Spathoglossum pacificum*, scattering broadly and densely over the marginal portion of the host thalli.

Our plants accord quite well with the ones shown by Nakamura in diagnostic characters, such as the development of basal structure, the mode of ramification, the cell shape, and the occurrence of chromatophores, etc.

The male reproductive organ described by Nakamura is found in addition to the monosporangia.

The spermatangial branchlets are curved slightly inwards, or sometimes outwards. The spermatangia occur terminally or subterminally on the spermatangial mother cell, which results by repeated divisions from the initial cell of the branchlets.

Frequently the cells of branchlet become directly the spermatangial mother cell itself. The carpogonium and the cystocarps are not discerned in our plants. According to Nakamura, the carpogonium is terminal on the 1—3-celled lateral branchlets, and 6μ wide and 12μ long including the trichogyne. The cystocarp is corymbose cluster in shape. The carposporangia are elliptical and 11—14μm broad, 18—20μm long.

It is found very rarely that the multicllelular hair-like prolongation is developed from the top of branchlet, although the character was not mentioned previously. It consists of two to three cells. The terminal cell is elongate long.

Nakamura combined the present species with *Acrochaetium robustum* Børgesen and *A. sargassicola* Børgesen.

The most important reason to combine the both species into one is that the basal structures, which were treated by Børgesen one of the important characters to distinguish the two species, are not different each other, but continued by the intermediate forms. According to the plant at hand, the basal structure, containing the creeping and penetrating flaments, accords quite well with Nakamura's in general, except that the pseudoparenchymatous basal disc extends rather broadly on the host surface in our plant. As a result, Nakamura's combination and emendation of the present species seem to be the reasonable treatment.

Rhodochorton hyalosiphoniae Nakamura

(Text—fig. 7)

Nakamura(1941) p. 287—289, figs. 14—16

Korean Name: 가시붉은털 (nom. nov.)

Plant epiphytic, partly endophytic, caespitose, 0.5—1.2mm high, consisting of basal creeping to penetrating and erect filments; basal filaments creeping on host surface forming pseudoparenchymatous disc, partly penetrating into host cortex, branched irregularly, tightly coherent one another, cells of creeping filament tetra- to polygonal, 10—15μm in diam., cells of penetrating filaments 5—

10μm broad, 15—30μm long; erect filaments branched frequently 3—4 times alternately, secundly or irregularly, branches and branchlets becoming narrower outwards, especially the latter ending in hair-like prolongation, apex slightly inflated, obtuse, cells of erect filament cylindrical, scarcely constricted at septa, 9—11μm broad, 20—22μm long at lower, 10—12μm broad, 25—30μm long at middle, 8—10μm broad, 20—35μm long at upper portions of main axes, 8—10μm broad, 15—20μm long in branches, 5—8μm broad, 10—15μm long in branchlets, cell wall 2—3μm thick; hair-like prolongations multicellular, hyaline, 1.5μm broad, up to 100μm long; chromatophores parietally laminate, with large pyrenoid at middle to upper half portion; monosporangia elliptical to ovoid, terminal or lateral on branches and branchlets, pedicellate (2—3-celled), frequently arranged in series on adaxial side of branchlets forming fan-shaped fascicle, about 9μm broad, 14μm long: color pale violet.

Habitat: Epiphytic and partly endophytic on the surface of other algae in littoral zone

Material: Gapado, Jaeju-island (May 12, 1972)

This plants, found on *Hizikia fusiforme*, were associated with *Rh. densum*, *Rh. sancti-thomae*,

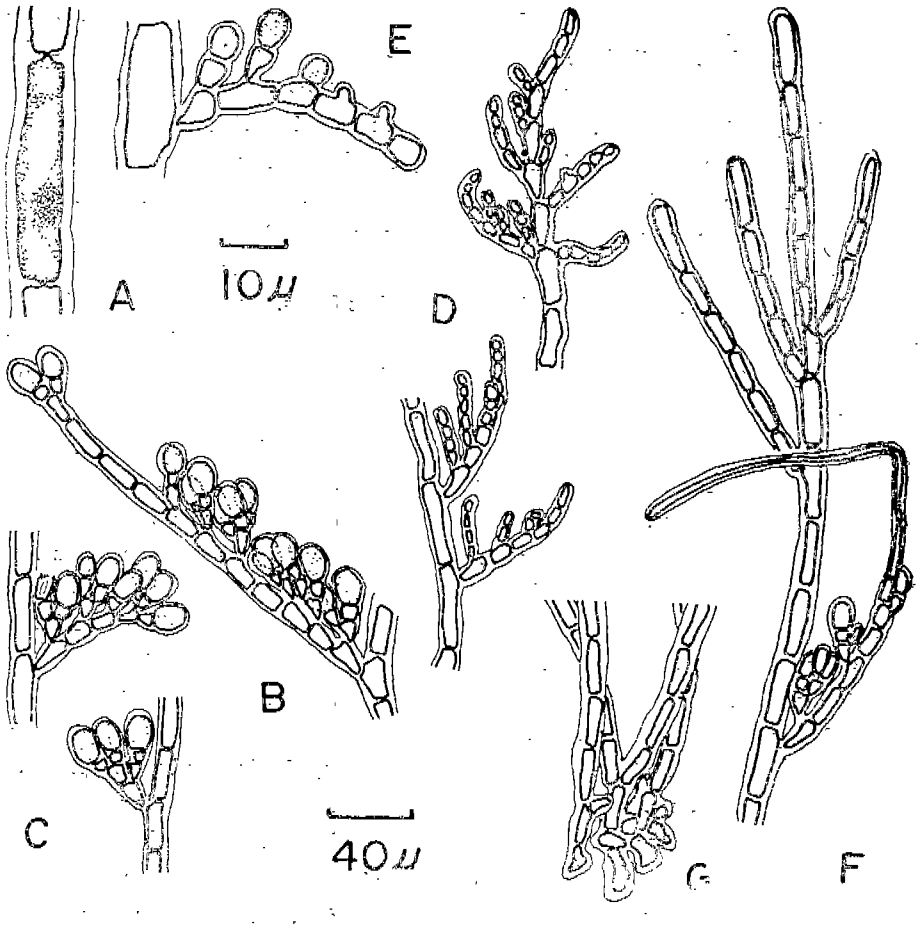

Fig. 6 *Rhodochorton rovustum* (Børgesen) Nakamura
A, cell of erect filament; B—C, monosporangia;
D, spermatangial branches; E, spermatangia;
F, part of erect filament with hair-like prolongation; G, basal structure.

and *Rh. daviesii*. Compared with the original species diagnostically, the plant at hand is characteristic in that the basal creeping filaments are coherent more tightly one another and develops rather broadly on the surface of the host cortex. The penetrating filamenst are also developed distinctly among the host itssue. These penetrating filaments would be accepted an important character to distinguish this plant from the other related ones; *Rh. daviesii* and *Rh. magnificum*, as mentioned by Nakamura.

Considering Woelkerling's opinion (1971, p. 30) on these three species of *Rhodochorton* (*Rh. daviesii*, *Rh. magnificum* and *Rh. hyalosiphoniae*), *Rh. daviesii*, and *Rh. hyalosiphoneiae* at hand are similar in general appearance, especially the

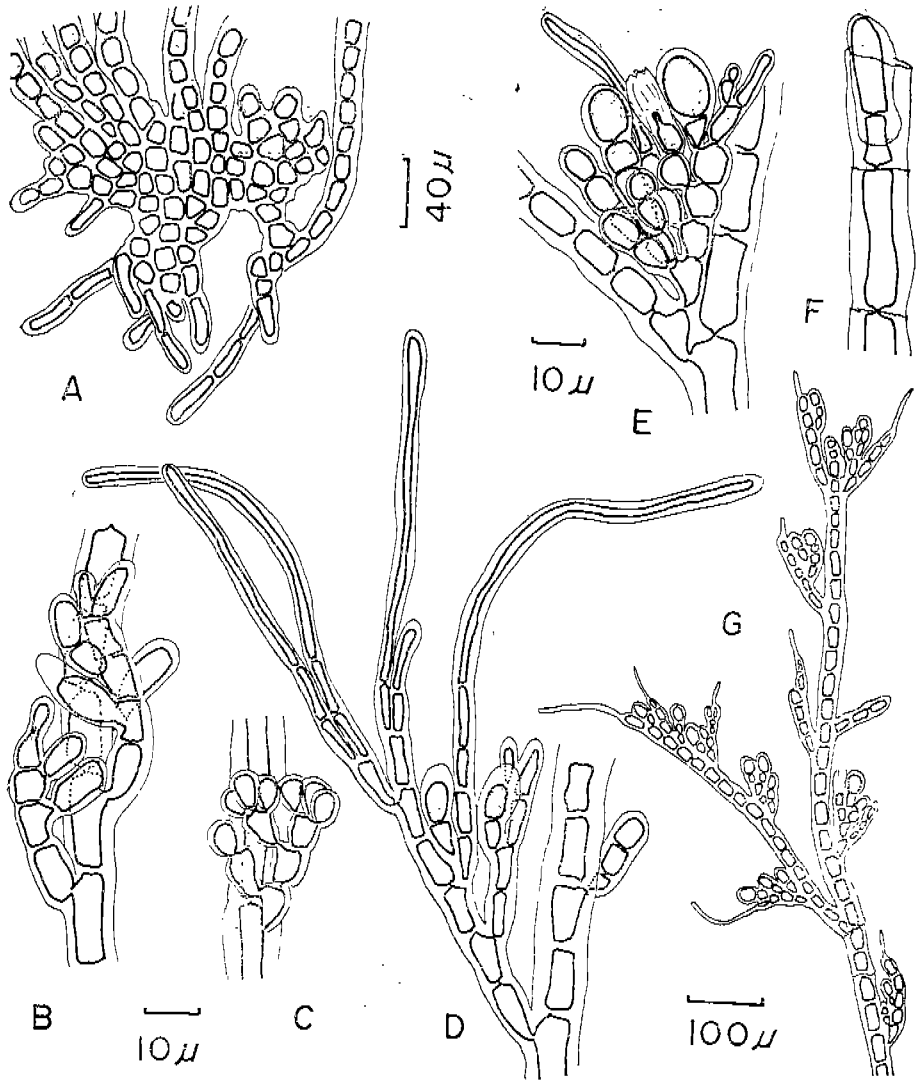

Fig. 7 *Rhodochorton hyalosiphoniae* Nakamura
A, basal structure; B, young cystocrap in early developmental stage;
C, spermatangia(?); D, hair-like prolongations;
E, monosporangia; F, regeneration of erect filament;
G, part of erect filament;.

ramification and the cell shape of erect filament, and the shape and size of monosporangia, etc. However, the former is slightly smaller than the latter, and the penetrating filaments of the latter develop more broadly and abundantly than the former (though Woelkerling insists the basal system can not become the criterion to distinguish the both species, because *Rh. daviesii* develops also the endophytic filaments). On the other hand, *Rh. magnificum* is rather a distinct species, as mentioned above.

The hair-like prolongation is multicellular. It consists of a few cells. The terminal cell of them becomes much elongated, while the others remain without elongation. We could also find the two hair-like prolongations developed sympodially on the same apex of the branches or branchlets, as mentioned by Nakamura. The regeneration of the erect filaments from the wounded apices seems to occur rather commonly in this plant.

The monosporangia are found abundantly in our plants. Besides, it is found rarely that some thalli bear the gonimblast only in early developmental stages. The mode of development of the gonimoblast is quite similar to the ones illustrated in *Rh. robustum* (Nakamura 1941, p. 286, fig. 11).

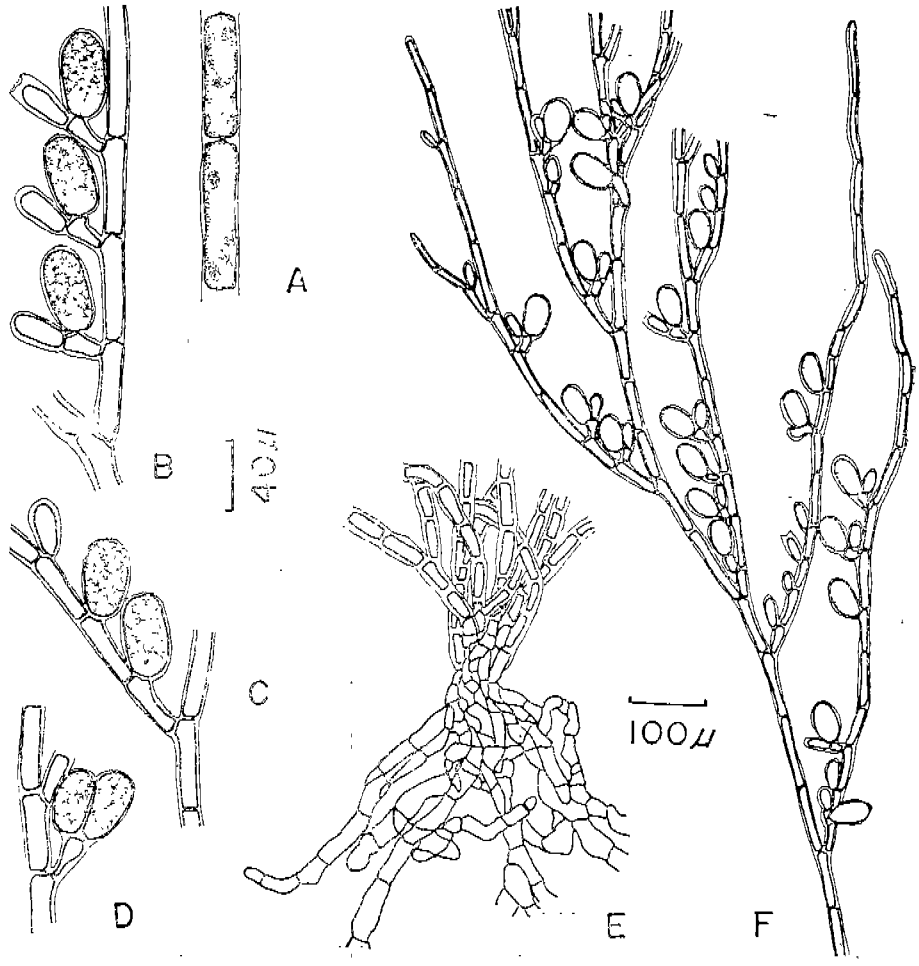

Fig. 8 *Rhodochorton codicola* (Børgesen) Nakamura
A, cells of erect filament; B—D, monosporangia;
E, basal structure; F, part of erect filament bearing monosporangia.

According to the material, the carpogonial branch consists of 2 to 4 cells in the present plant.

Rhodochorton codicola (Bǿrgesen) Nakamura
(Text-fig. 8)

Nakamura (1944) p. 113—115, fig. 10; Kang (1965) p. 51; (1966) p. 59

Acrochaetium codocola Børgesen(1927) p. 33, figs. 18—20

Korean Name: 청자붉은털

Plant endophytic, caespitose, extended broadly on host surface, 2—3mm high, composed of endophytic and erect filaments; basal endophytic filaments penetrating into host tissue, multicellular, abundant, contorted, branched irregularly, much entangled one another especially at upper portion, thicker than erect filament, cells of endophytic filament cylindrical, curved or irregular in shape, hyaline, 15—30μm broad, 40—70μm long; erect filaments arising from endophytic filaments, almost straight, richly branched, branches and branchlets issuing 3—5 times irregularly, alternately, or secundly with various intervals, with acute angles, obtuse at apex, cells of erect filament cylindrical, scarcely constricted at septa, 15—20μm broad, 40—45μm long at lower, 12—14μm broad, 60—80μm long at middle, 8—10μm broad, 60—90μm long at upper portions of erect filament, thin walled; hair-like prolongation wanting; chromatophores parietally lobed, poor in content, with 1—3 pyrenoids of 5—7μm in diam.; monosporangia numerous, secund seriate in arrangement on branchlets, obovate to elliptical, pedicellate (1—2-celled) or sessile, 20—23μm broad, 35—45μm long; tetrasporangia not found: color purple.

Habitat: Endophytic among the utircles of *Codium fragile*

Material: Gapado, Jaeju-island (Nov. 6, 1972)

Kang(1965, 1966) reported this species from Ulrungdo, Pusan and also from Chaeju island(= Jaeju-island). The plants seem to occur rather commonly in the coasts of Korea.

The endophytic filaments are conspicuous and well developed. They from a dense bunch among the utricles of *Codium fragile*. There are numerous monosporangia on well develop branches and branchlets. Unfortunately, the tetrasporangia mentioned by Nakamura were not found in our plants. According to him, the tetrasporangia are divided cruciately, and 20—28μm broad and 40—50 μm long.

Rhodochorton rhizoideum Drew
(Text-fig. 9)

Drew(1928) p. 182, Pl. 42, figs. 42—44; Nakamura(1944) p. 115, fig. 11.

Korean Name: 헛뿌리붉은털 (nom. nov.)

Plant endophytic, caespitose, extended broadly on host surface, 3—5mm high, consisting of endophytic and erect filaments; basal endophytic filaments well developed, multicellular, branching irregularly, extended more or less, cells of endophytic filament irregular in shape, sometimes slightly constricted at septa, thicker than erect filament, slightly pigmented with parietal chromatophores, 15—30μm broad, 60—100μm long, thin walled; erect filaments arising from endophytic filaments, branched 3—5 (mostly 4) times at basal portion alternately, secundly or irregularly, scarcely constricted at septa, branchlets mostly secund in arrangement, slightly inflated, with obtuse apex, cells of erect filament cylindrical, decreasing in size from base to apex, about 9μm thick-walled (in lower portion sometimes becoming of 4—5μm thick), hair-like prolongation wanting; chromatophores parietal, usually band-shaped, especially poor in content in terminal 3—4 cells except for apical cell of branches and branchlets; pyrenoids recognizible a few in mumber within single cell, 4μm in diam.; monosporangia lateral or terminal in occurrence, pedicellate (1-celled), seldom sessile, frequently seriate in arrangement along branches, elliptical in shape, 20—30μm broad, 30—45μm long: color purple.

Habitat: Endophytic on the other algae in littoral zone

Material: Gapado, Jaeju-island (Aug. 8, 1972)

Our plant were found on *Codium fragile*.

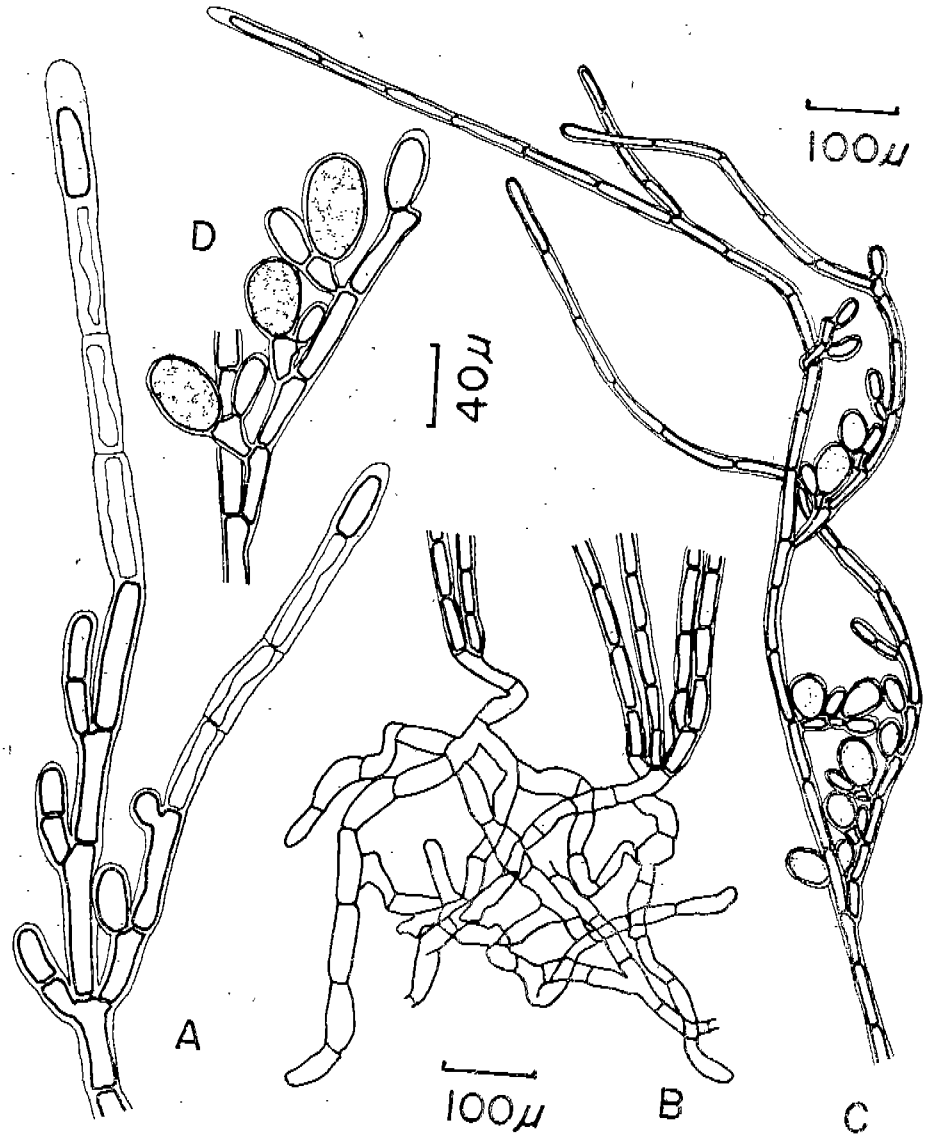

Fig. 9 *Rhodochorton rhizoideum* Drew
A, terminal portion of erect filament; B, basal structure;
C, part of erect filament bearing monosporangia; D, monosporangia.

According to Drew and Nakamura the present plant is distinguishable by the thick walled cells (especially at basal portion by Nakamura), prominant pyenoids, and large monosporangia, etc. Considering the diagnostic characters and also the characters shown by the material at hand, *Rh. rhizoideum* is much similar to *Rh. codicola* in that the well developed endophytic filaments, the mode of ramifications in erect filaments and, the occurring pattern and shape of monosporangia, etc. With precise investigation, however, there could find some noticeable characters to distinguish the both species; in *Rh. rhizoideum* the endophytic filaments contain poor chromatophores within, while there are recognizible no chromatophores within those of *Rh. codicola*. The erect filaments are also

Table. 1 Some important diagnostic characters of *Rhodochorton* in Korea

Species	Basal system	Height(mm)	Branches	Cells of erect filament			
				Shape	Size(μm) in position		
					lower breadth×length	middle b.×l.	upper b.×l.
Rh. terminale	epiphytic	0.1—0.15	rare 1—3 times	moniliform	4.5—5.5 × 7—8	5.5—6.5 × 6.5—8	4.5—5.5 × 6.5—8
Rh. densum	〃	0.2—0.3	not common 1—3 times	elongate barrel shaped clavate	4—5 × 8—9	5—7 × 10—12	5—6 × 8—12
Rh. sancti-thomae	〃	0.2—0.6	common 1—2 times	cylindrical-obovate	5—7 × 10—12	6—8 × 12—15	4—6 × 13—16
Rh. daviesii	〃	1—1.5	common 3—4 times	cylindrical	10—13.5 × 16—22	9—11 × 17—24	7—7.5 × 12—18
Rh. magnificum	epiphytic & partly endophytic	3—5	abundant 3—5 times	〃	12—15 × 40—60	10—12 × 50—70	6—8 × 80—100
Rh. robustum	〃	0.8—1.2	common 1—3 times	〃	8—12 × 20—25	10—12 × 24—26	8—10 × 30—40
Rh. hyalosiphoniae	〃	0.5—1.2	common 3—4 times	〃	9—11 × 20—22	10—12 × 25—30	8—10 × 20—35
Rh. codicola	endophytic	2—3	abundant 3—5 times	〃	15—20 × 40—45	12—14 × 60—80	8—10 × 60—90
Rh. rhizoideum	〃	3—5	abundant 3—5 times	〃	15—20 × 40—50	12—14 × 40—80	10—12 × 40—80

《**Table. 1 Continued.**》

Species	Hair-like prolongation	Chromatophores	Pyrenoid	Monosporangium breadth×length (μm)	Tetrasporangium b.×l.(μm)	Spermatangium b.×l.(μm)	Carposporangium b.×l.(μm)
Rh. terminale	none	parietally lobed	single	6.5—8 × 9.5—12	—	—	—
Rh. densum	〃	〃	〃	5—7 × 12—15	—	—	—
Rh. sancti-thomae	unicellular	〃	〃	5×10	8—10 × 11—14	—	—
Rh. daviesii	multi-cellular	〃	〃	8—9 × 12.5—15	(13)—15—18* × 17—21	3×4*	8—10* × 16—20
Rh. magnificum	〃	parietal band	(〃)	18—20 × 25—30	—	5×7	10×20
Rh. robustum	multicellular, rare	parietally lobed	〃	10—12 × 13—15	—	5—6 × 5—6	11—14* × 18—20
Rh. hyalosiphoniae	multi-cellular	parietally laminate	〃	9×14	—	—	—
Rh. codicola	none	parietally lobed	1—3	20—23 × 35—45	20—28** × 40—50	—	—
Rh. rhizoideum	〃	pairetal band	1—3	20—30 × 30—45	—	—	—

※ data from Woelkerling(1971) ※※ data from Nakamura(1944)

rather rich in chromatophores, comparatively longer in cell length, and somewhat thicker in cell wall in the present species.

In addition to them, the both species can be distinguishable by the fact that in *Rh. rhizoideum* the terminal 3—4 cells just below the apical cell of the erect filament become much feeble and contain poor chromatophores, so that they look like a hair-like prolongation known in the other members of *Rhodochorton*.

The pyrenoids in the cells of erect filament are not so conspicuous in our plant.

From the above investigation, some important diagnostic characters of the nine species identified in Korean waters are summerized in Table 1.

The writers wish to express their sincere thanks to Prof. J. W. Kang, Pusan Fisheries College, for his kind advice and for the loan of some precious herbarium specimens.

References

Børgensen, F. 1915—20 The marine algae of the Danish West Indies Ⅱ. Rhodophyceae. *Dansk. Bot. Ark.*, 1—504.

_____. 1927. Marine algae from the Canary Islands Ⅲ Rhodophyceae. part Ⅰ. Bangiales and Nemalionales. *Biol. Meddr.*, 6(6); 1—97.

Dillwyn, L.W. 1809. "British Confervae", see Drew(1928) cited in this paper.

Drew, K. 1928. A revision of the genera *Chantransia*, *Rhodochorton*, and *Acrochaetium*. *Univ. Calif. Publ. Bot.*, 14(5); 139—224, Pls. 37—13.

Hamel, G. 1927. "Recherches sur les genres *Acrochaetium* Naeg. *Rhodochorton* Naeg". *Dissertation*(Paris).

Kang, J.W. 1965. Marine algae of Ulrungdo island. *Bull. Pusan Fish. Coll.*, 6(2); 41—58.

_____. 1966. On the geographic distribution of marine algae in Korea. *Ibid.*, 7(1,2); 1—125.

Knaggs, F. 1964. Cytological and life-history studies in the genus *Rhodochorton*. *Br. Phycol, Bull.*, 2; 393.

_____. 1966. *Rhodochorton purpureum* (Lightf.) Rosenvinge: Observations on the relationship between reproduction and environment 1. The relationship between the energy of incident light and tetrasporangium formation. *Nova Hedwigia*, 11;405—411.

_____. & Conway, E. 1964. The life-history of *Rhodochorton floridulum* (Dillw.) Naeg. 1. Spore germination and the form of the sporlings. *Brit. Phycol. Bull* 2;339—341.

Lee, I.K. 1973. A check list of marine algae in summer of Baegryeong Island. *Bull. Coll. Lib. Art. & Sci.* S. N.U. 19;437—448.

Naegeli, C. 1861. Beitrage zur Morphologie und Systematik der Ceramiaceae. *Sber. bayer. Akad. Wiss.*, 2;297—415.

Nakamura. Y. 1941. The species of *Rhodochorton* from Japan Ⅰ. *Sci. Pap. Inst. Alg. Res., Fac. Sci. Hokk. Univ.*, 2(2);273—291.

_____. 1944. *ditto*, Ⅱ. *Ibid.*, 3(1);99—119.

Rosenvinge, L.K. 1909. The marine algae of Denmark pt. 1. Rhodophyceae. *K. danske Vidensk. Selsk. Skr.*, 1—151.

Swale, E. & Belcher, J. 1963. Morphological observations on wild and cultured material of *Rhodochorton investiens* (Lcn.) nov. comb. (*Balbiana investiens*(Len.) Sirodot). *Ann. Bot.* N.S., 27;281—90.

West, J.A. 1968. Morphology and reproduction of the red alga *Acrochaetium pectinalum* in culture. *J. Phycol.*, 4;89—99.

_____. 1969. The life histories of *Rhodochorton purpureum* and *Rhodochorton tenue* in culture. *Ibid.*, 5;12—21.

Woelkerling, W.J. 1971. Morphology and taxonomy of the *Audouinella* complex (Rhodophyta) in southern Australia. *Austr. J. Botany*, Suppl. 1.,1—91, figs. 1—27.

(Received April 1, 1974)