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On Some Species of *Spongomorpha* from Hokkaido, Japan

By

YOSHIO SAKAI

In consequence of studies on the *Spongomorpha*-complex by several Japanese phycologists, the following six species, two varieties, and one form of the genus *Spongomorpha*, and two species of the genus *Acrosiphonia* have been reported from Hokkaido, the Kurile Islands, and Saghalien:

genus *Spongomorpha* KUETZING

1. *Sp. arcta* KUETZING
2. *Sp. duriuscula* (RUPR.) COLLINS
- 2a. var. *cartilaginea* (RUPR.) YAMADA
- 2b. var. *tenuis* YAMADA
3. *Sp. Hystrix* STROEMFELT
4. *Sp. Mertensii* (RUPR.) SETCHELL et GARDNER
5. *Sp. ochotensis* TOKIDA
- 5a. f. *tenuis* TOKIDA
6. *Sp. saxatilis* (RUPR.) COLLINS

genus *Acrosiphonia* J. G. AGARDH

1. *A. duriuscula* (RUPR.) YENDO
2. *A. Mertensii* (RUPR.) YENDO

Since 1951 the present writer has been studying systematically the species of the genus *Spongomorpha* from Hokkaido under the direction of Prof. Y. YAMADA. The following four species and one variety are described in this paper using chiefly specimens preserved in formalin solution. To the diagnostic characters of the species of the genus *Spongomorpha* the present writer has added some characters such as rim-shaped septum (Figs. 1, E; 7, D etc.), sterile branch (Fig. 6, A), and thickness of cell-membrane. Especially, the rim-shaped septum seems to be peculiar to the genus *Spongomorpha*.

Sincere thanks are expressed to Prof. Y. YAMADA for his kind guidance and valuable suggestions during the course of this study.

I. Species ramis erectis

Spongomorpha breviararticulata SAKAI, spec. nov.

Figs. 1-3

Frondibus epiphyticis vel saxicolis, ca. 3-5 cm altis, fusco-vel luteo-viridibus,

rigidis, erectis, densis, non implicatis; rhizoideis descendentibus ex partibus inferioribus frondium, ordinis ramosis, tenuibus, $40-50\mu$ crassis, cellulis diametro 2-5-plo longioribus, chromatophoris laxis; membranarum cellularum diametro $1/4-1/6$ -plo crassioribus in partibus omnibus frondium; ramis principalibus erectis, $100-130\mu$ crassis, cellulis diametro $1\frac{1}{2}-3.0$ -plo longioribus, horizontaliter striatis; ramis ramulisque rectis, elongatis, secundis, raro oppositis, axillis acutis, maxime 200μ crassis, cellulis brevioribus, diametro $1/3-1.0$ -plo longioribus; cellulis

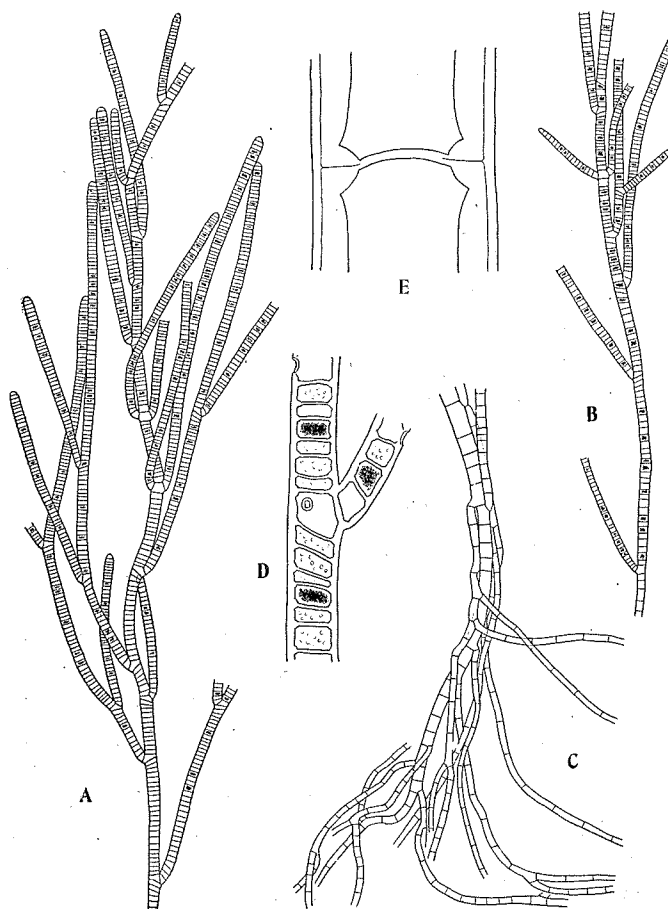


Fig. 1. *Spongomorpha breviarticulata* SAKAI.

- A. Upper part of frond with sporangia. $\times 7$.
- B. Middle part of frond with sporangia. $\times 7$.
- C. Basal part of frond with rhizoids. $\times 23$.
- D. Mother cell of branch showing inclined septum. $\times 52$.
- E. Rim-shaped septum. $\times 200$.

maternis ramorum ramulorumque inclinatis; sporangiis formatis in ramulis ramisque, solitariis raro binis vel ternis; septis cellularum oriformibus elaboratis in partibus omnibus frondium.

Japanese name: Kitami-motsuregusa (nov.)

Type locality: Menashidomari, Kitami Prov.

Distribution: Okotsu, Kushiro Prov.

Fronds epiphytic or saxicolous, about 3–5 cm high, dark or yellowish green in color, rigid, erect, dense, not entangled together; rhizoids descending from lower parts of fronds, ordinarily branching, slender, 40–50 μ in diam., cells 2–5 times as long as diam., with thin chromatophores; cell-membrane 1/4–1/6 times as thick as diam. in all parts of fronds; primary branches erect, 100–130 μ in diam., cells $1\frac{1}{2}$ –3.0 times as long as diam., with horizontal striations; branches and branchlets straight, elongate, secund, rarely opposite, reaching 200 μ in diam., cells shorter, 1/3–1.0 times as long as diam.; mother cells of branches and branchlets inclined; sporangia formed in branchlets and branches, solitary, seldom two or three in succession; septa elaborate rim-shape in all parts of fronds.

The new species grows on the fronds of *Phyllospadix* sp. or on rocks, and has short segments and elaborate rim-shaped septa (Fig. 1, E). Furthermore, the septa of branch- and branchlet-mother cells are inclined to the branching direction (Fig. 1, D).

On the shore of Okotsu, near Kushiro City, globular masses of this alga were collected by Mr. S. SATO. He said that many *Spongomorpha*-balls which have dark green color were floating on the sea-surface at the beginning of August, 1951. The present writer, however, received only one *Spongomorpha*-ball from him (Fig. 2), and the writer himself collected only some broken balls cast ashore. At a glance, the ball has a similar appearance with *Aegagropila Sauteri* (NEES) KUE-TZING from Lake Akan, Hokkaido. The ball in question differs from

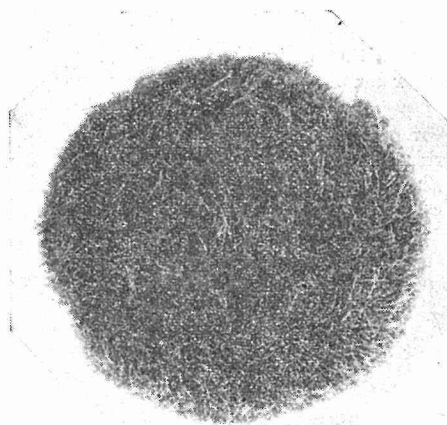


Fig. 2. Globular mass of *Spongomorpha breviariculata* SAKAI. $\times 1$.

Aeg. Sauteri by its rough surface and irregularly arranged filaments. It is about 5.5 cm in diameter, dark green in color, and consists principally of the filaments of the new species which arrange in an irregular manner together with some fragments of *Ahnfeltia plicata* in the centre of the ball. The rhizoids of the fronds which form the ball arise in all directions from all parts of the

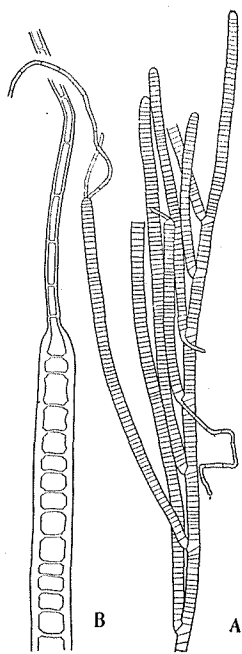


Fig. 3. Filaments of globular mass of *Spongomorpha breviarticulata*.

- A. Fragment of frond with rhizoids. $\times 20$.
 B. Rhizoid arising from tip cell of branchlet. $\times 30$.

fronds, even from the top cells of the branchlets (Fig. 3, A, B). From this fact, it seems to the present writer that the fragments of the fronds of *Sp. breviarticulata* are able to live in the ball.

The characters of the fronds of the *Spongomorpha*-ball differ from those of *Sp. breviarticulata*, only in existence of rhizoids which arise from all parts of the fronds. All other characters, however, are about the same as in this new species.

In the dimensions, rigidity, sporangium, and ramification, the new species resembles *Sp. Hystrix* f. *littoralis* JÖNSSON. The length of the segments of the new species, however, is much shorter than that of JÖNSSON's alga in the lower portion, and longer in the upper part of the fronds. (That is, the new species differs from JÖNSSON's alga by the length of its segments which becomes shorter upwards.) On the other hand, the new species resembles *Acrosiphonia flabelliformis* JÖNSSON in its rigidity, short segment, and ramification. But, *A. flabelliformis* is distinguishable from the new species by its prostrate-lying habit, by its wide filaments, and by the long segments in the upper parts of the fronds.

Spongomorpha duriuscula (RUPR.) COLLINS

var. *tenuis* YAMADA Fig. 4

Mar. alg. Urup. (Sci. Pap. Inst. Alg. Res., Fac. Sci., Hokkaido Univ. vol. I, no. 1, 1935) p. 11; OKAMURA, Nippon Kaiso Shi, 1936, p. 72; NAGAI, Mar. alg. Kurile Isl. Pt. 1 (Jour. Fac. Agr., Hokkaido Univ. vol. 46, 1940) p. 31, pl. II, figs. 1-2.

Fronds saxicolous, about 10-15 cm high, green in color, not entangled together, but dense, rigid, not adhering to paper in drying; rhizoids descending from basal parts of fronds, numerous, branching, 30-60 μ in diam., cells 2-8 times as long as diam., with thin chromatophores, cell-membrane 1/10-1/7 times as thick as diam., ending in rounded cells; primary branches straight, 80-140 μ in diam., 1-3 times as long as diam., sometimes with horizontal striations; cell-membrane thin, 1/9-1/15 times as thick as diam. in branches and branchlets; branches and branchlets straight, dilated upwards, axils acute in lower parts, but obtuse in upper parts, branching lateral, 110-180 μ in diam., cells 1-3 times as long as diam., with slightly constricted articulations; sporangia

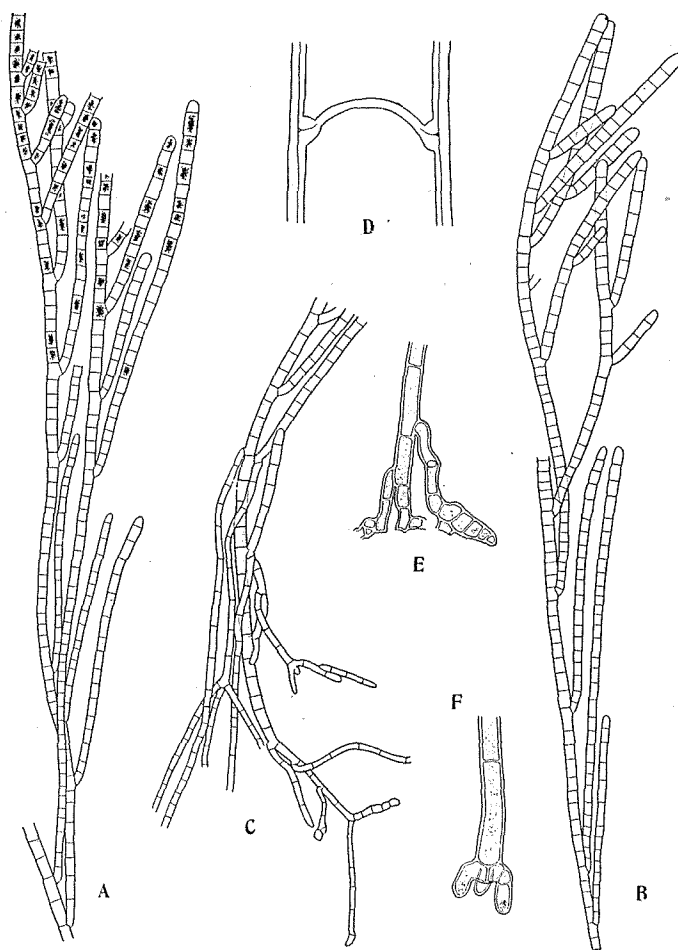


Fig. 4. *Spongomorpha duriuscula* v. *tenuis* YAMADA.

- A. Upper part of frond with sporangia. $\times 12$.
- B. Upper part of frond. $\times 12$.
- C. Basal part of frond with rhizoids and horizontal striations. $\times 51$.
- D. Rim-shaped septum. $\times 200$.
- E, F. Terminal part of rhizoids. $\times 60$.

reaching 200μ in diam., formed in upper parts of fronds, 2-3 or more in succession, with slightly constricted articulations; septa normally rim-shaped in middle parts of fronds, but more simple in other parts.

Japanese name: Hosomotsuregusa.

Distribution: Hokkaido; Kurile Islands.

This alga is common on the shores of Hidaka and Akkeshi, where it grows on rocks in the tidal zone, it shows rigid texture in spite of its thin cell-membrane.

According to COLLINS (1909, p. 357), *Sp. duriuscula* (RUPR.) COLLINS has "patent or recurved ramuli". Afterward, SETCHELL and GARDNER (1920) placed this species among the group which has never hooked branches. Furthermore, the present writer can not observe any recurved branch in a specimen of *Cladophora alaskana* COLLINS (Phyc. Bor.-Amer. no. 225), the synonym of the species. Moreover, in this variety no recurved branch is ever observed.

Spongomorpha saxatilis (RUPR.) COLLINS

Fig. 5.

Green alg. N. Amer. (1909) p. 360; Ibid., Mar. alg. Vancouver Isl. (Victoria Mem. Museum Bull. no. 1. 1913) p. 104; SETCHELL and GARDNER, Mar. alg. Pacif. coast of N. Amer. Pt. II (1920) p. 226; YENDO, Note on alg. new to Jap. (Bot. Mag. Tokyo vol. 30, 1916) p. 245; OKAMURA, Nippon Kaiso Shi (1936) p. 73; KAWABATA, List mar. alg. Isl. of Shikotan (Sci. Pap. Inst. Alg. Res., Fac. Sci., Hokkaido Univ. vol. 1, no. 2, 1936) p. 201; NAGAI, Mar. alg. Kurile Isl. Pt. 1 (Jour. Fac. Agr., Hokkaido Univ. vol. 46, 1940) p. 34; YAMADA and TANAKA, Mar. alg. Akkeshi. (Sci. Pap. Inst. Alg. Res., Fac. Sci., Hokkaido Univ. vol. 3, no. 1, 1944) p. 50.

Conferva saxatilis RUPRECHT, Tange d. ochot. Meeres (1851) p. 403.

Cladophora saxatilis (RUPR.) DETONI, Syll. Alg. I (1889) p. 311; SETCHELL and GARDNER, Alg. N.-W. Amer. (1903) p. 223

Fronds saxicolous, 3-10 cm high, rich green, not entangled together, but dense, rather rigid, adhering to paper in upper parts of fronds; rhizoids descending from lower parts of fronds, numerous, often branched, 35-65 μ in diam., 4-9 times as long as diam., with thick cell-membrane, 1/4-1/3 times as thick as diam., rarely with horizontal striations; primary branches straight, lateral, axils acute, 80-140 μ in diam., reaching 170 μ at tips, cells 1-3 times as long as diam., sometimes with horizontal striations; branches in middle or lower parts of fronds acuminate, alternate or sometimes opposite, axils acute, 80-100 μ in diam., $\frac{1}{2}$ -1 $\frac{1}{2}$ times as long as diam., cell-membrane 1/10-1/14 times as thick as diam., with dense chromatophores; branches in upper parts of fronds dilated, lateral, axils acute, 110-150 μ in diam., sometimes reaching 180 μ in tips, 3-7 times as long as diam., cell-membrane soft, thin, 1/10-1/17 times as thick as diam., with thin chromatophores, ending in clavate cells; sporangia formed in all parts of fronds, rarely in dilated branches, solitary, sometimes 2-3 in succession; septa normally rim-shaped, but more simple in dilated branches and rhizoids.

Japanese name: Togenashi-motsuregusa.

Distribution: Hokkaido; Kurile Islands; Pacific coast of North America; Saghalien.

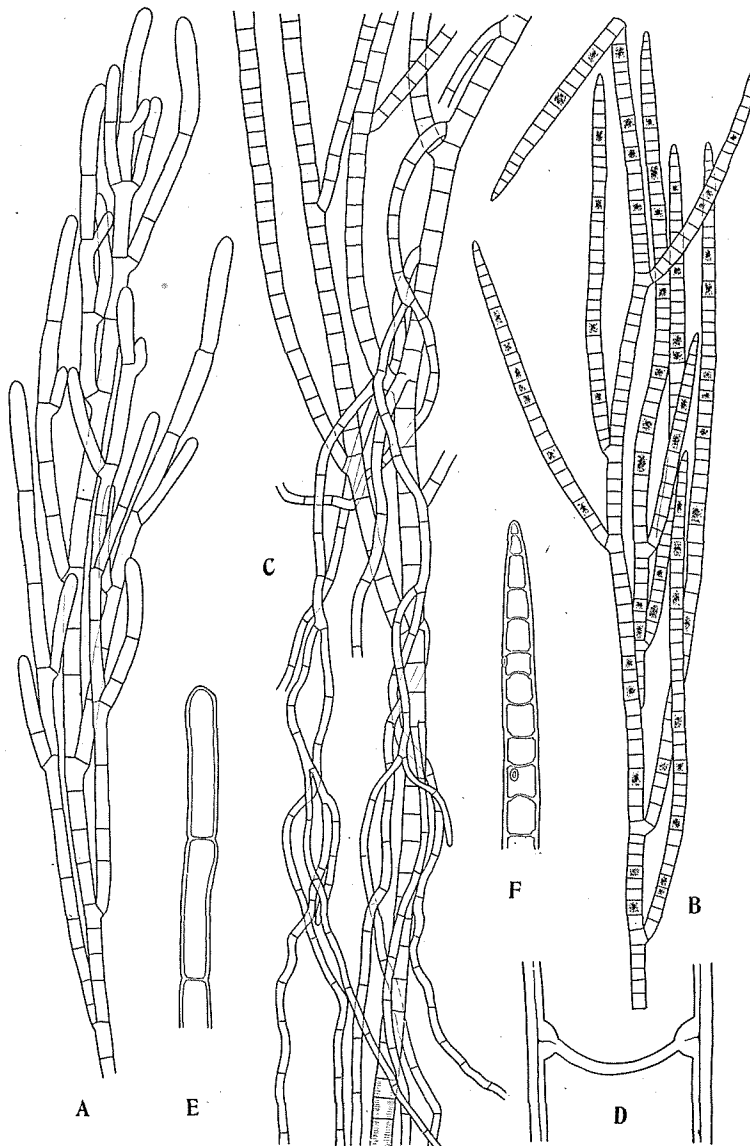


Fig. 5. *Spongomorpha saxatilis* (RUPR.) COLLINS

- A. Upper part of frond showing dilated branches. $\times 18$.
 B. Middle part of frond showing acuminate branches with sporangia. $\times 18$.
 C. Basal part of frond with rhizoids and horizontal striations. $\times 27$.
 D. Rim-shaped septum. $\times 230$. E. Tip of dilated branch. $\times 23$.
 F. Tip of attenuate branch with two sporangia. $\times 37$.

This characteristic species was described basing on the existence of two sorts of branches, the acuminate and dilated ones. The cells of the acuminate branches are able to become sporangia (Fig. 5, B). On the other hand, the cells of the dilated branches are not able to form a sporangium. Furthermore, the dilated branches have thin chromatophores and cell-membrane, simple rim-shaped septa and clavate tips. The dilated branches seem to be sterile branches, as in *Sp. heterocladia* SAKAI. The branches adhere closely to paper in drying.

II. Species ramis recurvatis

Spongomorpha heterocladia SAKAI, spec. nov.

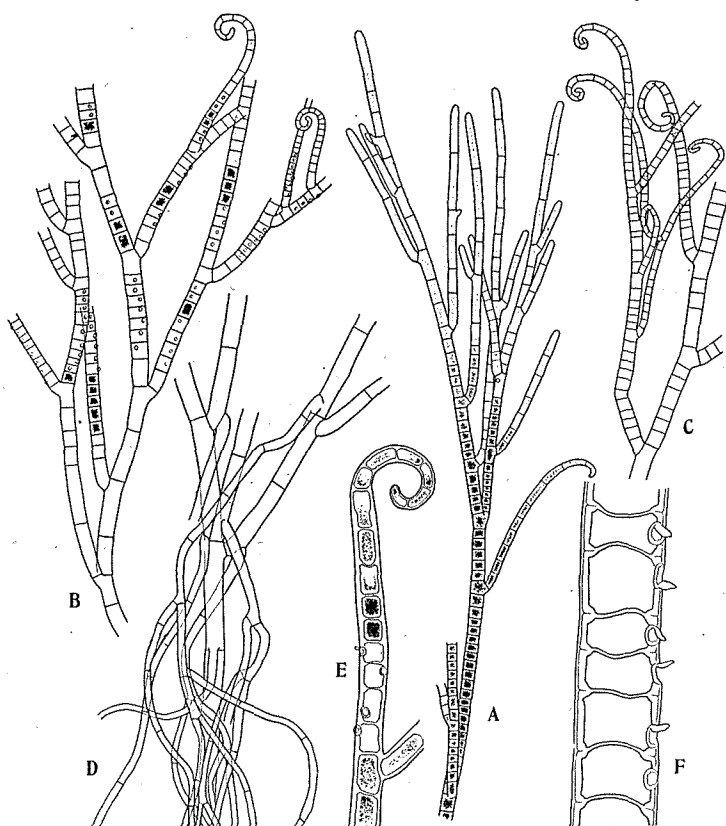
Fig. 6.

Frondibus epiphyticis, ca. 3–4 cm altis, fusco- vel luteo- viridibus, gracilibus, densis, partibus inferioribus implicatis; rhizoideis descendentibus ex partibus inferioribus frondium, numerosis, simplicibus vel ramosis, ca. 25–50 μ crassis, cellulis diametro ca. 2–9-plo longioribus, membranis cellularum diametro ca. 1/3-plo crassioribus, chromatophoris laxis; ramis principalibus rectis, crassioribus, ca. 100–130 μ crassis, cellulis diametro 2–5-plo longioribus, membranis cellularum diametro 1/3–1/4-plo crassioribus; ramis recurvatis emittentibus ex partibus inferioribus et mediis frondium, lateralibus, axillis acutis, tenuioribus, 35–80 μ crassis, cellulis diametro 1–4-plo longioribus, membranis cellularum tenuibus, apicibus obtusis; ramis sterilibus rectis, emittentibus ex partibus superioribus frondium, alternis vel nonnumquam secundis, cellulis inferioribus 80–100 μ crassis et diametro aequalibus, sed superne 60–80 μ crassis et diametro maxime 10-plo longioribus, chromatophoris laxis; sporangiis formatis in ramis recurvatis et ramis normalibus, seriatis; orificiis sporangiorum operculis ornatis; septis cellularum oriformibus normalibus in partibus mediis et basalibus frondium, sed formibus simplicioribus in ramis sterilibus et rhizoideis.

Japanese name: Iburi-motsuregusa (nov.)

Type locality: Muroran, Iburi Prov. (M. AKIYAMA).

Fronds epiphytic on *Phyllospadix* sp., about 3–5 cm high, dark- or yellowish green in color, soft, dense, entangled in lower parts, not above; rhizoids descending from lower parts of fronds, numerous, simple or branching, with thin chromatophores, about 25–50 μ in diam., cells about 2–9 times as long as diam., cell-membrane about 1/3 times as thick as diam.; primary branches straight, wider below, about 100–130 μ in diam., cells 2–4 times as long as diam., cell-membrane 1/3–1/4 times as thick as diam.; recurved branches issuing from lower parts and middle parts of fronds, lateral, axils acute, slender, 35–80 μ in diam., cells 1–4 times as long as diam., cell-membrane thin, apices obtuse; sterile branches straight, issuing from upper parts of fronds, alternate or sometimes secund, cells 80–100 μ in diam. as long as diam. below, but 60–80 μ in

Fig. 6. *Spongomorpha heterocladia* SAKAI

- A. Upper part of frond showing sterile branches. $\times 30$.
- B. Middle part of frond showing recurved branches and sporangia. $\times 20$.
- C. Recurved branches. $\times 20$.
- D. Basal part with rhizoids. $\times 30$.
- E. Recurved branch with sporangia. $\times 60$.
- F. Empty sporangia with lids. $\times 120$.

diam. and reaching 10 times as long as diam. upwards, with thin chromatophores; sporangia formed in recurved branches and normal branches, seriate; orifices of sporangia with lids; septa normally rim-shaped in middle or lower parts of fronds, but more simple in sterile branches and rhizoids.

The new species is found in spring growing epiphytically on *Phyllospadix* sp. The fronds of the alga comprise three sorts of branches such as the recurved, the sterile, and the rhizoidal ones. At a glance, the fronds of the new

species are not entangled together in the lower parts. Moreover, the obvious character of this species is having a lid on every orifice. Generally, the lids attach on the upper end of the orifices of the sporangia, but they detach easily. Furthermore, the present writer observed sometimes the lids on the orifices of *Sp. breviarticulata*. However, existence of the lid in the frond of *Spongomorpha* has not yet been described by any author. The sporangia form seriate rows (long ones consisting of 20 sporangia) in recurved and in normal branches. The rim-shaped septa have normal form in the middle or lower parts of the fronds, but show more simple form in sterile branches and rhizoids.

In general characters, the new species seems to show some relation to *Sp. cincinnata* FOSLIE. KJELLMAN (1893, p. 79) described regarding *Acrosiphonia cincinnata* (*Sp. cincinnata*), "Ramuli superiores curvati, patentes, inter se implexi, rami principales usque 115μ crassi". In the new species, however, the branchlets of the upper parts of the fronds are straight, sterile, and have acute axils. In addition to these characters, the new species has the lids on the sporangia. These characters distinguish most clearly the new species from all other species of *Spongomorpha*.

Spongomorpha spiralis SAKAI, spec. nov.

Fig. 7.

Frondibus saxicolis, ca. 3-5 cm altis, fusco-viridibus, gracilibus, densis, implicatissimis; rhizoideis descenduntibus ex partibus inferioribus frondium, numerosis, simplicibus vel ramosis, tenuibus, $15-40\mu$ crassis, cellulis diametro 3-9-plo longioribus, chromatophoris laxis, membranis cellularum diametro ca. $1/7-1/10$ -plo crassioribus; ramis principalibus et ramis lateralibus, vel sparsis, axillis patentibus in partibus mediis et superioribus frondium, sed acutis in partibus inferioribus, $55-75\mu$ crassis, cellulis diametro $1\frac{1}{2}-4\frac{1}{2}$ -plo longioribus, membranis cellularum tenuibus, ca. $1/10$ -plo crassioribus, articulis leviter constrictis; ramis recurvatis numerosis in partibus omnibus frondium, secundis, non acuminatis, articulis leviter constrictis; sporangiis formatis in partibus omnibus frondium, extra rhizoideis, seriatis (maxime 17 sporangiis); septis cellularum oriformibus normalibus in partibus basalibus frondium, sed formibus simplicibus in partibus superioribus et rhizoideis.

Japanese name: Uzu-motsuregusa (nov.).

Type locality: Horoman, Hidaka Prov.

Fronds saxicolous, about 3-5 cm high, dark green in color, soft, very dense and entangled together; rhizoids descending from lower parts of fronds, numerous, simple or branched, slender, $15-40\mu$ in diam., cells 3-7 times as long as diam., with thin chromatophores, cell-membrane about $1/7-1/10$ times as thick as diam.; primary branches and branches lateral, or irregular, axils patent in middle and upper parts of fronds, but acute in lower parts, $55-75\mu$ in diam.,



Fig. 7. *Spongomorpha spiralis* SAKAI.

- A. Upper part of frond. $\times 23$.
- B. Middle part of frond with seriate sporangia. $\times 23$.
- C. Basal part of frond with rhizoids. $\times 23$.
- D. Rim-shaped septum. $\times 250$.
- E. Rejuvenescens in middle part of frond. $\times 60$.

cells $1\frac{1}{2}$ – $4\frac{1}{2}$ times as long as diam., cell-membrane thin, about $1/10$ as thick as diam., with slightly constricted articulations; recurved branches numerous in all parts of fronds, issuing secundly, not acuminate, with slightly constricted articulations; sporangia formed in all parts of fronds, excepting rhizoid, seriate (long ones consisting of 17 sporangia); septa normally rim-shaped in basal parts of fronds, but simple in middle parts and rhizoids.

The new species is characterized by its digitate tufts, many recurved branches, and soft filaments.

The new species resembles *Sp. Mertensii* (RUPR.) SETCHELL et GARDNER, but it differs from *Sp. Mertensii* by its dark color, soft fronds, dense habit, and slender branches with wide axils. On the other hand, the new species resembles *Sp. ochotensis* TOKIDA and *Sp. spinescens* KUETZING. However, the new species differs from the former by its soft texture, saxicolous habit, slender diameter, and thin and soft cell-membrane. The latter is distinguished from the new species by its wide diameter, short segments, and having spinous branches.