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Study on the Charophytes-flora in Hokkaido (Japan) and its Phytogeographical Characteristics

A Preliminary Note

By

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Introduction

The present writer explored for specimens in Hokkaido twice, September to October 1951 and July to August 1955, to make clear the phytogeographical characteristics of Charophytes. The exploration ranged through almost all of the plains and mountainous parts were almost neglected. These travels continued about 45 days in all, but the collected specimens were very poor, contrary to his great expectation. All the specimens were preserved in polyethylene bags containing 3~4% formalin solution. The following work is the outcome of his research on these specimens and some dried specimens which are preserved in the Herbarium of the Botanical Institute, Faculty of Science, Kyoto University. The author wishes to express his heartfelt gratitude to Prof. Shiro KITAMURA who gave him a chance to examine these dried specimens.

Floristic and Taxonomic Investigations

The author has determined the following 5 species involving 4 varieties of *Nitella,* 1 species of *Tolypella* and 2 species including 1 variety of *Chara,* as shown in table 1.

Table 1. Species Collected in Hokkaido

Species Name.	Japanese Name.	Localities & Date.
Nitella opaca	Karasuno-hurasumo	Sapporo. (1905)
N. flexilis	Hime-hurasumo	Kusiro(1892) : Toyokoro (1951) : Tomakomai (1951) : Hamanaka-mura (1951) : Horonobu(1955).
N. Morongii var. *spiciformis*	Nagaho-no hurasumo.	Iwamizawa (1951)
N. rigida var. *Saitoiana*	Saito-hurasumo	Toyokoro (1951)
N. microcarpa		
var. *microglochin*	Hon-tiri-hurasumo	Toyokoro (1951)
var. *robusta*	Tukusi-hurasumo	Iwamizawa (1951)
Tolypella gracilis	Nippon-hurasumo-damasi	Iwamizawa (1951)
Chara Braunii	Syazikumo	Kusiro (1890) : Tohutu-numa (1952) : Ohnuma (1955) : Hime-ike (1955)
Chara globularis		
var. *delicatula*	Hime-kata-syazikumo	Nemuro (1891) : Sikaribetu-ko(1929) : Tomakomai (1951) : Akan-ko (1955)
var. *capillacea*	Katasyazikumo	Nemuro (1893) : Akkesi (1951) : Tomakomai (1951) : Horonobu(1955).

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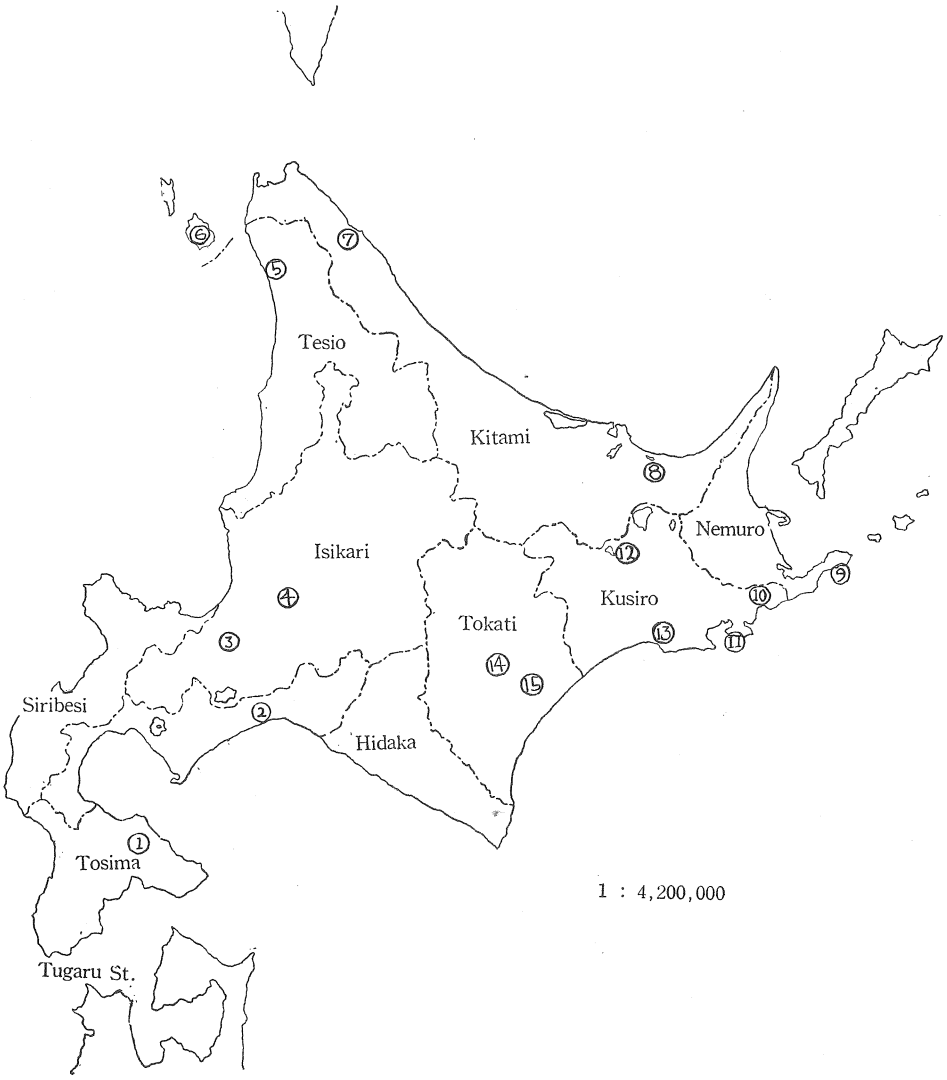
Fig. 1. Localities, where Characean Specimens were Collected.

1. Ohnuma	2. Tomakomai	3. Sapporo	4. Iwamizawa	5. Horonobu
6. Hime-ike	7. Tonbetu	8. Tohutu-numa	9. Nemuro	10. Hamanaka-mura
11. Akkesi	12. Akan-ko	13. Kusiro	14. Sikarinbetu-ko	15. Toyokoro



Despite the wide and frequent distribution of lakes, ponds and swamps, the Characean flora of Hokkaido is extraordinarily poor. Concerning this problem, the author will discuss the phytogeographical view later.

All these species are distributed also in Honsyu, and almost all of them are widely distributed throughout the world, except *Nitella Morongii* var. *spiciformis, N. rigida* var. *Saitoiana* and *Tolypella gracilis.*

The terminology and nomenclature employed in this paper mainly follow the writer's

previous work "Japanese Charophyta, 1954" though some changes can be found. The descriptions of these Charophytes and their main characteristics are based on the materials from the island of Hokkaido and the figures are the author's own illustrations of these materials, using camera lucida.

The Key

The following key is intended to make it easy to distinguish one plant from other. Though this method is very artificial, vegetative characteristics are employed as far as possible, so that any one can determine plants in any stage. Accordingly the order of species in this paper does not always follow the systematic rank.

1. Each whorl of branchlets has no stipulodes on its base
  2. Branchlets furcate once or more, each ray of the same rank is equal in length
    3. Branchlets furcate uniformly once, dactyls 1-celled
      4. Dactyls acuminate gradually ····· 1) *Nitella opaca*
      4. Dactyls acuminate abruptly, or rather dull ····· 2) *N. flexilis*
    3. Dactyls composed of more than 2 cells
      4. Dactyls uniformly 2-celled ····· 3) *N. Morongii* var. *spiciformis*
      4. Dactyls 2 or 3-celled
        5. Branchlets furcate 1~2-times ····· 4) *N. rigida* var. *Saitoiana*
        5. Branchlets furcate 2~3-times ····· 5) *N. microcarpa*
  2. Branchlets simple or furcate once ····· 6) *Tolypella gracilis*
1. Each whorl of branchlets with stipulodes on its base.
  2. Stems and branchlets with no cortex-cells ····· 7) *Chara Braunii*
  2. Stems and branchlets covered with cortex-cells ··· 8) *Chara globularis*

Genus Nitella

Nitella Agardh in Syst. Alg., 1824, p. 27 : K. Imahori, Jap. Charoph. 1954. p. 47 : R. D. Wood & Muenscher in Cornell Exp. Stat. Mem. 338, 1956, p. 7.

Monoecious or dioecious. Plants light beautiful green, rather flexible. Internodal cells of stems uniformly unicellular, sometimes attaining more than 20 cm long and 1 mm in diametre. Branchlets 5~8 in a whorl, 1~4-times furcate ; each ray of the same order usually equal in length. Dactyls 1~2~3-celled usually, but rarely more than 3 cells. Without stipulodes, spine cells, bracts and bracteoles. Oogonia produced usually laterally at the furcations of branchlets, solitary or 2~3 aggregated ; coronula rather small, composed of 2 rows, each of 5 cells. Antheridia small, protandrous and deciduous, terminally produced. The following 5 species are found in this region.

Non. Jap. : Hurasumo, or Hurasuko-mo.

1. Nitella opaca

Nitella opaca Agardh, Syst. Alg. 1824, p. 124 : Imahori, Jap. Charoph. 1954, p. 51 : Wood & Muenscher in Cornell Exp. Stat. Mem. 338, 1956, p. 7.

Plant dioecious, 15~20 cm high, brownish green. Sterile branchlets about half the length of

an internode, 6 in whorl, uniformly once furcate into 2~3 dactyls. Dactyls 1/3~2/5 the length of entire branchlets, unicellular, with mucronate tips. Fertile whorls forming loose heads terminally, without mucus covers. Fertile dactyls occasionally unequal in length so as to seem that they are differentiated into main and lateral rays.

Oogonia usually geminate, rarely solitary at the furcations of fertile branchlets of female plants, 650μ long by 500μ wide ; spiral cells showing 7~8 convolutions, swelling considerably at the apex ; coronula rather small, 30μ high and 90μ wide at the base, deciduous at fertilizing stage. Antheridia moderately large, 550~700μ in diameter. Oospore spheroid, 370~400μ long by 350~370μ wide, dark chestnut brown to black, with 5~6 prominent ridges : membrane decorated with delicate and irregular fibers.

ILLUSTRATIONS : MIGULA (1897) figs. 35~36 ; J. GROVES & B-W. (1920) pl. 7 ; IMAHORI (1954) pl. 1 ; WOOD & MUENSCHER (1956) pl. 1.

SPECIM. EXAM. ; Exsiccatae in the Herb. Kyoto Univ., with no number collected by Tamaki WATANABE in Aug. 1905 from Sapporo.

DISTR. : Asia, Europe, Africa, N. & S. America.

NOM. JAP. : Karasu-no-hurasumo.

REMARKS AND DISCUSSION : This species greatly resembles *Nitella flexilis* so that we can hardly determine this species when it is sterile, though *N. opaca* is rather small and colored dark green to blue. However, fertile plants of *N. opaca* are easily distinguishable by its dioecious habits, heads of fertile whorls, larger antheridia and smaller oospores. The specimen examined, as described above, is a dried sample so that the present description may somewhat disagree in the case of fresh plants.

2. Nitella flexilis

Nitella flexilis AGARDH, Syst. Alg., 1824, p. 124 ; IMAHORI, Jap. Charoph. 1954, p. 54 ; WOOD & MUENSCHER in Cornell Exp. Stat. Mem. 338, 1956, p. 8

Plant monoecious, moderately large, 20~40 cm high, bright beautiful green. Internodes elongated usually, about twice the length of branchlets. Fertile and sterile whorls similar. Branchlets 6~7 in a whorl, uniformly once furcate into 2~3 dactyls. Each dactyl nearly equal in length and about 1/3~1/4 length of entire branchlets, to the apex abruptly pointed and terminates with a minute prolongation of cell wall.

Male and female gametangia produced together at the furcations of fertile branchlets. Antheridia solitary, 500μ in diameter. Oogonia solitary or 2~3 aggregated, 750μ long by 600μ wide ; spiral cells showing 7~8 convolutions, swelling considerably at their apex ; coronula deciduous, 50μ high and 80μ wide at the base. Oospores dark brown to black, 500μ long by 440μ wide, with prominently flanged ridges ; membranes differentiated outer smooth and inner fine granular layers.

ILLUSTRATIONS : MIGULA (1897), figs. 37 & 38 ; J. GROVES and B.-W. (1920), pl. 8 ; IMAHORI (1924), pl. 1 ; WOOD & MUENSCHER (1956), pl. 2.

SPECIM. EXAM. : K. I. No. 993, Ohnuma, Toyokoro-mura, Prov. Tokati, Oct. 1. 1953 ; K. I. No. 982, Tarumae, Tomakomae, Prov. Iburi, Sept. 24, 1951 ; K. I. No. 1324, Ohi-bokuzyo, Horonobu, Prov. Tesio, July 25, 1955 ; Pon-numa, Tonbetu-mura, Prov. Kitami, July 30,

1955 ; Exsiccatae in Herb. Kyoto Univ., FAURIE No. 8688, Kusiro, Prov. Kusiro, Sept. 1892.

HAB. : in ponds, lakes, swamps and ditches, pH. 6.4~6.8.

DIST. : Asia (Kamchatka, Japan), Europe, N. & S. America.

NOM. JAP. : Hime-hurasumo.

REMARKS AND DISCUSSION : The present species is one of the most widely distributed Nitellas in the temperate zone, especially in the Northern Hemisphere. This plant can be found through all seasons, but it rather prefers cold water, consequently it grows luxuriously in winter. However it produces gametangia in May and June and these organs are very deciduous in the maturation stage. Accordingly, only a few samples were fertile, though a considerable number of sterile plants of this species could be found.

What are the remarkable characteristics of this species are that the dactyls are abruptly pointed towards the apex, features of fertile and sterile whorls are not different, the oospores are very large and have flanged ridges, and the antheridia are also very large. On account of its vigorous nature, it is the first plant to grow in newly-dug ponds, and is capable of growing in a considerably deep water in which only limited light is available and no other aquatic plants can live. This natural ability and its elongated internodes make it the vantageous for experimental use of all the members of this group.

3. Nitella Morongii var. spiciformis (Pl. 1)

Nitella Morongii ALLEN T. F. emend WOOD, R. D. in Rhodora 51, 1949, pp. 13~18, with pl. 1119 ; WOOD & MUENSCHER in Cornell expt. Stat. Mem. 338, 1956, p. 15.

var. *spiciformis* (MORIOKA) IMAHORI **stat. nov.**

Nitella spiciformis MORIOKA in Journ. Jap. Bot. 17, 1941, p. 63 ; IMAHORI, Jap. Charoph. 1954, p. 90.

Plants monoecious, rather small, up to 10 cm high, brownish green. Stem moderately slender, 300~350μ in diameter. Sterile branchlets divergent, 6 in a whorl and (1)~2-times furcate ; primary rays half to two thirds as long as the entire branchlets, 250μ in diameter ; secondary rays 3~(4), 250μ in diameter, occasionally furcate once more into 2~(3) tertiary rays, but sometimes simple ; dactyls elongated, 150~200μ in diameter, uniformly 2-celled, whose ultimate cell 52~110μ long by 32~41μ wide and long cone-shaped. Fertile whorls forming terminal of axillary spikes, without mucus ; branchlets 4~5 in a whorl, 1~(2)-times furcate ; the primary rays about 3/5 of the entire branchlets : secondary rays 3~4, 1 of whose rays furcates once more, usually ; dactyls uniformly 2-celled.

Male and female gametangia produced sejunct usually at each furcation. Antheridia usually produced at the secondary furcations, about 180μ in diameter, sessile. Oogonia produced at the primary furcations usually, 500~530μ long by 350~380μ wide, sessile : spiral cells showing 7 convolutions, elongated considerably towards the apex ; coronula 40μ high, 65μ wide at the base. Oospores brown, 270~320μ long by 200~240μ wide, with 6 flanged ridges ; membrane irregularly and densely decorated with worm-like figures.

ILLUSTRATIONS : MORIOKA (1941), p. 63, fig. 5 : IMAHORI (1954), pl. 18.

SPECIM. EXAM. : K. I. No. 987, Iwamizawa-tyo, Sorati-gun, Prov. Isikari, Sept. 27, 1951.

HAB. : in a pond, pH. 6. 5

DISTR. : endemic to the northern half of Japan.

NOM. JAP. : Nagaho-no-hurasumo

REMARKS AND DISCUSSION : *Nitella Morongii* was first described by Dr. T. F. ALLEN, based on a specimen collected by Thos MORONG on the Island of Nantucket in 1887. Since that time about 50 specimens of this species were collected in North America, but they caused some taxonomical difficulties. In 1949, Dr. R. D. WOOD examined these specimens of *N. Morongii* and closely-allied species *N. maxeana* ALLEN. Consequently, he decided that these two species must be identified as the same species, and emended the description of *Nitella Morongii*.

The present specimen was at first determined by the writer as *N. spiciformis* MORIOKA. in his volume "Japanese Charophyta." He had considered at that time that *N. spiciformis* might be a synonymy of *N. Asagrayana* SCHAFFNER ex NORDSTEDT, but could not find any definite conclusion. Recently, he have found a specimen of *N. Morongii* which was distributed from the New York Botanical Garden in the Herbarium of the University of Tokyo, and concluded that the present specimen is rightly *'Nitella Morongii'*, though its oospores are somewhat larger than the typical description.

Nitella Morongii has been an endemic species in North America and it is very interesting that some American species are also found in Japan. The connection between Asia and North America on Charophytes was discussed as early as 1880 by Dr. T. F. ALLEN in his article "Similarity between the Characeae of America and Asia". His idea is based on two species common to both South Asia and the South or warmer parts of North America. The present author has largely increased the number of these common species. That is to say, *N. megacarpa* (*N. microcarpa* var. *megacarpa*) and *Chara sejuncta* are distributed only in Japan and North America ; besides, these remarkable species *N. Morongii*, *N. acuminata* and *N. axillaris* are species common only to Asia and America.

Dr. ZANEVELD suggested that this species should be united with *N. translucens*. But, as Dr. WOOD has insisted, the present author has not found any considerable common characteristics between them. Besides, the following differences, cited in table 2 lead to the conclusion that they are distinctly separated species.

Table 2. Differences between *Nitella translucens* and *N. Morongii*

Characteristics	*N. translucens*	*N. Morongii*
Sterile branchlets	Uniformly once furcate	1~2-times furcate
Size of the primary and secondary rays of sterile branchlets	Primary rays very large so that the secondary rays inconspicuous.	Secondary rays visible with naked eyes.
Fertile branchlets	1~2-times furcate	uniformly twice furcate
Oogonia	2~4 together 475~525×400~425μ	solitary 290~386×210~288μ
Oospore	225~250×250~300μ 6 prominent ridges	238~268×180~210μ 5 prominent ridges
Antheridium	250~375μ diam.	134~179μ diam.

However, the writer is obliged to re-investigate these *Nitella translucens* group, and will solve this problem in the near future.

4. Nitella rigida var. Saitoiana (Pls. 2, 3 & 4)

Nitella rigida ALLEN in Bull. Torrey Bot. Club 25, 1898, p. 73 : IMAHORI, Jap. Charoph. 1954, p. 115.

var. *Saitoiana* (Allen) IMAHORI **stat. nov.**

N. Saitoiana ALLEN, T. F. in Torrey Bot. Cl. Bull., 25, 1898, p. 74 : IMAHORI, Jap. Charoph. 1954, p. 123.

Plant monoecious, 20~30cm long, rather slender and flexible, light green. Stem slightly more slender than typical form, with 6~7 nodes. Internodes 1~2-times the length of branchlets, 350~400μ in diameter. Sterile whorls greatly expanded, 4~6 branchlets spreading from each node ; branchlets 1~2 cm long, 1~2~(3)-times furcated ; primary rays 3/5~4/5 length of the entire branchlets, 230~340μ in diameter ; secondary rays 3~4, 170~200μ in diameter, 1/3~2/3 length of the primary rays, occasionally simple ; tertiary rays 2~3, 100~130μ broad at the base, rarely furcate once more into 2~3 quaternary rays. Dactyls of sterile branchlets 2~3, generally much elongated but rarely abbreviated, occasionally extraordinarily unequal in length, 2~3-celled, terminal cells coneshaped, 38~82μ long and 24~41μ wide at base. Fertile whorls small and moderately compact, without mucus covers, sometimes forming spikelets ; branchlets 6 in a whorl, furcate twice (rarely thrice) ; primary rays 1/2~3/5 length of the entire branchlets ; the secondary rays 4~5 ; dactyls 2~3, 2~3-celled.

Male and female gametangia produced at every furcation solitary or conjunct. Antheridia 200~220μ in diameter, with short stalks whose length reaches 30~80μ. Oogonia solitary, 480~540μ long by 320~340μ broad with 7~8 spiral convolutions ; coronula rather small, 25~32μ high and 55~64μ wide at base. Oospore 360~400μ long by 250~280μ broad, with 4~5 flanged and acute ridges ; membranes covered with papillae arranged irregularly.

ILLUSTRATIONS : ALLEN (1898) p. 74 : MAKINO (1929), p. 394 : IMAHORI (1954), fig. 42.

SPECIM. EXAM. : K. I. No. 975, Horo-oka, Toyokoro-mura, Prov. Tokati, Oct. 1. 1951.

HAB. : in a swamp, pH. 5.6, growing with *N. flexilis*

DISTR. : endemic to Japan.

NOM. JAP. : Saito-hurasumo.

REMARKS AND DISCUSSION : This plant was first established by Dr. ALLEN, as an independent species, which was distinguished from the nearly allied species *N. rigida* and *N. Tanakiana* only by its more diffuse habit, by forming no spiklets of fertile whorls. These three plants and *N. Moriokae,* however, have many resemblances to each other in their habit of branchlets furcation, 5~6 prominent ridges of oospores and having 3-celled dactyls. Thus as the present author has already pointed out, these plants are destined to be re-arranged, though he wants to do this arrangement completely in a separate paper in the near future, *N. Saitoiana,* first of all, is combined with *N. rigida* in this paper.

Besides the differences as stated above, var. *Saitoiana* is, as a matter of fact, different from *N. rigida* in the decoration of oospore membranes, which is rather coarse in the

case of the latter plants. On the other hand, papillae found in the oospore of *N. rigida* show more or less variable aspects and occasionally indicate an intermediate figure between these two plants, as the author has already illustrated in his last volume (pl. 27). Consequently, the difference in decoration between the oospore membrance may not be an important and elementary characteristic of the difference between these plants. Moreover, the spikelets of fertile whorls can be found also in var. *Saitoiana* distinctly, and the habit of diffusion cannot be an immutable characteristic for any species. Furthermore, the writer was able to examine isotypic specimens of these two species which were distributed from the New York Botanical Garden. The examination of these specimens has induced the conclusion that these two plants cannot be separate species. (See Plates 2 and 3)

According to the original description by Dr. ALLEN, this plant resembles *N. Morongii* in many respects, especially in its habits. Dr. ALLEN concluded also that *N. rigida, N. Saitoiana, N. Tanakiana N. Morongii* and *N. axillaris* belong to the same group which is characterized by a condensation of the fertile verticils, which form spike-like racemes or dense axillary clusters. However, the present writer considers that **N. rigida group** (*N. Tanakiana, N. rigida* and its var. *Saitoiana, N. Moriokae*) differs distinctly from **N. axillaris group** *N. axillaris, N. Morongii* and *N. sublucens*) by the 2~3-celled and rather elongated dactyls.

5. Nitella microcarpa

Nitella microcarpa BRAUN in Monatsber. k. Akad. Wiss. Berlin (1858), 1859, p. 357 : IMAHORI in Jap. Charoph. 1954, p. 133 : WOOD & MUENSCHER in Cornell Exp. Stat. Mem. 338, 1956, p. 16.

Plants monoecious, dark to brownish green, 20~30 cm high. Stem moderately slender to stout, 500~1120μ in diameter ; the basal internodes 2~3-times and subterminal internodes 1~1.5-times the length of branchlets. Sterile branchlets rather spreading, 2~3-times furcate. Fertile branchlets rather compact, 3~4-times furcate. Dactyls 2-celled generally but occasionally 3-celled, elongated or much abbreviated. Male and female gametangia produced together at all furcations. Oogonia 2~4 aggregated. Oospores with 5~6 prominent and slightly flanged ridges ; membrane reticulated.

DISTR. : Asia, N. & S. America, Africa and Australia.

NOM. JAP. : Tiri-hurasumo.

var. microglochin

var. *microglochin* (A. BR.) ZANEVELD in Blumea 4, 1940 p. 103 : IMAHORI, Jap. Charoph. 1954, p. 135.

Plants stout, dark green to brownish green, up to 25 cm high. Stem 500~750μ in diameter ; internodes 1.5~2-times the length of branchlets. Sterile branchlets 2~3 cm long usually, 6 in a whorl, 2~3-times furcate, rather expanded ; primary rays about half the length of the entire branchlets, 350~450μ in diameter ; secondary rays 4~6, 250~350μ in diameter ; tertiary rays 2~4, 1~2 of which are occasionally furcated once more. Dactyls usually two-celled, rarely 3-celled, elongated or much abbreviated.

Male and female gametangia produced together at all furcations of branchlets, but usually lacking at the fourth furcations. Antheridia only produced at the furcation, 200~230μ in

diameter. Oogonia produced 2~3 together at the furcation, 320~360μ long by 290~320μ wide, with 7~8 spiral convolutions ; coronula 55~65μ high, 45~55μ wide at base. Oospores light to golden brown, 230~250μ long by 180~250μ wide ; striae 5~6 prominent and with slight wings ; membranes decorated with perfect network.

ILLUSTRATIONS : BRAUN (1882), pl. 2, figs. 56~59 ; IMAHORI (1954), pl. 36.

SPECIM. EXAM. : K. I. No. 996, Itonuma, Horo-oka, Toyokoro-mura, Oct. 1. 1951.

HAB. : in a swamp, pH. 6. 3.

DISTR. : tropical and subtropical Asia (India, Malay Peninsula, Celebes, Timor, Burma—all of these situated 10~20° N.) and Japan.

NOM. JAP. : Hon-tiri-hurasumo

REMARKS AND DISCUSSION : It is very interesting that such a tropical to subtropical plant is distributed in Japan so far as the northernmost limit of this locality (43° N.).

This plant is remarkable for its characteristics of 2~3-celled and occasionally abbreviated dactyls, aggregated oogonia, small coronula, prominent ridges of oospores and reticulate oospore membranes. By these features, *N. microcarpa* is easily distinguishable from the closely allied species. The variety '*microglochin*' has a rather slender form, smaller oospores and usually abbreviated dactyls, and by these characteristics the plant of this variety is easily distinguishable from other members of the present species.

The plant occasionally grows in water containing much iron mould, therefore, it is often colored brown. It seems also that this plant prefers rather acid water.

subsp. robusta (Pls. 5 & 6)

var. *robusta* IMAHORI **stat. nov.**

Nitella robusta IMAHORI, Jap. Charoph. 1954, p. 136.

Plants monoecious, extraordinarily stout, covered with abundant clay and overgrown with epiphytes. Stem up to 1120μ in diameter : internodes of the lower parts of plants twice the length of branchlets, and of the upper parts almost as long as the branchlets. Sterile branchlets 6 in a whorl, 2~3cm long, spreading, twice to thrice furcate ; primary rays about half the length of branchlets, 400~670μ in diameter ; secondary rays 5~7, about 2/3 length of the primary rays, 230~320μ in diameter ; tertiary rays 3~4, about 1/3 length of the primary rays, 170~230μ in diameter, rarely furcate once more into 2~3 quaternary rays, which are much abbreviated and 130~200μ in diameter. Dactyls 2-celled generally, but rarely 3-celled ; ultimate cells 70~100μ long, 30~40μ wide at base. Fertile branchlets 6 in a whorl, 1~2 cm long, compact or spreading, 3~4-times furcate ; primary rays 2/5~3/5 length of entire branchlets, 320~350μ in diameter ; secondary rays 5~7, 160~240μ in diameter ; tertiary rays 3~4, 150~200μ in diameter ; quaternary rays 3, whose 1 or 2 furcate once more into 2~3 abbreviated quinary rays ; dactyls generally 2-, rarely 3-celled, elongated or abbreviated.

Male and female gametangia produced at all furcations except ultimate ones, solitary or together. Antheridia sessile, oval shape, 200~240μ long by 170~190μ broad, occasionally produced laterally. Oogonia usually 2~3 aggregate terminally, 530~570μ long by 380~420μ wide, with 9~11 spiral convolutions ; coronula rather large, 80μ high, 49~60μ wide at

base. Oospores light to dark brown, 330~380μ long by 300~350μ wide, with 6 prominent and slightly flanged ridges ; membrane reticulate or papilliformae.

ILLUSTRATION : IMAHORI (1954), pl. 33.

SPECIM. EXAM. : K. I. No. 985, Iwamizawa-tyo, Prov. Isikari, Sept. 27, 1951.

HAB. : in a pond, pH. 6. 5, growing with *Tolypella gracilis*,

DISTR. : endemic to Japan.

NOM. JAP. : Tukusi-hurasumo.

REMARKS AND DISCUSSION : This variety was first described as an independent species, based on a lone specimen from Kyusyu by the present writer. According to his description, *N. robusta* is distinguished from other closely allied species by larger and acute coronula, stout stems and especially by the decoration of oospore membranes. On the other hand, some specimens with stout stems were determined as a southern hemisphere plant, *N. microcarpa* var. *Glaziovii* ZANEVELD, though almost all of these specimens were sterile.

According to the author's recent re-examination, however, the specimen from Hokkaido has some fertile whorls which he could investigate and clarify as to the following three points : the first is that the size of oogonia and oospores of this plant are more or less larger than those of var. *Glaziovii* ; according to the description of superior authorities var. *Glaziovii* has oospores as large as 280$\mu\times$260μ but the present plant has oospores whose minimum size is 330$\mu\times$300μ. The second point is that the author found that the decoration of oospore membranes of this specimens agree with that of *N. robusta*. Namely, the upper surface of the membrane of the present specimen shows a distinct network, though the lower surface indicates papillae forms as in the illustrated figure of *N. robusta* in the author's last volume (1954, pl. 33 fig. 6). Besides, the author's further study of *N. robusta* concluded that this illustrated figure shows only the upper surface of oospores, and accordingly when the microscope is adjusted to the lower surface a distinct network can be seen. (See Plate 6) The third discussion will be made on the shape and size of coronula. The writer has described in (1954, p. 129) that the coronula of *N. robusta* is large and cone-shaped like *Chara Braunii*. On the other hand, the present plant has some intergrade forms of coronula between *N. robusta* (Chara form) and *N. microcarpa* (usual form of Nitella). In short, the younger oogonium has the usual form and the ripe oogonium has the Chara form. These forms of gradual transition are figured in the plate.

From the facts above stated, it can be concluded that *N. robusta* and the present specimen is the same species, and these plants must be a variety of *N. microcarpa,* though they are distinctly different from var. *Glaziovii,* in the size of oospores and coronulal form.

This new variety differs from var. *microglochin* by its stouter nature, condensed branchlets, having usually elongated dactyls, larger oospores and conical coronula.

Genus Tolypella

Tolypella von LEONHARDI in Lotos 13, 1863 ; F. K. DAILY in Butler Univ. Bot. St. 11, 1953, p. 10 ; IMAHORI, Jap. Charoph. 1954, p. 140 ; WOOD & MUENSCHER in Cornell Exp. Stat. Mem. 338, 1956, p. 17.

Plants monoecious or dioecious, rather slender and flexible, occasionally incrusted with annular lime. Sterile branchlets moderately spreading, either simple or divide into a stout main axis and slender short lateral rays, both of which are composed of chains of cells. Fertile branchlets very small and compact, usually furcate once into 1 main axis and 2 lateral rays. Antheridia with long or short stipes, rather dorso-ventrally compressed figures. Oogonia 2~3 aggregated usually, with coronula made of 2 rows of 5 cells each. Oospores not compressed like those of *Nitella*. Only one species is distributed in the region.

6. Tolypella gracilis (Plate 7)

Tolypella gracilis IMAHORI in Bot. Mag., Tokyo, 63, 1950, p. 260 ; ibid in Jap. Charoph. 1954, p. 141.

Plants monoecious, very slender, bluish green, up to 10 cm high. Stem moderately slender, 250~300μ in diameter ; internodes 1~2-times the length of branchlets. Sterile branchlets ca. 1 cm long, 6 in a whorl, spreading, simple or once furcate into 1 main and 1~2 lateral rays, both of which composed of 1~5 cells. Fertile branchlets 6 in a whorl, condensed into small heads, once furcate. Ultimate cells of branchlets conical, 60~170μ long by 40~50μ broad.

Male and female gametangia produced together at the furcations, or male ones clustered at the base of branchlets. Antheridia ellipsoid, with short stalks, 180~200μ long by 200~240μ wide. Oogonia solitary or geminate, 430~500μ long (incl. coronula) and 350~380μ broad, with 8~9 spiral convolutions ; coronula 40~46μ high and 60~70μ wide at base. Oospores brown, subglobose, 360~380μ long and 340~360μ wide with 6 prominent and flanged ridges ; membrane covered with fibrous or delicate vermiculate figures.

ILLUSTRATIONS : IMAHORI (1950), p. 260, fig. 2. ; ibid. (1954), pl. 39.

SPECIM. EXAM. : K. I. No. 986. Iwamizawa-tyo, Prov. Isikari, Sept. 27, 1951.

HAB. : in a small pond, pH. 6. 5, growing with *N. microcarpa*.

DISTR. : endemic to north Japan.

NOM. JAP. : Nippon-hurasumo-damasi.

REMARKS AND DISCUSSION : As Mr. H. SUGA (1956) has pointed out, this species prefers growing in rather acid and cold water. It has very variable features, but the mode of furcation of branchlets is always constant. Young oogonia produced laterally at an antheridium usually, and afterwards their relative position tends to be reversed, though some exceptions to this can be found.

According to the writer's systematic account, this species is rather nearly allied to the section "Pluricellulatae" of Genus *Nitella*. The author considers that this species is one of the relating species between *Nitella* and *Tolypella*, but this problem will be discussed in a separate paper in the near future.

Genus Chara

Chara VAILLANT in Mém. Akad. Roy. Sci. Paris, 1719, p. 17 ; DAILY in Butler Univ. Bot. St. 11, 1953, p. 19 ; IMAHORI Jap. Charoph. 1954, p. 143 ; WOOD & MUENSCHER in Cornell Exp. Stat. Mem. 338, 1956, p. 24.

Plants monoecious or dioecious, usually larger than genus *Nitella*. Stem corticated or

ecorticated, with or without spine cells. Stipulodes, bracts and bracteoles present. Branchlets consisting of some articulations and never furcate. In monoecious plants, antheridia produced below the oogonia, usually sessile. Oospores larger and longer than those of *Nitella* and *Tolypella*, and their ridges are numerous and fainter than *Nitella*,

7. Chara Braunii

Chara Braunii GMELIN in Flor. Bad. Alast. 4, 1826, p. 646 ; DAILY in Butler Univ. Bot. St. 11, 1953, p. 19 ; IMAHORI, Jap. Charoph. 1954, p. 145 ; WOOD & MUENSCHER in Cornell Exp. Stat. Mem. 338, 1956, p. 25.

Plants monoecious, 20~30 cm high, bluish green. Stem moderately slender, up to 500μ in diameter ; internodes 2~3-times length of branchlets, perfectly ecorticate and with no spinecells. Stipulodes moderately developed, twice to thrice as long as the diameter of internodes, forming a single whorl alternating with branchlets. Branchlets 8~11 in a whorl, as numerous as stipulodes, with 3~4 articulations and terminating with crown of 3~4 mucronate cells ; bract-cells unilateral, long and acute ; bracteoles similar with bract-cells but somewhat longer and acute.

Male and female gametangia produced together at the two lowest nodes of fertile branchlets. Antheridia 240μ in diameter. Oogonia solitary or geminate, 750~900μ long (incl. coronula) by 420~450μ broad, with 10~11 spiral convolutions ; coronula 150~170μ long by 250μ broad at the base. Oospores black and opaque, elongated ellipsoid, 600~680μ long by 310~390μ wide, with 10~11 rather faint ridges.

ILLUSTRATIONS : H. & J. GROVES (1884), tab. 242 ; MIGULA (1897), figs. 81~83, as *C. coronata* ; J. GROVES & B-W. (1924), pl. 26 ; IMAHORI (1954) fig. 53 ; WOOD & MUENSCHER (1956) pl. 8.

SPECIM. EXAM. : FAURIE no. 2929, exsiccatae in Herb. Kyoto Univ., Kusiro-shi, Prov. Kusiro, Aug. 25, 1890 ; numberless exsiccatae in Herb. Kyoto Univ., leg. M. HIRANO, Tohutu-numa, Prov. Kitami, Aug. 1952 ; K. I. No. 1395, Ohnuma, Hakodate, Prov. Tosima, July 18, 1955 : K. I. No. 1396, Hime-ike, Risiri Island, Prov. Kitami, July 28, 1955.

HAB. : in ponds and lakes, pH. 6.7~7.3.

DISTR. : cosmopolitan typically.

NOM. JAP. : Syazikumo

REMARKS AND DISCUSSION : *Chara Braunii* is the most generally found plant in the world, as well as in Japan. These cosmopolitan species are generally polymorphic and the present species is also more or less variable in its features and structures. Many authorities discussed this variability and attempted to subdivide this species into several varieties or forms. But as Dr. T. F. ALLEN had already pointed out, the species is very polymorphic and has many intergradations, so that it is not practical to distinguish the specific forms in the case of this plant. On the other hand, however, Dr. ZANEVELD (1940) divided this species into 6 varieties and a few forms. According to the present author's study, *Chara Braunii* shows two forms in Japan. Namely, almost half of the collected specimens seem to belong to var. *Braunii*, and others attached to var. *oahuensis*. However, these specimens here examined show some contradictory features ; stipulodes of these specimens are rather

conspicuous and show var. *Braunii* form, but oospores are moderately large and indicate the characteristic of var. *oahuensis*. Moroever, there can be found many interjacent features between the two varieties. For these reasons the writer cannot define distinct varietal differences among Japanese specimens of this species.

8. Chara globularis

Chara globularis THUILLER, Flor. Env. Paris, ed. 2, 1779, p. 472 ; DAILY in Butler Univ., Bot. St. 11, 1953, p. 35 ; IMAHORI, Jap. Charoph. 1954, p. 163, ; WOOD & MUENSCHER in Cornell Exp. Stat. Mem. 338, p. 30.

Plants monoecious, variable in height, 10~100 cm, grayish green, rather fragile. Stem covered with triplostichous cortex and rudimentary spine-cells. Stipulodes in two rows of two to each branchlet, but rather rudimentary. Male and female gametangia produced alone usually, and rarely together.

var. delicatula

var. *delicatula* (AGARDH) IMAHORI **nom. Nov.**

Chara delicatula AGARDH em. A. BRAUN, Syst. Alg. 1824, p. 130 ; DAILY in Butler Univ. Bot. St. 11. 1953, p. 44 ; IMAHORI, Jap. Charoph. 1954, p. 161.

Plants rather small and slender, up to 20 cm high. Stem 300~340μ in diameter ; internodes 2~3-times length of branchlets ; primary cortical cells more developed than the secondary ones. Stipulodes reduced but more remarkable than those of var. *capillacea* ; upper row more developed than the lower one. Branchlets 7~8 in a whorl, 220~250μ broad at base, 0.8~1.5 cm long, composed of 7~8 corticated articulations and 1~3 naked end cells ; cortex diplostichous. Bracts 5~7, inconspicuous. Bracteoles developed, somewhat longer than a mature oogonium.

Gametangia produced at the three lowermost node of branchlets. Antheridia 360~390μ in diameter. Oogonia 950~1,050μ long by 520~600μ wide ; spiral cells showing 13~14 spiral convolutions ; coronula 100~180μ high, 180~240μ wide at the base, terminate with round tip. Oospores black and opapue, 650~750μ long by 450~550μ wide, with 12~13 ridges.

ILLUSTRATIONS : BRAUN & NORDSTEDT (1882), tab. 7, fig 269~270 ; MIGULA (1897) fig. 148 ; J. GROVES & B-W. (1924), pl. 14 ; IMAHORI (1954), fig. 61.

SPECIM. EXAM. : K. I. No. 981, Tarumae, Tomakomai, Prov. Iburi, Sept. 24, 1951 ; FAURIE No. 7523, Exsiccatae in Herb. Kyoto Univ. Nemuro-mati, Prov. Nemuro, Aug. 27, 1891 ; Numberless exsiccatae in Herb. Kyoto Univ., Sikaribetu-ko lake, Oct. 1929 ; K. I. No. 1327, Tiurui, Akanko lake, Prov. Kusiro, Aug. 3. 1955.

HAB. : in lakes, pH. 6.6~8.7, usually growing with *C. globularis* var. *capillacea.*

DISTR. : Asia (Siberia, China, Japan & India), North America & Europe.

NOM. JAP. : Hime-kata-syazikumo.

REMARKS AND DISCUSSION : This plant has been considered as an independent species "*Chara delicatula*" by many researchers. On the other hand, however, some researchers considered this as a variety or subspecies of *Chara fragilis* (=*C. globularis*). For example, Dr. R. D. WOOD, a most famous authority on this group, considered the plant at first (1949, 1950) as a separate species, and later (1956) treated it as a synonymy of

C. globularis. The present author has treated this plant as *C. delicatula*, though he had some question in doing so, as he has already pointed out in his volume (1954, p. 163). According to his latest study, he concluded that the plant must be a variety of *Chara globularis*.

This variety differs from the typical form of *C. globularis* by its more slender and short height, rather developed stipulodes, and the developed and elongated bracteoles of branchlets, and especially by the cortical cells whose primary cells are more developed than the secondary ones.

According to the recent work by Dr. WOOD & MUENSCHER, *Chara Macounii* is also included in this species, but as the present author has never examined this third plant, he has not be able to offer criticism on this problem. It can be said, however, that *Chara globularis* has rarely conjunct gametangia, so that it occasionally seems to be a dioecious plant.

var. capillacea

var. *capillacea* ZANEVELD in Blumea 4, 1940, p. 195 ; IMAHORI, Jap. Charoph. 1954, p. 163.

Plants 30~60 cm high, green to grayish green. Stem moderately slender, 400~650μ in diameter ; internodes 1~3-times the length of the branchlets, covered with triplostichous cortex, whose primary cells and secondary cells equally developed, and with rudimentary spine-cells. Stipulodes much reduced and obscure so that hardly visible with lower power microscopes. Branchlets 7~8 in a whorl, each one 1~2 cm long, consisting of 7~8 corticated articulations and terminated with 2~4 ecorticate cells. Bractcells 6~7, extraordinarily reduced. Bracteoles somewhat shorter than the length of mature oogonium.

Male and female gametangia produced solitary at the lowermost 3 branchlet nodes. Antheridia 350~420μ in diameter, rather deciduous. Oogonia 850~1,000μ long (incl. coronula), 500~630μ wide, with 14~15 spiral convolutions ; coronula 160~180μ high, 200~240μ wide at base. Oospores black and opaque, with 11~12 inconspicuous ridges, covered with smooth membrane.

ILLUSTRATIONS : MIGULA (1897), figs. 146~147 ; GROVES & B-W. (1924), pl. 43 ; IMAHORI (1954) fig. 63 ; WOOD & MUENSCHER (1956) pl. 11. Specim. exam. : FAURIE No. 10,902, Exsiccatae in Herb. Kyoto Univ. Nemuro, Prov. Nemuro, Aug. 23, 1893 : K. I. No. 992, Hyotanike pond, Wange, Akkesi-tyo, Sept. 30. 1951 : K. I. No. 981, Tarumae, Tomakomai Prov. Iburi, Sept. 24, 1951 ; K. I. No. 1325, Ohi-bokuzyo, Horonobu, Prov. Tesio, July 25, 1955:

HAB. : in lakes and swamps, pH. 6.4~7.6, occasionally growing with *C. globularis* var. *delicatula* and *N. flexilis*,

DISTR, : Asia (Japan, Formosa, Siberia, Songaria, Altai, India, Indo-China, Malaysia) Africa, Australia, Europe, North and South America,—a cosmopolitan species.

NOM. JAP. : Kata-syazikumo.

REMARKS AND DISCUSSION : This species is one of the most widely distributed species in the temperate zone especially in the northern hemisphere. It is usually found growing in considerably deep ponds or cold water, mixed with the preceeding variety.

The plant is easily distinguishable from other Charas of Japan, by fragile nature and grayish color, rudimentary spine cells and stipulodes, and short bract cells. The difference

between this and the preceeding variety is discussed on the last page.

It is questionable whether Dr. ZANEVELD or G. O. ALLEN's varietal name has priority, as Dr. H. Horn af RANTZIEN has already pointed out.

Phytogeographical View

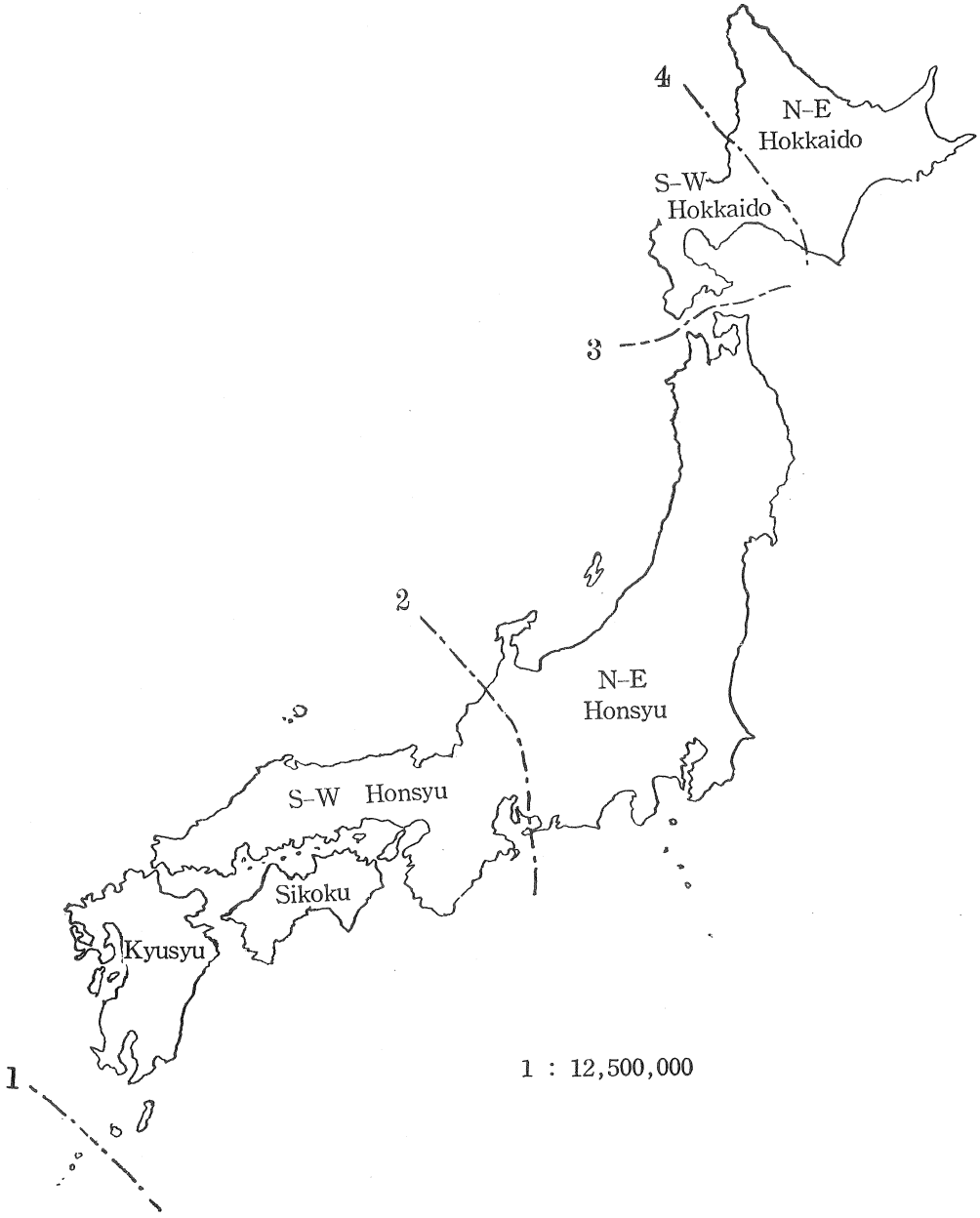
Hokkaido is situated at the northernmost of the Japanese islands, 42~46° N. and 140~146° E. The phytogeographical position and significance of Hokkaido has been discussed by some Japanese and other authorities. In short, three opinions can be found : the first is that the whole of Hokkaido is separated from the Honsyu region by Tugaru Strait, and the boundary line is called "Blakiston's line" : the second is that Hokkaido is divided by Isikari Plain, and the south western half of Hokkaido belongs rather to the Honsyu region, and the north eastern half is rather closely related to Karahuto (Sakahlin) and Siberia : the last one is that the whole of Hokkaido is most closely related to Honsyu and that the whole of Hokkaido and Honsyu form a "Hondo-Yezo region." The following work is a discussion of these three opinions from the standpoint of Characean flora, though the author's materials are very poor in making a distinct conclusion, in spite of his long exploration as stated in the introduction.

The worldly distribution outline of Hokkaido's Charophytes can be indicated in the following table.

Table 3. The World-wide Distribution of Charophytes, Collected in Hokkaido

	Europe	Africa	Australia	North America	South America	Asia (ex. Japan)	Japan				
							Kyusyu	Sikoku	S-W-Honsyu	N-E-Honsyu	Hokkaido
N. opaca	+	+		+	+	+	+	+	+		+
N. flexilis	+			+	+	+		+	+	+	+
N. Morongii var. *spiciformis*				+						+	+
N. rigida							+	+	+	+	
var. *Saitoiana*									+	+	+
N. micrcarpa		+	+	+	+	+					
var. *microglochin*						+	+		+	+	+
var. *robusta*									+	+	+
Tolypella gracilis									+	+	+
Chara Braunii	+	+	+	+	+	+	+	+	+	+	+
Chara globularis	+	+	+	+	+	+					
var. *capillacea*						+			+	+	+
var. *delicatula*	+			+		+	+		+	+	+

Fig. 2. Phytogeographical Lines which Divide Japanese Flora.
1. Watase's line 2. Masamune's line 3. Blakiston's line 4. Isikari line



This table shows the following phytogeographical characteristcs.

1) No endemic species for Hokkaido can be found.
2) Two cosmopolitan and two subcosmopolitan species are distributed in this region.
3) Two endemic species for Japan are also found in this island.
4) It seems that Blakiston's line has no significance in the Characean flora.

The fourth phytogeographical characteristic has, however, some difficulty, because it is not mentioned how many species of the North-Eastern Half of Honsyu (N-E-Honsyu) are common with Hokkaido. To make clear the matter, the following table may be shown.

Table 4. Charophyta Found in the N-E-Honsyu Region and Their Distribution in Any Region of Japan.

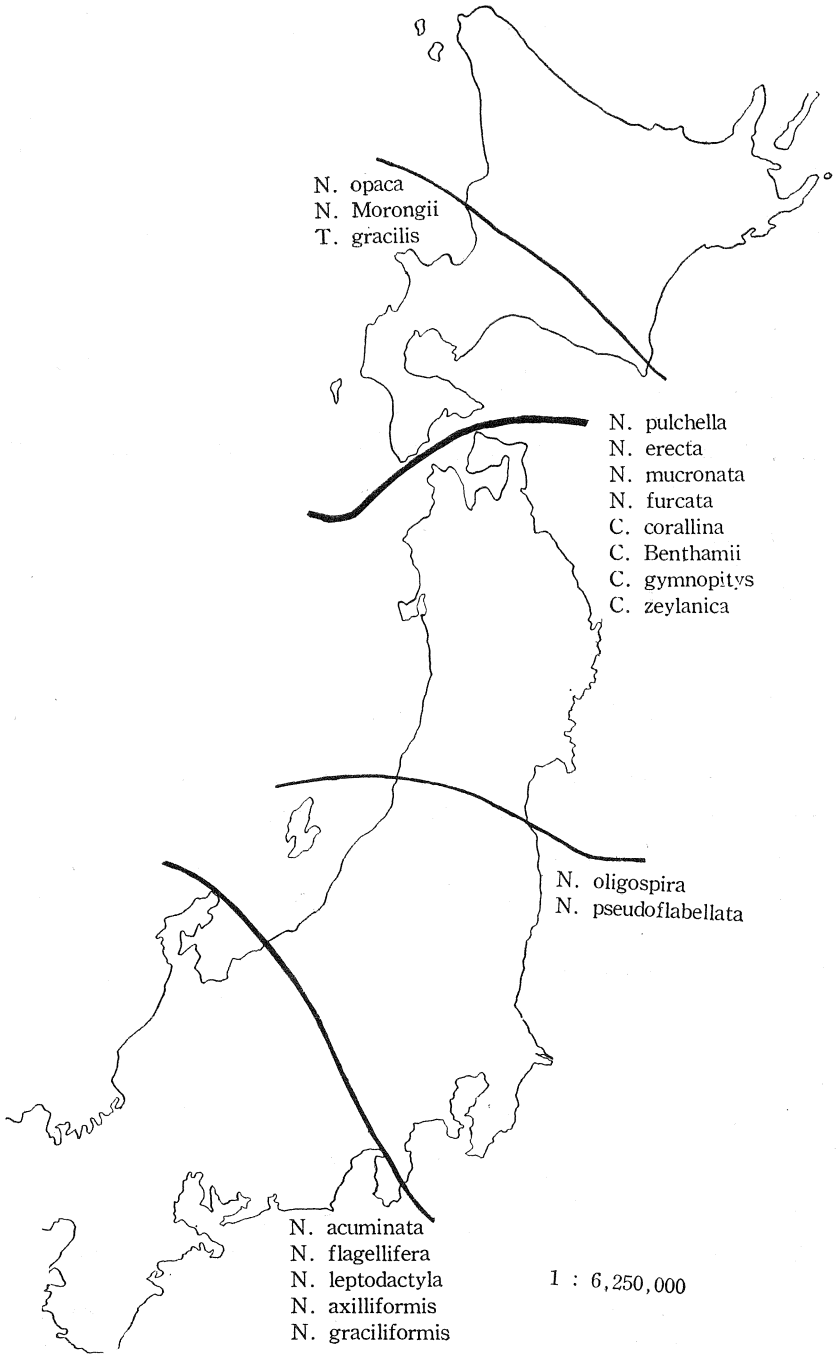
	Hokkaido	N-E-Honsyu	S-W-Honsyu	Sikoku	Kyusyu
N. paucicostata	−	+	−	−	−
N. flexilis	+	+	+	+	−
var. *longifolia*	−	+	+	−	+
N. acuminata					
var. *subglomerata*	−	+	+	+	+
var. *capitulifera*	−	+	+	+	+
N. Allenii	−	+	+	−	−
N. stricta	−	+	−	−	−
N. crispa	−	+	−	+	−
N. pulchella	−	+	+	+	+
N. spinosa	−	+	+	−	+
N. Horikawae	−	+	+	−	+
N. flagellifera	−	+	+	−	−
N. confervacea	−	+	−	−	+
N. tenuissima	−	+	−	−	−
N. pusilla	−	+	+	−	−
N. multipartita	−	+	+	−	−
N. dimorpha	−	+	+	−	−
N. leptodactyla	−	+	+	+	+
N. gracillima	−	+	+	+	+
N. Morongii	−	−	−	−	−
var. *spiciformis*	+	+	−	−	−
var. *oligogyra*	−	+	+	−	−
N. pseudoflabellata					
var. *pseudoflabellats*	−	+	+	+	+
var. *mucosa*	−	+	+	−	+
N. oligospira	−	+	+	+	+
N. expansa	−	+	+	−	−
N. orientalis	−	+	+	−	+
N. axilliformis	−	+	+	+	+
N. sublucens	−	+	−	+	+
N. furcata					
var. *furcata*	−	+	+	+	+
var. *fallosa*	−	+	+	−	−

N. japonica	−	+	+	−	+
N. gracilens	−	+	−	−	−
N. erecta	−	+	+	+	+
N. rigida	−	+	+	+	+
var. *Saitoiana*	+	+	+	−	−
var. ? *Tanakiana*	−	+	+	−	−
var. ? *Moriokae*	−	+	+	−	−
N. mucronata	−	+	+	+	+
N. graciliformis	−	+	+	+	+
N. gracilis	−	+	+	+	+
N. microcarpa					
var. *microglochin*	+	+	+	−	+
var. *robusta*	+	+	+	+	+
ssp. *megacarpa*	−	+	−	−	−
N. Tuyamae	−	+	+	−	−
N. hyalina	−	+	+	−	+
Tolypella gracilis	+	+	+	−	−
Chara Braunii	+	+	+	+	+
C. corallina	−	+	+	+	+
C. Benthamii	−	+	+	+	+
C. gymnopitys					
var. *gymnopitys*	−	+	+	+	+
var. *flaccida*	−	+	+	+	+
C. globularis					
var. *capillacea*	+	+	−	−	−
var. *delicatula*	+	+	−	−	+
C. sejuncta	−	+	+	+	+
C. zeylanica	−	+	+	+	+
Number of common spp.	7	43	35	23	29
Number of spp. comprised in the region	8	43	39	28	33
% of common spp.	87.5	100	89.7	82.1	87.9

This table shows that the North-Eastern-Honsyu (N-E-Honsyu) region has 43 species, of which only 7 species are also found in Hokkaido. It is very remarkable also that the Characean flora of the Hokkaido region is very poor and not worth looking at compared with the florae of other neighbouring regions. In fact, the writer had some unpleasant experiences as follows. In summer 1955, during about 20 days exploration, he was able to collect only a few specimens with difficulty, and he sailed back across the Tugaru-strait in great disappointment. The next day, however, he could collect several times that number of specimens in only one day's exploration of Tugaru Peninsula.

Moreover, some subtropical or warm temperate species of Charophytes are distributed in Honsyu and they are all limited to the Tugaru Strait, as shown in the following figure.

Fig. 3. Distributional Map Indicating the Northernmost Limits of Some Subtropical or Warm Temperate Charophytes Found in Japan.



Consequently, it can be said that the Blakiston's line has moderate significance, contrary to the first conclusion. Furthermore the author adopted his mathematical method, which was already used in some phytogeographical articles of his,[1] to show the affinities of the Hokkaido or N-E-Honsyu and their neighbouring regions. The following two tables can be introduced.

Table 5. The Affinity of the Relation between the Flora of Hokkaido and any Adjacent Region.

N-E-Honsyu : $50\times7\left(\frac{8+43}{8\times43}\right)\fallingdotseq51.9\%$

S-W-Honsyu : $50\times\frac{7(8+39)}{8\times39}\fallingdotseq52.7\%$

Sikoku : $50\times\frac{6(8+28)}{8\times28}\fallingdotseq48.2\%$

Kyusyu : $50\times\frac{4(8+33)}{8\times33}\fallingdotseq32.0\%$

Table 6. The Affinity of the Relation between the Flora of North-Eastern-Honsyu and its Adjacent Regions.

Hokkaido : $50\times\frac{7\ (8+43)}{8\times43}\fallingdotseq51.9\%$

S-W-Honsyu : $50\times\frac{35(43+39)}{43\times39}\fallingdotseq78.5\%$

Sikoku : $50\times\frac{23(43+28)}{43\times28}\fallingdotseq67.5\%$

Kyusyu : $50\times\frac{29(43+33)}{43\times33}\fallingdotseq77.5\%$

Finally the writer wishes to analyse the Characean distribution in Hokkaido, in order to make clear whether the Isikari Plain Line is important or not. These analyses are indicated in the following Tables 7, 8 & 9.

Table 7. An Analysis of Characean Distribution in Hokkaido and Their Relation to the Adjacent Regions.

	North-Eastern Hokkaido	South-Western Hokkaido	North-Eastern Honsyu	South-Western Honsyu	Sikoku	Kyusyu
N. opaca	−	+	−	+	+	+
N. flexilis	+	+	+	+	+	−
N. rigida var.*Saitoiana*	+	−	+	+	−	−
N. Morongii var. *spiciformis*	−	+	+	−	−	−
N. microcarpa	+	+	+	+	−	+
Tolybella gracilis	−	+	+	+	−	−
Chara Braunii	+	+	+	+	+	+
Chara globularis	+	+	+	+	+	+
no. of common species	5	7	7	7	4	4
% of common species	62.5	89.5	87.5	87.5	50.0	50.0

1) 1954 : Similarity between the Characeae of Formosa and Philippine Islands, and 1955 : Phytogeographical Survey on Charophyta-flora in the Ryukyu Islands. Formula is $V=50\times C\left(\frac{a+b}{ab}\right)$.

Table 8. The Affinity of the Relation between the Charophytes-flora of the North-Eastern Region of Hokkaido and its Neighbouring Regions.

S-W-Hokkaido	$50\times4\left(\frac{7+5}{7\times5}\right)\fallingdotseq68.5\%$
N-E-Honsyu	$50\times5\left(\frac{5+43}{5\times43}\right)\fallingdotseq55.5\%$
S-W-Honsyu	$50\times5\left(\frac{5+39}{5\times39}\right)\fallingdotseq55.5\%$
Sikoku	$50\times3\left(\frac{5+28}{5\times28}\right)\fallingdotseq35.4\%$
Kyusyu	$50\times2\left(\frac{5+33}{5\times33}\right)\fallingdotseq23.5\%$

Table 9. The Affinity of the Relation between Charophytes-flora of the South-Western Region of Hokkaido and its Neighbouring Regions.

N-E-Hokkaido	$50\times4\left(\frac{7+5}{7\times5}\right)\fallingdotseq68.5\%$
N-E-Honsyu	$50\times6\left(\frac{7+43}{7\times43}\right)\fallingdotseq50.0\%$
S-W-Honsyu	$50\times6\left(\frac{7+39}{7\times39}\right)\fallingdotseq50.5\%$
Sikoku	$50\times5\left(\frac{7+28}{7\times28}\right)\fallingdotseq44.5\%$
Kyusyu	$50\times3\left(\frac{7+33}{7\times33}\right)\fallingdotseq26.0\%$

The last two tables indicate distinctly that Isikari Plain Line is far less significant than Blakiston's line, though it may be a somewhat inaccurate investigation, which is caused by the fact that only moderately poor samples are available at present. Further investigation must be made in the near future.

In conclusion, Blakiston's line is more significant than any other lines which are considered in or around Hokkaido up to the present time, as far as Charophytes-florae are concerned. It is also very interesting that Blakiston's line which was advocated from the zoogeographical point of view at first, accords with the phytogeographical line, especially on the Characean distribution. It is reasonable and natural, however, in considering the mechanism of dispersion of these plants. Namely, Charophytes are usually dispersed by a water farrow which picks up or is adhered to by some bodies and oospores of these plants. In fact many species of this farrow, for example —— *Bubulcus ibis coromandus, Gorsachius goisagi, Charadrius alexandrinus* —— are distributed as far north as this line.

Summary

1. The writer identified 8 species of Charophytes from Hokkaido.
2. Descriptions, illustrations, examined specimens, habitats, distributions and remarks of each species are explained.
3. Some alternations of systematic rank have been made, i. e.

N. spiciformis ⟶ *N. Morongii* var. *spiciformis*
N. Saitoiana ⟶ *N. rigida* var. *Saitoiana*
N. robusta ⟶ *N. microcarpa* var. *robusta*
C. delicatula ⟶ *C.globularis* var. *delicatula*

4. Some flolistic analyses were made to clear up the phytogeographical characteristic of Hokkaido's Characean flora.
5. Among three opinions on the limiting line of florae in or around Hokkaido Island, Blakiston's line is most reasonable from the standpoint of Characean phytogeography.

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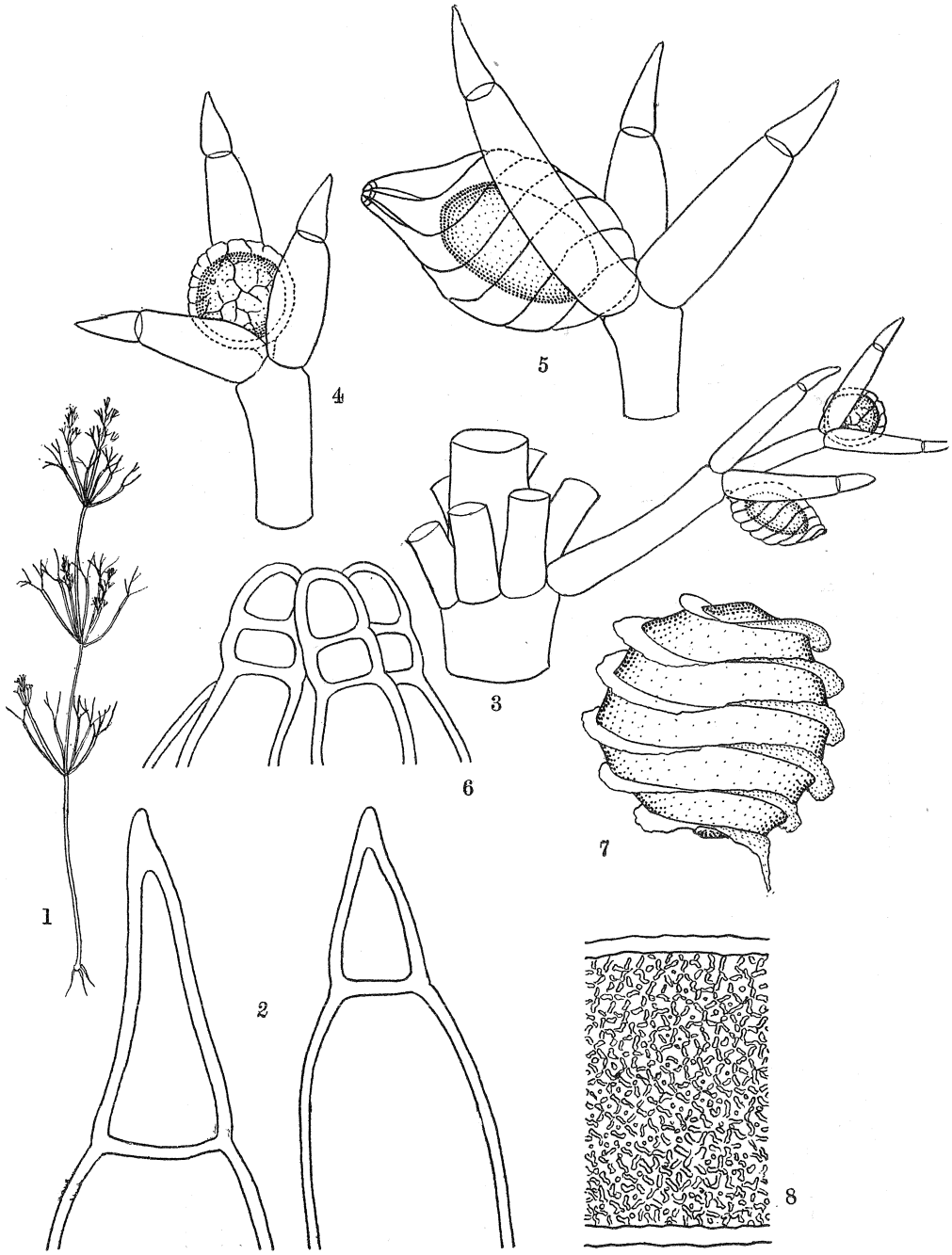
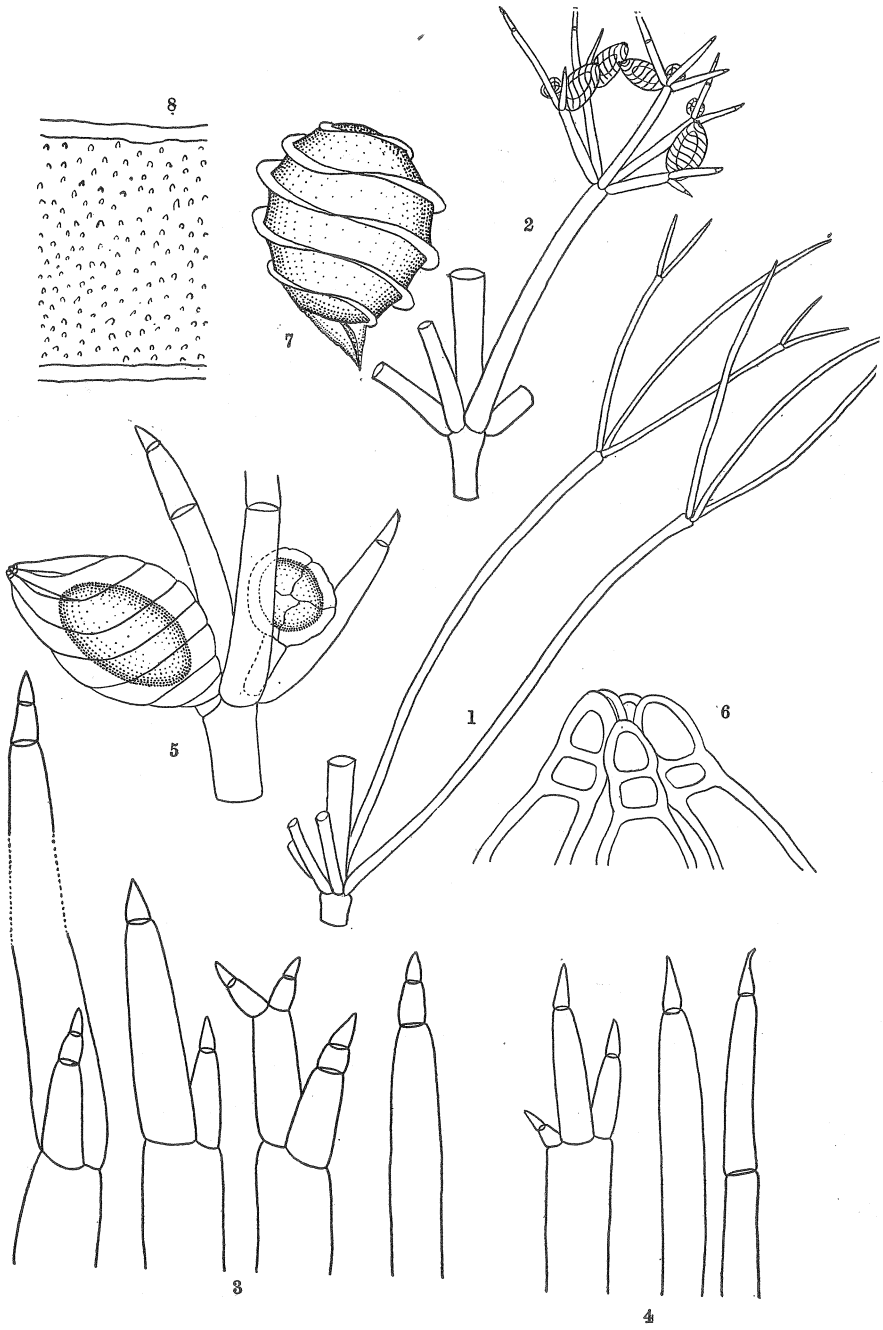
Plate 1. *Nitella Morongii* ALLEN var. *spiciformis* IMAHORI



1. Plant, nat. size. 2. End-cells of dactyls ×600 3. A fertile branchlet, ×45.
4. Antheridium, ×100 5. Oogonium, ×100 6. Coronula, ×130
8. Decoration of oospore membrane, ×750.

Plate 2. *Nitella rigida* ALLEN var. *Saitoiana* IMAHORI.



1. Sterile branchlets, ×4. 2. Fertile branchlet, ×20. 3. Dactyls of sterile branchlets, ×60. 4. Dactyls of fertile branchlets, ×80. 5. Oogonium and antheridium produced at a node of ferteil branchlet, ×80. 6. Coronula, ×800. 7. Oospore, ×120. 8. Decoration of oospore membrane, ×800.

Plate 3. Isotypic Specimen of *Nitella rigida* ALLEN (×2/3)

Plate 4. Isotypic Specimen of *Nitella Saitoiana* ALLEN (×2/3)

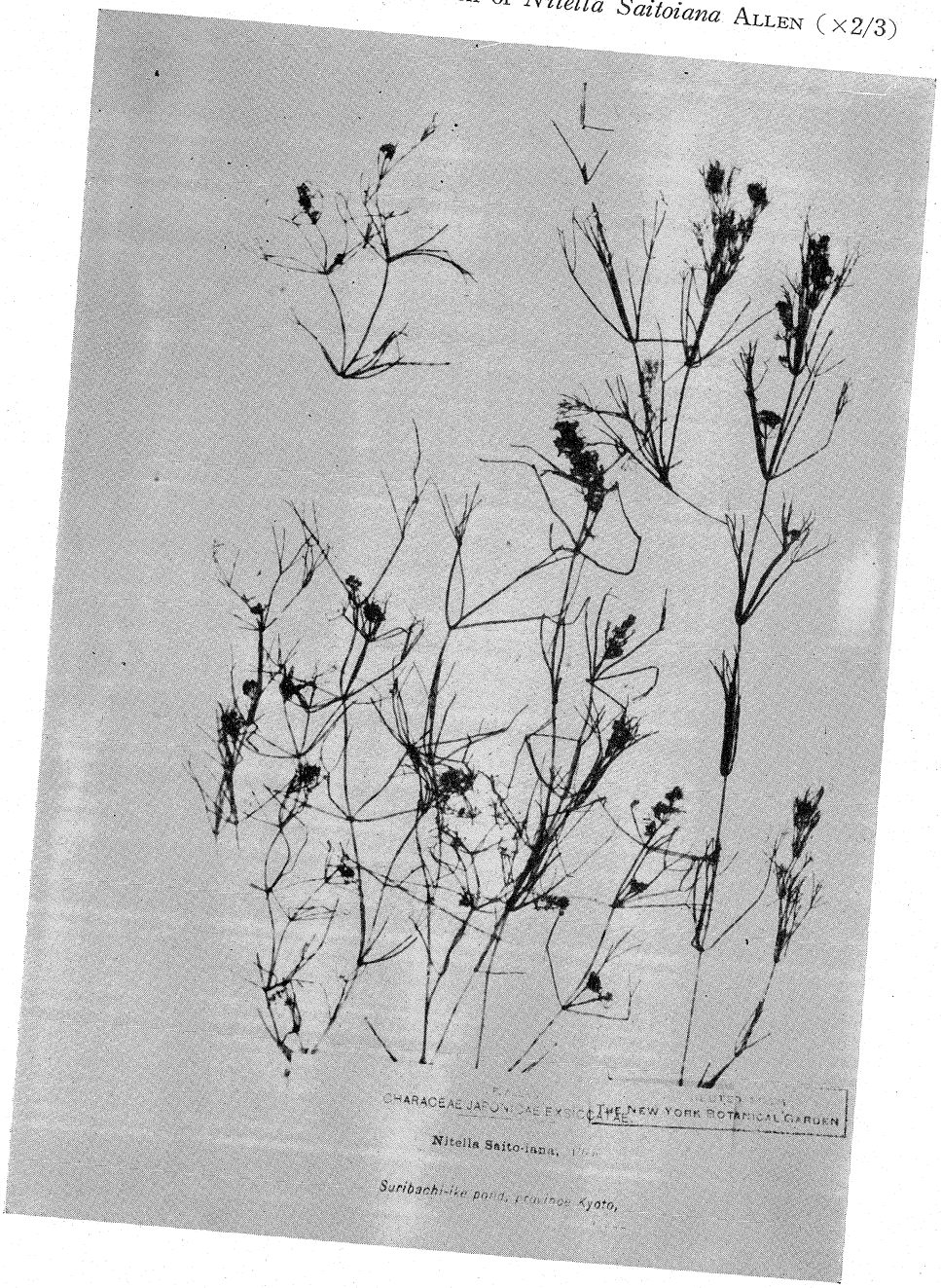
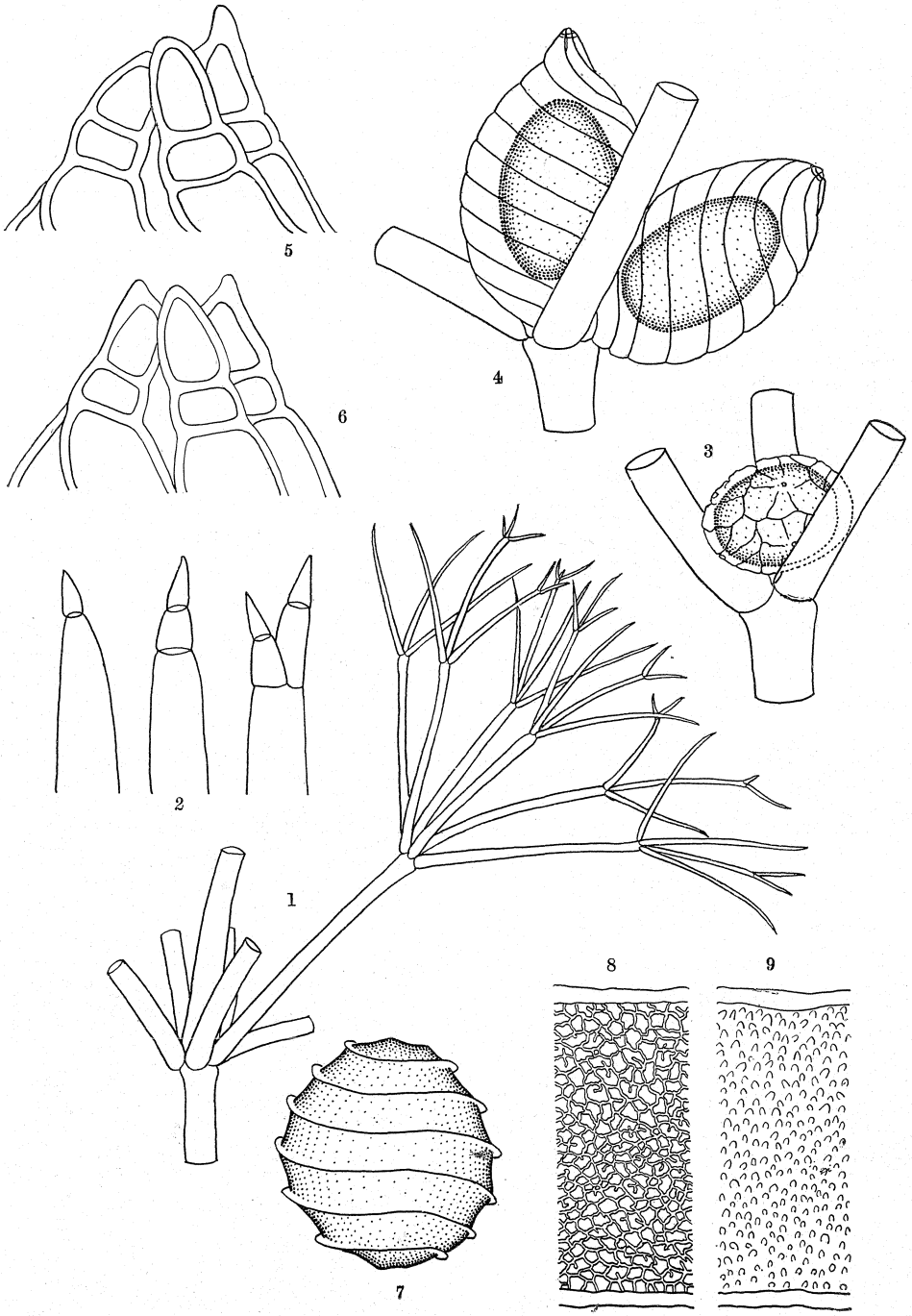
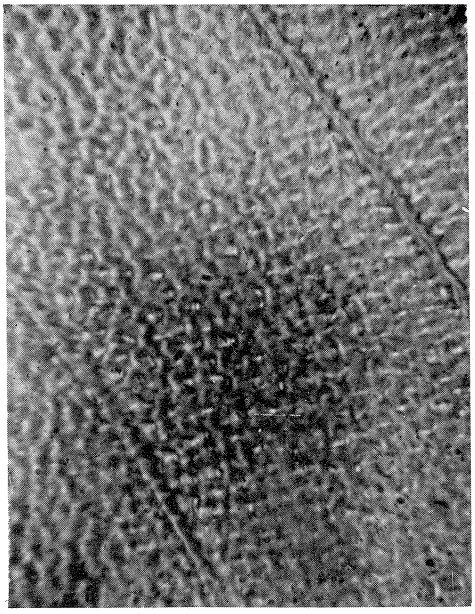


Plate 5. *Nitella microcarpa* BRAUN subsp. *robusta* IMAHORI



1. A part of sterile whorl, ×4. 2. End-cells of dactyls, ×80. 3. Antheridium, ×120. 4. Geminate oogonia, ×80. 5. Coronula, interform between Nitella- and Chara-form, ×600. 6. Coronula, Chara-form, ×600. 7. Oospore, ×120. 8. Inner aspect of oospore membrane, ×800. 9. Outer aspect of oospore membrane, ×800.

Plate 6. Microphotograph of oospore's decoration of *Nitella microcarpa* var. *robusta*.

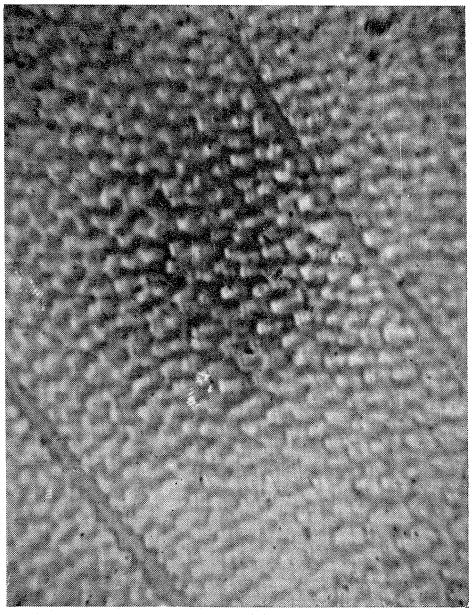


A

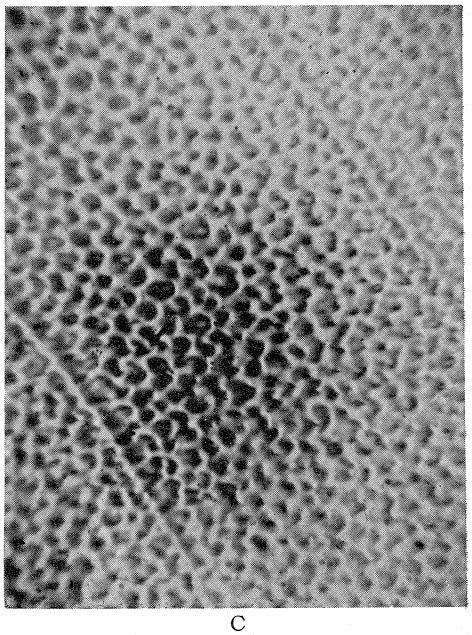
A. upper surface figure (×900)

B. intergradiate figure

C. lower surface figure.

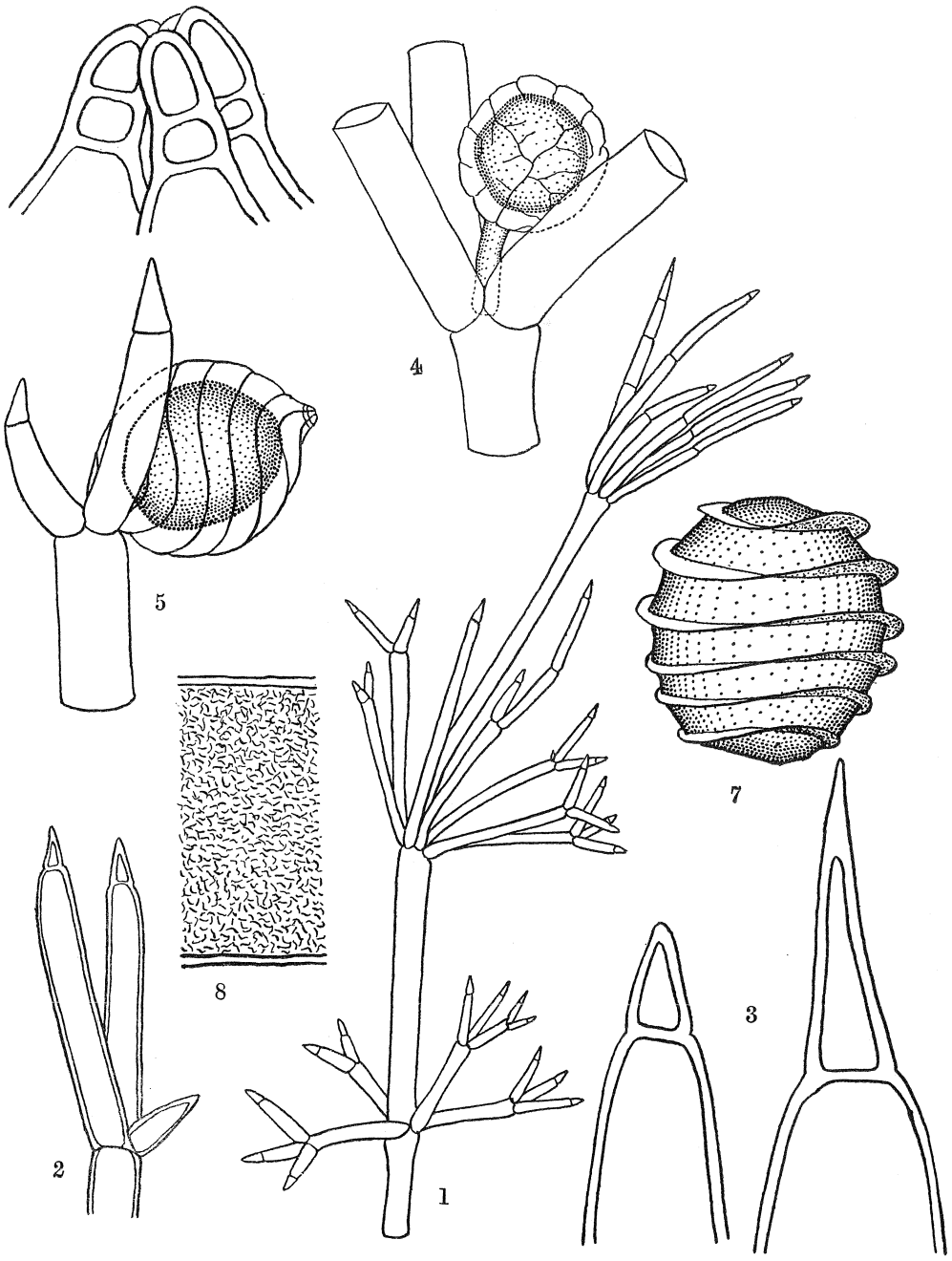


B



C

Plate 7. *Tolypella gracilis* IMAHORI



1. Superior part of a plant, ×36. 2. Dactyls, ×120. 3. Endcells, ×200.
4. Antheridium. ×120. 5. Oogonium, ×180. 6. Coronula, ×800.
7. Oospore, ×180. 8. Decoration of oospore membrane, ×1,200.