Michio MASUDA*: *Neodilsea crispata*, a new species of red algae (Cryptonemiales, Rhodophyta)

増田道夫*: 紅藻類の新種チヂレアカバについて

Since 1968, I have been studying the marine algae of the Shiretoko Peninsula in the north-eastern coast of Hokkaido. A number of individuals of a linear-lanceolate, foliose red alga which appears to belong to the genus *Neodilsea* were found at several places, growing on rocks below low-water mark to upper sublittoral belt in early summer to autumn.

After morphological observations in nature and in culture, I came to the conclusion that this alga is a new species of *Neodilsea* because of the shape of the thallus being linear-lanceolate and the margin of well grown thallus being curled, naming it *Neodilsea crispata*. A description of *N. crispata* will be given below.

Materials and Methods Most of the materials used for the present study were collected by myself from the Shiretoko Peninsula and a part of them were collected by Prof. Emer. Y. Yamada from there. They were preserved in 10% formalin in sea-water or 70% ethyl alcohol. A portion of the liquid-preserved materials were dried on herbarium sheets. Slides for microscopic examination were made by hand sections and stained with cotton blue or erythrosine, using the liquid-preserved or living material.

For culture studies, fertile plants collected at Utoro on September 23, 1971, were transported to Muroran under refrigeration. Small pieces of a fertile plant were rinsed with filtered seawater and were placed in Petri dishes with autoclaved seawater, each piece in a separate dish. Newly liberated spores were washed 2 or 3 times in autoclaved seawater with a micropipette. After washing, the spores were placed on a glass slide with several drops of culture medium. This slide was maintained in Petri dishes in a moist condition for 1–2 days, until the spores attached to the substratum. The germlings were cultured in the Petri dishes for 10 days to

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make continuous observations of the early developmental stages of spores. Then they were transferred to a glass vessel (6.5 cm × 8.0 cm) containing 200 ml of medium.

All the experiments were carried out with a unialgal and still culture, employing ESP medium (Provasoli, 1968). The culture medium was replenished at intervals of 30 days. Cultures were kept in freezer-incubators illuminated with cool white fluorescent lamp (ca. 1500–2500 lux) and regulated temperatures and photoperiods in the following combinations: 10°C and 14 hours of light, 14°C and 14 hours of light, 18°C and 14 hours of light, and 18°C and 10 hours of light daily.

Neodilsea crispata Masuda, sp. nov.

Frondes solitariae vel caespitosae, disco parvo ad substratum adfixae, ambitu lineari-lanceolatae, basin versus gradatim fastigiatae, 19–47 cm altae, 2–4.5 cm latae, tenuiter membranaceae, rugosae, 200–350μm crassae, margine crispatae, nonnumquam undulatae; organa genitalia super thallum distributa; rami carpogoniales ex 10–12 cellulis compositi, distincte curvati; rami cellulae auxiliaris ex 8–12 cellulis compositi; cystocarpia in medulla immersa; spermatangia ovoidea, 6–7μm × 4–5μm in magnitudine; tetrasporangia oblongo-obovata, 67–83μm × 40–50μm in magnitudine, oblique cruciatim divisa; color brunneo-ruber; substantia tenera, exsiccatione firme chartae adhaerens.

Japanese name: Chijire-akaba (nov.)

Holotype: SAP-29716, tetrasporangial specimen collected at Utoro, Shari Town, Shiretoko Peninsula, on Sept. 23, 1969 by M. Masuda (in SAP).

Additional collections: Abashiri; x. 1968 (cystocarpic and tetrasporangial, cast ashore). Utoro; vi. 1969 (sterile), vii. 1968 (sterile), viii. 1968 (female, male and tetrasporangial), ix. 1943 (tetrasporangial, Y. Yamada, SAP-29729), ix. 1969 (cystocarpic, male and tetrasporangial), ix. 1971 (cystocarpic, male and tetrasporangial), x. 1968 (tetrasporangial). Rusha; ix. 1943 (tetrasporangial, Y. Yamada, SAP-29730). Shiretoko Misaki; ix. 1943 (tetrasporangial, Y. Yamada, SAP-29731). Moire-ushi; vii. 1968 (sterile), viii. 1968 (tetrasporangial), x. 1968 (tetrasporangial). Seseki; viii. 1968 (sterile). Rebuncho; x. 1968 (cystocarpic, male and tetrasporangial). Shibetsu; ix. 1969 (male, cast ashore).

Fronds solitary or caespitose, attached to the substratum by a small disc, linear-lanceolate in outline, tapering gradually towards the base, 19–

47 cm high, 2–4.5 cm broad, thin membranous, wrinkled, 200–350μm thick, curled and sometimes undulate at margin; reproductive organs distributed over the thallus; carpogonial branches composed of 10–12 cells, distinctly curved; auxiliary cell branches composed of 8–12 cells; cystocarps immersed in the medulla; spermatangia ovoid, 6–7μm×4–5μm in size; tetrasporangia oblong-obovate, 67–83μm×40–50μm in size, obliquely cruciately divided; colour dark red; substance soft, firmly adhering to paper in drying.

Observations *Habit and seasonal variation in gross morphology.* This alga grows on rocks below low-water mark to upper sublittoral belt, as-

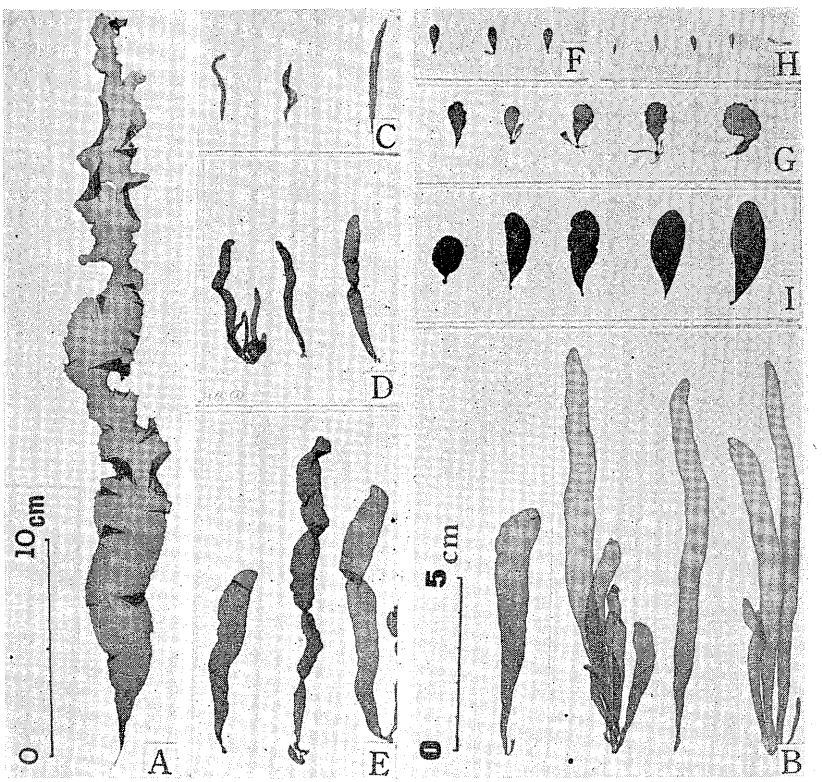

Fig. 1. *Neodilsea crispata*, *N. yendoana* and *N. tenuipes* in nature and in culture grown at 10°C in a 14-hr photoperiod. A–E: *N. crispata* in nature collected at Utoro (A–B) and in culture (C–E); A, Tetrasporangial plant collected on Sept. 23, 1969 (Holotype, SAP-29716); B, Young plants collected on July 8, 1968 (SAP-29725); C, 2-month old; D, 3-month old; E, 4-month old. F–G: *N. yendoana* in culture; F, 2-month old; G, 4-month old. H–I: *N. tenuipes* in culture; H, 2-month old; I, 4-month old. Use scale in A for A; scale in B for B–I.

sociating with *Sargassum confusum, Rhodoglossum japonicum, Rhodymenia palmata, Pterosiphonia bipinnata* and others.

This plant is apparently a summer annual, never being collected in winter and spring, and achieves its most luxuriant growth in August, at that time attaining a height of about 45 cm. It produces reproductive organs in August and probably into September. The male plant, the female plant and the tetrasporangial plant are indistinguishable in outline. However, the male plant is somewhat yellowish in colour in comparison with the latter two. The plants diminish in size after discharging spermatia, carpospores and tetraspores from the distal part of the thallus. When young, the thallus is linear in shape, tapering gradually towards the base and is entire at its margin (Fig. 1, B). As it grows, the marginal part of the thallus becomes curled except near the base (Fig. 1, A; Fig. 3, D–F; Fig. 5, D–F), assuming a linear-lanceolate shape. The thallus is almost cylindrical quite near the base, measuring 875–1000μm in diameter. The measurements of length and breadth of the thallus are shown in Fig. 2. From this figure it is clear that the present alga is more linear-lanceolate in shape than *N. integra* (Kjellm.) A. Zinova.

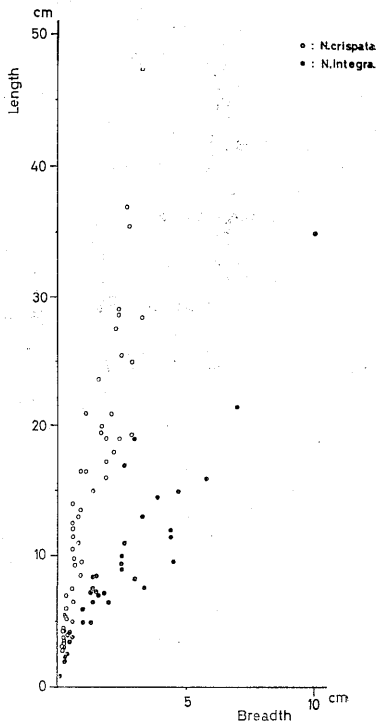

Fig. 2. Length-breadth relationships of the thallus *Neodilsea crispata* from Utoro and *N. integra* from Greenland.

Structure of the thallus. The thallus is multiaxial and consists of a cellular cortex and a filamentous medulla (Fig. 3, A). It is about 200–220μm thick in the upper portion of the plant, 240–300 μm thick in the middle portion, and 250–350μm thick in the lower portion. The cortical layer is composed of dichotomously branched anticlinal filaments, each filament consisting of 5–8 cells.

The outermost layer consists of 1 or 2 small cells, measuring 12.5-22.5μm× 10-15μm. The outermost cells sometimes bear unicellular colourless hairs. The cortical cells gradually increase in size inwards, measuring 25-30μm×

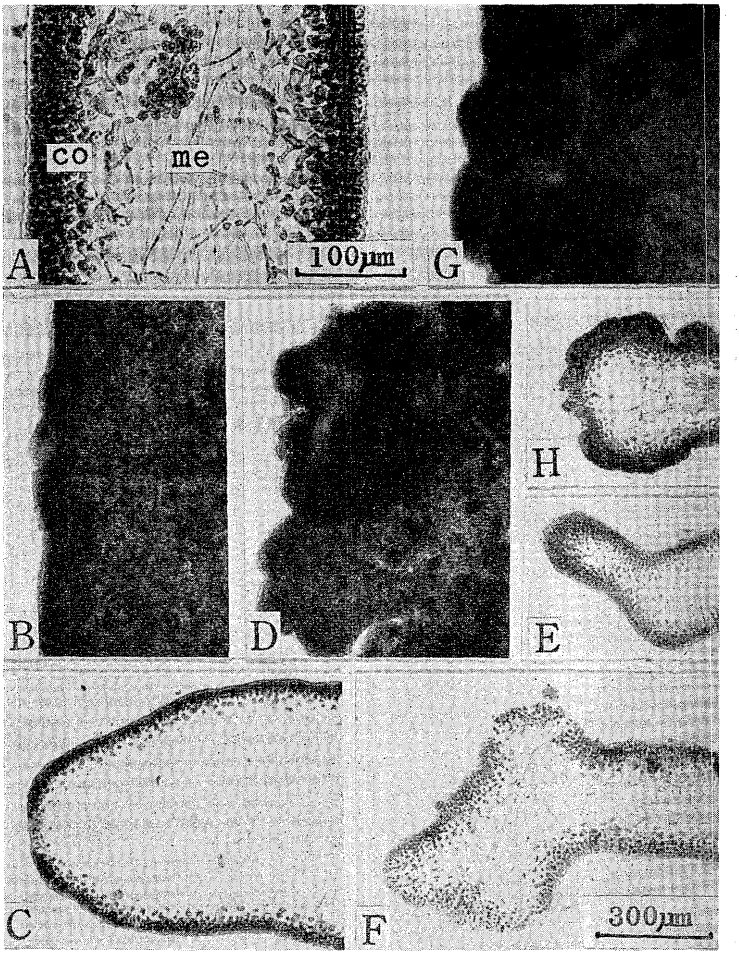

Fig. 3. *Neodilsea crispata*. A: Vertical section of the middle portion of a cystocarpic plant, showing a cellular cortex (co) and a filamentous medulla (me). B: Surface view of the lower marginal portion of a tetrasporangial plant, showing entire structure. C: Cross section of the same. D: Surface view of the middle marginal portion of a tetrasporangial plant, showing curled structure. E-F: Cross section of the same. G: Surface view of the middle marginal portion of a cultured plant, showing curled structure. H: Cross section of the same. Use scale in A for A; scale in F for B-H.

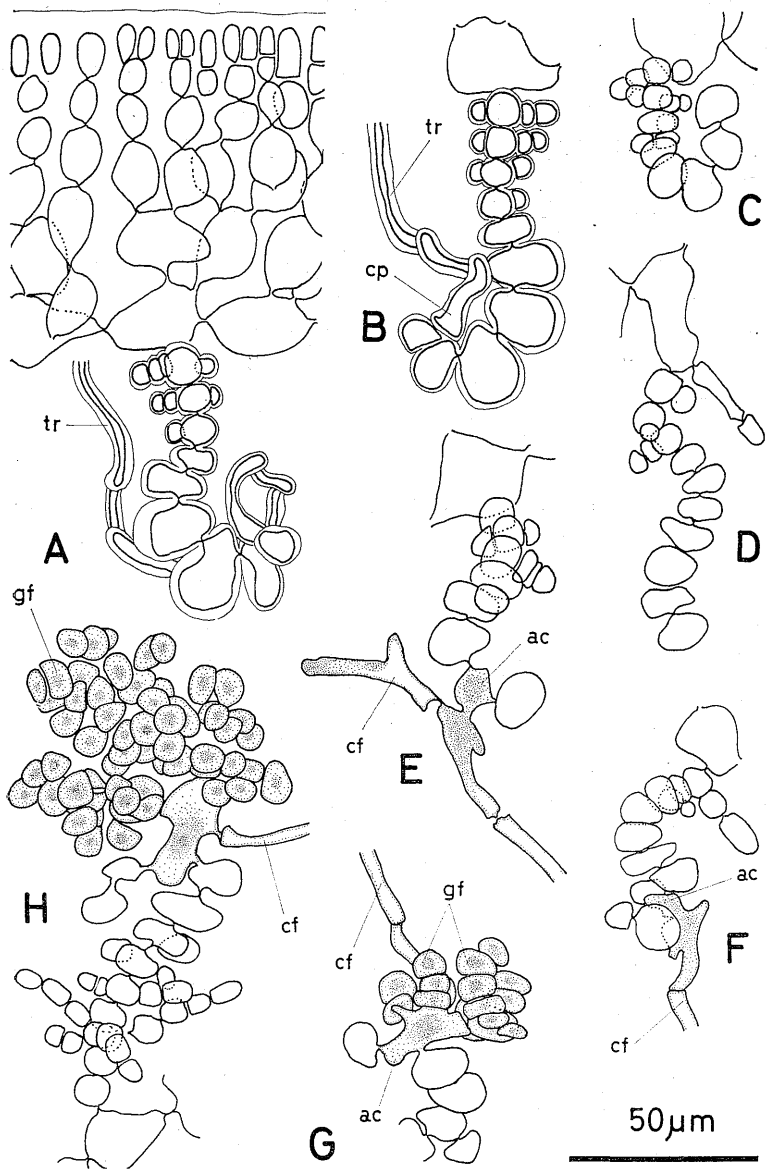

Fig. 4. Female reproductive organs and early developmental stages of cystocarps of *Neodilsea crispata*. A: Cross section of a female plant, showing a carpogonial branch. B: Carpogonial branch. C-D: Auxiliary cell branches. E-F: Connecting filaments fusing with an auxiliary cell. G-H: Development of gonimoblast filaments. ac, auxiliary cell; cf, connecting filament; cp, carpogonium; gf, gonimoblast filament; tr, trichogyne.

32.5-60μm and giving off the medullar filaments from the one or two innermost cortical cells.

The medulla consists of seemingly uniseriate filaments which are 10–12.5μm thick and loosely, irregularly arranged (Fig. 3, A). It comprises about half of the thickness of the thallus.

Reproductive organs. The carpogonial and auxiliary cell branches are formed on different and separate branchlets arising from the innermost cortical cells. The carpogonial branches are distinctly curved and are composed of 10–12 cells, the fourth cell from the distal end being usually the largest and the fifth being second in size. The trichogyne is long and irregularly twisted. The lower cells of the carpogonial branch usually have short branchlets (Fig. 4, A–B).

The auxiliary cell branches are also distinctly curved and are composed of 8–12 cells. Sometimes they bear short branchlets. The second or sometimes the third cell from the distal end of the auxiliary cell branches becomes an auxiliary cell (Fig. 4, C–D). The processes of the fertilization and the primary fusion were not observed but it was seen that the connecting filaments connected with the auxiliary cells (Fig. 4, E–F). After fusion with the connecting filament, the auxiliary cell cuts off gonimoblast initials (Fig. 4, G). Two or more groups of gonimoblast initials arise from one auxiliary cell (Fig. 4, H) and develop into a cystocarp. The cystocarps are immersed in the medulla in small groups, usually slightly pushing up the frond surface and easily distinguished from the vegetative parts with the naked eye by the marked small dark points. The carpospores are formed from almost all cells of the gonimoblast.

The spermatangia are cut off from the outer cortical cells which function as spermatangial mother cells. They are formed 1 or 2 by an oblique division of the mother cells and usually ovoid, measuring 6–7μm$\times$ 4–5μm. Only one plant from 3-month old cultures grown at 18°C in a 10-hr photoperiod became fertile and formed many spermatangia. They were quite the same in features and size as those formed on the plant in nature (Fig. 5, A–B).

The tetrasporangia occur abundantly on both surfaces of the thallus except the lower parts and are indiscernible with the naked eye. They are cut off as a side branch from the lower cells of the anticlinal cortical fila-

ments and are oblong-obovate, measuring 67–83μm×40–50μm. The contents of each sporangium divide obliquely cruciately to form 4 spores (Fig. 5, C).

Culture experiments. When liberated, tetraspores assume a perfect globular shape. They are red in colour, containing numerous chloroplasts

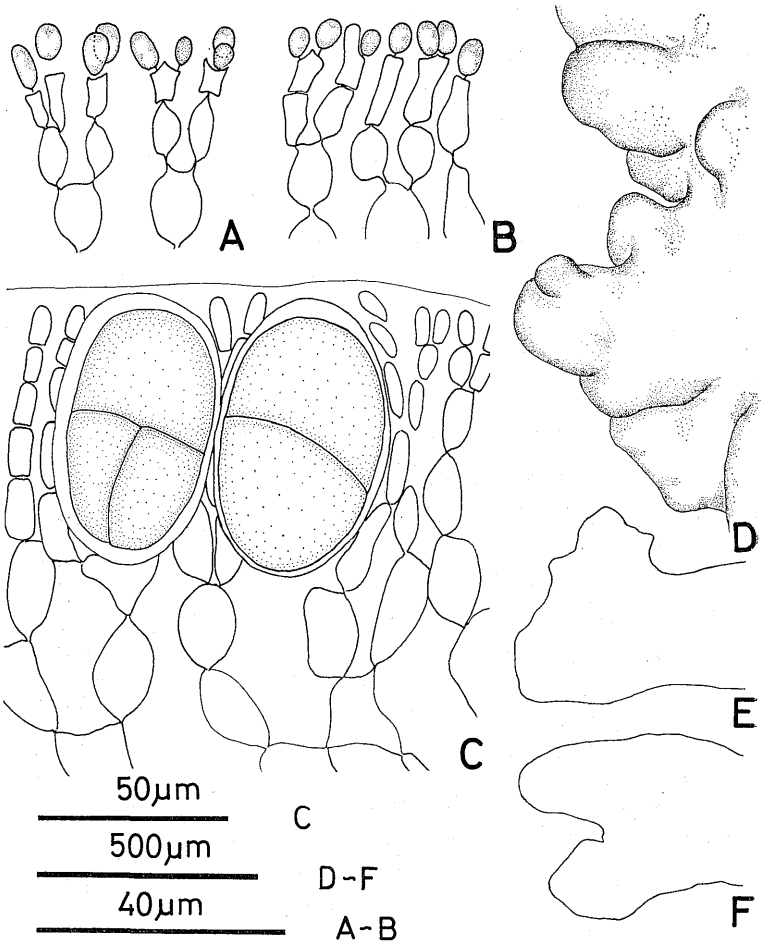

Fig. 5. *Neodilsea crispata.* A: Cross section of a male plant from 3-month old culture grown at 18°C in a 10-hr photoperiod. B: Cross section of a male plant collected at Utoro on Sept. 23, 1969. C: Vertical section of a tetrasporangial plant, showing two tetrasporangia. D: Surface view of marginal portion of a tetrasporangial plant, showing curled structure. E-F: Cross section of the same.

(Fig. 6, A). The diameter of tetraspores of this alga vary from 31.5μm to 40μm, exhibiting the mean value of 34.5μm.

The tetraspore is usually divided into two almost equal daughter cells within one day after liberation (Fig. 6, B). Then several cell divisions occur at right angles to the first division or sometimes obliquely (Fig. 6, C). Thereafter, successive cell divisions are formed parallel, at right angles or obliquely to the first division and in parallel to the substratum. The germling results in a multicellular hemispherical disc, growing both concentrically and upwards (Fig. 6, D). After 10 days, long, colourless hairs develop by the outgrowth of surface cells of the disc (Fig. 6, E). They are fairly common in the both cultured and natural plants, as in those of *Neodilsea yendoana* and *N. tenuipes* (Fig. 6, H–I).

As growth advances, the upright shoots develop remarkably and reach a height of about 1–2 mm after 21 days in the cultures grown at 14°C in a 14-hr photoperiod (Fig. 6, F). The measurement of length and breadth of

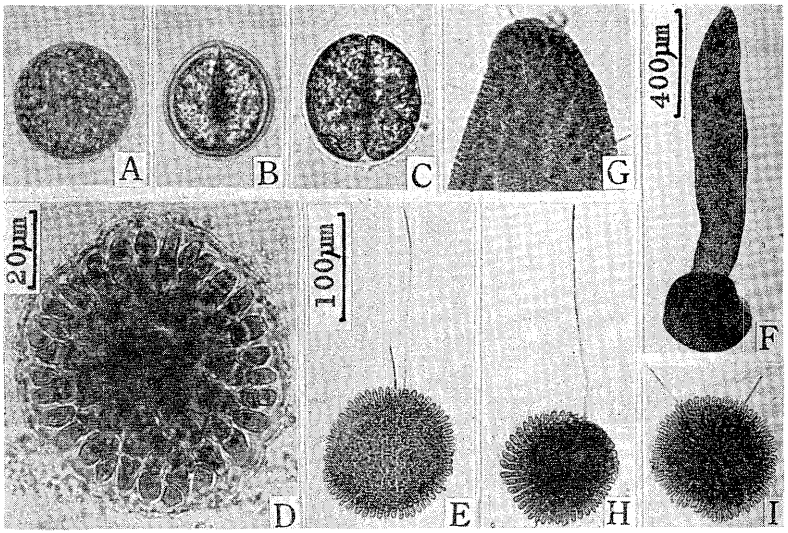

Fig. 6. Tetraspore and its various stages of germination in *Neodilsea crispata*, *N. yendoana* and *N. tenuipes*. A-G: *N. crispata*. H: *N. tenuipes*. I: *N. yendoana*. A: Tetraspore. B: 1-day old germling. C: 2-day old one. D: 7-day old one. E, H–I: 10-day old ones. F: 21-day old one. G: Uppermost portion of 30-day old one, showing colourless hairs. A-C; Living materials, D-I; Glycerin preserved ones. Use scale in D for A-D; scale in E for E, G–I; scale in F for F.

the thalli from 2-month, 3-month and 4-month old cultures grown in a 14-hr photoperiod at 10°C, 14°C and 18°C are shown in Fig. 7. Some of these thalli are photographed in Fig. 1, C–E. The Fig. 7 shows that the cultured plants apparently have a tendency to grow linear-lanceolately. The frond surface of the cultured plants also becomes wrinkled. The marginal part of the thallus became curled in 5-month old cultures grown at 14°C in a 14-hr photoperiod as in those in nature (Fig. 3, G–H).

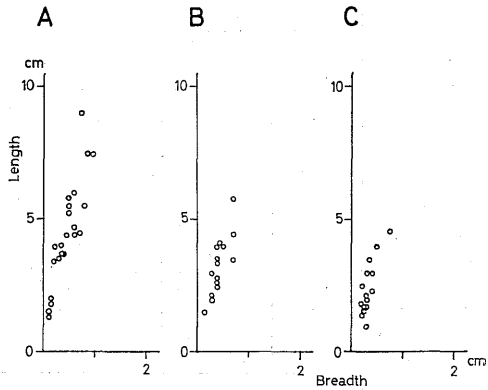

Fig. 7. Length-breadth relationships of the thallus in 2-month, 3-month and 4-month old cultures grown in a 14-hr photoperiod at 10°C (A), 14°C (B) and 18°C (C).

Discussion Because of the structure of the thallus and the development of reproductive organs, this alga apparently belongs to the genus *Neodilsea* (family, Dumontiaceae). Until now four species have been described in the genus *Neodilsea*. Diagnostic characters of those species and this alga are shown in Table 1. This alga is clearly distinguishable from other species by the following two characteristics, the shape of the thallus being linear-lanceolate and the margin of well grown thallus being curled. As mentioned already, these two characters of this alga are well exhibited in cultured plants as well as those from nature. In the cultures of *N. yendoana* Tokida and *N. tenuipes* Yamada et Mikami from Muroran, the shape of the thallus of the former was oblong, obovate or roundish, that of the latter obovate or oblong, and the margin of the thallus of the both species was entire as those in nature (Fig. 1, F–I). Therefore these two characters are of sufficient importance to warrant specific distinction, naming this alga *Neodilsea crispata*.

Moreover, of the four known species, *N. integra* (Kjellm.) A. Zinova is closest to this alga. Plants of *N. integra* were not available for culture studies, but many specimens from Greenland (in the herbarium of the

Table 1. Diagnostic characters of all known species in the genus *Neodilsea*.

Characters \ Species	*N. yendoana*	*N. tenuipes*	*N. americana*	*N. integra*	*N. crispata*
Shape of thallus	oblong, obovate, roundish	obovate, oblong, (Mikami, 1954)	circular (Abbott, 1968)	obovate, oblong obovate, lanceolate (Lund, 1959)	linear-lanceolate
Shape of thallus-base	cuneate	broadly cuneate rounded (Mikami, l. c.)	—	attenuate	attenuate
Thickness of thallus	350–725μm	300–550μm (Mikami, l. c.)	300–350μm (Abbott, l. c.)	300–400μm (Chihara, 1967) 200–340μm	200–350μm
Margin of thallus	entire	entire	entire	entire	curled
Size of tetrasporangia	37. 5–42. 5μm × 60–77. 5μm	35μm × 45μm (Mikami, l. c.)	15–18μm × 27–30μm (Abbott, l. c.)	20–25μm × 35–50μm (Chihara, l. c.)	40–50μm × 67–83μm
Size of spermatangia	4–5μm × 10–12μm 4–5μm × 5–7μm (Tazawa, 1956)	3–4μm × 4–5μm (Tazawa, l. c.)	—	—	4–5μm × 6–7μm

Botanical Museum, the University of Copenhagen) and from Cape Thompson, Alaska (in the herbarium of National Science Museum, Tokyo) were examined by myself with the help of Drs. S. Lund, J. B. Hansen and M. Chihara. As shown in Fig. 2, *N. integra* apparently differs from this alga in the shape of the thallus. The margin of the thallus of *N. integra* including the fertile plants were entire without exception, as far as examined.

In addition to these two characters mentioned above, *N. yendoana* is easily distinguished from this alga by having a thick thallus and a cuneate base. *N. tenuipes* differs from this alga in having a broadly cuneate to rounded base, smaller tetrasporangia and smaller spermatangia. *N. americana* Abbott also is distinguishable from this alga in having smaller tetrasporangia.

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北海道知床半島産の紅藻アカバ属*Neodilsea*の一種を新種チヂレアカバ(*N. crispata* sp. nov.)として報告する。本種は初夏から秋にかけて低潮線付近から漸深帯上部に生育し，体は線形，あるいは広線形をなす。よく生長したものは体の縁辺部が不規則に縮れる。この2つの形質は他のアカバ属の種に見られないものである。また室蘭産のアカバ(*N. yendoana* Tokida)およびマルバアカバ(*N. tenuipes* Yamada et Mikami)と本種を培養により比較し，アカバ属の分類学的形質について考察した。すなわち，上記の2つの形質は培養個体においても顕著に発現し，本種に特異な形質であることが実験的に明らかにされた。

○高等植物分布資料 (79)　Materials for the distribution of vascular plants in Japan (79)

ミズスギ　*Lycopodium cernuum* L. ミズスギは日本の暖地には普通であるが，中部日本から北海道にかけて，ブナ林帯の温泉地熱地帯に点々と分布することが知られている。箱根大湧谷のものは古くから知られて来たが，関東大震災の時に地熱が低下し絶滅した。我々は1972年11月に硫気孔地域の植生調査の途次，ミズスギを箱根湯ノ花沢の噴気孔周辺でかなり豊富に，しかも旺盛に生育しているのを見出した。

本種は北海道登別温泉，岩手県滝ノ上温泉，長野県中房温泉などにも知られ，高橋秀男氏によると高瀬川の上流域にも産するという。このうち滝ノ上温泉のものは，1972年8月の所見では絶滅寸前である。　(松浦正郎，大場達之)

□初島住彦：**琉球植物誌** (Flora of the Ryukyus) pp. xi, 940, pl. 30, B5版，1971, ca. ¥12,600 沖縄生物研究会発行。初島教授は多年鹿児島大学にあってこの大著を完成した。原稿は既に1968年に一応完成したが，印刷の都合で出版がおくれたので，その後の研究を考慮して追加と訂正分 pp. 25 を巻末に加えた。別に正誤表 3 pp. もある。地域は奄美群島を含み，シダ植物・顕花植物の科・属・種の記載，産地，検索表がくわしく，この地のフロラの全般が新しい光の下に集約された。図版には初島教授の新種，外国にあるタイプの標本の写真，生植物のカラー写真も含まれている。巻頭には地誌・気候・植物地理（各島群別および近隣地域との比較）が概説され，琉球植物探検年表，主要な採集者80名の肖像写真，文献目録，用語解説もある。著者は本書もなお予報的のものであるとし，更に今後の検討を期待しているが，このように広い範囲に亘り，かつ不連続に分布する島群の植物誌をまとめられた諸困難を思い，長年の努力に深い敬意を払うものである。　(津山　尚)