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A new genus *Kurogia* (Delesseriaceae, Rhodophyta) from Hokkaido, northern Japan

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Kurogia pulchra is described as new to the Delesseriaceae, the subfamily Delesserioideae. It is distinguished by an alternate position of the cell rows of the second order resulting from an oblique division of certain cells of the first order cell row, a feature unique among the genera of Delesseriaceae. It shares with a limited number of genera sympodial growth of the thallus. A pericarp without any ornamentation and production of 4 tetrasporangia per tier in the stichidium-like bladelets discriminate this genus from the related genus *Zinovaea*. 'Kurogia group' is proposed to include *Kurogia* and *Zinovaea*.

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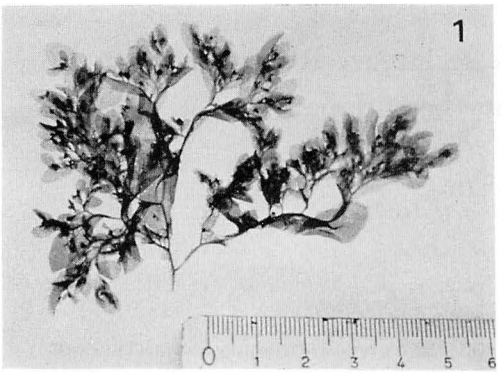
In the course of our research on the marine algae of the coast effected by the Oyashio Cold Current, I collected a red alga belonging to the Delesseriaceae from Nemuro Peninsula, eastern Hokkaido, Japan. Several unique characteristics of this alga are concluded to be sufficient to establish a new genus, *Kurogia*, for this alga.

Observations

Structure of the thallus: Only two individuals of this alga were collected up to present. One is a female frond with mature cystocarps (Fig. 1), and the other is tetrasporangial. This alga seems to grow in deep water, as the specimens were obtained in the state of drifting at the sea shore or entangled in a gill net for flat fish settled at a depth of about 28 m. These individuals are devoid of the basal part. The larger tetrasporangial plant (Fig. 2) is about 17 cm high.

The mode of growth of the thallus is sympodial. Each blade ceases growth earlier. From the midrib of the determinate blade attaining up to 7 cm long and 2 cm wide, several similar blades are issued only on its adaxial side. Blades of the next order are borne in the same way. Later, the wings of older blades are eroded away resulting in a midrib with a stem like appearance. The blade has entire margins and is without lateral veins. When young, the margin of the blade is somewhat undulate or vaguely crenulate. The midrib does not reach the apex of the blade. It consists of larger cells with few rhizoidal filaments (Fig. 8). The wing is monostromatic.

The growth of the blade takes place by the transverse division of an apical cell. Each resulting segment of the first order cell row cuts off two lateral pericentral cells. The lateral pericentral cells become initials of cell rows of the second order, which in turn cut off cells that function as apical cells of tertiary cell rows. Not all cell rows of the third order reach the blade margin (Fig. 4). In the bladelet shown in Fig. 5, cells 1-7 from the apex in the first order cell row do not give rise to adaxial and abaxial pericentrals, as a result the apical area remains monostromatic. From cell 8 or beyond in the cell



Figs. 1–2. *Kurogia pulchra* YOSHIDA

Fig. 1. Holotype, SAP 034547. Cystocarpic, May 8, 1978.

Fig. 2. Tetrasporophyte, SAP 034548, May 19, 1969.

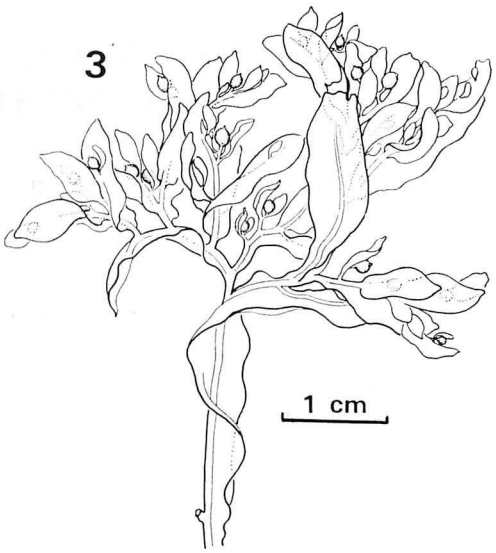
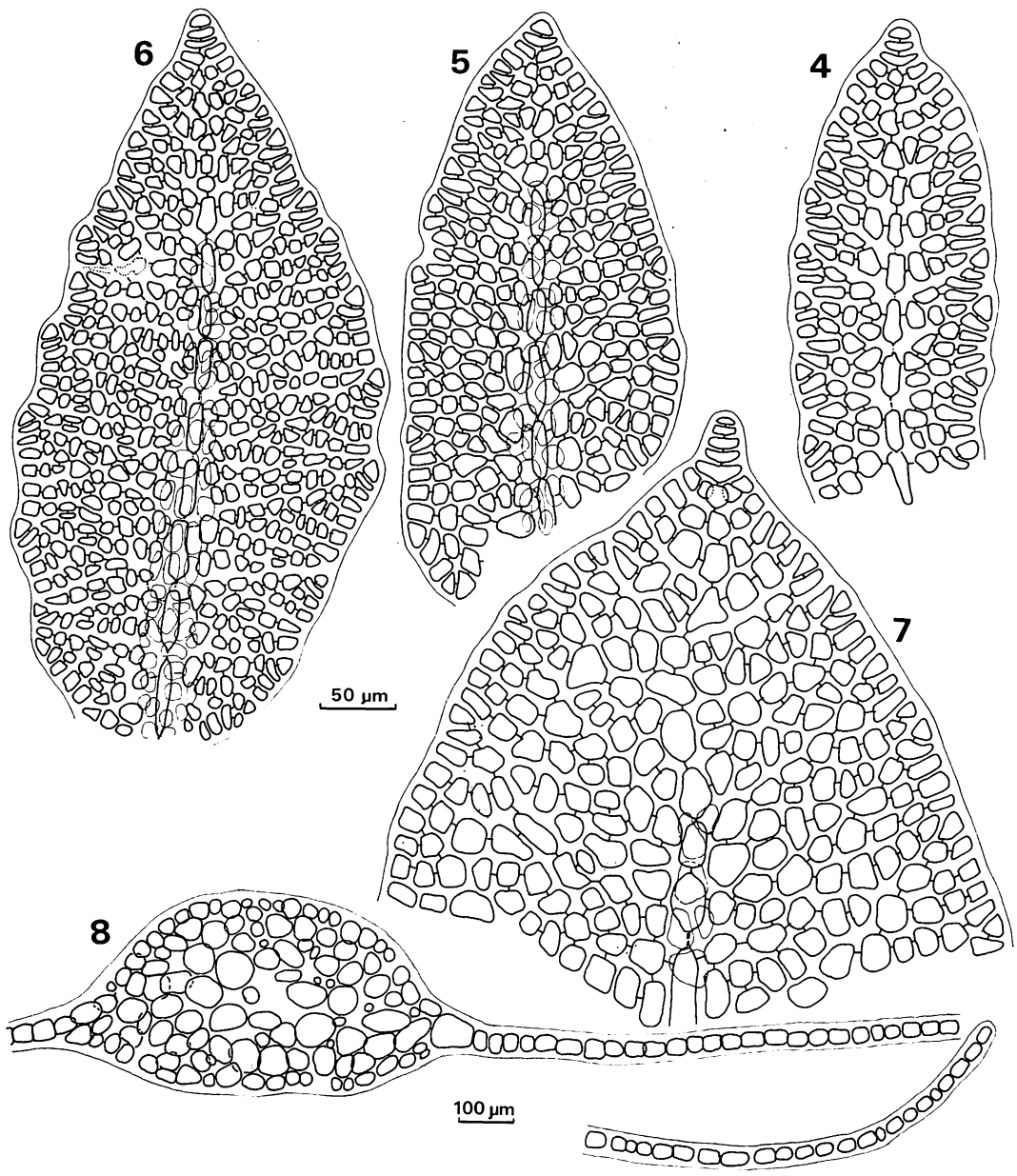


Fig. 3. *Kurogia pulchra* YOSHIDA
A part of the thallus with cystocarps.

row of the first order adaxial and then abaxial pericentrals are cut off to form a midrib. When the blade is about 400 μm in length (Figs. 5, 6), one or two cells among the cells 5–7 from the apex in the first order cell row divide with an oblique wall. Each resulting daughter cell of this division has only one cell row of the second order on its left or right side. Following this oblique division of two successive cells, four cells of the first order cell row bear alternately the cell rows of the second order. In addition to this mode of division, one or more intercalary divisions, commonly observed in the genera of Nitophylloideae, occur also in the cell row of the first order, although this is not shown in the figure. By these divisions, the cell row of the first order becomes obscure (Fig. 7), and it is completely undetectable in mature blades. In the part of blade with midrib, cells of the first order cell row do not undergo intercalary division, but elongate considerably. Intercalary cell divisions occur also in the cell row of the second order. Later, the apical cell ceases to divide.

The blades of the next order are initiated by the anticlinal division of the adaxial pericentral derivatives.

Cystocarp: The female individual obtained bears ripe cystocarps (Fig. 3). Developmental process of the procarp could not be followed. Cystocarps are formed on the midrib of the blades. It is considered that the number of procarps formed on a fertile blade is very limited (only one ?), because no abortive procarp could be observed near the developing cystocarp even in its



Figs. 4-8. *Kurogia pulchra* YOSHIDA

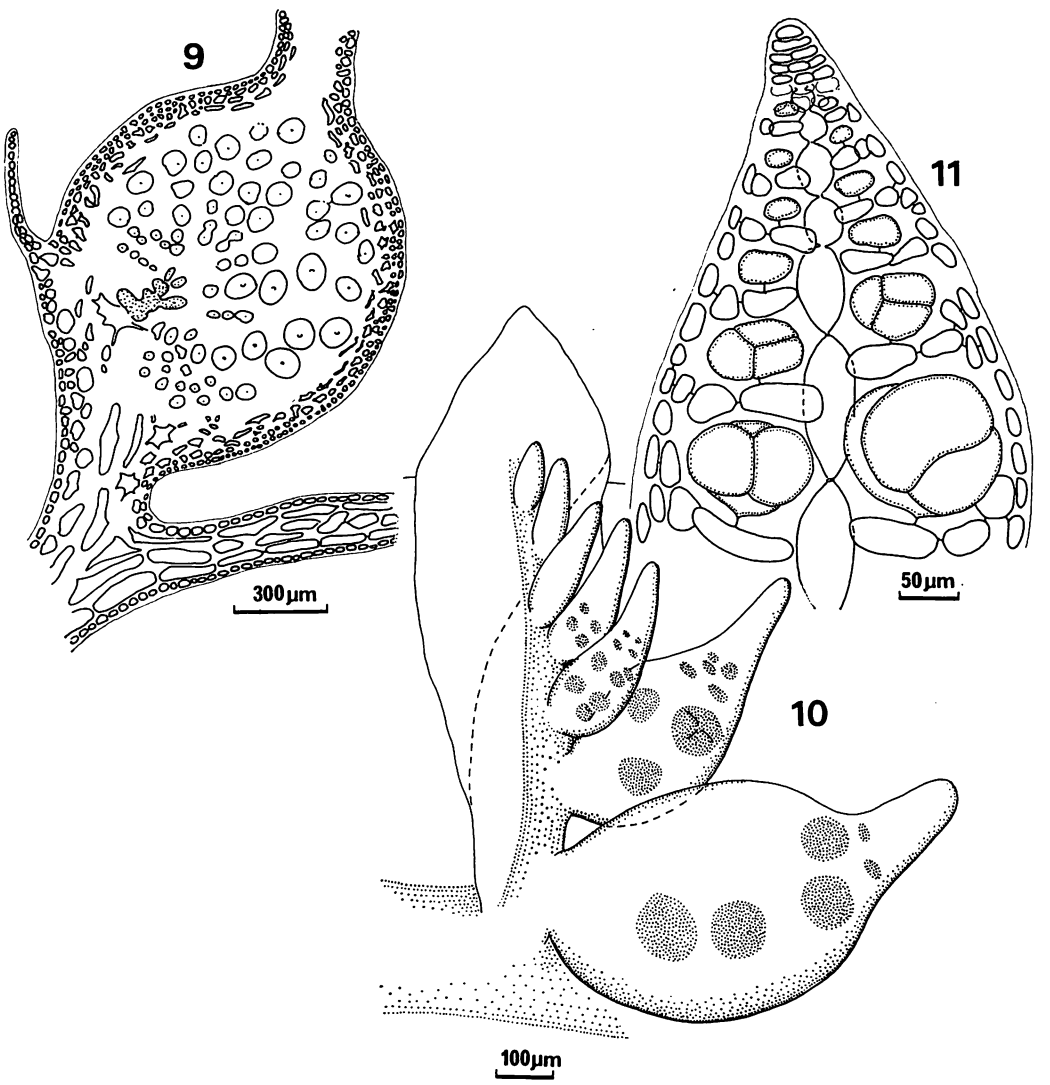
Figs. 4-7. Development of blade.

Fig. 8. Cross section a blade, showing midrib and monostromatic wings.

very early stage of development. The procarp is produced on the adaxial side of the midrib. Mature cystocarp is sessile on the blade, spherical in shape, attaining up to 2 mm in diameter, with conspicuous rostrate projection delimiting the ostiole. Surface of the pericarp is smooth without any ornamentation.

There is no large fusion cell or placental cell at the base of gonimoblast. Carposporangia, 90–100 μm in diameter, are produced in chains (Fig. 9).

Tetrasporangia: Tetrasporangia are formed in the stichidia-like bladelets borne adaxi-



Figs. 9–11. *Kurogia pulchra* YOSHIDA

Fig. 9. Section of mature cystocarp.

Fig. 10. Stichidium-like tetrasporangial bladelets.

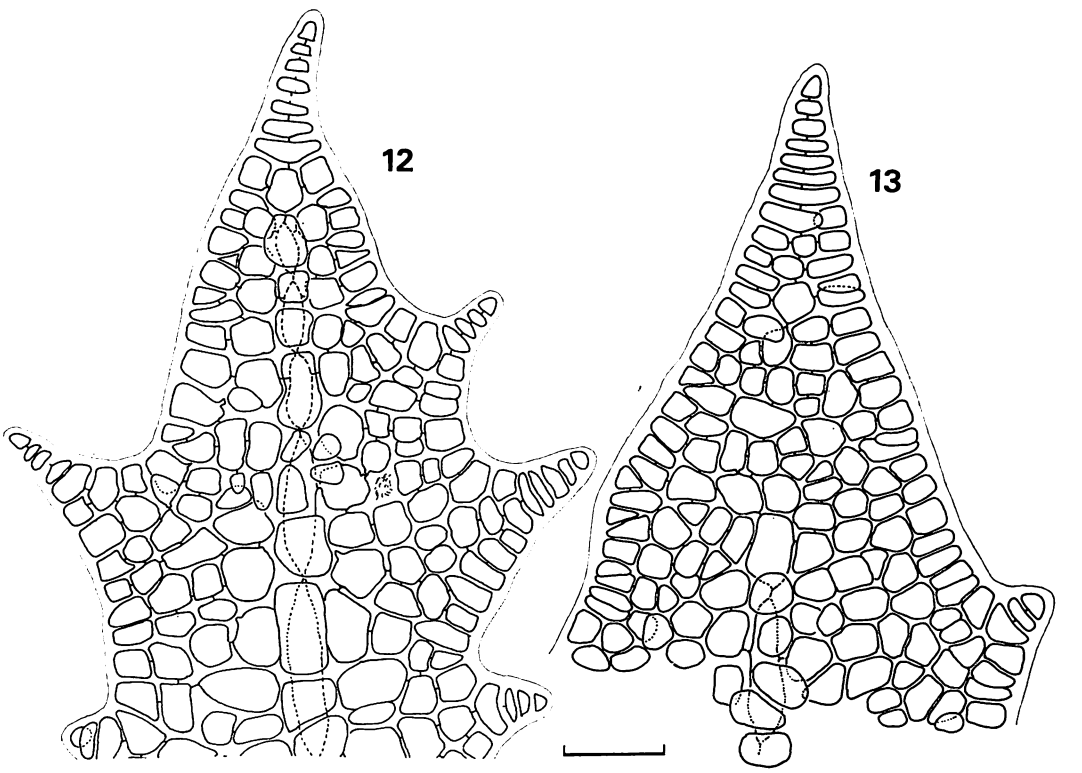
Fig. 11. A part of stichidium-like bladelet, optical section showing 2 out of 4 tetrasporangia per tier.

ally on the midrib of the blade (Fig. 10).

A sporangial primordium is cut off by transverse division of a pericentral cell. The superficial layer of cortical cells is formed after the primordia are cut off (Fig. 11). Four tetrasporangia per tier are produced. Mature sporangia divide tetrahedrally, and are 160–200 μm in diameter.

Discussion

Although there are some deficiencies in our knowledge of this plant concerning the development of procarps and spermatangial thalli, it is clear from the observations given above that this plant belongs to the Delesseriaceae. In this family, it



Figs. 12–13. *Zinovaea acanthocarpa* WYNNE
Apical segmentation in young blade. Scale 50 μm.

can be placed in the subfamily Delesserioideae, judging from the position of cystocarps and the development of tetrasporangial primordia from surface cells. This taxon, however, occupies very unique position in this subfamily because of its mode of apical segmentation and other characters discussed later. As for the mode of development of the frond, sympodial growth is a conspicuous character of this taxon, this mode of growth being shared only by *Sympodophyllum reinboldii* SHEPLEY et WOMERSLEY, *Cumathamnion sympodophyllum* WYNNE et DANIELS and *Zinovaea acanthocarpa* WYNNE. The plant described here is different from the former two in many respects. The mode of apical segmentation is Membranoptera type in *Sympodophyllum* and Delesseria type in *Cumathamnion*. In both genera, the alae are polystromatic and tetrasporangia are formed in the flat blades indistinguishable from the vegetative ones. The monostromatic alae and position of cystocarps as well as the stichidia-like tetrasporangial blades are similar to those of *Zinovaea* which has other differences shown below.

I examined the type collection of *Zinovaea acanthocarpa* throught the kindness of Dr. WYNNE. In discussing *Zinovaea*, WYNNE (1970) was uncertain that it was a member of the Delesseriaceae. From my examination of his material, and my study of the plant discussed here, which I consider to be closely related to *Zinovaea*, I believe that both taxa should be assigned to the Delesseriaceae, subfamily Delesserioideae. In *Zinovaea*, the pattern of apical segmentation of the blade is very difficult to follow except in very young stage of development (Fig. 12). Here intercalary division occurs only in the cell rows of the second order. However, in a more advanced stage, represented in Fig. 13, the

intercalary division is recognized also in the cell row of the first order. Division of cells of the first order cell row with oblique walls as seen in my plant is uncertain in *Zinovaea*, because very soon it is impossible to trace the cell row of the first order. *Zinovaea* has unique characteristics such as the triquetrous appearance of blade owing to a keel on the midrib, and cystocarps with distinctive spiny outgrowths. Tetrasporangial bladelets in *Zinovaea* produce 3 tetrasporangia per tier, because of the fact that the abaxial pericentrals do not cut off a sporangial initial.

These differences warrant the establishment of a new genus for the plant discussed here.

Kurogia YOSHIDA gen. nov.

Thallus axibus sympodialiter evolutis instructus; cellulae apicales pariete transversali discendens; in gradu praecosi progressum laminae dispositio alterna seriei ordinis secundi adest e divisione obliqua cellularum certarum ordinis primi; divisiones cellularum intercalarium in ordine primario secundoque adsunt; initia tertia marginem thalli non omnino attingentia; costa apicem laminae haud attingens; alae laminae monostromaticae, sine venis lateralibus; costa in axibus vetioribus e cellulis magnis filamentis rhizoidalibus intersparsis constans; laminae adaxialiter unilateralique productae; cystocarpium unicum in costa cujusque laminae fertilis crescens; pericarpii pagnia laevis sine ullo ornamento; carposporangia catenata; 4 tetrasporangia in ramulis stichidiiformibus omnis ordinis portata.

Thallus with sympodially developed axes; apical cell dividing with transverse wall; at an early stage of blade development, oblique division of certain cells of the first order cell row gives rise to alternata arrangement of the cell row of the second order; intercalary divisions occurring in the cell rows of the first and second orders; not all tertiary initials reaching thallus margin; midrib not reaching blade apex; wings of the blade monostromatic, without lateral veins; midrib in older axes composed of large cells interspersed with rhizoidal filaments; blades produced adxially and unilaterally; single cystocarp developing on the midrib of each fertile blade; pericarp smooth without any ornamentation; carposporangia produced in chains; tetrasporangia produced in stichidium-like bladelets; 4 tetrasporangia per tier.

Type species: *K. pulchra* YOSHIDA

Kurogia pulchra YOSHIDA, sp. nov. (Figs. 1–11)

Thallus roseus, mollis membranaceus, usque ad 17 cm altus, unilateraliter multo ramosus; laminae oblongae, usque ad 2 cm latae et 7 cm longae; apices juveniles acuti, sed demum maturitate obtusi esse convertant; lamina margine maturitate plerumque integra, undulata vel juvento dubie crenulata; cystocarpium sessile in costa laminae fertilis, sphaericum, usque ad 2 mm in diametro, ostiolo rostrato conspicuo; laminae ultimatae tetrasporangiales stichidiiformes conicae, basi leviter constrictae, usque ad 0.9 mm longae, 0.4 mm latae; tetrasporangia tetrahedraliter divisa, 160–200 μm in diametro; planta spermatangialis ignota.

Thallus pink, soft membranaceous, up to 17 cm high; much branched on one side of blade; blades oblong, up to 2 cm wide and 7 cm long; young apices acute, becoming obtuse at maturity, margin nearly entire at maturity, undulate or vaguely crenulate when young; cystocarp sessile on the midrib of fertile bladelet, spherical in shape, up to 2 mm in diameter, with conspicuous rostrate ostiole; tetrasporangial stichidium-like ultimate bladelets conical, with slightly constricted base, up to 0.9 mm long, 0.4 mm wide; tetrasporangia tetrahedrally divided, 160–200 μm in diameter; spermatangial plant unknown.

Holotype: Cystocarpic, May 8, 1978, Cape Nosappu, Nemuro Prov. Hokkaido, drift, T. YOSHIDA (SAP 034547).

Additional specimen: Tetrasporangial, May 19, 1969, off Notsuka-mappu, Nemuro Prov. Hokkaido, from gill net laid at

28 m depth, M. KUROGI and T. YOSHIDA (SAP 034548).

Japanese name: Ikada konoha (nov.).

The genus is named in honour of Professor Munenao KUROGI, Hokkaido University, leader of research on marine algae of eastern Hokkaido.

When MIKAMI (1971) described the genus *Congregatocarpus*, he recognized that intercalary cell divisions occur in cell rows of the first order, a feature of the subfamily Nitophylloideae, but for other features, the genus was more closely allied to the subfamily Delesserioideae in which he placed it. Later, he (1973) proposed for this genus 'Congregatocarpus group' (Delesserioideae) emphasizing the presence of intercalary divisions in the first order cell row and the production of cystocarps and tetrasporangia in special proliferations.

Zinovaea and *Kurogia* share also the characteristic of occurrence of intercalary cell divisions in the cell row of the first order. But they differ from the 'Congregatocarpus group' in the sympodial mode of growth. I propose here 'Kurogia group' for the genera *Kurogia* and *Zinovaea* with the following characterization:

Intercalary division present in the cell rows of the first and second orders; not all tertiary initials reaching thallus margin; frond composed in a sympodial manner; carposporangia produced in chains; tetrasporangia borne in stichidial bladelets.

I wish to express my hearty thanks to Professor Munenao KUROGI, Hokkaido University, Professor Hideo MIKAMI, Sapporo University, and Professor Isabella A. ABBOTT, Stanford University, for their invaluable advice and reading the manuscript. I am particulary grateful to Dr. Michel J. WYNNE, University of Michigan, for sending me type materials of *Zinovaea acanthocarpa* and *Cumathamnion sympodophyllum*. I am indebted to Professor Hideo TOYOKUNI, Shinshu University, for the preparation of Latin description. This work was partly supported by a grant from the Ministry of Education.

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吉田忠生：紅藻コノハノリ科の1新属

北海道根室半島で採集された紅藻コノハノリ科の1種は，嚢果が中肋上に作られることからコノハノリ亜科に所属する。(1)葉片の頂端成長が永続せず，その中肋上の向軸面側に次位の葉片が順次できて成長を続けて行く連基的な成長，(2)第1位細胞列の末端に近い数個の細胞が斜の膜で分裂して，その部分で第2位細胞列が互生的に生ずるようになる，(3)四分胞子嚢は円錐形のスチキジア状の小葉片の各段に4個ずつ作られる等の特徴から新属新種と考定し，イカダコノハ *Kurogia pulchra* として記載した。第1位細胞列に介生分裂があることなどから *Zinovaea* 属と近縁であると考えられるので，この2属を含める Kurogia Group を提案した。(060 札幌市北区北10条西8丁目　北海道大学理学部植物学教室)