

Michio Masuda, Masao Ohno and Gavino C. Trono, Jr.: A taxonomic assessment of *Porphyra suborbiculata* Kjellman, a food species from the Philippines*

Key Index Words: Nori sheets—Philippines—Porphyra—*Porphyra crispata*—*Porphyra suborbiculata*—taxonomy.

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Five species of *Porphyra* have been reported from the Philippine Islands (Silva *et al.* 1987). These are mainly limited to the northern coasts of Luzon Island. *Porphyra* thalli are locally known as "gamet" and are collected along the coast of Ilocos Norte. They are sold in the form of dried sheets called "pedazo" at the local market (Trono and Ganzon-Fortes 1988). The materials for preparation of the dried "gamet" are washed with freshwater and are made into sheets, 100-150 × 100 cm in size and about 5 mm thick and are dried under the sun. The dried sheets are expensive in comparison with other seaweeds such as *Enteromorpha*, *Codium*, *Caulerpa*, *Halymenia*, *Gracilaria* and *Laurencia*.

"Gamet" is prepared in the form of salad or used in soups. The utilization of *Porphyra* as food is limited to the populations along coastal communities in northern Luzon. This report presents observations on the ecology, morphology and taxonomy of *Porphyra* in Ilocos Norte.

Materials and Methods: Plants were collected at Ablan, Burgos, Ilocos Norte, Luzon Island on February 1 and 3, 1990, fixed and preserved in 10% formalin in seawater. A portion of the collections was dried for herbarium sheets, or was transported to Japan. Voucher specimens are deposited in the herbarium, Faculty of Science, Hokkaido University at Sapporo (SAP). Dried sheets were pur-

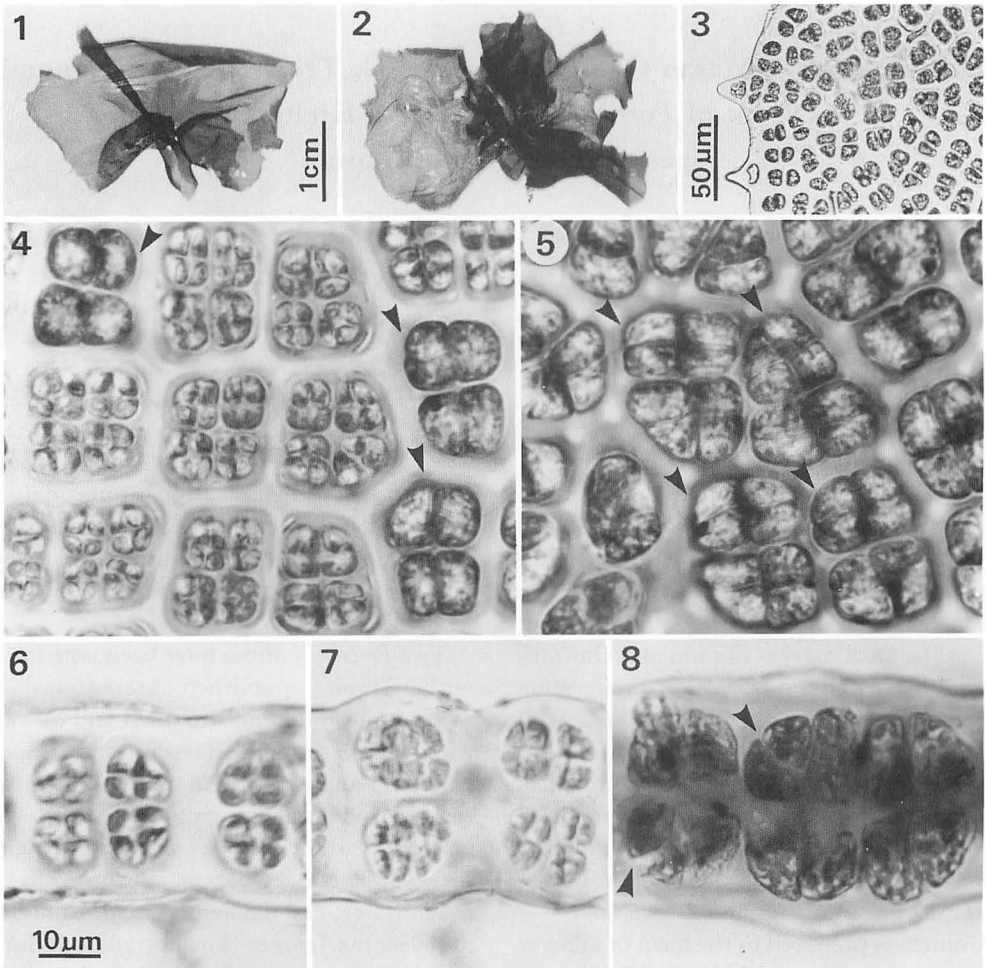
chased from a local gamet gatherer.

Ecology: *Porphyra* plants were found growing on rocky, wave-exposed upper intertidal zone in Ilocos Norte from November to February. At the time the survey was done, the water temperature was 25.9°C and salinity was 34.8‰.

Two *Porphyra* entities have been noted previously (Trono unpublished observations): one with roundish to reniform thalli and the other with lanceolate thalli. The entity with lanceolate thalli appears to be dominant during the early period of the growing season in November, but was not seen or collected during this survey. The rocky habitat is exposed to very rough water, and the gatherers were only able to collect the "gamet" for short periods during low tides for one or two calm days a week during the winter months from November to February.

Morphology: Specimens collected and materials of dried sheets purchased have the following features in common. Foliose thalli are purplish red in color, round, reniform or funnel-shaped, 1-3 cm high, rolled toward one side (Fig. 1). Several thalli are deeply lobate near the base (Fig. 2) and show a habit similar to the green alga *Ulva conglobata*. Each thallus possesses a discoid holdfast, 0.8-1.2 mm in diameter, and an obscure stipe. The thalli are monostromatic, 35-45 μm thick at the center (1 cm above the base), 22-25 μm thick at the vegetative margin. Vegetative cells in surface view are polygonal in shape, 20-30 μm long × 12-22 μm wide. The cells are irregularly arranged, contain a single stellate

* This work was supported by the overseas research project with the grant from the Ministry of Education, Science and Culture, Japan: No. 01041067 (1989) and No. 02041064 (1990).



Figs. 1-8. *Porphyra suborbiculata* Kjellman. Figs. 1, 2. Herbarium specimens collected at Ablan, Burgos, Ilcos Norte, northern Luzon Island on February 3, 1990 (SAP 054606). Fig. 3. Marginal portion of a thallus, showing microscopic serrations. Fig. 4. Surface view of a spermatangial area intermixed with zygotosporangia (arrowheads); note each spermatangium composed of 16 cells (a/4, b/4), each of three zygotosporangia of 4 cells (a/2, b/2). Fig. 5. Surface view of a zygotosporangial area; note each of four zygotosporangia (arrowheads) composed of 8 cells (a/2, b/4). Figs. 6, 7. Transverse section of a spermatangial area; note spermatangia composed of 4 layers (c/4 stage) in Fig. 6 and those of 8 layers (c/8) in Fig. 7. Fig. 8. Transverse section of a zygotosporangial area; note each of two zygotosporangia composed of 4 layers (left and center, c/4; arrowheads indicating one of the last divisions, others out of focus) and a zygotosporangium of 2 layers (right, c/2 stage). Scale in Fig. 1 applies also to Fig. 2; scale in Fig. 6 applies also to Figs. 4, 5, 7 and 8.

chloroplast, are elliptical to rounded rectangular in transverse section, 20-30 μm high \times 15-30 μm wide at the center of the thallus. The lowermost cells of thalli bearing rhizoidal filaments are variable in shape and size in surface view, angulate-capitate to oblong-capitate, 20-60 μm long \times 20-35 μm wide. Microscopic serrations are present along the margins of the blades (Fig. 3).

Plants are monoecious. Spermatangia occur in a continuous marginal band without intervening vegetative cells. Zygotosporangia¹⁾ occur adjacent and just inside the spermatangial areas and also form a continuous broad

¹⁾ This new term was new term was proposed on the basis of a peculiar ontogeny of the zygote in *Bangia* and *Porphyra* by Guiry (1990).

band without intervening vegetative cells. These two areas are sometimes intermixed at certain portions (Fig. 4). Fertile cells are rounded rectangular to elliptical in surface view and fertile portions of the thalli are 35–50 μm thick. Spermatangial parent cells are divided into 16 cells in surface view (the division formula = $a/4$, $b/4$, Fig. 4) and 8 layers in sectional view (the division formula = $c/8$, Fig. 7). After presumed fertilization, zygotes are divided into 8 cells in surface view (the division formula = $a/2$, $b/4$, Fig. 5) and 4 layers in sectional view (the division formula = $c/4$, Fig. 8). The number of divisions represents maxima. In many spermatangia the division formula is $a/4$, $b/4$, $c/4$ (Fig. 6) and in many zygotosporangia it is $a/2$, $b/4$, $c/2$ (Fig. 8, right). Release of spermatia and zygotospores was not confirmed.

Taxonomic remarks: Five species of *Porphyra* have been reported from Ilocos Norte, northern Luzon Island (Silva *et al.* 1987): *P. atropurpurea* (Olivi) De Toni, *P. crispata* Kjellman, *P. denticulata* Levring, *P. marcosii* Cordero and *P. suborbiculata* Kjellman. The last four species have microscopic serrations along the margins of the thallus. This peculiar feature characterizes several species in the genus. *Porphyra denticulata* differs from the alga in question in its lanceolate form of thalli, 32 spermatia formed within a spermatangial pocket, and 8 zygotospores formed per zygotosporangium (Levring 1953). *Porphyra marcosii* is distinguished from the present alga by its linear-lanceolate thalli and 8 zygotospores per zygotosporangium (Cordero 1977). In addition to these four species, the following seven species of *Porphyra*, all of which grow in Asiatic waters, are known to possess microscopic serrations along margins of their blades: *P. dentata* Kjellman (1897), *P. dentimarginata* C. Y. Chu et S. C. Wang (1960), *P. guangdongensis* Tseng et T. J. Chang (1978), *P. haitanensis* T. J. Chang et B. F. Zheng (1960), *P. okamurae* Ueda (1932), *P. tanegashimensis* Shinmura (1974), and *P. vietnamensis* Tanaka et P.-H. Ho (1962). These species, except for *P. dentimarginata*, can be distinguished from our alga by their lanceolate

thalli. *P. dentimarginata* has round to elliptic thalli, but it differs from the Ilocos Norte plants in its exceedingly thicker (76–120 μm) thalli (Chu and Wang 1960).

The alga under study is similar in many respects, except for the division formula of spermatangia, to *Porphyra suborbiculata* (Table 1). According to Kurogi (1972), division numbers of spermatangia and zygotosporangia in the species of *Porphyra* he studied vary with age. The division numbers of young plants are smaller than those of old plants and these young plants can release spermatia and zygotospores. Furthermore, Miura (1968) reported geographical variation in the division formula of zygotosporangia for *Porphyra katadae* Miura. Our alga can therefore be identified with *Porphyra suborbiculata* Kjellman despite the variation in spermatangial division.

One other alga that requires discussion is *Porphyra crispata* Kjellman. This species has been reported from various localities in Asiatic waters (Ueda 1932, Tanaka 1952, Dawson 1954, Miura 1967, Tseng *et al.* 1983). According to Kurogi and Yamada (1986), however, Kjellman's type materials of *P. crispata* were not *Porphyra* but a green alga *Monostroma nitidum*. *Porphyra crispata* Kjellman (1897) should be reduced to be a synonym of *Monostroma nitidum* Wittrock (1866). Kjellman (1897) described neither marginal serrations nor reproductive structures for *P. crispata*. Ueda (1932), Tanaka (1952) and Miura (1967) gave detailed descriptions of a species of *Porphyra* which they referred to *P. crispata* Kjellman. It is likely that further study will result in a new name for this entity.

The taxonomic relationship between *Porphyra suborbiculata* and *P. crispata* sensu Ueda requires further comment. Taxonomic features of both algae are summarized in Table 1. As these algae were first reported from Japanese waters (the type locality of *P. suborbiculata* is Goto Islands), references are limited to papers of the three major Japanese authors, Ueda (1932), Tanaka (1952) and Miura (1967). Ueda (1932) characterized his *P.*

Table 1. A comparison of *Porphyra suborbiculata* Kjellman and *P. crispata* sensu Ueda

Characters	<i>P. suborbiculata</i>			<i>P. crispata</i>		
	Ueda (1932)	Tanaka (1952)	Present authors	Ueda (1932)	Tanaka (1952)	Miura (1967)
Thallus shape	round, reniform or funnel-shaped	ovate or reniform	round, reniform or funnel-shaped	elliptical or reniform	ovate or reniform	reniform to linear
Thallus size	3–7 cm high	3–10 cm high, 3–7 cm wide	1–3 cm high	2–4(–8) cm high	2–5 cm high, 2–4 cm wide	up to 10 cm high
Thallus division	present only in old plants	not described	present	present	present	present
Thallus margin	rolled in old plants	slightly undulate	rolled toward one side	undulate	lacinate with slightly crenate	not described
Serration	present	present	present	present	present	present
Color	purplish red	light pink or purplish red	purplish red	light red or russet	light red or russet or light russet	glossy blackish purple
Thickness of vegetative part	25–35 μm	30–48 μm	35–45 μm	45–50 μm	45–68 μm	60 μm
Vegetative cell in surface view	nearly round	angular with rounded angles	polygonal; 20–30 μm long, 12–22 μm wide	long elliptical	oblong-elliptical; 15–20 μm in diam.	not described
Vegetative cell in cross section	quadrate with rounded angles; slightly higher than wide	quadrate with rounded angles; slightly higher than wide	quadrate with rounded angles; 20–30 μm high, 15–30 μm wide	elliptical; 32 \times 20 μm , one half times as high as wide	elliptical; 55–60 \times 20–27 μm , one half times as high as wide	not described
Rhizoidal cells	angulate capitate	angulate capitate	angular to oblong capitate; 20–60 μm long, 20–35 μm wide	oblong capitate; 55–60 μm long, 20–24 μm wide	oblong capitate	oblong or capitate
Thickness of fertile part	45–48 μm	40–50 μm	35–50 μm	55–65 μm	not described	not described
Female and male areas	not described	splashed	splashed	separated	separated	not described
Division formula of zygotosporangia	a/2, b/4, c/4 or a/2, b/2, c/4	a/2, b/4, c/4	a/2, b/4, c/4	a/2, b/2, c/6 or a/2, b/2, c/6 + 2(a/1, b/1, c/1)	a/2, b/4, c/4	a/2, b/2, c/4 or a/2, b/2, c/8
Division formula of spermatangia	a/4, b/4, c/4	a/4, b/4, c/4	a/4, b/4, c/8	a/4, b/4, c/8	a/4, b/4, c/8	a/4, b/4, c/8

crispata as follows: 1) a peculiar division of zygotosporangia, 2) a smaller thallus, 3) exceedingly elongated capitate cells bearing rhizoidal filaments, and 4) a caespitose thallus similar to *Ulva conglobata*. Tanaka (1952) and Miura (1967) seemed to agree with the opinion of Ueda. There is, however, a discrepancy in the description of the division formula of zygotosporangia by these authors. According to Ueda, the division formula of zygotosporangia for his *P. crispata* is $a/2$, $b/2$, $c/6$ or $a/2$, $b/2$, $c/6+2$ ($a/1$, $b/1$, $c/1$), but according to Tanaka, it is $a/2$, $b/4$, $c/4$. The latter is the same as that of *P. suborbiculata* given by Ueda and Tanaka (Table 1). According to Miura (1967), the division formula of zygotosporangia of *P. crispata* sensu Ueda is usually $a/2$, $b/2$, $c/4$ and rarely $a/2$, $b/2$, $c/8$. Miura (1967) states that the division mode of zygotosporangia described by these three authors is basically similar. The size of thalli overlaps each other and is not clearly separated. The shape of lowermost cells bearing rhizoidal filaments is very variable within an individual, and so it is not a good diagnostic character. "Caespitose" thalli (sensu Ueda and Tanaka) may be formed by divisions of funnel-shaped thalli. Our observations on specimens in the field showed that the *Porphyra* population was composed of variable shapes of foliose thalli. Divided "caespitose" thalli resembling *Ulva conglobata* in outer appearance were found among round, reniform or funnel-shaped thalli.

Ueda (1932) and Tanaka (1952) were in agreement with regard to the division formulae of spermatangial parent cells for *Porphyra suborbiculata* and *P. crispata* sensu Ueda: the former species is $a/4$, $b/4$, $c/4$ and the latter is $a/4$, $b/4$, $c/8$. However, Kurogi (1972) described the division formula of *P. suborbiculata* as identical to that of *P. crispata*.

Tanaka (1952) emphasized the occurrence of splashed patches of spermatangial and zygotosporangial areas for *Porphyra suborbiculata*. We also found such intermixed areas in the Philippine materials. However, each area is widely distinct and intermixed areas are very narrowly restricted. It is question-

able whether this character has taxonomic significance.

Finally, thallus thickness in both algae should be compared. *Porphyra crispata* has thicker thalli than *P. suborbiculata* (Table 1); however, it is hardly possible to distinguish *P. crispata* as described by Ueda (1932) from *P. suborbiculata* as described by Tanaka (1952) on the basis of thallus thickness. Thus, there is no clear distinction between *P. suborbiculata* and *P. crispata* sensu Ueda and it is suggested that the latter is "caespitose" and may be older thalli of the former. In order to clarify further the status of *Porphyra crispata* sensu Ueda it is necessary to analyze its seasonal and geographical variations.

We are grateful to: Professor T. Yoshida, Hokkaido University and Professor M. D. Guiry, National University of Ireland for their criticism of the manuscript; Drs. H. Nakahara and T. Ajisaka, Kyoto University for their help in collecting materials.

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増田道夫¹・大野正夫²・Gavino C. Trono, Jr.³：フィリピンで
食用にされているマルバアマノリ

フィリピンのルソン島北部の Ilocos Norte 州では、11月から2月にかけて生育するアマノリ属から乾海苔を作成して食用にしている。生育期の後期の乾海苔製品並びに現地で2月に採集した標本は、藻体の形、大きさ、厚さ、鋸歯、及び生殖器官の分裂様式の特徴からマルバアマノリ (*Porphyra suborbiculata* Kjellman) であることが判明した。ツクシアマノリ (*P. crispata* sensu Ueda) と本種との関係についても論じた。(1060 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；²781-11 土佐市宇佐町井尻194 高知大学海洋生物教育研究センター；³Marine Science Institute, College of Science, University of the Philippines, Diliman, Quezon, Philippines)