

## Note on the Species of *Ceramium* (Ceramiace Rhodophyta) from Ullungdo Island, Korea

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The taxonomic note was given to the species of *Ceramium* from Ullungdo Island. Five species, *Ceramium aduncum* Nakamura, *C. codii* (Richardson) G. Mazoyer, *C. flaccidum* (Harvey ex Kützinger) Ardissonne, *C. paniculatum* Okamura, and *C. tenerrimum* (Martens) Okamura were collected during this study. *C. aduncum* was collected in the intertidal and upper subtidal zones from December to February. They had a narrow internodal space showing 1/3-1/5 times as large as nodal band. *C. codii* had the spermatangial mother cells developed on abaxial cortical cells of cortical band. *C. paniculatum* collected in summer and winter had a creeping thallus and alternative branching type in gross morphology. The axial cell of *C. flaccidum* showed 2.3-2.8 L/B ratio, smaller than those of plants from Chejudo Island.

**Keywords:** taxonomy, *Ceramium*, Rhodophyta, cortical band, Ullungdo Island

*Ceramium* Roth is a large genus of red algae, which is widely distributed and encompasses about 70 to 100 species (Boo, 1984). The species are distinguished from each other mainly by the cortication of thallus, curvature of branch apices, occurrence of gland cells, shape of spines but the taxonomy is chaotic due to failure of referring to the original and authentic materials as well as to the seasonal and environmental modification of plants (Dixon, 1960; Boo, 1993). Eleven species of this genus have been collected along the coast of Korea. The morphological and cultural studies on this species have been carried out (Boo, 1984; Boo and Lee, 1985; Suh and Lee, 1984). In Ullungdo Island, six species have been collected mainly in floristic and ecological survey (Lee and Boo, 1981) but any report have not been given descriptions on these species in detail except for *C. paniculatum*. The present study was made to describe morphological features of the plants of five species collected in Ullungdo Island.

### MATERIALS AND METHODS

Plants were collected at eight sites in Ullungdo

Island, Korea, from Nov. 1989 to Feb. 1992. Specimens were fixed with 5-10% formaline-seawater in the field and others were transferred to laboratory in cooling water. Some of them were prepared for dried specimens and others liquid preservation in 5-10% neutralized formaline-seawater in SNU Herbarium. For microscopic observation, plants were stained with 1% aniline blue solution. The taxonomic description was made on the species whose specimens were collected during the study.

### DESCRIPTIONS OF THE SPECIES

*Ceramium aduncum* Nakamura, 1950, pp. 158-160.

(Fig. 1A-B)

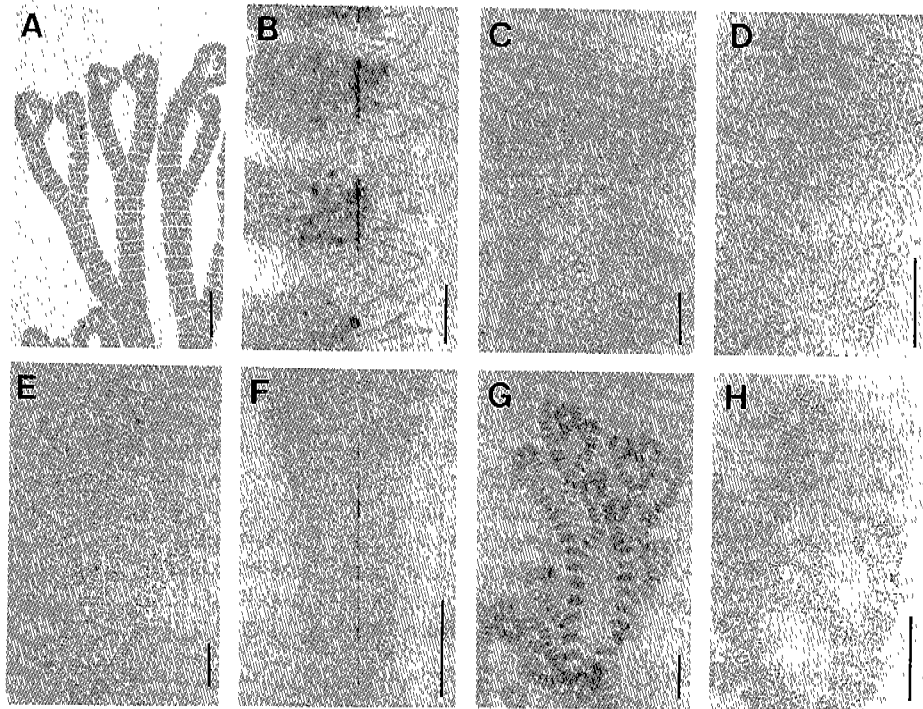
**Korean name:** 고리비단풀

**Synonyms:** *Ceramium circinatum* Yendo (non J. Agardh), 1917, p. 92; *Ceramium cloriensis* Dawson (non Setchell & Gardner), 1950, pp. 134-137.

**References:** Nakamura, 1965, pp. 138-140; Itono, 1972, p. 81; 1977, pp. 115, 199-200, 267-268; Boo, 1984, pp. 249-259, Figs. 48-49.

Plants epiphytic to epilithic, pseudodichotomously branched, subcomplanate, partially prostrate, up to 2(-3) cm high, dark red; rhizoids developed from

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**Fig. 1.** *Ceramium aduncum* Nakamura, *C. codii* (Richardson) G. Mazoyer, *Ceramium flacidum* (Harvey ex Kützinger) Ardissonne and *Ceramium paniculatum* Okamura. A-B, *Ceramium aduncum*: A, an upper part of a thallus; B, rhizoids developed from cortical cells; C-D, *C. codii*: C, an upper part of a thallus; D, spermatogonia clusters adaxially developed; E-F, *C. flacidum*: E, an upper part of a thallus; F, cortical bands; G-H, *C. paniculatum*: G, an upper part of a thallus; H, apical part magnified. (Scale bar; A, 200  $\mu$ m; B-C; E-H, 100  $\mu$ m; D, 50  $\mu$ m).

periaxial cells, 2-3(-4) celled, ending with multicellular pad; apical parts of filaments strongly incurved; axial cells cylindrical, 185-350  $\mu$ m long, 150-250  $\mu$ m broad, 7/3-1/1 L/B ratio, with internodal space 1/3-1/5 times nodal bands; periaxial cells 8-9(-10) in ring, originated from axial cells acropetally; gland cells spherical, 15-20 $\times$ 20-25  $\mu$ m, 5-8 in every cortical node; gametophytes and tetrasporophytes not collected.

**Type locality:** Goza, Sima Province, Japan.

**Habitat:** On coralline algae, *Ecklonia cava*, and rock in the upper subtidal zones (in 1-3 m depth).

**Distribution:** Pacific coast of Central America (Nakamura, 1950), Japan, China, Along the coasts of Korea (Boo, 1984).

**Materials examined:** Summok (17 Feb. 1990), Tonggumi (16 Feb. 1990; 18 Dec. 1990; 16 Feb. 1992), Dodong (26 Feb. 1991).

This species is distinguished by presence of gland cells at cortical bands and strongly incurved branches. It has been reported from the east and west coasts and Chejudo Island in Korea (Boo, 1984).

The plants from Ullungdo Island were collected in the intertidal and upper subtidal region from December to February. Most plants were vegetative and grew on the coralline algae, *Ecklonia cava* and rocks. Boo (1984) reported that this species grew along all the coast of Korea in winter season. The plants from the east coast of Korea, Anin, Anmok and Jumunjin, which are located in the similar latitude to that of Ullungdo Island, had reproductive structures from October to December. However, most plants from Ullungdo Island were only vegetative and showed different phenology from that of those sites during this study. The phenology of this species in Ullungdo Island may be affected by seawater temperature variation, different from those of the plants from the other sites. Boo (1984) reported that the spines in apex described by Nakamura was not found in the plants from Korea. The plants from Ullungdo Island also did not have any spines (Fig. 1A, B). So, the taxonomic validity of the feature was not proven. Most plants in Ullungdo Island had the strongly incurved apex and agreed to Boo(1984)'s

description in morphology. But they had the narrow nodal space showing 1/3-1/5 times of nodal band and had 5-8 gland cells in every cortical node. Suh and Lee (1984) reported that the strongly incurved apex showed variability in culture and suggested that the degree of the curvature might be affected by environmental condition.

***Ceramium codii* (Richards) G. Mazoyer, 1938, p. 324.**

(Fig. 1C-D)

**Korean name:** 청각비단풀

**Basionym:** *Ceramothamnion codii* Richards, 1901, p. 264.

**Synonyms:** *Ceramothamnion adriatum* Schiller, 1912, p. 90; *Ceramium mucronatum* Segi, 1944, p. 33.

**References:** Dixon, 1958, pp. 14-16; Nakamura, 1954, pp. 15-65; Kang, 1966, p. 89; Itono, 1972, p. 80; 1977, pp. 30-31, 97-98; Boo, 1984, pp. 178-194, Figs. 32-34.

Plants epiphytic, subdichotomous, creeping on substratum by basal parts, up to 1-2 cm high, bright red; rhizoids simple to branched, developed from periaxial cell, 2-4 celled, ending with multicellular pad; erect filaments 3-5 times subdichotomously branched, without conspicuous main axis, 70-80  $\mu$ m broad, subcomplanate, straight in apex; axial cells cylindrical, 25-40  $\mu$ m long, 15-20  $\mu$ m broad, 5/4-8/3 L/B ratio; rhodoplasts linear, arranged parallel to axis; periaxial cells four to five, dividing acropetally; gland cells absent; spermatangia arising from adaxial cortical cells, clustered; female gametophytes and tetrasporophytes not collected.

**Type locality:** Bermuda of the Atlantic Ocean.

**Habitat:** On the other plants (*Codium fragile*) in the subtidal zones (in 3-6 m depth).

**Distribution:** Cosmopolitan; Pacific Ocean (Korea, Japan and Tasmania), North Atlantic Ocean, Indian Ocean, Mediterranean Sea (Feldmann-Mazoyer, 1940), Baltic Sea.

**Materials examined:** Summok (20 May 1991).

This species has been reported over the world and East coast and South coast including Chejudo Island in Korea (Boo, 1984). It is hard to collect the plants because of small thallus less than 2 cm. Boo (1984) observed that the plants from Korea had dichotomous branches, erect thallus in culture and no

gland cell. The presence of gland cells was described in European plants (Feldman-Mazoyer, 1940) and Nakamura (1954) recognized it as a character to distinguish species in *Ceramium*. But there have been disputes on that (Dixon, 1960; Womersley, 1978).

The plants from Ullungdo Island had subdichotomous branches creeping on the surface of the thallus of *Codium fragile*. The axial cells are 25-40  $\mu$ m long and 15-20  $\mu$ m broad, rather shorter and narrower than those of Japanese and European plants. The male plants were collected from the subtidal zones at Summok in Ullungdo Island. Boo (1984) reported that the development of the spermatangia began at the adaxial side of cortical band toward the abaxial side in the culture plants. However, the spermatangia on plants from Ullungdo Island were restricted on the adaxial side of cortical band (Fig. 1D).

***Ceramium flaccidum* (Harvey ex Kützing) Ardisson, 1871, p. 40.**

(Fig. 1E-F)

**Korean name:** 명주비단풀

**Basionym:** *Hormoceras flaccidum* Kützing, 1862, p. 21.

**References:** Womersley, 1978, pp. 234-238, Figs. 14-15; Boo, 1984, pp. 215-227.

Plants epiphytic to epilithic, alternately branched, partially prostrate, up to 1 cm high, light to dark red; rhizoids developed from corticated nodes, one- to two-celled, ending with multicellular pad; lateral branches incurved in apex; axial cells 220-225  $\mu$ m long, 80-95  $\mu$ m broad, 2.3-2.8 L/B ratio; periaxial cells five; gametophyte and tetrasporophytes not collected.

**Type locality:** Kilkee Island, Ireland.

**Habitat:** On other plants (*Corallina* sp.) and rocks in the intertidal and subtidal zones (in 2-3 m depth).

**Distribution:** Pacific Ocean (Korea, Japan, Baja California, Marshall Island, Solomon Island), Atlantic Ocean, South China Sea, Indian Ocean, Mediterranean Sea (Boo, 1984).

**Materials examined:** Tonggumi (18 Dec. 1990), Summok (17 Feb. 1990).

*Ceramium flaccidum* is widely distributed all over the world and but reported only from Chejudo Island in Korea (Boo, 1984). This species is characterized by oblique upper cortical cells in upper part

of cortical band and longish cortical cells arranged in row in lower part of cortical band, tetrasporangia developed verticillately at cortical band (Womersley, 1978). The plants collected from Ullungdo Island were vegetative and collected in winter at Tonggumi and Summok (Fig. 1E, F). Gland cells and hair cells were not observed but elongate cells like hair were developed from cortical cells. Boo (1984) suggested that the development of hair cell might be affected by environmental condition. He also described that the gland cells were developed on the lower part of adult plants. The gland cells on the plants from Ullungdo Island might not be observed because of younger plants. Boo (1984) described that the Korean plants were different from type specimen in that they were less than 5 cm height, five periaxial cells and five to six cortical cell lines. The axial cell of plant from Ullungdo Island had 2.3/1-2.8/1 L/B ratio smaller than those of plants from Chejudo Island showing 2.5/1-3.1/1 L/B ratio. The reexamination on the species status of those plants will be required.

***Ceramium paniculatum* Okamura, 1896, p. 36.**  
(Fig. 1 G-H)

**Korean name:** 바늘비단풀

**References:** Okamura, 1936, p. 737; Dawson, 1944, p. 319; 1962, pp. 61-62, Figs. 5-7; Nakamura, 1965, pp. 145-148, Figs. 9-10; Kang, 1966, p. 90; Itono, 1972, p. 75; 1977, pp. 101-103, 263-4; Boo, 1984, pp. 259-271, Figs. 51-52.

Plants epiphytic to epilithic, pseudodichotomously to alternately branched, up to 2-3 cm high, dark to bright red; rhizoids developed from periaxial cells, 2-3 celled, ending with end of multicellular pad; apical parts of filaments strongly incurved; spines originated from periaxial cell, 2-5 celled; axial cells 300-450  $\mu\text{m}$  long, 100-150  $\mu\text{m}$  broad, 3.0/1-3.5/1 L/B ratio periaxial cells seven in ring; cortical cells divided acro-basipetally, forming band; gland cells absent; spermatangia developed from cortical cells in dense patches adaxially; tetrasporangia oblong, developed adaxially from periaxial cells, 45-55 $\times$ 30-45  $\mu\text{m}$ ; female gametophytes not collected.

**Type locality:** Kamahara, Iwaki, Sapporo, Japan (Dawson, 1962)

**Habitat:** On *Corallina pilulifera* or *Chondria crassicaulis* in the intertidal zone.

**Distribution:** Pacific Ocean including Korea, Japan and Hawaii.

**Materials examined:** Summok (10 Aug. 1992; 17 Feb. 1990), Tonggumi (18 Oct. 1990; 18 Dec. 1990).

*Ceramium paniculatum* has been reported from the coasts of Korea (Kang, 1966; Boo, 1984). This species is characterized by abaxially developed spines. The plants from Ullungdo Island grew on the coralline algae and *Chondria crassicaulis* in cluster from August to December. They had rhizoids developed from cortical cell of creeping thallus and alternative branches. The axial cells of these plants showed 3/1 to 3.5/1 of L/B ratio which was similar to those of other plants from Korea. Boo (1984) described the adaxial development of tetrasporangia as a major character of this species. He reported that the gametophytes and tetrasporophytes were collected from the south and east coast of Korea all the year round. However, most plants from Ullungdo Island were male and tetrasporangial plants collected in summer and winter.

***Ceramium tenerrimum* (Martense) Okamura, 1921, p. 112.**

**Korean name:** 털비단풀

**Basionym:** *Hormoceras tenerrimum* Martens, 1866, p. 146.

**References:** Okamura, 1936, p. 736; Nakamura, 1965, pp. 133-135, Fig. 5; Itono, 1972, p. 82; 1977, pp. 111-113, 199; Kang, 1966, pp. 89-90; Boo, 1984, pp. 227-237, Fig. 44.

Plants epilithic to epiphytic, branched pseudodichotomously to alternately with conspicuous main axis, flaccid, up to 10 cm high, bright red; rhizoids unicellular, ending with multicellular pad; branches incurved at apex; axial cells 450-600  $\mu\text{m}$  long, 60-70  $\mu\text{m}$  broad, 7.5/1-8.5/1 L/B ratio, with internodal space 4-7 times as long as nodal band; periaxial cells six in ring, cutting off cortical cells; gametophytes and tetrasporophytes not collected.

**Type locality:** Nagasaki, Japan.

**Habitat:** On other plants (*Sargassum thunbergii*, *Gelidium amansii*, *Corallina* sp.) or rock in the intertidal zones.

**Distribution:** Pacific Ocean, Atlantic Ocean (Brazil, North Africa, Florida), Mediterranean Sea. Along the coast of Korea (Kang, 1966; Boo, 1984).

**Materials examined:** Summok (10 Aug. 1992), Tonggumi (9 Aug. 1992).

The plants of this species were collected in the intertidal zones from Ullungdo Island. This species is characterized by large, entangled thallus, abaxially developed spine, strongly incurved apex and elongated axial cell. Boo (1984) suggested that the plants from Japan and Korea were different from those from Europe in that the latter had seven cortical cells acropetally developed. The plants from Ullungdo Island were all vegetative and had more elongated axial cells rather than those of other species.

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## 鬱陵島産 紅藻 비단풀屬 植物 5種에 대한 註解

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### 적 요

울릉도산 비단풀속 식물 5종에 대한 형태 분류학적 검토를 수행하였다. 본조사기간 동안 채집된 식물은 *Ceramium aduncum* Nakamura (고리비단풀) 을 비롯하여 *C. codii* (Richards) G. Mazoyer (청각비단풀), *C. flaccidum* (Harvey ex Kützing) Ardissonne (명주비단풀), *C. paniculatum* Okamura (비늘비단풀), *C. tenerimum* (Martense) Okamura (털비단풀) 등 5종이었으며, 이들 중 고리비단풀은 12월에서 2월 사이 조간대와 조하대 상부에서 생육하고 마디는 좁았다. 청각비단풀은 수배우체만 채집되었으며 정자낭은 피층마디의 향측면에 발달하였다. 비늘비단풀은 포복하고 호생분지하며 여름에서 겨울까지 채집되었다.

주요어: 비단풀속, *Ceramium*, 홍조, 울릉도, 분류학적 검토

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