

A taxonomic study on *Pediastrum boryanum* Meneghini in Korea

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In order to reexamine the *Pediastrum boryanum* complex in Korea, 10 strains of *Pediastrum boryanum* complex were isolated from 10 different locations in Korea and were cultured in the laboratory. Ultrastructure of the cell wall, the cell shape, and the processes on the peripheral cells were examined. The isolates were classified as *P. boryanum* var. *boryanum*, *P. boryanum* var. *brevicorne* which is reported for the first time in Korea, and *P. boryanum* var. *longicorne*. The previously reported taxa, *P. boryanum* var. *brevicorne* f. *punctulatum* was included in *P. boryanum* var. *brevicorne*. *P. boryanum* var. *rugulosum* was classified as *P. angulosum*. The cell wall ultrastructure and the length of the processes on the peripheral cells were the most distinctive characters for infraspecific classification of *P. boryanum*.

Keywords: *Pediastrum*, Taxonomy, Chlorococcales, Chlorophyta, Morphology

The genus *Pediastrum* Meyen is a member of Hydrodictyaceae which belongs to Chlorococcales, Chlorophyta. They are distributed throughout the world as euplanktons or tychoplanktons. Since the first report of three species of *Pediastrum*-*P. simplex*, *P. duplex*, and *P. biradiatum* by Meyen in 1829, more than 300 taxa of *Pediastrum* were reported worldwide (Parra, 1979; Wu, 1987). *Pediastrum boryanum* was first reported by Meneghini in 1840. More than 50 taxa, which are now identified as varieties and forms of the species of *P. boryanum*, had been reported by numerous investigators. The major taxonomic characteristics which had been applied for identification of the species of *Pediastrum* were (1) the number and the shape of the cells in the coenobium, (2) perforations between the cells, and (3) length of the processes on the peripheral cells. Parra (1979) and Wu (1987) introduced the ultrastructure of the cell wall as an important character in *Pediastrum* taxonomy. Observing the cell wall ornamentation and the process of coenobia formation, Parra (1979) treated more than 50 taxa of *Pediastrum* which had been reported by many investigators as varieties and formae of the species *P. boryanum*. Four varieties and one forma of *P. boryanum* were reported in

Korea (Chung and Shim, 1969; Chung, 1962; Lee and Park, 1985). The taxonomic criteria applied for identification of the species were based on light microscopic observation only, which are now proved to be variable. In order to reexamine the taxonomic identity of those taxa, the authors isolated 10 strains of *P. boryanum* complex from 10 different locations in Korea, and examined their cell wall ultrastructure, shape of the cells, and the processes of the peripheral cell as well as the coenobia formation.

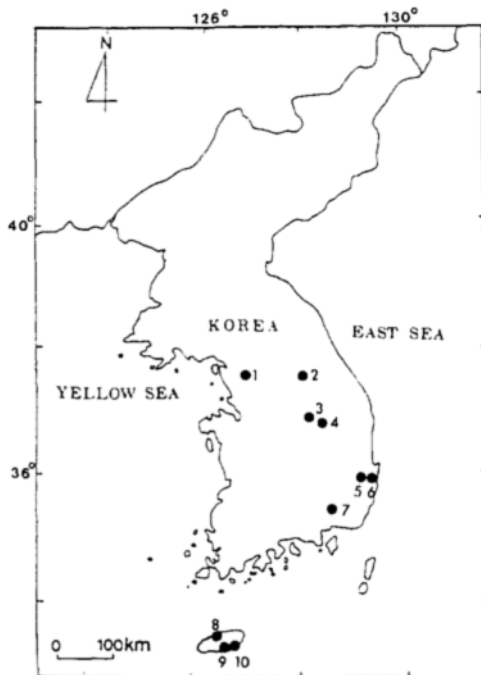
MATERIALS AND METHODS

10 strains of *P. boryanum* were isolated from the collections made at 10 different localities in Korea (Table 1, Fig. 1). Collections were made from 1991 to 1994. The isolates were grown in Bold's media in an environment chamber with 15 hours light/9 hours dark cycle, 4,000 Lux, and a temperature of 25-27°C. All experiments were carried out in unialgal culture. Morphological variations of each isolate were observed in both synchronized and stationary cultures. Observation of the coenobium and cell wall structure was made by LM and SEM. For the SEM observation, materials were fixed in FAA and osmium tetroxide, dehydrated with alcohol series, and gold-coated after critical-point drying (Bisalputra *et al.*, 1973; Gough *et al.*, 1976; Harvey, 1973; Lyon, 1969).

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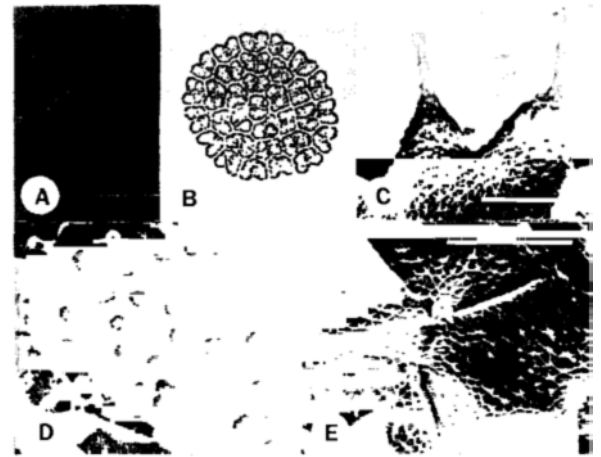
Table 1. Ten strains of *P. boryanum* complex and collection sites

Taxon	Strain no.	Locality
<i>P. boryanum</i> var. <i>boryanum</i>		
	SM 5301	Sookmyung Women's Univ., Seoul
	SM 5302	Maepochon, Danyang-gun, Chungbuk
	SM 5303	Kyungju, Choyang Res., Kyongbuk
	SM 5304	Chilchon, Namjeju-gun, Cheju
	SM 5305	Hagari, Pukcheju-gun, Cheju
<i>P. boryanum</i> var. <i>brevicornis</i>		
	SM 5401	Kongjichon, Chunchon, Kangwon
	SM 5402	Pomun Lake, Kyungju, Kyongbuk
	SM 5403	Haman-gun, Kyongnam
	SM 5404	Namwon, Namjeju-gun, Cheju
<i>P. boryanum</i> var. <i>longicornis</i>		
	SM 5501	Dukchon, Danyang-gun, Chungbuk

**Fig. 1.** The collection sites of *Pediastrum boryanum* complex in Korea. 1: Sookmyung Women's Univ., Seoul; 2: Kongjichon, Chunchon, Kangwon; 3: Maepochon, Danyang-gun, Chungbuk; 4: Dukchon, Danyang-gun, Chungbuk; 5: Kyungju, Choyang Res., Kyongbuk; 6: Pomun Lake, Kyungju, Kyongbuk; 7: Haman-gun, Kyongnam; 8: Hagari, Pukcheju-gun, Cheju; 9: Chilchon, Namjeju-gun, Cheju; 10: Nam-won, Namjeju-gun, Cheju.

RESULTS

Based on the morphology of the cell and the cell wall ultrastructure the 10 isolates were classified into three varieties of *P. boryanum*. The shape of

**Fig. 2.** *Pediastrum boryanum* var. *boryanum* (Turpin) Meneghini. A, B: Coenobia; C, D: Detail structure of peripheral cell wall; E: Detail structure of inner cell wall (Scale bars. A, B: 25 μ m; C, D, E: 3 μ m).

the peripheral cell and the length of the processes on the peripheral cell along with the cell wall ultrastructure were the important characters for identification of the species of *Pediastrum*. Among the three varieties *P. boryanum* var. *brevicornis* A. Braun is reported for the first time in Korea. The classification system was based on Parra (1979).

Key to the *Pediastrum boryanum* complex in Korea

1. cell wall reticulate in triangular fashion-----2
2. process of the peripheral cell very short-----
-----*P. boryanum* var. *brevicornis* A. Braun
2. process of the peripheral cell, 1/2 the cell length-----*P. boryanum* var. *boryanum* (Turpin) Meneghini
1. cell wall irregularly reticulate-----*P. boryanum* var. *longicornis* Reinsch

Pediastrum boryanum var. *boryanum* Meneghini 1840

Coenobia composed of 4-64 cells, peripheral cells 5 to 6 sided with two processes (Fig. 2. A, B). The length of the process is 1/2 of the peripheral cell. Cell wall reticulate in triangular fashion with a wart on each angle (Fig. 2. B, C, D). The density of the warts variable. Size of the coenobium 16-208 μ m, peripheral cells 6-35 μ m long, 5-31 μ m wide, inner cells 4-26 μ m long, 4-27 μ m wide. Diameter of the wart 0.3-0.7 μ m, density of the warts, 12-18 /10 μ m.

Pediastrum boryanum var. *brevicornis* A. Braun 1855

Coenobia 4-32 cells, processes on the peripheral

cells two, never exceed 1/2 the cell length, about 3 μm (Fig. 3. A, C). Cell wall reticulate in triangular fashion with warts, 5-12 /10 μm (Fig.3. B, D). Size of the warts 0.4-0.8 μm . Size of the coenobium 18-20 μm with peripheral cells 6-18 μm long, 5-13 μm wide, inner cells 5-14 μm long, 5-13 μm wide. This variety was reported for the first time in Korea.

***Pediastrum boryanum* var. *longicorne* Reinsch 1867**

Coenobia 4-64 cells, 26-68 μm in diameter. Peripheral cells 10-14 μm long and 8-12 μm wide, inner cells 6-8 μm long and 6-8 μm wide (Fig. 4. A). Cell wall irregularly reticulate, the reticulation irregularly polygonal (Fig. 4. B, C). The processes on the peripheral cells 4 μm , 1/2 the cell length.

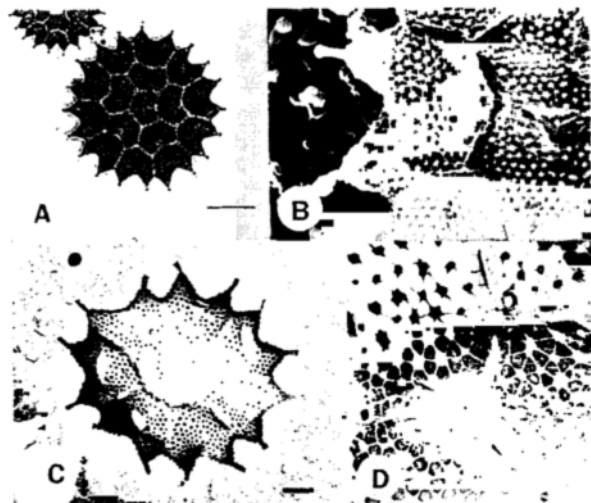


Fig. 3. *Pediastrum boryanum* var. *brevicorne* A. Braun. A, C: Coenobia; B: Detail structure of peripheral cell wall; D: Detail structure of inner cell wall (Scale bars. A: 25 μm ; B, C, D: 3 μm).

DISCUSSION

The five taxa of *Pediastrum boryanum* complex which had been reported in Korea are *P. boryanum* var. *boryanum*, *P. boryanum* var. *brevicorne* f. *punctulatum*, *P. boryanum* var. *longicorne*, *P. boryanum* var. *rugulosum*, and *P. boryanum* var. *perforatum*. These taxa were classified on the basis of the existence of perforation between the cells, the size of the peripheral cells and the ornamentation on the cell wall observed by light microscope. According to the investigation we have made, the existence of the perforations between the cells were variable within the same isolates. The length of the processes were quite stable which could be expressed by the ratio to the cell length. The cell wall ornamentation observed by light microscope served as a tool for identification of the species of *Pediastrum* in some degree. However, in the *Pediastrum boryanum* complex we have examined, the light microscope did not show the details except the granules, however the SEM observation of the cell wall provided one of the most dependable taxonomic character.

The main characteristics of *P. boryanum* var. *brevicorne* which separates from other varieties are the triangular reticulation of the cell wall and the extremely short process of the peripheral cell. A. Braun(1855) described this variety as having very short process and cell wall with conspicuous punctata.

Pediastrum boryanum var. *brevicorne* f. *punctulatum* was reported by Chung (1962) and Lee and Park (1985). Parra (1979) examined this plant and treated it as a synonym of *P. boryanum* var. *boryanum* because the cell wall structure and the length of the processes were identical with *P. boryanum* var. *boryanum*. *Pediastrum boryanum* var. *rugulosum*



Fig. 4. *Pediastrum boryanum* var. *longicorne* (Reinsch) Raciborski. A: Coenobium; B, C: Detail structure of peripheral cell wall (Scale bars. A: 25 μm ; B, C: 3 μm).

was reported by Chung (1968). According to his description the plant had very short processes, undulate cell wall with coenobium size of 150-200 μm , and cell size of 22-29 μm . The undulate cell wall and short processes of peripheral cell are the characteristics of *P. angulosum* rather than *P. boryanum*. The reticulate cell wall structure is the characteristic of *P. boryanum* group. The authors could not examine *P. boryanum* var. *perforatum* since Chung (1962) reported this variety without any description, and there were no further reports on this variety.

The 10 isolates of *P. boryanum* group were identified on the basis of the cell wall structure and the length of the processes on the peripheral cells. The isolates SM 5401, SM 5402, SM 5403, and SM 5404 which had very short processes (less than 1/2 of the cell length) were identified as *P. boryanum* var. *brevicornis* (Fig. 3. A, C). The isolates SM 5301, SM 5302, SM 5303, SM 5304, and SM 5305 with the processes about 1/2 of the cell length were identified as *P. boryanum* var. *boryanum* (Fig. 2. A, B). Isolate SM 5501 was identified as *P. boryanum* var. *longicornis*, because the reticulation on the cell wall was polygonal while it was triangular in the other two varieties (Fig. 4. B, C). The variety *longicornis* was separated also by the absence of the warts on the reticulate cell wall. The critical characteristics in infraspecific classification of *Pediastrum boryanum* were the ultrastructure of the cell wall and the length of the processes on the peripheral cells.

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