

Two Species of *Sphacelaria* New to Korea

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韓國產 *Sphacelaria* 屬의 二未記錄種

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Two unrecorded species of *Sphacelaria* from Korea are investigated taxonomically. *Sphacelaria fusca* Agardh is characterized by its filamentous thallus, irregular branches with longitudinal divisions mixed with secondary transverse divisions in segments, cylindrical propagula with (2)-3-(4) arms, spherical unilocular sporangia with one pedicellate cell and ellipsoidal plurilocular sporangia. Judging from field phenology, the propagula formation is independent upon temperature and photoperiod, while the sporangium formation seems to be dependent on lower temperature. *Sphacelaria californica* Sauvageau is characterized by its filamentous thallus, opposite to pinnate branches with longitudinal divisions mixed with secondary transverse divisions in segments and tribuliform propagula. The lateral end cells of the propagula arms divide into two, which is another character differing from *S. plumula*.

Key Words: New to Korean flora, Phenology, *Sphacelaria californica*, *Sphacelaria fusca*, Sphacelariales

Sphacelaria Lyngbye is a large genus commonly occurring in most coast of the world (Bold and Wynne, 1985). Although the genus is well defined and relatively easily recognized, sub-generic taxa are less readily delimited because of the great plasticity shown by various entities, and from the resultant variability of the specimens collected from different populations (Haas-Niekerk, 1965;

Goodband, 1971). However, the taxonomy of *Sphacelaria* is based primarily on the work of Sauvageau (1900-1914), who studied materials of world-wide distribution and whose investigations are fundamental to the knowledge of the genus.

In Korea, Kang (1966) reported seven species as a floral list: *Sphacelaria yamadae* Segawa, *S. sessilis* Takamatsu, *S. prostrata* Takamatsu, *S.*

*Dedicated to Prof. Jae Won Kang, celebrating his sixtieth birthday.

divaricata Montagne, *S. apicalis* Takamatsu, *S. lutea* Takamatsu and *S. furcigera* Kuetzing. In recent Lee (1980) reported *S. variabilis* Sauvageau, and Song and Sohn (1983) described *S. radiata* Takamatsu.

During this investigation, *Sphacelaria fusca* Agardh and *S. californica* Sauvageau are collected and identified for the first time in Korea. The morphological and phenological characters of both species are investigated as a part of experimental taxonomic work on Korean *Sphacelaria*.

MATERIALS AND METHODS

Sphacelaria fusca was monthly collected from January to December, 1985 at the littoral zone of Sokcho (38° 12.3'N, 128° 36.3'E) in the eastern coast of Korea. They were epiphytic on *Sargassum* spp. and 1-1.5 cm in height. Field populations of *Sphacelaria californica* which cast ashore at Songna (36° 15'N, 129° 20'E) on June, 1985 and Kyongpo (37° 47'N, 128° 55'E) on March, 1986 were collected. They were reproductive with plurilocular sporangia and propagula, and 2-3 cm high.

Descriptions and illustrations were based on materials preserved in 5% formalin-sea water. Specimens examined were preserved in the Herbarium, Kangreung National University.

RESULTS AND DISCUSSION

Sphacelaria fusca Agardh

(Text-figs. 1-15)

Agardh (1828) p. 34; Sauvageau (1900-1914) p. 206; Taylor (1957) p. 120; Haas-Niekerk (1965) p. 148.

Korean Name: 세가닥갯쇠털 (신칭 n.n.)

Description: Plants usually 1-1.5 cm in length, densely caespitose, irregularly branched on each

side of filaments, epiphytic on other macroalgae by rhizoids, commonly dark brown to yellow in living; rhizoids discoid, originated from basal part of erect filaments; axis and lateral branches terete, consisting of segments, 40-45 μm wide in middle portion, gradually attenuate toward apex; lateral branches usually originated from apical or segment cells, irregular; segments rectangular, in surface view divided longitudinally into 3-6 slender cells, sometimes divided transversely, 40-45 μm \times 45-60 μm in size; apex elongate, one celled; hairs originated from apical cells, very thin; propagula originated from segment cells, (2)-3-(4) furcate in form, usually arranged secundly in upper portion of filaments, with stalk of 5-10 segments; unilocular sporangia spherical, developed secundly on lower portion of filaments, with one pedicellate cell, 60-85 μm in diameter; plurilocular sporangia oblong to ellipsoidal, developed irregularly, often constricted at middle portion, with one to three pedicellate cells, 45-55 μm \times 65-80 μm in size.

Habitat : Epiphytic on *Sargassum* spp. and other macrobenthic algae in lower to sublittoral zone.

Materials : East coast; Sokcho (every month except August, 1985).

Taxonomic account. *Sphacelaria fusca* is characterized by its filamentous thallus, irregular branches with longitudinal divisions mixed with secondary transverse divisions in segments, cylindrical propagula with (2)-3-(4) arms, spherical unilocular sporangia with one pedicellate cell and ellipsoidal plurilocular sporangia with 1-3 pedicellate cells. It distributes from tropical to boreal zones and highly variable in shape (Agardh, 1828; Sauvageau, 1900-1914; Haas-Niekerk, 1965).

Our plants usually occur at the lower littoral zone of Sokcho in the east coast of Korea and agree basically well to the previous descriptions (Agardh, 1828; Sauvageau, 1901-1914; Taylor, 1957; Haas-Niekerk, 1965). The number of

longitudinal divisions in the segments, which can be an important character delimiting species in *Sphacelaria* (Sauvageau, 1900-1914; Takamatsu, 1943; Haas-Niekerk 1965; Goodband, 1971), is 3-6 and the secondary transversal divisions appear sometimes or regularly in segments with branches. However, the hairs occur only in April populations. Sauvageau (1900-1914) reported that hairs often occurred in European plants. They may depend in part upon environmental conditions.

The propagula arms appear to be usually (2)-3-(4) furcate in cylindrical form. As shown in Table 1, the occurrence frequency of trifurcate forms (80%) is much higher than that of bifurcate (4%) or tetrafurcate forms (16%). Haas-Niekerk (1965) reported that they were bifurcate (61%) or trifurcate (39%) in the plants from the Netherlands. However, Goodband (1971) suggested that the number of propagula arms is useful taxonomically if a large enough sample is available for examination, mentioning that it was very variable.

Unilocular sporangia develop secondly in

series on the lower portion of the thallus with propagula. Plurilocular sporangia develop irregularly on the thallus and have 1-3 pedicellate cells. They are often oblong to ellipsoidal, but some are constricted at the middle portion. It is interesting that the plants with unilocular sporangia produce many propagula, while those with plurilocular sporangia produce no propagula.

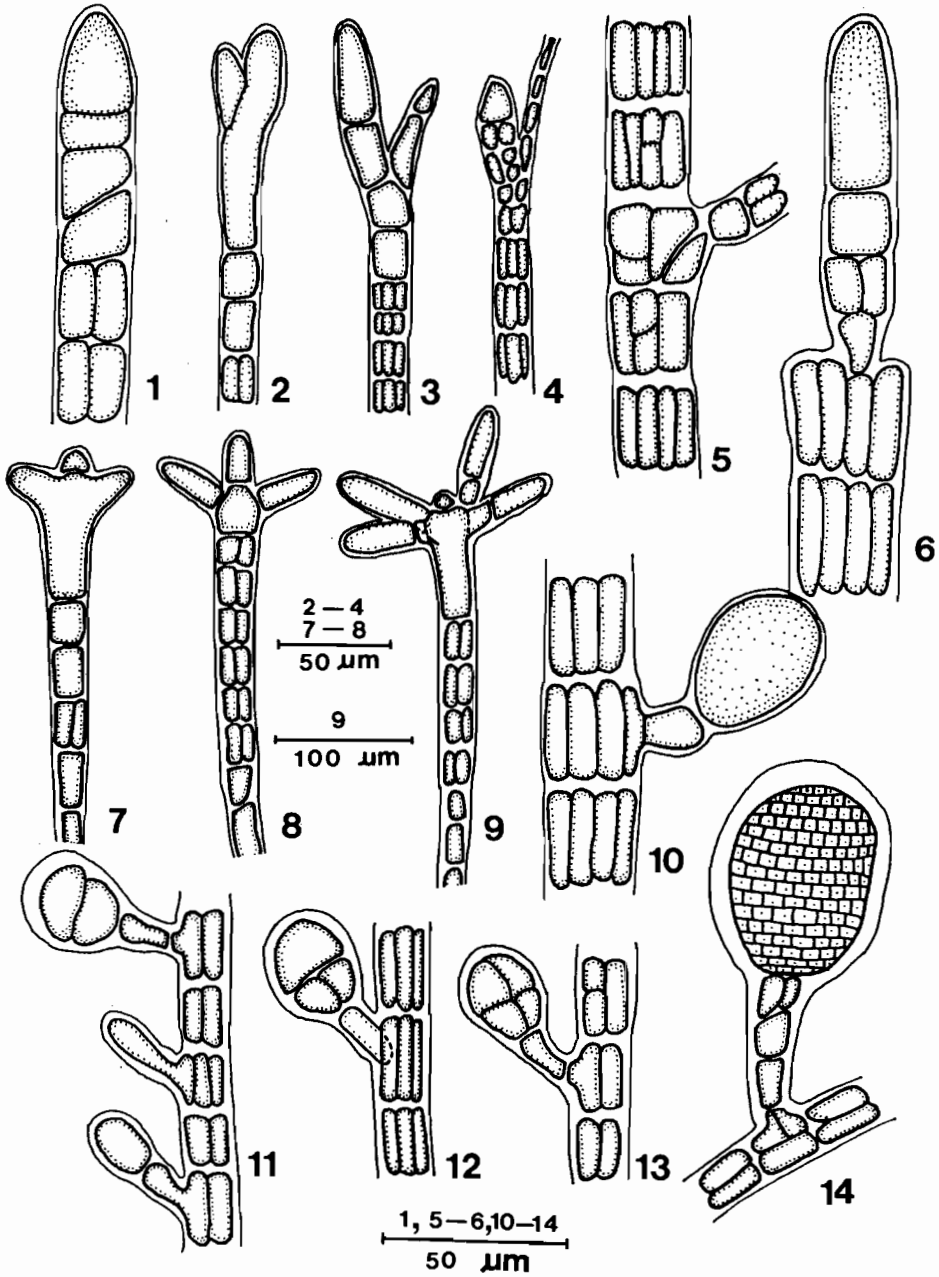
Van den Hoek and Flinterman (1968) reported that the production of sporangia, gametangia and propagula depended on temperature and photoperiod in the cultured plants of *Sphacelaria furcigera* Kuetzing. According to them, the propagula were not formed at lower temperature (4°C) or under short-day conditions (8-hours day length) at elevated temperature (12 and 17°C). On the other hand, Haas-Niekerk (1965) reported that they were formed from June to October in *S. fusca*. In our plants, they are formed all through year (Fig. 15). It means that their formation is not dependent on temperature and photoperiod in this area.

Unilocular sporangia are formed from November to May when the temperature of surface

Table 1. The occurrence frequency of propagula arms of *Sphacelaria fusca* from Sokcho in the east coast of Korea

Population	Two-arm		Three-arm		Four-arm		Total
	Number	Frequency	Number	Frequency	Number	Frequency	
January	6	13(%)	40	85(%)	1	2(%)	47/8*
February	3	9	23	70	7	21	33/3
April	2	2	85	80	19	18	106/10
May	3	3	90	89	8	8	101/10
June	5	8	55	89	2	3	62/10
July	2	2	78	83	14	15	94/10
September	2	2	79	79	19	19	100/10
October	2	2	77	85	12	13	91/10
November	3	3	60	66	28	31	91/10
December	3	3	70	70	27	27	100/10
Total	31	4	657	80	137	27	825/91

* Examined plants.



Figs. 1-14. *Sphacelaria fusca* Agardh.

Fig. 1. Actively dividing apex. Fig. 2. Single celled hair. Fig. 3. Two celled hair. Fig. 4. Fully grown hair. Fig. 5. Main axis with a branch and segments divided transversally. Fig. 7. Young propagula with two-arm. Fig. 8. Young propagula with three-arm. Fig. 9. Young propagula with four-arm. Fig. 10. Unilocular sporangium. Fig. 11. Early stage in formation of plurilocular sporangia. Fig. 12. Trihedrally divided stage of plurilocular sporangium. Fig. 13. Tetrahedrally divided stage of plurilocular sporangium. Fig. 14. Mature plurilocular sporangium.

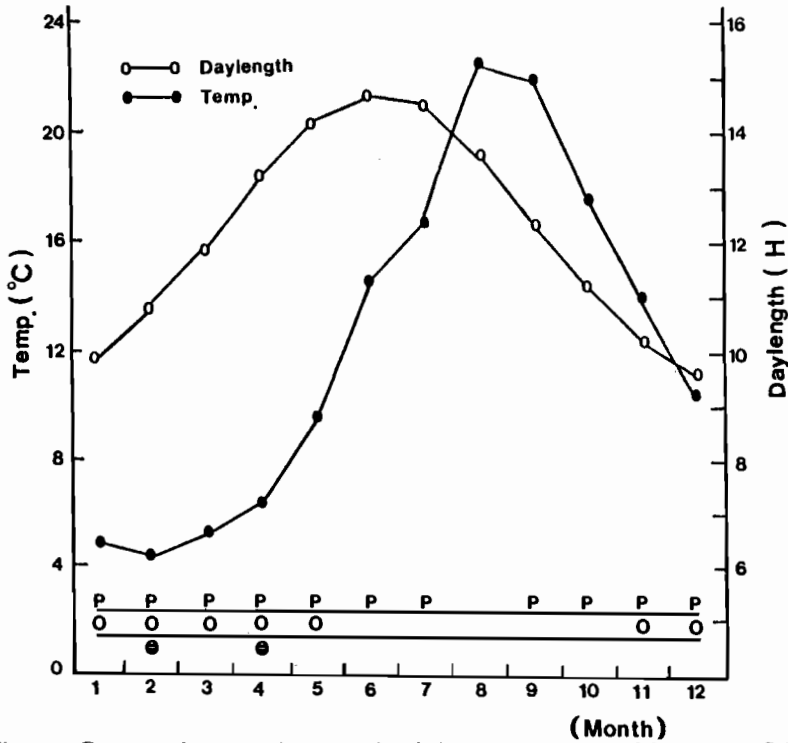


Fig. 15. Presence of reproductive organs in relation to temperature and daylength in *Sphacelaria fusca*. Daylength is represented as possible irradiation of sunshine (P: propagula, O: unilocular sporangium, (=): plurilocular sporangium).

seawater falls below 15°C and the daylength lies between 9.6 hours in November and 14.2 hours in May (Fig. 15). Van den Hoek and Flinterman (1968) pointed out that they appeared at 4 and 12°C, with some evidence to suggest that short-day conditions were involved.

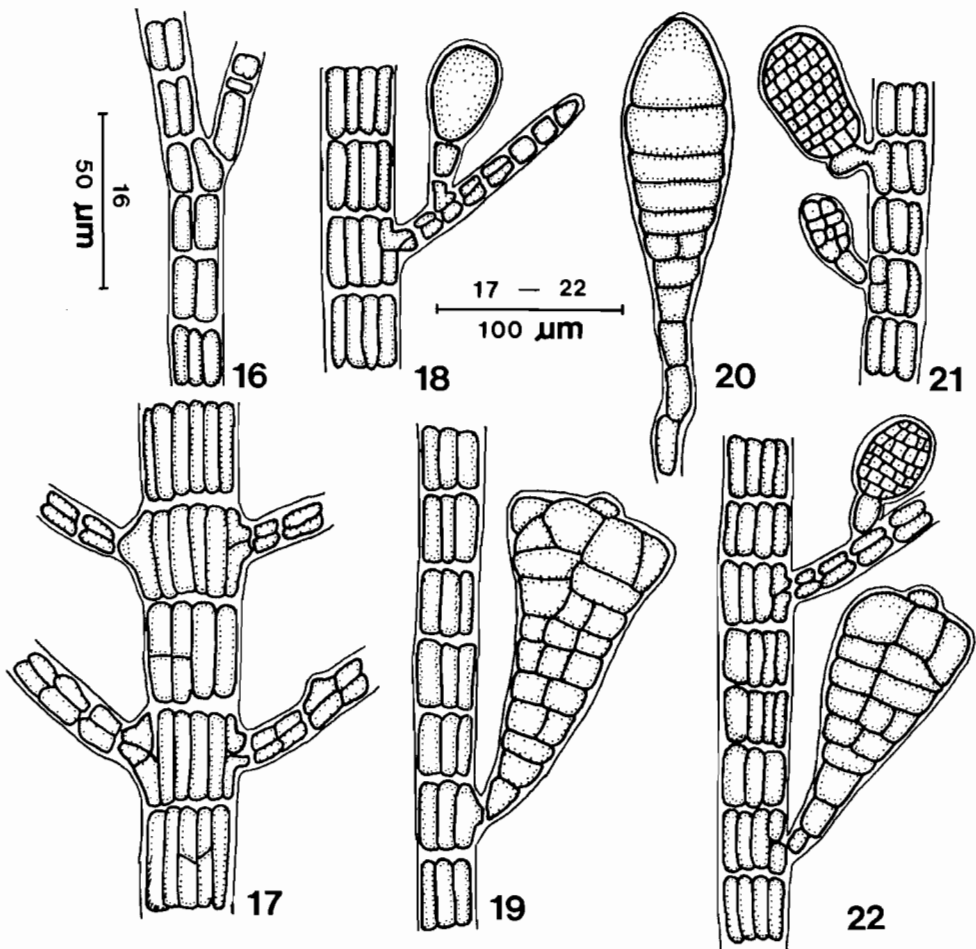
Plurilocular sporangia are formed in January and April populations, when the temperature falls below 8°C and the daylength lies between 10.8 hours in January and 13.2 hours in April. Van den Hoek and Flinterman (1968) also pointed out that they appeared under long-day conditions (16-hours daylength) at 4 and 12°C. Thus, our phenological data do not agree with the laboratory data of van den Hoek and Flinterman (1968).

***Sphacelaria californica* Sauvageau**
(Text-figs. 16-22)

Sauvageau (1900-1914) p. 108; Setchell and Gardner (1915) p. 395; Abbott and Hollenberg (1976) p. 216. Korean Name

Korean Name : 굵은 갯취털 (신칭 n.n)

Description: Plants usually 2-3cm high, tufted, oppositely to pinnately branched on each side of filaments, epiphytic on other macrobenthic algae by rhizoids, light olive to brown in living; rhizoids forming small disk, originated from basal parts of filaments; axis and laterals terete, consisting of segments, 50-70 μm wide in middle portion of filaments, gradually attenuate toward apex; lateral branches usually originated from apical to segment cells, opposite to pinnate; segments rectangular, in surface view divided longitudinally into 4-7 slender cells, sometimes divided transversally, 50-70 μm × 50-65 μm in size; apex elongate, one celled; hairs originated



Figs. 16-22. *Sphacelaria californica* Sauvageau.

Fig. 16. A filament with hair. Fig. 17. Main axis with opposite branches and segments divided transversely. Fig. 18. Young propagula. Fig. 19. Mature propagula. Fig. 20. Ovoid propagula. Fig. 21. Mature plurilocular sporangium. Fig. 22. A branch with propagula and plurilocular sporangium.

from apical cells, very thin; propagula originated from segment cells, obovoid to tribuliform, 140-160 μm in length; plurilocular sporangia obovate to ellipsoidal, developed secondly, often constricted at middle portion, with one pedicellate cell, 30-40 μm \times 50-70 μm in size.

Habitat : Epiphytic on *Sargassum* spp. Cast ashore.

Materials : East coast; Songna (June, 1985), Kyongpo (March, 1986).

Taxonomic account. *Sphacelaria californica* is

characterized by the filamentous thallus, opposite to pinnate branches with longitudinal divisions mixed with secondary transverse divisions in segments, obovoid to tribuliform propagula and ellipsoidal plurilocular sporangia with one pedicellate cell. It distributes from tropical to temperate zones (Sauvageau, 1900-1914; Setchell and Gardner, 1925).

The species, first described by Sauvageau (1900-1914) as *Sphacelaria plumula* var. *californica*, was recognized a distinct species by Setchell and Gardner (1925). According to them, the

species, while close to *S. plumula* Zanardini, differs in having the lower portion of the axis free from branches and a basal disk and straight axis.

Our plants agree basically well to the previous descriptions (Sauvageau, 1900-1914; Setchell and Gardner, 1925). However, they are more slender than the plants from Southern California.

The propagula arms usually develop on the basal parts of the branches and their lateral end cells divide into two, which can be another character differing from *S. plumula*. The plants with propagula arms produce many plurilocular sporangia.

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摘 要

갯쇠털속 2 未記錄種을 분류학적으로 考察하였다. *Sphacelaria fusca* Agarch는 사상체로 불규칙 분지를 하며 마디세포는 종횡으로 분열하고 胚芽枝는 3차상으로 나누어지며, 구형의 단자낭과 타원형의 복자낭을 갖는 점이 특이하다. 胚芽枝의 형성은 수온이나 광주기와 무관하다고 생각되나 단자낭과 복자낭은 저온 조건에서 형성되었다. *S. californica* Sauvageau는 가지가 對生 또는 互生을 하며 역삼각형의 胚芽枝를 갖는 점이 특이하다. 胚芽枝의 양쪽 정단세포들이 둘로 나누어지는 점이 *S. plumula*와 다르다.

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