CULTURE OF AN ANTARCTIC SEAWEED, *PHYLLOPHORA ANTARCTICA* (PHYLLOPHORACEAE, RHODOPHYCEAE)

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Abstract: An Antarctic seaweed, *Phyllophora antarctica* was collected beneath the sea ice of the coast of East Ongul Island (69°00′S, 39°35′E) of Lützow-Holm Bay. The specimens were carried to the laboratory in Japan by the icebreaker FUJI, and then they were kept at controlled temperature in an incubator for two years.

The new fronds appeared from the margin of older thalli at temperature of 3°C and light intensity of about 3000 lx. These plants were maintained under several culture conditions for a long time, but the reproductive organ did not appear on the fronds.

The optimum temperature for the growth of the fronds was about 3°C. The growth rate was 20.3±6.9% increase of wet weight per week under the optimum culture condition. The optimum temperature for photoshynthetic activity was between 10°C and 15°C under light intensity of 10000 lx.

1. Introduction

A typical Antarctic seaweed, *Phyllophora antarctica* A. et E.S. GEPP (Phyllophoraceae, Rhodophyceae) occurs commonly beneath the sea ice on the coast of East Ongul Island (69°00′S, 39°35′E) of Lützow-Holm Bay. No information on the physiological ecology and morphology of Antarctic seaweeds is available, except the photosynthetic activity of this species collected from Syowa Station (OHNO, 1976a, b). In January 1981, plants of *Phyllophora antarctica* were collected from beneath the ice on the coast of East Ongul Island by the biologists of the 22nd Japanese Antarctic Research Expedition (JARE-22). The living plants were brought to the laboratory in Japan and cultured in the incubator at various temperatures for two years. The present study deals with the observations on the morphology, growth rate and photosynthetic activity of *Phyllophora antarctica* cultured in the laboratory.

2. Method

In January 1981, the SCUBA observations of the benthos were made at some locations around Syowa Station (69°00′S, 39°35′E) of Lützow-Holm Bay, Antarctica by the biologists of JARE-22 (NAKAJIMA *et al.*, 1982). The plants of *Phyllophora antarctica* were collected by diving from a steep rocky bed about 8 m beneath the ice on the coast of the Kita-no-seto Strait on 31st January 1981. The living materials were also found attached to sea urchins kept in cages beneath the ice on the same coast.

The plants were cultured in a refrigerator of the icebreaker FUJI, at temperature about 0°C. Each culture bottle (3 *l* plexiglass bottle) contained several individuals of the algae with 1 *l* of filtered seawater. The water was changed at intervals of three days. After three months voyage back to Tokyo, they were transported to a room, which was maintained at a constant temperature of 0°C, in the National Institute of Polar Research, Tokyo. From October 1981, the plants were again transported to the laboratory of Kochi University. The materials were kept in the incubator at temperatures ranging from 0° to 15°C and under fluorescent lamp illumination ranging from 1000 to 3000 lx with photoperiod 12 h per day. The plants were placed in 200 m*l* of artificial seawater (Jamarin's medium) in laboratory dishes (500 m*l*).

The growth rate of the fronds grown under various temperature and the light intensity (1000 and 3000 lx) was determined every week, and the average percentage increase in fresh weight of the fronds was calculated. Net photosynthetic activity of new fronds cultured was measured by Winkler method, after the fronds were placed in D.O. bottles for one hour.

3. Results and Discussion

3.1. Observation on the morphology

Antarctic seaweed *Phyllophora antarctica* was found on the coast of Mac. Robertson Coast, the Adélie Coast and on the coasts of Victoria Land and Lützow-Holm Bay (NEUSHUL 1968; OHNO, 1976a).

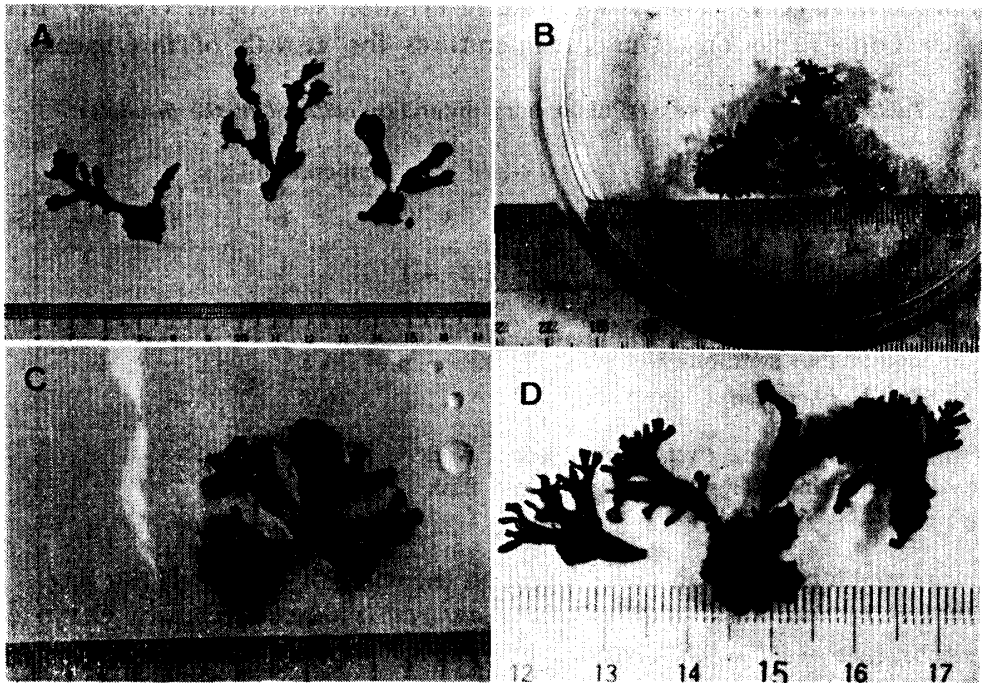

Fig. 1. A: Phyllophora antarctica *collected from the coast of East Ongul Island on January 31, 1981.*
B: New fronds developed from older portions.
C, D: The fronds grown in the incubator.

The adult thallus of this species shows bifurcation many times. The thallus is about 1 cm wide and attains a length of 15 cm in natural habitat. The new fronds originate from the stalk or from the margin of older parts of the thallus (Fig. 1A: OHNO, 1976a).

The plants which were kept in filtered seawater under 0°C temperature and lower light intensity in the incubator did not grow and gradually lost pigmentation. While, the plants at temperature of 3°C and light intensity of about 3000 lx with artificial seawater developed new fronds from the surface and from the margin of older parts after 2 weeks (Fig. 1B). The new fronds during their development showed bifurcation 2 to 3 times in about 3 months period. In the cultured plants, the fronds appeared to be more closely forked than those collected from the coast of Antarctica (Figs. 1C, D).

These plants were maintained under various culture conditions for two years. But the reproductive organs did not appear in the fronds cultured in the laboratory. The reproductive organs were also not found either in this species collected from the coast of Syowa Station.

3.2. Growth rate and photosynthetic activity

Phyllophora antarctica survived and continued to grow at temperature of 0–10°C and illumination of 3000 lx for 12 h per day in the laboratory. The growth rate of fronds was very slow at 0° and 8°C. Though the fronds survived at temperature of 10°C, their weight did not increase. At temperature of 15°C, the fronds gradually lost pigmentation. At temperature of 3°C, the growth rate was 20.3±6.9% increase of wet weight per week. The plants were also cultured with aeration or without aeration in the flask (1 *l*). The growth rate in aeration was higher (16.8%) than that without aeration (Table 1). These temperatures for growth of this species in the

Table 1. Growth rate of Phyllophora antarctica *cultured in the incubator.*

	Light condition (12 h/day)	Temperature (°C)					
		0	3	4	8	10	15
A	1000 lx (No aeration)	+	5.2±4.1				
	3000 lx (No aeration)	+	20.3±6.9	9.9±0.2	+	+	−
B	3000 lx (No aeration)	+		10.8	+	+	−
	3000 lx (Aeration)	+		16.8	+		

Growth rate: Increase (wet weight) % per week.
A: Put into laboratory dish. B: Put into flask.
+: Survived. −: Decay.

culture were much higher than those found on the coast of Lützow-Holm Bay. In the habitat where the specimens of *Phyllophora antarctica* were collected by OHNO (1976a), water temperature was −0.5°C and light intensity was 650 lx. In *Laminaria* on the coast of Alaska at 1 m depth beneath the ice, an increase in frond length of 1.2 cm (5.5% of total frond length) for 12 days is recorded (HEALEY, 1972). Several species of subarctic coralline algae studied, by ADEY (1970), grew very rapidly under water temperature between 5° and 10°C. It is very interesting that the optimum

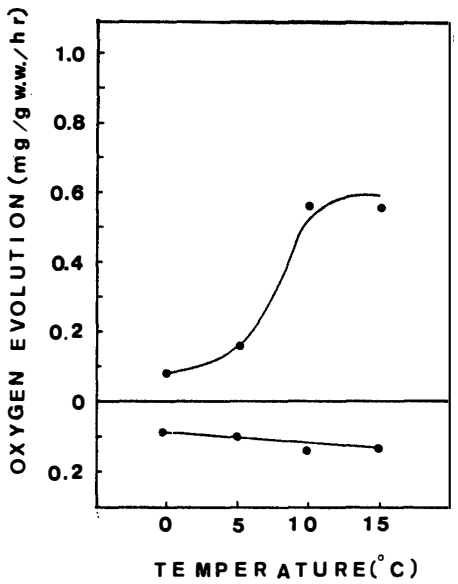

Fig. 2. Photosynthesis- and respiration-temperature relationship in Phyllophora antarctica. *Above: Apparent photosynthesis, Below: Respiration.*

temperature for growth of polar seaweeds in the laboratory was higher than that of its natural habitat.

Figure 2 shows the temperature dependence of net photosynthesis and respiration of this alga in cultures. The optimum temperature for the photosynthetic activity was between 10° and 15°C under 10000 lx. The photosynthetic activity at temperature of 0°C was lower than 0.1 mg O_2/wet wt/h. The respiration rate increased by raising the temperature up to 15°C. BUNT (1964) found the optimum temperature of photosynthetic activity of Antarctic diatoms at about 15°C. OHNO (1976b) measured the photosynthetic activity of this species immediately after it was collected at Syowa Station and found that the optimum temperature of the photosynthetic activity was about 20°C under 8000 lx, but the fronds kept under 15° or 20°C for 3 days, had lost pigmentation. HEALEY (1972) reported that the temperature optima for photosynthesis and respiration of Arctic seaweeds, *Chaetomorpha*, *Fucus* and *Halosaccion*, were much higher than those of natural habitat. From the results obtained on several polar algae, it is recognized that the photosynthetic activity of polar algae is always optimum at higher temperature conditions as compared with that at low temperatures of natural habitat.

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