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STRUCTURE OF MOSS COLONIES IN THE SYOWA STATION AREA, ANTARCTICA

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Abstract: The morphological structure of colonies in vertical section was investigated for *Bryum argenteum, B. pseudotriquetrum* and *Ceratodon purpureus* in the Syowa Station area, Antarctica. The colonies of these species were composed of two layers: shoot layer containing green shoot tips and brownish shoots and rhizoid layer containing rhizoids and disrupted plant materials. The colonies of *B. argenteum* were shallower than those of other Antarctic mosses, and also those of *B. argenteum* in Japan. The depth of the rhizoid layer of all three mosses were almost the same, but the shoot layer of *B. argenteum* in Antarctica was very shallow. In some cases, *B. argenteum* and *B. pseudotriquetrum* were found in the same colonies. Three structural patterns were recognized in the arrangement of two species in the same colonies.

1. Introduction

Various abiotic environments in Continental Antarctica are considered as extremely severe for mosses and lichens (*e.g.* SMITH, 1972; NAKANISHI, 1977). It is important to recognize how these plants first become established on soil or rock surfaces, and how these colonies are maintained in such environments.

In this study, we examined the colony structure of three mosses growing in the Syowa Station area, Antarctica, especially the layered structure and arrangement of shoots in colonies composed of two mosses.

2. Materials and Methods

Dried specimens of colony samples of *Bryum argenteum, B. pseudotriquetrum* and *Ceratodon purpureus* collected in Syowa Station area (39°35′E, 69°00′S), Antarctica were used for this study. For comparison, colonies of *B. argenteum* collected near the National Institute of Polar Research in Tokyo (139°43′E, 35°45′N) were used. Vertical sections of the colonies were made and their structure were recorded. All the specimens used in this study were deposited in the herbarium of the National Institute of Polar Research (NIPR).

Two layers were recognized in vertical section of colonies on these species: an upper 'shoot layer' and a lower 'rhizoid layer' (Fig. 1). In the shoot layer, shoots were not disrupted. Only the upper 1–2 mm of shoots were green, and

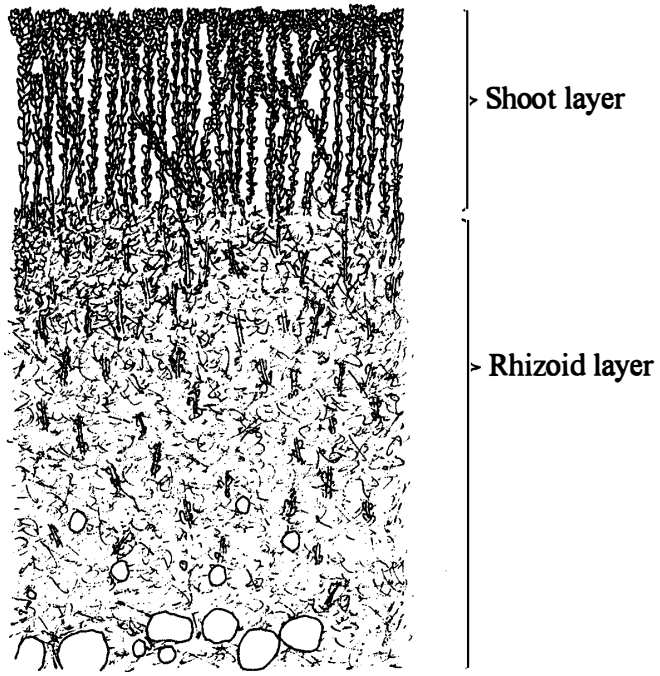

Fig. 1. Schematic of structure of moss colonies in Antarctica.

lower part of them are brownish. In the rhizoid-layer, disrupted plant materials and numerous rhizoids were randomly arranged and tangled. The depth of both layers was measured on each sample.

Where the colonies were composed of two or more species, arrangement of shoots of each species were recorded in detail.

Selected specimens examined: *Bryum argenteum*: Antarctica: Skarvsnes, SHIMIZU 80; Hamnenabben, Langhovde, SHIMIZU 266; Mt. Tenpyô, Skarvsnes, SHIMIZU 194; West Ongul Island, KOBAYASHI 042-B; Cape Hinode, Prince Olav Coast, KOBAYASHI H39-A; Yokoike Valley, Langhovde, NAKANISHI A66; Rundvågshetta, Sôya Coast, KANDA 660.

Japan: National Institute of Polar Research, Kaga, Itabashi-ku, Tokyo, IMURA 6004, IMURA 6005.

Bryum pseudotriquetrum: Hakugindai, Langhovde, KANDA 85–13; Unigahama, Langhovde, KANDA 87–1; Yatude Valley, Langhovde, KANDA 91–4.

Ceratodon purpureus: Hakugindai, Langhovde, KANDA 85–9; Unigahama, Langhovde, KANDA 86–3; Yatude Valley, Langhovde, KANDA 91–7.

3. Results and Discussion

3.1. Colony structure and depth

The colonies of *Bryum argenteum* in Antarctica consist of densely packed stems, especially at the surface. Each shoot produced some short branches from near their apices, so the surface of colonies were almost closed. Depth of colonies ranged 2–15 mm with a mean of 6.8 mm (Table 1). It is noteworthy that the rhizoid layer was significantly thicker (ranged 0–12 mm with a mean of 4.4

mm) than the shoot layer (ranged 1–6 mm with a mean of 2.4 mm). The rhizoid layer was composed of disrupted shoot fragments and numerous rhizoids. The rhizoidal belts (MATSUDA, 1968) were not observed in the shoot layer.

The colonies of *Bryum argenteum* in Japan were composed of closely packed shoots, but less dense than those in Antarctic colonies. Depth of colonies ranged 9–15 mm with a mean of 11.2 mm. That of shoot layer ranged 3.5–11 mm with a mean of 7.0 mm, and rhizoid layer ranged 2–8.5 mm with a mean of 4.4 mm. Shoot layer of Japanese colonies was thicker than that of Antarctic colonies. The rhizoidal belts were not observed in the shoot layer.

The colonies of *Bryum pseudotriquetrum* in Antarctica were composed of more loosely arranged shoots than those of *B. argenteum*. Between-stem spaces were clearly visible at the surface of the colonies. Depth of colonies ranged 13–50 mm with a mean of 24.3 mm, considerably thicker than that of colonies of *B. argenteum*. That of shoot layer ranged 5–50 mm with a mean of 20.9 mm, and rhizoid layer ranged 0–8 mm with a mean of 3.4 mm. In most colonies, the rhizoidal belts were clearly observed in the shoot layer.

The colonies of *Ceratodon purpureus* in Antarctica were composed of somewhat loose shoots. Depth of colonies ranged 7–34 mm with a mean of 21.3 mm, similar to that of *B. pseudotriquetrum* colonies. That of shoot layer ranged 5–34 mm with a mean of 21.3 mm, and rhizoid layer ranged 0–15 mm with a mean of 3.3 mm. In some colonies, the rhizoidal belts were clearly observed in the shoot layer.

KANDA (1981) has previously studied the depth of colonies of *Bryum pseudotriquetrum* and *Ceratodon purpureus* in the Syowa Station area, Antarctica. He reported that, colonies about 2 cm in depth were most frequent in the region. Our results obtained in this study are comparable to those of the KANDA (1981) for these species. Colonies of *B. argenteum* are significantly shallower. Antarctic colonies of *B. argenteum* are about half the depth of Japanese colonies of this species.

A characteristic feature of the Antarctic colonies of *B. argenteum* is the thick rhizoid layer, about two times thicker than shoot layer. The presence of a thick rhizoid layer in Antarctic moss colonies has also been recorded by SEPPELT and

Table 1. Depth of moss colonies in Antarctica and Japan.

	Number of colonies	Mean depth (mm)		
		colonies	shoot layers	rhizoid layers
Antarctic colonies				
Bryum argenteum	33	6.8	2.4	4.4
Bryum pseudotriquetrum	12	24.3	20.9	3.4
Ceratodon purpureus	10	21.3	18.0	3.3
Japanese colonies				
Bryum argenteum	5	11.2	7.0	4.6

ASHTON (1978) and NAKATSUBO and OHTANI (1992). However, neither the development or function of this layer has been investigated.

3.2. Moss community structure

As a result of cryoturbic disturbance, moss communities in Antarctica are often highly convoluted, showing a complex hummock and hollow structure. Structural patterning may also result from invasive colonization of a primary species by another.

In the study area we investigated, mixed communities of *Bryum pseudotriquetrum* and *C. purpureus* were not found. Although uncommon, a few mixed colonies of *B. argenteum* and *Ceratodon purpureus* (2 out of 33 colonies sampled) were collected. Mixed colonies of *Bryum argenteum* and *B. pseudotriquetrum* were more common (10 out of the 33 colonies sampled).

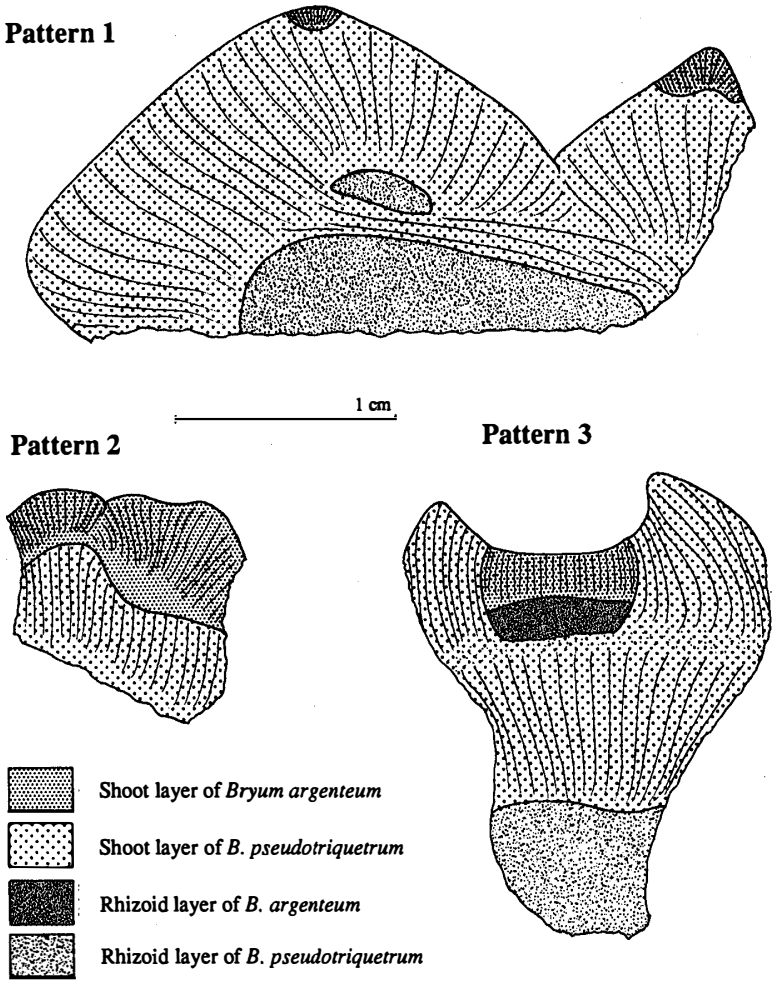

Fig. 2. Patterns of shoot arrangement in vertical section of colonies in which Bryum argenteum *and* B. pseudotriquetrum *were found. Pattern 1 was drawn from* KANDA *840907-008. Pattern 2 drawn from* KANDA *761108-001. Pattern 3 drawn from* KANDA *761108-011. All the specimens were deposited in the herbarium of National Institute of Polar Research (NIPR).*

The arrangement of shoots of mixed colonies of *Bryum argenteum* and *B. pseudotriquetrum* were classified into three patterns (Fig. 2).

Pattern 1: In one specimen, colonies of *B. argenteum* are found on the colony of *B. pseudotriquetrum*. They are very small, and found only on the peak of the hummock of the colony of *B. pseudotriquetrum*.

Pattern 2: In four specimens, only *B. argenteum* was observed from the surface view. But under the rhizoid layer of the species, old brownish shoots of *B. pseudotriquetrum* were found. The shoots of *B. pseudotriquetrum* were displaced and overgrown by those of *B. argenteum*.

Pattern 3: In five specimens, colonies of *B. argenteum* were found growing in those of *B. pseudotriquetrum*. Stems of the more vigorous *B. pseudotriquetrum* appear to surround and eventually overtop those of the smaller and less vigorous *B. argenteum*.

LONGTON and HOLDGATE (1979) and NAKATSUBO and OHTANI (1992) considered that sectional profiles of moss colonies reveal successional stages. Under the influence of the extreme environmental conditions, Antarctic moss communities represent dynamic ecosystems showing complex interactions between moisture and nutrient availability, cryoturbic disturbances, species interactions and colonization processes. Colony profiles reveal stem contortions which facilitate interpretation of community dynamics. However, only longer term monitoring of specific study sites will permit a true understanding of the nature of species association and dynamic interrelations in moss communities.

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