Some Problems on the Future Ecological Study of Mosses in the Syowa Station Area, East Antarctica

Hiroshi KANDA*

昭和基地周辺における蘚類の生態学的研究課題

神 田 啓 史*

要旨：日本南極観測の20年を通して，昭和基地周辺で行われてきた蘚類研究が概観され，いくつかの研究課題が指摘された．
(1)地域的および全南極的な植物散布の観点で蘚類植生の定着を考察すること．
(2)蘚類の分類や分布の研究と平行して，土壌の諸性質や栄養塩と植生との関係を解析すること．
(3)蘚類の仮根帯の形成過程を解明すること．
(4)蘚類の生育形，ことに湖水中に生きているものに関する知見を得ること．
(5)蘚類の生殖器と胞子体の発達過程を解明すること．
これらの課題の解明は，環境監視の指標としての蘚類の生態的意味を理解するうえで基礎的知見を与えるであろう．

Abstract: Some problems expected to be solved on the future ecological study of mosses in the Syowa Station area were pointed out. The mechanism of settlement of the moss vegetation in the Antarctic botanical zone should be studied. Second, the analysis of the relationship between nutrients in soil and the moss vegetation is necessary. Furthermore, the investigation of formation of the rhizoidal lines seen in a transection of moss colonies, the examination of variation in morphological characters of mosses from both genotypic and phenotypic viewpoints and the studies on the sporophyte maturation are suggested.

These studies give the fundamental knowledge in the ecology of mosses as one of the biological indicators to monitor the Antarctic environment.

1. Introduction

Since 1978, a project of environmental monitorings has been carried out

* 国立極地研究所. National Institute of Polar Research, 9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173.

in the vicinity of Syowa Station, East Antarctica. This project consists of the following articles: measurement of nitrogen oxide and carbon dioxide in the air, observation of chemical compounds in the lake water, detection of bacteria in soil at fixed stations, soil algae at fixed stations and population census of penguins and seals. These articles aim to obtain information on the direct or indirect human impact to the natural environment in the Syowa Station area. At present, the moss is not used as an indicator for the monitoring.

The purpose of this short report is to point out problems on the future ecological study of mosses in the Syowa Station area.

2. Settlement of the Moss Vegetation in the Antarctic Botanical Zone

From the vicinity of Syowa Station, East Antarctica, six species of mosses have hitherto been known: *Bryum argenteum, B. pseudotriquetrum, Ceratodon purpureus, Grimmia lawiana, Pottia austro-georgica* and *P. heimii* (KANDA, 1981a). Three species of them are cosmopolitan. It was stated by BARTRAM (1938) that the bulk of the moss species in the Antarctic botanical zone was composed of the cosmopolitan species. According to him, the Antarctic moss vegetation is the remnants of pre-glacial climax vegetation which survived the harsh glacial environment. However, the prevalent views are that the moss vegetation in the present Antarctica was introduced from other regions by air current such as a prevailing westerly wind or through the agency of birds at a relatively recent time (DARLINGTON, 1965; SEKI, 1974; ZANTEN, 1971, 1978). In the Syowa Station area, YAMANAKA (private communication) found out pollens and spores in snow and lake deposit. He mentioned that these pollens and spores had been brought there over a long distance of about 4000 km. This fact supports the views mentioned above.

HOLDGATE (1964) divided the Antarctic botanical zone into two parts, namely the continental and the maritime Antarctic areas. This division is based upon the mean monthly air temperature and the presence of flowering plants and liverworts. CAMERON *et al.* (1977) also showed a schema of the Antarctic biome based upon the mean temperature and the mean annual precipitation. In the schema, liverworts are placed in an area with the highest precipitation and temperature in the Antarctic biome. However, it seems that further investigations are necessary to adopt the liverwort as an indicator of

the warm and moist conditions in the Antarctic botanical zone, because a hepatic species of *Cephaloziella* was reported from Cape Hallet (72°19′S, 170°18′E) and it was dispersed to the Wilkes Land (STEERE, 1965; GREENE, 1967).

A local dispersal by a part of organisms such as buds or leaf bits of mosses seems to favor reformation and expansion of the moss vegetation. At the same time, this accounts for the wide-ranged dispersal of mosses around all ice-free areas of Antarctica (RUDOLPH, 1970).

The mechanism of settlement of the Antarctic moss vegetation should be considered from the viewpoint of the local and global dispersal in the whole Antarctic region. However, information on the air-borne dispersal of mosses is not sufficient in Antarctica.

3. Moss Vegetation in the Syowa Station Area

3.1. Moss distribution and its ecological aspects

The study on mosses in the Syowa Station area was started by HORIKAWA and ANDO (1961) on the basis of the specimens collected by the first (1956–1957), third (1958–1959) and forth (1959–1960) expeditions. Between 1973 and 1975, a project entitled "The studies of the Antarctic ecosystem as the background for assessing human impact to the environment" was put into operation. Under this project, the ecological and taxonomical researches on mosses progressed resulting in significant contributions (KOBAYASHI, 1974; SHIMIZU, 1977; YAMANAKA and SATO, 1977; NAKANISHI, 1977, 1979; OCHI, 1979; KANDA, 1979, 1981a, b). Approximately 5000 moss specimens including the first collection have been maintained in the herbarium of the National Institute of Polar Research (NIPR) and some universities of Japan. After HORIKAWA and ANDO (1961), the moss flora was fragmentarily studied in some localities, but recently KANDA (1981a, b) has surveyed the moss florae throughout the Prince Olav Coast and the Sôya Coast.

On the relation between the moss vegetation and its environmental conditions, MATSUDA (1968) first noted the fact that the snow drift which was brought by prevailing wind gives good water supply for moss vegetation and the vegetation patterns are in parallel with the wind direction. Thereafter, some habitat types of mosses in ice-free areas were classified according to the degree of the water supply (NAKANISHI, 1977; SHIMIZU, 1977; KANDA,

1981b). Furthermore, features of substrates for moss habitats were studied at some localities: the relations between moss vegetation and sea birds (MATSUDA, 1968), between terrestrial plant communities and bird nests (NAKANISHI, 1977) and between the distribution pattern of plant communities and nutrients (YAMANAKA and SATO, 1977) were investigated. The pottiaceous species and *Bryum argenteum*, which generally prefer calcareous sites, occur more frequently in the Sôya Coast, and *Grimmia lawiana* is more abundant in the Prince Olav Coast (KANDA, 1981a, b). Properties of soil such as texture, constituent minerals and nutrients contained seem to affect the development and the species composition of moss communities. There are, however, few data dealing with the relation between the nutrients and the moss vegetation.

3.2. Growth form of mosses

MATSUDA (1968) took notice of the rhizoidal lines in transection of the colony of *Bryum pseudotriquetrum* (as *B. inconnexum*). He pointed out that the rhizoidal lines were formed by the annual periodicity in the growth of moss. In some localities, the lines were obscure and in other localities they did not appear. The intervals between the lines were different in samples obtained from different habitats. The process of the rhizoid formation in the Antarctic moss cushions is not yet known. The investigations on the subject are expected.

KANDA (1981b) examined the depth of moss turfs of *B. pseudotriquetrum* and *Ceratodon purpureus* in the Prince Olav Coast and the Sôya Coast. The turf depth of *Bryum pseudotriquetrum* is in a range of 1–4 cm in the Prince Olav Coast, whereas it is 1–10 cm in the Sôya Coast. On the other hand, *C. purpureus* shows a relatively small variability in the depth in both localities. The growth of mosses depends upon the degree of water supply due to topographic features such as stream, pond, lake and snow drift. As pointed out by NAKANISHI (1977), mosses of the genera *Ceratodon* and *Bryum* in the Syowa Station area have also a preference for the water supply just like those in the temperate zone.

The growth form and morphological features of mosses in natural conditions have to be observed from both the genotypic and phenotypic viewpoints. The less divergent round leaf character specific to Antarctic plants of *Ceratodon purpureus* is only phenotypic (KANDA, 1979). On the contrary, pronounced inherent differences are present between colonies of *Polytrichum strictum* in

different environments, particularly with respect to length and stem elongation (LONGTON, 1974).

Hydrophytic bryaceous mosses were often collected from the bottom of some ponds in the Syowa Station area (OCHI, 1976, 1979; NAKANISHI, 1977). This moss is sterile, filiform and without sexual organs, but it bears globose gemmae on the rhizoids. NAKANISHI (1977) and OCHI (1979) annotated that this moss was closely similar to the *Bryum korotkevicziae* or its variety *hollerbachii*. However, this specimen has not been studied in comparison with the type specimens. A taxonomic revision of this specimen is expected in the near future.

4. Sporophyte Maturity

In 1975, matured sporophytes of *Pottia heimii* (as *Bryum antarcticum*) was discovered in the ice-free areas of the Sôya Coast. This discovery is one of the important contributions to the moss ecology in the continental Antarctica (NAKANISHI, 1977; KANDA, 1981a). The reproduction of mosses in the continental Antarctica is usually vegetative. This reproductive form is also considered to be an adaptation to a harsh environmental condition. GREENE (1967) reported that young and immature sporophytes of *Pottia heimii* (as *B. antarcticum*) had been discovered once at Cape Bernacchi and once at Mable Point, Southern Victoria Land. Since these capsules were all aborted, he mentioned that the fruiting success was doubtful. However, this species is able to produce the matured sporophyte in a certain natural condition in the continental Antarctica. The sporophytes of other species have never been found in the vicinity of Syowa Station or in other regions of the continental Antarctica.

It would be useful to examine the factors governing the formation of sporophytes in Antarctica to solve the problems on the adaptation of mosses to the Antarctic environments.

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