

Bryoflora of Schirmacher Oasis, East Antarctica: A Preliminary Study

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Abstract

Systematic survey and collection of bryophytes was carried out in Schirmacher Oasis and its environs during the austral summer of 1997. Nine species of mosses under five genera and four families have been recorded including sporophyte bearing plants of *Bryum pseudotriquetrum* (Hedw.) Schwaegr.

Introduction

In terms of available water and the temperature regime, the two vital environmental factors, the Antarctica represents climatically the harshest region of the world. The only parallel of the Antarctic biome that could be seen elsewhere, though with only a small degree of overlap, is that with arctic and alpine tundra. Whereas, the extreme conditions met in the interior of the continent more or less present the "Martian environment" (Vishniac & Mainzer, 1973; Walton, 1987). the Antarctic terrestrial biological diversity is, therefore, confined to ice-free areas of coastal outcrops and offshore islands, inland nunataks, mountain ranges and Oases.

The bryophytes, because of their poikilohydric nature and alternative strategy of adaptation, are one of the very few plant groups which grow in Antarctica. As such, their role in habitat modification, nutrient cycling, primary production and providing shelter and security to associated invertebrate animal - the bryobionts, bryophiles, bryoxenes as well as occasional, assume a particular significance. Incidentally, barring just two species of vascular plants, viz. *Deschampsia antarctica*, a grass belonging to family Poaceae, and *Colobanthus quitensis*, a pearlwort of family Caryophyllaceae reported to be occurring in Antarctica (Seppelt & Broadly, 1988), the only other groups of plant recorded from the icy continent include lichens, fungi, algae and bacteria. Thus the Antarctic continent, with its off-lying islands, is unique in being the only major landmass almost entirely vegetated by cryptogams, with the lichens predominating in drier, more exposed situations, while the bryophytes dominant in the more sheltered and moister habitats. The Antarctic flora in general is impoverished due to both, harsh environment and isolation of the continent because of vast, cold and turbulent oceanic barrier of the southern seas.

The bryophytic flora of Antarctica comprise about 70 species of mosses and 10 liverworts (Seppelt, 1986). But most of these are confined to maritime

Antarctic region. i.e. more northerly part of Antarctic Peninsula and the islands to the north, whereas the continental Antarctic bryoflora is characterised by just a few species of generally wide distribution belonging to 8-10 genera only, viz. *Bryoerythrophyllum*, *Bryum*, *Cephaloziella*, *Ceratodon*, *Dicranella*, *Didymodon*, *Grimmia*, *Plagiotheccium*, *Pottia* and *Sarconeurum*. *Bryum* is the largest moss genus occurring in Antarctica. But, because of great phenotypic plasticity exhibited by it in response to extreme environmental conditions, coupled with general lack of sporophytes make this as taxonomically most difficult and confused genus in the continent. *Sarconeurum*, a monotypic moss genus widely distributed in Antarctica and southern South America (Green, 1975; Matteri, 1982), shows the southern most distribution by any bryophyte, being recorded at 82° 42'S latitude (Wise & Gressit, 1965).

The Schirmacher Oasis, lying within the coordinates 70° 44' - 70°46' South latitudes and 11°20' - 11°55' East longitudes, is relatively smaller, rocky oasis covering an area of about 34 sq. km, elongated in East-West direction. It is a 'typical Oasis' (Korotkevish, 1969) situated between the ice shelf in the north and polar ice-cap in the south. The relatively ice free oasis is studded with about 200 water bodies (lake, ponds, lakelets, basins) ranging from 1 sq m to 2.217 sq km in size. The banks of these water bodies and the innumerable melt water stream provide the most congenial habitat for the growth of bryophytes.

The biological studies, carried out under the Indian Scientific Program in and around Schirmacher Oasis, has so far focused on phytoplanktons, algae, bacteria, lichens and fungi (Wafer & Untawale, 1983; Pant, 1986; Kashyap, 1988; Dasgupta, et al., 1988; Shivaji et al., 1988, 1989; Gupta & Kashyap, 1995, 1998; Pandey & Kashyap, 1995; Upreti & Pant 1955; Singh & Agarwal, 1998; Singh & Venkataramana, 1998; Gupta et al. 1999), but no bryological investigations have been undertaken except for the incidental observations by the members of various expeditions. A perusal of literature reveals that though the oasis has been under investigations by the scientists of erstwhile U.S.S.R. since 1961 and the German Democratic Republic (between 1976-90), yet no systematic taxonomic studies on bryophytes of Schirmacher Oasis and its environs have been done except for the reported occurrence of *Bryum algens* Card. And *Plagiotheccium simonovii* Savicz. & Smirn. - a benthic species occurring in deep lakes in the eastern part of the Oasis (Savich-Lyubitskaya & Smiranova, 1964, 1972). Recently, however, Richter (1999) recorded *Bryoerythrophyllum recurvirostre* (Hedw.) Chen, *Bryum argenteum* Hedw., *Ceratodon purpureas* (Hedw.) Brid, *Grimmia lawiana* Willis and *Sarconeurum glaciale* (C. Muell). Card. & Bryhu from Schirmacher Oasis.

Materials and Methods

The author participated in the XVI Indian Scientific Expedition to Antarctica to carry out bryological studies in the Schirmacher Oasis and its surroundings during the austral summer of 1996-97. For the purpose of survey the entire Oasis was broadly divided into three regions: the Western Schirmacher (with a

total area of ca 10 sq. km between the longitudes 11° 20' -11°35' E), the Central Schirmacher (with a total area of ca 14 sq. km between the longitudes 11°35' - 11°45' - 11°55' E) (see map). While survey and collection of plant specimens in western Schumacher was accomplished from a field camp established about 8 km west of the permanent Indian station - Maitri, that in the central and eastern part of the oasis was carried out from Maitri itself. In all, 23 traverses were undertaken between 6th January to 21st February 1997, which included 7 in western, 10 in central and 6 in eastern Schirmacher. Besides, five collection forays were also made in Filchner Fjella and its surroundings in Orvin-IV mountains and one to the nearby nunatak 'Kailash'. As a result of these explorations a total of 345 plant specimens, were collected, which included 43 lichens, 2 algae and remaining bryophytes. Of these 88 specimens were collected from eastern Schumacher, 88 from central Schumacher, 134 from western Schumacher, 29 from Orvin-IV mountains (28 lichens and one algae) and 6 from the 'Kailash'

The specimens were preserved in drying paper packets and field data on their habit, habitat, colour and abundance were recorded. After shade-drying, the specimen have been preserved in herbarium packets of 4"x5" size, in accordance with the internationally accepted herbarium methodology, and have been deposited in the herbarium of Botanical Survey of India, Northern Circle, Dehra Dun having the acronym BSD. The identifications have been done on the basis of available literature, taking into account both morphological as well as anatomical features of the plants. The genera and species of the mosses recorded during the course of the study are arranged alphabetically, whereas the families are arranged as per the classification proposed by Vitt (1984).

The terrestrial mosses, though quite widespread in the Schirmacher Oasis colonising a range of habitats from soils just outside the snow field, sheltered situations in exposed areas, patterned grounds, biogenic remains and around the nests of south polar Skua (*Catharacta macromiciei*) etc., but they are most abundant and luxuriant along the banks of water bodies and the meltwater streams.

Enumeration

BRYACEAE

Bryum argenteum Hedw., Spec. Musc. 181.1801.

Plants forming close yellowish brown or brownish green turves with reddish stems. Leaves closely imbricated, broadly ovate or obovate, apiculate-acuminate, entire; nerve reddish below, percurrent, quite variable in length.

Very common.

Distrib: India: The Himalayas, Meghalaya, Orissa, Nilgiri and Palni Hill.

Cosmopolitan.

Bryum pseudotriquetrum (Hedw.) Schwaegr., Spec. Suppl. 1 (2): 110. 1816. *Mnium pseudotriquetrum* Hedw., Spec. Musc. 190. 1801. Plants forming loose or dense, deep green - purplish turves. Leaves spreading, oblong-lanceolate, entire or denticulate near apex; never reddish, excurrent. Sporophyte present; seta

2-4 cm long, curved at the top, hyaline or whitish; capsule inclined, clavate, yellowish brown.

Very common, but only few fruiting plants were seen in two population, one each in Western and Eastern part of the Oasis. This is one of the very few bryophytes recorded in fruiting condition from Antarctic botanical zone, including the continental Antarctica (Webb, 1973; Sepelt, 1986). However, it will be interesting to study the phenology of gametangial development, fertilisation and spore dispersal in this species.

Distrib : India : The Himalayas.

Cosmopolitan.

Apart from the above two widely distributed Antarctic species of Bryum, the primary investigations have also revealed following three species, which have so far not been recorded from the Antarctic botanical zone. The species have been tentatively identified and need detailed further study. Including that of the type for authentication.

Bryum cf. *atropurpureum* (Dicks.) Wahlenb. In Fuernr., Flora 12 (2) Erg.:56. 1829. *B. bicolor* Dicks., Pl. Crypt. Brit Fasc.4; 16. 1801.

Plant forming compact reddish turves; stems slender. Leaves crowded or distant, broadly ovate-lanceolate; nerve reddish, excurrent.

Common.

Distrib:India:The Himalayas.

Cosmopolitan.

Bryum cf. *bornholmense* Winkelm et Ruth., Hedwigia 38: 122, 1899.

Plant forming low, green turves. Leaves ovate-lanceolate with darker; nerve strong, prominently excurrent.

Occasional, in Western Schirmacher.

Distrib.:Europe, N . America.

Bryum cf. *mildeanum* Jur., Verh. Zool Bot Ges. Wien 12:967.1862.

Plants forming shining pale green turves; stems slender, red below. Leaves concave, broadly ovate, acuminate, entire or finely denticulate; nerve red, excurrent. Not so common.

Distrib:India: Western Himalaya, Meghalaya, Nilgiri Hills.

Middle East Asia, Northern Africa, Europe.

POTTIACEAE

Bryoerythrophyllum recurviroste (Hedw.) Chen in Hedwigia 80 : 255. 1941. *Weisia recurvirostris* Hedw., Spec. Musc 71. 1801.

Plants forming low, reddish green or brown turves or mats ; stems usually dichotomously branched. Leaves erect-spreadig, lanceolate, acute, margins recurved almost up to base; nerve percurrent.

Not Common.

Distrib : India : Kashmir

Cosmopolitan.

Pottia cf. heimii (Hedw.) Hamp., Flora 20: 287. 1837. *Gymnostomum heimii* Hedw., Spec. Musc. 32., 1801.

Plants forming compact, yellowish green or green cushions. Leaves increasing in size upwards, oblong-lanceolate or ovate, acute or acuminate, margins serrated near apex; nerve reddish, may or may not be excurrent.

Not Common.

Distrib.: East and South-East Asia, Europe, North and South America, Australia, New Zealand, Antarctica.

DITRICHACEAE

Cedratodon purpureus (Hedw.) Brid., Bryol. Univ. 1 : 480. 1826. *Dicranum purpureum* Hedw., Spec. Muse. 136. 1801.

Plants forming yellow or brownish green tufts, often with reddish tinge; stems branched. Leaves ovate or linear-lanceolate with revolute margins except at the acuminate apex; nerves percurrent or very slightly excurrent.

Common.

Distrib. : India : The Himalayas and the Western Ghats.

Cosmopolitan.

GRIMMIACEAE

Grimmia Sp.

Plant forming small, brownish green tufts. Leaves lanceolate with hyaline apices; Nerves excurrent.

Common, in Western Schirmacher.

Richter (1995) recorded *G. lawiana* Willis from the Schirmacher Oasis, a taxon also reported from other Antarctic locations. The above specimens could belong to the same species, but this aspect needs further detailed study.

Apart from the mosses growing in most congenial niches, they often exhibit typical necrotic centres because of tiered vegetational pattern wherein turves and cushions of mosses have orange, yellow or grey encrustations of several lichens, like species of *Caloplaca*, *Leparia*, *Physcia*, *Xanthoma* and black patches of blue green alga *Nostoc commune*. Often yellowish white encrustations of fungi *Arthrobotrys ferox* are also seen on moss cushions (J.R. Sharma, pers. Comm).

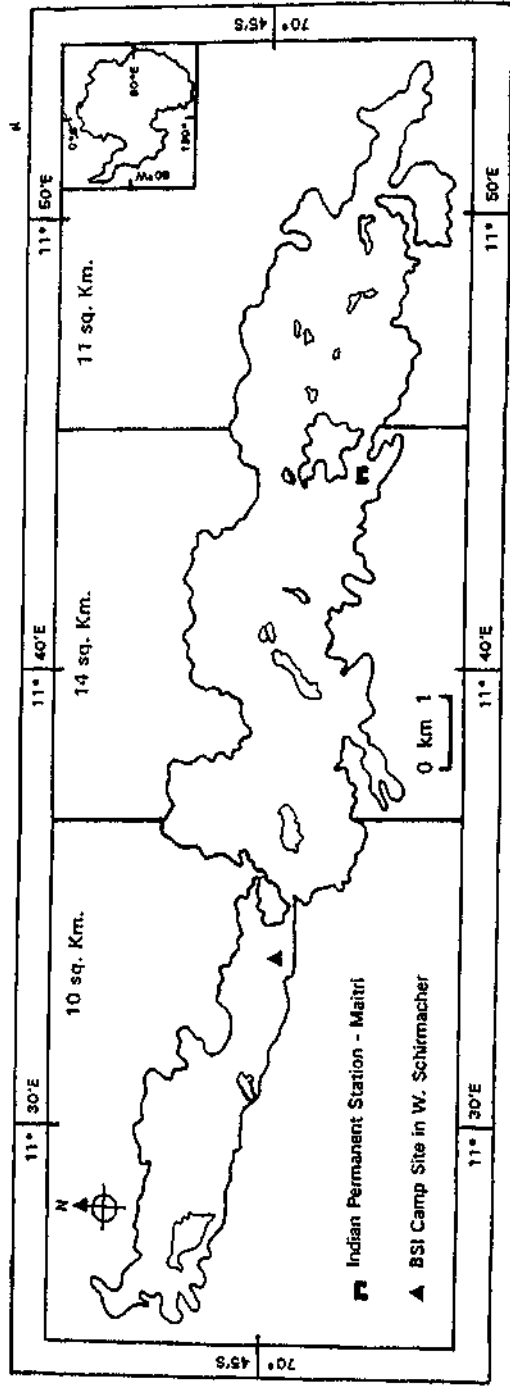
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References

- Dasgupta, J., G.C. Saxena, B. Banerjee & S.K. Basu. 1988. Studies on some Antarctic bacteria. In: Dwivedi, S.N., Mathur, B.S. & Hanzura, A.K. (eds.) Proceeding Workshop on Antarctic Studies, pp 441-449
- Green, S.W. 1975. The Antarctic moss *Sarconeurum glaciale* (C. Muell.) Card. & Bryhn in Southern South America. Brit. Antarct. Sur. Bull. 41: 187-191.
- Gupta, R.K. & A.K. Kashyap. 1995. Water uptake and loss by Antarctic Cyanobacterium *Nostoc commune*. Eleventh Indian Expedition to Antarctica, Scientific Reprot, DOD Tech. Pub. 9; 221-227.
- Gupta, R.K. & A.K. Kashyapa. 1998. Algal colonization of Schirmacher Oasis, Antarctica. Fourteenth Indian Expedition to Antarctica, Scientific Report. DOD Tech. Pub. 12; 187-192.
- Gupta, R.K. G.P. Sinha & D.K. Singh, 1999. A note on lichens of Schirmacher Oasis, East Antarctica. Indian J. For 22: 292-294.
- Kashyap, A.K. 1988. Studies on Algal flora of Schirmacher Oasis, Dronning Maud land, Antarctica. In: Dwivedi, S.N., Mathur, B.S. & Hanzura, A.K. (eds.) proceedings Wrokshop on Antarctic Studies, pp. 435-439.
- Matteri, CM. 1982. Patagonia bryophytes 6. Fruiting *Sarconeurum glaciale* (C. Muell.) Card. Et Bryhn newly found in sothern Patagonia. Lindbergia 8: 105-109.
- Pandey, K.D. & A.K. Kashyap. 1995. Diversity of Algal flora in six fresh water streams of schirmacher Oasis, Antarctica. Tenth Indian Expedition to Antarctica, Scientific Reprot. DOD Tech. Pub. 8: 219-229.
- Pant, A. 1986. Studies on Antarctic Phytoplankton, Third Indian Expedition to Antarctica, Scientific Report. DOD Tech. Pub. 3: 87-96.
- Richter, W. 1995. Biology, In: Bormann P. & Fritzscher, D. (eds.) The Schirmacher Oasis, Queen Maud Land, East Antarctica, and its surroundings, pp. 321-347.
- Savich-Lyubitskaya, L.I. & Z.N. Smirnova. 1964. Deepa water representative of Plagiothecium Br. Et Sch. In the Antarctic. Inf. Byull. Sov. Antarkt. Eksped. Leningard 49: 33-39.
- Savich-Lyubitskaya, L.I. & Z.N. Smirnova. 1972. Bryum algens Card. - the most common moss in East Antarctica. Trudy Sovt. Antarkt.Eksped. Leningard. 60 : 328-345.
- Seppelt, R.D. 1986. Bryophytes of Vestfold Hills. In : Pickard J. (ed.) Antarctic Oasis. Terrestrial environments and the history of vestfold Hills. Sydney. pp. 220-244.
- Seppelt, R.D. & P.A. Broady. 1988. Antarctic terrestrial ecosystems: The vestfold Hills in context. Hydrobiologia 165: 177-184.
- Shivaji, S., N.S. Rao, L. Saisree, V. Seth, G.S.N, Reddy & P.M. Bhargava. 1988. Isolation and Identification of *Micrococcus roseus* and *Olanococcus* sp. from

- Schirmacher Oasis, Antarctica, J. Bio. Sciences 13: 409-414.
- Shivaji, S.N., Rao, L. Saisree, V.Seth, G.S.N. Reddy & P.M. Bhargawa. 1989. Isolation and identification of *Micrococcus roseus* and *Olanococcus sp.* from Singh, L. & K. Venkataramana, 1998. Isolation and characterisation of psychrotropic Antarctic bacteria from blue-green algal mats and their hydrolytic enzymes. Fourteenth Indian Expedition to Antarctica, Scientific Report. DOD Tech. Pub. 12: 199-206.
- Singh, L. & M.K. Agarwal. 1998. Air Microflora of Antarctica. Fourteenth Indian Expedition to Antarctica, Scientific Report. DOD Tech. Pub. 12: 193-198.
- Upreti, D.K. & G. Pant. 1995. Lichen flora in and around Maitri region, Schirmacher Oasis, East Antarctica. Eleventh Indian Expedition to Antarctica, Scientific Report. DOD Tech. Pub. 9: 229-241.
- Vishniac, W.V. & S.E. Mainzer. 1973. Antarctica as a Martian model. Life Sciences and space research 11: 25-31.
- Vitt, D.H. 1984. Classification of Bryopsida. In : Schuster, R.M. (ed.) New Manual of Bryology 2 : pp. 696-759.
- Wafer, S. & A.G. Untawale. 1983. Flora of Dakshin Gangtori in Antarctica. First Indian Expedition to Antarctica, Scientific Report. DOD Tech. Pub. 1: 182-185.
- Walton, D.W.H. 1987. Antarctic terrestrial ecosystems. Environment International 13: 83-93.
- Webb, R. 1973. Reproductive behaviour of mosses on singy Island, south Orkney Islands. Brit. Antarct. Surv. Bull. 36: 61-77.
- Wise, K.A. & J.L. Gressitt 1965. Far southern animal and plant. Nature 207: 101-102.



Sketch Map of Schirmacher Oasis

Legends for the photographs

1. An aerial view of the Schimacher Oasis (Photo : D.K. Singh).
2. An aerial view of permanent Indian station Complex Maitri (Photo :D.K. Singh).
3. Members of XVI IAE joined by two Norweigin Geologists in their camp at Filchner Fjella. In Orvin-IV mountains. (Photo : D.K. Singh).
4. Moss turves close the snow bank (Photo : D.K. Singh).
5. Moss cushion on biogenic remains of snow petrel (*Pagodroma nivea*) (Photo : D.K. Singh).
6. *Bryum* growing in a sheltered situation among the rocks (Photo : D.K. Singh).
7. Moss turves of *Bryum* encrustes with ephiphytic fungus. (Photo : D.K. Sigh).
8. Turves of *Bryum pseudotriquetrum* (Hedw.) Schwaegr. With few plants bearing sporophytes (indiside box). (Photo : D.K. Sigh).



*An aerial view of the Schirmacher Oasis
(Photo : D.K.Singh.)*



*An aerial view of permanent Indian Station Complex - Maitri
(Photo: D.K.Singh)*



Members of XVI IAE joined by two Norweigin Geologists in their camp at Filchner Fjella. in Orvin-IV mountains. (Photo: D.K.Singh.)



Moss turves close to the snow bank (Photo: D.K.Singh)



*Moss cushion on biogenic remains of snow petrel
(Pagodroma nivea) Photo: D.K.Singh*



*Bryum growing in a sheltered situation among the rocks
(Photo: D.K.Singh)*



*Moss tufts of Bryum encrusted with ephiphytic fungus
(Photo: D.K.Singh.)*



Turves of Bryum pseudotriquetrum (Hedw.) Schwaegr. with few plants bearing sporophytes (inside box) (Photo: D.K.Singh)