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Biodiversity of Larsemann Hills, Antarctica

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General Note
Article is recommended to print as color version in recycled paper. *Save Trees, Save Climate*.

ABSTRACT

Antarctica is the coldest, driest place and fifth-largest continent on this Earth and contains many unique geological, glaciological and biological features. The Larsemann Hills (69°20'S to 69°30'S Latitude., 75°55'E to 76°30'E Longitude) is located approximately halfway between Vest fold Hills and Amery Ice Shelf on South-eastern coast of Prydz Bay. Human activities in Larsemann Hills is promoted due to its coastal location, ice free landscape, Australian summer research base (Law base), Chinese research station (Zhongshan) and Russian research stations (Progress) were established within the area of 3 km from each other on eastern broknes. After that there was rapid infrastructure development in the area and further scientific research and the potential for tourist visits resulted in notable localised alteration of the environment, ultimately affect the biodiversity. The Antarctic environment / climate is highly susceptible to the impacts of human activities and has much less natural ability to recover from disturbance than the environment of other continents. These changes ultimately affect the environment and growth of organisms. Larsemann Hills represent the southernmost coastal oasis contains diverse flora and fauna. In flora - Mosses, Lichens and Algae were observed. Among algae mainly Cosmarium, Diatoms, Dinoflagellates and Cyanobacterial mats were observed from different water bodies and terrestrial habitats. As for as fauna is concerned breeding sea bird like Snow petrels, Wilson's Storm Petrel, South polar Skuas were found. Besides this, Seals, Adelie Penguin and Emperor Penguin were occasionally observed in Larsemann Hills area. However, very little is known about the terrestrial micro fauna. In lakes and streams species of protozoans, platyhelminths, rotifers, tardigrades, nematodes, arthropods, etc. have been reported.

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Keywords: Biodiversity, Larsemann Hills, Antarctica

1. INTRODUCTION

Antarctica is almost completely covered in ice and it is a gift of nature in natural forms. This untouched continent attracts scientific workers to study the nature in natural form. There are two seasons summer and winter. 1st December to 28th February is summer and 1st March to 30th November is winter period. On the basis of duration of light the day is of six months and night is of six month. There is no permanent human population and however, various Antarctic research stations from many nations that are inhabited by summer and winters teams of scientists with Leaders on rotation for scientific work.

2. LARSEMANN HILLS

The Larsemann Hills is an ice-free area located approximately halfway between Vestfold Hills and Amery Ice Shelf on South-eastern coast of Prydz Bay (Fig 1 & 2). This area has a low, gentle and rolling topography merging with the polar ice cap in the south-southeast and surrounded by sea in other three directions. It is punctuated with small islands to the north and northeast.

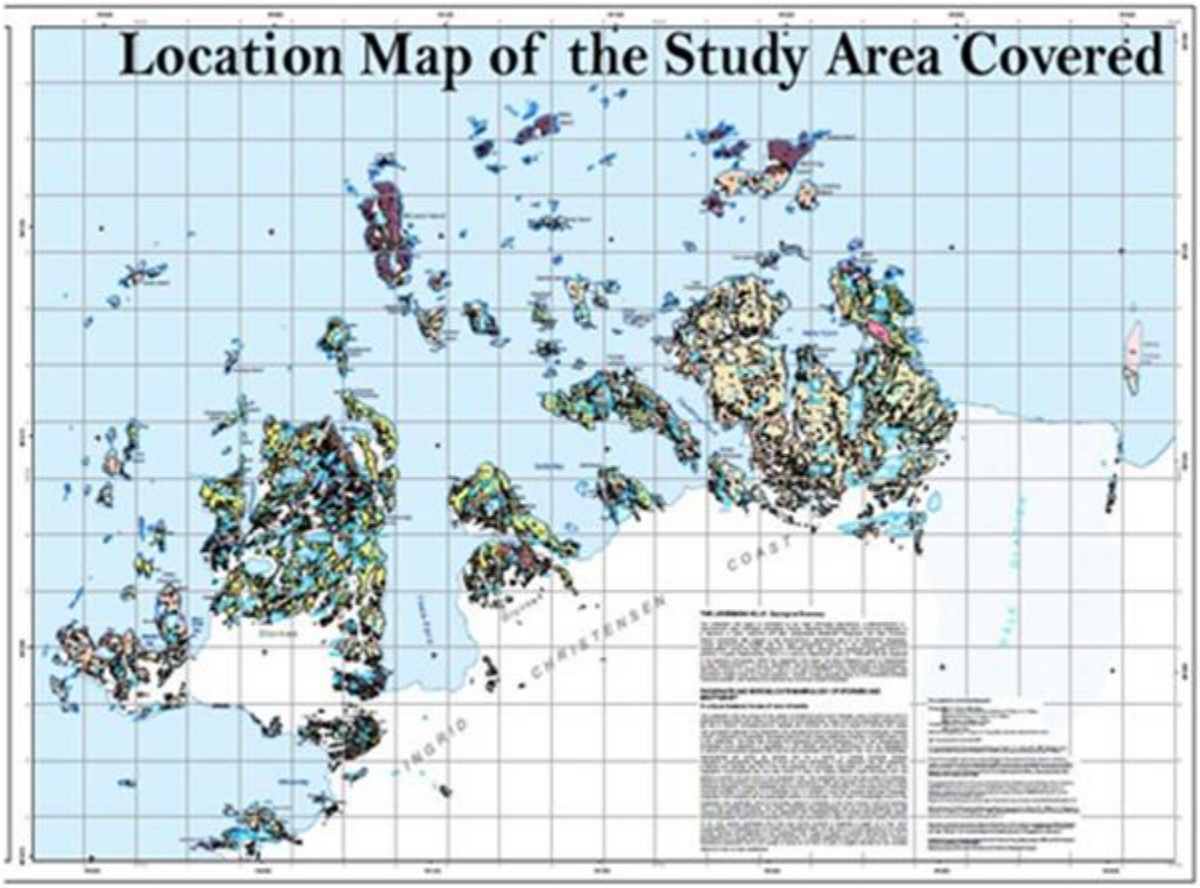

Figure 1
Map of Larsemann Hills, Antarctica

The region consists of two main peninsulas (Stornes and Broknes), together with other peninsulas and a number of scattered offshore islands. At 40 km^2**,** the Larsemann Hills is the second largest of only four major ice free oasis. The highest elevations are around 180 m above sea level (ANARE, 2000). The hills are dissected by steep valleys lying between the ice sheet and the coast. Many valley floors are filled with multi-year ice but those that are ice-free contain a complex geomorphological history preserved in erosional features, including glacial striae and tafoni, glacial and glacio fluvial sediments (Stuwe et al., 1989). More than 150 freshwater lakes are found in the Larsemann hills (Gillieson et al., 1990) ranging from small ephemeral ponds to large water bodies such as Progress Lake (10 ha and 3.8 m deep). Some of these water bodies are briefly ice-free or partially ice-free in the summer

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months when their temperatures increase rapidly; surface water in some of the shallower ones reaches more than 8°C. For the remainder of the year (8 - 10 months) they are covered with about 2 m of ice. Some lakes have evidence of past shorelines which are up to 2 m above present levels but do not exhibit the highly elevated salinities associated with lakes in the Rauer Islands (Hodgson et al., 2001). Lake systems are typically closed and contained in steep-sided V-shaped valleys normally around 50 - 100 m deep and less than 1 km long. These valleys dissect the area and provide a conduit for summer melt water streams between the few lake systems that are open. During Antarctic summer in December, January and February the daily air temperature frequently exceeds 4°C and has been known to reach 10°C (ANARE 2000). Mean monthly winter temperature is between -15°C and -18°C. Precipitation occurs as snow and is unlikely to exceed 250 mm water equivalent annually. Strong, katabatic winds blow most mornings. Preliminary studies by McMinn and Hodgson (unpublished) and Ellis-Evans et al. (1998) have revealed that lakes in the Larsemann Hills contain a great diversity of biological and physical markers from which past environments can be inferred. Some of the most scientifically important lakes on eastern Broknes and other lakes of Larsemann Hills area are collectively recognised as the area of most important ecological feature. These lakes are particularly valuable for their relatively simple natural ecosystems and are susceptible to physical, chemical and biological modification within their catchable boundaries.

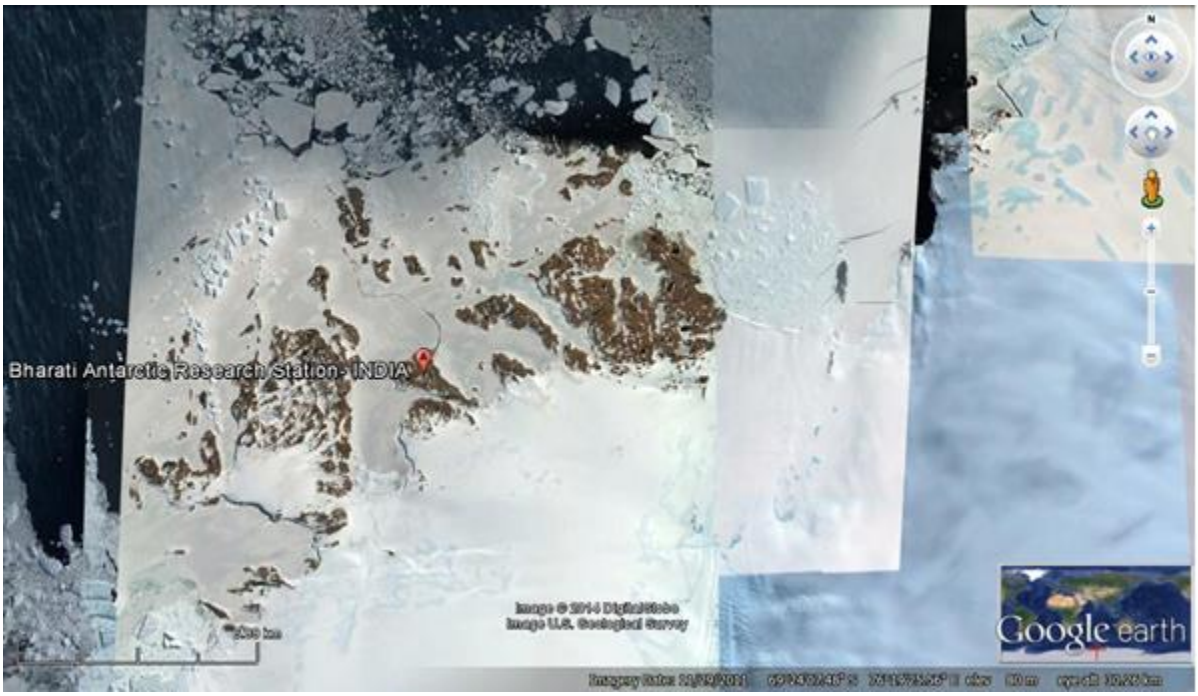

Figure 2
Satellite Imagery Map of Larsemann Hills, Antarctica

Coastal location and ice free landscape in Larsemann Hills area attracted human activity as tourist visit and its potentials for scientific researches induced human activity is affecting the diversity of this area. The Antarctic climate/environment is super susceptible to the impacts of human activities and has negligible natural ability to recover from disturbance than the environment of other continents. So the primary study of biodiversity in this area before impact of human activity is of valuable significance.

Microclimatic conditions and presence of freshwater lakes during summer provide hospitable environment able to support Antarctic life forms. Biodiversity from diverse habitats of Larsemann Hills have been studied by some workers of different countries. However, the work by Indian workers is still in very nascent stage as Indian Research Station Bharati was recently established in March, 2012.

3. DIVERSITY OF FLORA AND FAUNA

Larsemann Hills coastal oasis contains diverse flora and fauna. In flora - Mosses, Lichens, Algae and Bacteria were observed. In algae mainly Cosmarium, Diatoms, Dinoflagellates and Cyanobacterial mats were observed from different water bodies and terrestrial habitats. As for as fauna is concerned, breeding sea bird like Pagodroma nivea (Snow Petrels), Oceanites oceanicus (Wilson's Storm Petrel), Catharacta maccormicki (South Polar Skuas) was found. Besides this, Leptonychotes weddelli (Weddell Seals), Pygoscelis adeliae (Adelie Penguin) and Aptenodytes forsteri (Emperor Penguin) were occasionally observed in Larsemann Hills area. However, very little is known about the terrestrial micro fauna. In lakes and streams species of Protozoans, Platyhelminths, Rotifers, Tardigrades, Nematodes, Arthropods, etc. have been reported.

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As per the report, the Larsemann Hills indicate the flora of the Ingrid Christensen Coast is relatively uniform and restricted to a distribution of bryophytes, lichens and terrestrial algae. It is believe that the nature of basement rock, the relatively recent exposure from the ice cap and prevailing wind direction in greater Prydz Bay area contribute to the less than 1 % of the Larsemann Hills has vegetative cover.

Terrestrial life forms including bryophytes, lichens and accompanying invertebrates are found inland from the coast. Nevertheless large moss beds are known to occur in sheltered sites on the larger island associated with Pygoscelis adeliae (Adelie penguin) moulting sites and nunataks in the southwest.

4. BRYOPHYTES

Bryophytes are represented by widely spread terrestrial mosses in a mosaic of habitats like soils, outside the snow fields, marginal zones or bank of the water bodies and melted water streams, sheltered habitats of exposed knobs with representative but low to moderate snow accumulation, biogenic remains and around the nests of Catharacta maccormicki (south polar Skua). Bryophytes also found in liquid phase of water and among the running water they become biological indicator of the boundary of water. The presence of mosses on nunataks and in mountain ranges depends on the availability of water. The presence of few species of mosses in such type of environment indicates their ecological limits. Altogether seven species of mosses and one species of liverwort (ASAM 6, 2007) have been reported depicted in Table 1.

Table 1
Bryo-diversity of Larsemann Hills, Antarctica

S. No.	Name of the Species	Family	Type
1	Bryum algens Cardot	Bryaceae	Moss
2	Bryum argenteum Hedw.	Bryaceae	Moss
3	Bryum pseudotriquetrum (Hedw.) Schwaegr	Bryaceae	Moss
4	Ceratodon purpureus (Hedw.) Brid.	Ditrichaceae	Moss
5	Grimmia antarctici Card	Grimmiaceae	Moss
6	Grimmia lawiana J.H. Willis	Grimmiaceae	Moss
7	Sarconeurum glaciale (C.Bryhn.) Card. Et Bryhn	Pottiaceae	Moss
8	Cephaloziella exiliflora H.Streimann	Cephaloziellaceae	Liverwort

Out of seven species of mosses, Bryum pseudotriquetum (Hedw.) Schwaegr is found most abundantly. However, only one species of liverwort Cephaloziella exiliflora H.Streimann is reported on the unnamed outcrop south of Stornes Peninsula and known from only four other Antarctic localities.

5. LICHENS

Lichens species have been reported from diverse habitats of McLeod Island of Larsemann Hills, Antarctica. Eighteen species of lichens from McLeod Island was earlier studied by Australian researchers. Rod Seppelt studies the lichens of whole Ingrid Christensen Coast, Prydz Bay and listed 25 species of lichens including four species (Acarospora gwynnii C.W. Dodge & E.D. Rudolph, Buellia frigida Darb., Candelariella flava (C.W. Dodge & G.E. Baker) Castello & Nimis and Umbilicaria decussate (Vill.) Zahlbr.) from Larsemann Hills which was remain unpublished. After that, Singh et al., 2007 reported 25 lichen species from this area. Recently, lichen flora of this region studied by Rai et al., 2012 and comprises 27 species (Table 2).

Table 2
Lichen diversity from McLeod Island of Larsemann Hills, Antarctica

S. No.	Name of the Species	Family	Growth	Substratum
1	Acarospora gwynnii C.W. Dodge & E.D. Rudolph	Acarosporaceae	Crustose	Rock
2	Arthonia lapidicola (Taylor) Branth & Rostr.	Arthoniaceae	Crustose	Rock
3	Buellia frigida Darb.	Caliciaceae	Crustose	Rock
4	Buellia grimmiae Filson	Caliciaceae	Crustose	Soil, Moss
5	Caloplaca athallina	Teloschistaceae	Crustose	Moss

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	Darb.			
6	Caloplaca citrina (Hoffm.) Th. Fr.	Teloschistaceae	Crustose	Rock
7	Caloplaca lewis-smithii Søchting & Øvstedal	Teloschistaceae	Crustose	Moss
8	Caloplaca saxicola (Hoffm.) Nordin	Teloschistaceae	Crustose	Rock, Soil
9	Candelariella flava (C.W. Dodge & G.E. Baker) Castello & Nimis	Candelariaceae	Crustose	Rock, Soil, Moss
10	Carbonea vorticosa (Flörke) Hertel	Lecanoraceae	Crustose	Rock
11	Huea coralligera (Hue) C.W. Dodge & G.E. Baker	Teloschistaceae	Crustose	Moss
12	Lecanora expectans Darb.	Lecanoraceae	Crustose	Soil, Moss
13	Lecanora geophila (Th. Fr.) Poelt	Lecanoraceae	Crustose	Moss
14	Lecidea cancriformis C.W. Dodge & G.E. Baker	Lecideaceae	Crustose	Rock, Soil
15	Lecidella patavina (A. Massal.) Knoph & Leuckert	Lecanoraceae	Crustose	Rock, Soil
16	Lecidella siplei (C.W. Dodge & G.E. Baker) May. Inoue	Lecanoraceae	Crustose	Rock
17	Physcia caesia (Hoffm.) Hampe ex Fürnr.	Physciaceae	Foliose	Rock, Moss
18	Physcia dubia (Hoffm.) Lettau	Physciaceae	Foliose	Rock
19	Pseudephebe minuscula (Nyl. Ex Arnold) Brodo & D. Hawksw.	Parmeliaceae	Fruticose	Rock, Soil
20	Rhizoplaca melanophthalma (Ram.) Leuckert and Poelt	Lecanoraceae	Crustose	Rock, Soil, Moss
21	Rinodina olivaceobrunnea C.W. Dodge & G.E. Baker	Physciaceae	Crustose	Soil, Moss
22	Rinodina peloleuca (Nyl.) Müll. Arg.	Physciaceae	Crustose	Rock
23	Sarcogyne privigna (Ach.) A. Massal.	Acarosporaceae	Crustose	Rock, Soil
24	Umbilicaria decussata (Vill.) Zahlbr.	Umbilicariaceae	Foliose	Rock
25	Usnea antarctica Du Rietz	Parmeliaceae	Fruticose	Rock
26	Xanthoria elegans (Link) Th. Fr.	Teloschistaceae	Foliose	Rock
27	Xanthoria mawsonii C.W. Dodge	Teloschistaceae	Foliose	Rock

Crustose lichens were dominant with 20 species. Physcia caesia (Hoffm.) Hampe ex Fürnr., Physcia dubia (Hoffm.) Lettau, Xanthoria elegans (Link) Th. Fr. and Xanthoria mawsonii C.W. Dodge were the only foliose lichen in this area. However, only two species viz. Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw. and Usnea antarctica Du Rietz. have been reported as fruticose lichen.

6. ALGAE

Australia, United Kingdom (Hodgson et al., 2001) Canada (Hannington, 2002) Belgium (Sabbe et al., 2003), etc. are working on algal flora on various Antarctic regions and presented comparative accounts of algal diversity with their respective countries and also in

different part of Antarctic region. But very little work has been done on studies on algal diversity from diverse habitats of Larsemann hills, Antarctica.

Algae occurs even in wide range of habitats and have been distributed all over land and water system often in such an environments where there is no other vegetation possibly due to their adaptive capability to extreme adverse environmental conditions with respect to different climatic / environmental factors, availability of nutrients, etc. Their occurrence even in wide range of ecologically stress conditions and extreme habitats proves that they are very tolerant. It occurs in fresh-water ecosystem like lakes, ponds, rivers, wetland, etc. and marine water system like salt marshes and pans, estuaries, brackish waters and ocean. Besides, it also occurs on stones, rocks, snow and in cold lakes, and on objects which remain moisten and get solar light from any angle even for a short span of time.

Diatoms, from fresh and saline water lakes of Larsemann Hills and Rauer Island have been studied (Sabbe et al. 2003 and Sarah, 2010) (Table 3).

Table 3
Algal diversity of Larsemann Hills, Antarctica

S. No.	Name of the Species	Class	Family
1	Diadesmis costei Le Cohu & Van de Vijver	Bacillariophyceae	Diadesmidaceae
2	Diadesmis langebertalotii Le Cohu & Van de Vijver	Bacillariophyceae	Diadesmidaceae
3	Diadesmis subantarctica Le Cohu & Van de Vijver	Bacillariophyceae	Diadesmidaceae
4	Diatomella balfouriana Greville	Bacillariophyceae	Pinnulariaceae
5	Psammothidium marginulatum (Grunow) L.Bukhtiyarova & Round	Bacillariophyceae	Achnanthidiaceae
6	Gomphonema parvulum (Kütz.) Kützing	Bacillariophyceae	Gomphonemataceae
7	Planothidium delicatulum (Kütz.) Round & Bukhtiyarova	Bacillariophyceae	Achnanthidiaceae

Phytoplanktons mostly comprises autotrophic nanoflagellates, dinoflagellates, desmids belongs to genus Cosmarium occurs in lakes. Study reveals that heterotrophic nanoflagelattes are more common in comparison to autotrophic nanoflagellates exhibiting low species diversity. Only three or four species in most lakes are particularly abundant in shallow lakes. Parphysomonas is very common in shallow lakes. Ciliates like Strombidium are most common genera and found in less quantity. Species of Holyophyra found in most lakes of this area. Coscinodiscus, Epithemia, Nitzschia, Thalassiosira, Oscillatoria and Chaetoceros have been reported from Larsemann Hills, Antarcica. Coscinodiscus and Nitzschia were most abundant and widely distributed respectively. Extensive cyanobacterial mates was observed in most of the lakes which has accumulated since ice retreat and is consequently thicker on the islands and thinner in young lakes adjacent to the polar plateau. These cyanobacterial (blue-green) mates are of exceptional thickness not generally observed in other freshwater system of Antarctica. Cyanobacterial mats are also widely distributed in streams and wet seepage area.

7. BACTERIA

The Antarctic continent shows microbial community development because of its special environment, geographic isolation and little anthropogenic influence. The Culture-independent community analysis reveals bacterial diversity. The dominant taxa in the glacier forefields are Actinobacteria, Acidobacteria, Proteobacteria, Bacteroidetes, and Chloroflexi. The connection of soil characteristics with bacterial community structure showed that soil parameter and soil formation along the glacier forefield influence the distribution of certain phyla (Bajerski and Wagner, 2013). Several groups like Proteobacteria or Gemmatimonadetes depend on water availability, whereas the most dominant group of the forefields the Actinobacteria is related to the presence of trace elements. Two new psychrotolerant bacteria, Herbaspirillum psychrotolerans and Chryseobacterium frigidisoli were found as novel species of the family of Oxalobacteraceae and Flavobacteriaceae, respectively. They are able to grow at low temperatures tolerating temperature fluctuations and not specialised to a certain substrate and well-adapted to the cold and oligotrophic environment. The prokaryotic community of Antarctic soil is estimated as divers and variable (Barrett et al., 2006, Niederberger et al., 2008).The dominant groups are Bacteroidetes, Actinobacteria, Proteobacteria, Deinococcus/Thermus, Acidobacteria, Firmicutes and Cyanobacteria (Aislabie et al., 2006). Herbaspirillum psychrotolerans sp. nov., a member of the family Oxalobacteraceae from a glacier forefield (Bajerski, 2013b). Chryseobacterium frigidisoli sp. nov., a psychrotolerant species of the family Flavobacteriaceae isolated from sandy permafrost from a glacier forefield (Bajerski, 2013a).

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Indian Research Station Bharati, Larsemann Hills, Antarctica

Bryophytes from Larsemann Hills, Antarctica

Bryophytes from Larsemann Hills, Antarctica

Lichens from Larsemann Hills, Antarctica

Algae in water logged area and from water body of Larsemann Hills, Antarctica

8. SEA BIRDS

Ecological and biological studies at broknes on the south polar skua i. e. Catharacta maccormicki have been carried out (Wang, 1991). Study indicates that Larsemann Hills area also provide breeding sites for other seabirds. Breeding sea bird like Snow petrels (Pagodroma nivea), Wilson's Storm Petrels (Oceanites oceanicus), south polar Skuas (Catharacta maccormicki) and Weddell seals haul out close to sea shore to breed and moult (Wang, 1991). These three species of seabird breed within the Larsemann Hills.

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Location of breeding pairs and numbers are recorded from eastern broknes but their distribution is throughout the remaining area is not certain. Snow petrels (Pagodroma nivea), Wilson's Storm Petrels (Oceanites oceanicus) nets found from October to February in sheltered bedrock fragments, cervices, boulder slops and rock falls on broknes. South polar Skuas (Catharacta maccormicki) are present between mid-late October and early April nesting on broknes. Besides this, Adelie Penguin (Pygoscelis adeliae) and Emperor Penguin (Aptenodytes forsteri) were occasionally observed in Larsemann Hills area but no breeding colonies are found in this area. However, the birds visit from colonies of nearby islands during summer season to moult.

9. SEALS

Weddell seals (Leptonychotes weddelli) are numerous on Larsemann Hills coast using the sea ice in the area to pup from October and to moult from late December until March. Weddell seals hauled out in Thala Fjored and on rafted ice immediately to west of Stornes and numerous smaller groups amongst offshore islands and ice to north-east of broknes. Crabeater seals (Lobodon carcinophagus) and Leopard seals (Hydrurga leptonyx) are also occasional visitors of this area.

10. TERRESTRIAL MICRO FAUNA

Little work is done on the terrestrial micro fauna of Larsemann Hills. Lakes and streams provide many habitats which contains rich and varied fauna typical of Antarctic regions. Species of rotifer (including Monogononta and Bedelloidea), tardigrades, arthropods, protozoans, platyhelminths and nematodes have been reported (Dartnall, 1995). Rotifers occur sporadically in number of lakes. The cladoceran Daphniopsis studeri is one of few species of freshwater crustacean known to occur in the lakes of continental Antarctica has been identified in most Larsemann Hills lakes. Benthic species of deep water lakes of this area are dominated by thick cyanobacterial mats (Ellis-Evan et. al., 1998).

Catharacta maccormicki (South polar Skua)

Pagodroma nivea (Snow petrel)

Oceanites oceanicus (Wilsons Storm Petrel)

Leptonychotes weddelli (Weddell Seal)

11. PROTOZOA

Protozoans have been reported from Scandent, Discussion, Sibthorpe, Progress, Reid and four unnamed lakes. Generally, seen on the bottom of the freshwater lakes were oval elliptical, transparent or pale brown ciliates, small ciliates with spikey tufts - holotrichia, large solitary paramecium-type ciliates and a few small amoebae.

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Pygoscelis adeliae (Adelie penguin)

Aptenodytes forsteri (Emperor Penguin)

12. PLATYHELMINTHES

Solitary specimen of small blind acoelomates was found in the sediments of lake Scandrett and Unnamed lake.

13. TARDIGRADA

Two species of smooth tardigrada were recorded from the freshwater lakes. These would appear to belong to the Isohysibius group reported from Discussion, Sibthorpe, Progress, Reid, and two unnamed lakes of Larsemann Hills. In addition Hfilnesium tardigradum Doyere was found in terrestrial mosses at the edge of lake Scandrett. Five genera of terrestrial tardigrade such as Hysibius, Minibiotus, Diphascon, Milnesium and Pseudechiniscus are reported in association with vegetation.

14. ROTIFERS

Seventeen species of rotifers viz. Cephalodella sterea, Cephalodella ventripes, Collotheca ornate cornuta, Encentrum mustela, Encentrum spatitium, Epiphanes senta, Lepadella patella, Lepadella acuminate, Notholca sp., Ptygura crystalline, Resticula gelida, Adineta grandis, Adineta sp., Habrotrocha constricta Philodina gregaria and two species of Philodina sp. have been reported from different lakes of Larsemann Hills, Antarctica.

15. NEMATODES

Terschellingia, Araeolaimus, Axonolaimus, Chromadorella, Daptonema, Halalaimus, Paralinhomeous, Sabatieria, Stiphonolaimus, Sphaerolaimus and Theristus found as dominant nematode genera from near shore Antarctic locations in the Larsemann Ice Shelf (Ingole and Singh, 2010).

16. ARTHROPODA

Two species of arthropoda found in the freshwater lakes i.e. c1adoceran Daphniopsis studeri Rüch and the copepod Acanthocyclops mirnyi Borutzky and Vinogradov. Daphniopsis studeri was the largest and most abundant species found. Large numbers of males were found in lake Scandrett during the February. This species is commonly recorded from the subantarctic islands of the Southern Indian Ocean. Acanthocyclops mirnyi was also found in the larger fresh water lakes. It was first found in the Bunger Hills (Korotkevich, 1958). Study of biodiversity of Larsemann Hills area is very important because of the rapidly increasing anthropogenic activity may bring about changes in diversity of flora and fauna and may also influence on micro and macro climatic conditions of this area.

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