

# **Preliminary assessment of biological diversity at Larsemann Hills, East Antarctica**

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## **Abstract**

Terrestrial and freshwater diversity increases rapidly from the maritime Antarctic to the sub-Antarctic islands. On the latter, variation in richness is comparatively well understood, especially in the case of vascular plants and insects and, to some extent, in the bryophytes.

The study was conducted in the Vicinity of Larsemann Hills, especially for the distribution of Moss, Lichen, and planktonic diversity of various lakes during the 30th Indian Expedition to Antarctica. The plankton collection and assessment study was conducted in three Lakes of Bharti Island, namely L3, L5, and L7. Lake L7 is the biggest lake on Bharati Island and is crucial for biological monitoring and aquatic studies. *Buelia* sp., *Rhizoplaca* sp., and *Candillerella* sp. were found as abundant lichen species over Bharti Island.

Besides this, some macro-fauna species, like seals, penguins, skua, snow petrel, etc., were also noticed during the expedition.

**Key words:** Biological diversity, Moss, Lichens, Phytoplankton, Zooplankton

## **Introduction**

The history of origin and the process of evolution have led to the diversity of life forms. Over the last few decades, increased environmental awareness has underlined the need to enhance our understanding of how the human race and biodiversity interact. It is surprising that till 1992, the subject of biodiversity was never given the attention it deserved, both at the national and international levels. Only in June 1992, at the United Nations Conference on Environment and Development (UNCED), biological diversity became a priority area for action for conservation and sustainable use.

From a terrestrial and freshwater perspective, Antarctica's low-energy environment and isolation mean that it is species poor. Indeed, Antarctica's terrestrial and freshwater systems represent the endpoint of the global gradient in diversity. Where life can exist, richness is typically low, and continental Antarctic systems represent some of the simplest in the world. For example,

some endolithic (within rock) communities are restricted to a few species of algae, fungi, and bacteria.

Terrestrial and freshwater diversity increases rapidly from the maritime Antarctic to the sub-Antarctic islands. On the latter, variation in richness is comparatively well understood, especially in the case of vascular plants and insects and, to some extent, in the bryophytes (mosses). The richness variation of the indigenous flowering plants, ferns, and insects is a consequence of energy availability, island area, and isolation to a lesser extent. Thus, the largest and most northerly islands generally have the highest plant and insect species richness.

In marine systems, the picture is much more complex. In some groups, such as the Decapod and Stomatopod Crustaceans and bivalves, diversity is low, and Brachyuran crabs (i.e., typical crabs) are absent from the region. However, in other groups, there seems to be almost no decline in Antarctic waters or an unusual diversity pattern. Thus, the Pycnogonids (sea spiders), Echinoderms (sea-urchins and their relatives), and Polychaetes (segmented worms) are especially rich in the Antarctic region. Indeed, in the case of sea spiders, the Antarctic region may be the area with the highest species richness globally.

Although the distribution of benthic and pelagic diversity across the Southern Ocean is poorly understood for most groups, owing to the paucity of information, especially for East Antarctica, one group is especially well known. The seabirds, essentially pelagic species that return to land to breed, have been well documented both in terms of their breeding populations and their at-sea distributions thanks to SCAR activities.

In Antarctica, summer is short and cold, with a maximum temperature of around zero °C. During this time, permanent rainfall and pronounced snow precipitations are common (Cygan, 1981; Rakusa-Suszczewski et al., 1993).

These conditions, along with those imposed by a long dark winter, do limit the occurrence of plant species in the region, especially flowering plants, since such conditions inhibit the reproductive cycle (Pereira & Putzke, 1994). Because of that, only two species of Angiosperms are known in Antarctica, *Deschampsia antarctica* Desv. and *Colobanthus quitensis* Kunth. On the other hand, moss and lichen species are more strong, developing quite well in polar conditions, which are the main representatives of the Antarctic flora (Pereira & Putzke, 1994; Ochyra & Våna, 1989).

Lichens are very representative in Antarctica. If we consider their contribution to the floral composition of Antarctica's ice-free areas, we will find they have yet to be studied much (Pereira, 1990).

Taxonomic and Phyto-sociologic studies are usually narrow, except for Redon (1985), which is more extensive, allowing the identification of most species.

Plankton refers to aquatic forms with little or no resistance to currents and living free-floating, suspended in natural waters. Planktonic plants (Phytoplankton) and planktonic animals (Zooplankton) are covered in this section.

Plankton, particularly phytoplankton, have long been used as water quality indicators. Some species flourish in highly eutrophic waters, while others are very sensitive to organic and chemical waste. The species assemblage of phytoplankton and zooplankton may help assess water quality.

### **Study area**

The study was conducted in the Vicinity of Larsemann Hills, especially for the distribution of Moss, Lichen, and planktonic diversity of various lakes during the 30th Indian Expedition to Antarctica. The plankton collection and assessment study was conducted in three Lakes of Bharati Island, namely L3, L5, and L7. Lake L7 is the biggest lake on Bharati Island and is quite important for biological monitoring and aquatic studies. However, Lake Water was found to have partially melted in most parts of the Lakes, but the plankton collection processes were performed on the melted portions of the lakes.

### **Methodology**

The standard books and Protocols were adopted for the monitoring and assessment of biological parameters in the aquatic and terrestrial ecosystems of Bharti Island. Standard methodologies were followed to collect, preserve and identify the different biological groups as given in APHA (2005). Plankton counting was conducted with the help of Bogorov / Sedwick Rafter Plankton Counter chambers as described in APHA (2005).

### **Result and Discussion**

The limnological study was executed for three Lakes, L3, L5, and L7. The study was performed to evaluate the phytoplankton and zooplankton of these lake ecosystems.

#### ***Plankton***

Among the Phytoplankton community, Basillariophyceae and Chlorophyceae groups were found dominant in the lake water at Bharti Island. Diatoms were found as a major constituents of Phytoplankton. Pinnularia, Nitzschia and Achnanthes were the major diatoms. Frazilaria, Navicula and Hantzchia might be present in Antarctic fresh waters (Gupta, 2002). Besides this, evidences of the presence of Nostoc, Osillatoria, in Antarctic water were also observed by Palanisamy (Palanisamy, 2010). Few unidentified Phytoplankton genera were also encountered in lake waters.

Among the Zooplankton groups, Cladocera, Copepoda, Protozoa and few Rotifers were found in lake water. Few Filinia, Aneuropsis and Euplotes were found in lake L-3, whereas few Brachionus, Angularis, Flania and Euplotes were found in L-5 lake. Few Daphnia and others unidentified Ciliates were also found in Lake L-7, which indicates presence of new species of Plankton.

### ***Benthos***

During the study period in 30<sup>th</sup> ISEA, the lakes were found in frozen condition so the sample could not be collected from the deep regions. However, Dartnall (1995) highlighted the aquatic invertebrate in Larsemann Hills. Sabbay *et al.* (2003) described the Benthic Flora of fresh water lakes in Larsemann Hills and Rauer Island in Antarctica. Sanyal (2004) observed few invertebrates Fauna in the Antarctica regions.

### ***Moss***

Mosses are found chiefly in areas of dampness and low light. Mosses are common in wooded areas and at the edges of streams. Mosses are also found in cracks between paving stones in damp city streets. Some types have adapted to urban conditions and are found only in cities. A few species are wholly aquatic, such as *Fontinalis antipyretica*, and others such as *Sphagnum* inhabit bogs, marshes and very slow-moving waterways. For example, such aquatic or semi-aquatic mosses can greatly exceed the normal range of lengths seen in terrestrial mosses. Individual plants 20–30 cm (8–12 in) or more long are common in *Sphagnum* species.

Wherever they occur, mosses require moisture to survive because of the small size and thinness of tissues, lack of cuticle and the need for liquid water to complete fertilisation. Some mosses can survive desiccation, returning to life within a few hours of rehydration.

Bryophytes are the simple form of plants. Mosses are preliminary green autotrophs, which may be found in the form of mat on the surface of peripheral islands of Antarctica. Few species of moss can be found in various parts of east Antarctica. Different sizes of moss mat may be observed. The colour of entire moss mats turns black during the winter period due to the harsh climatic conditions. And again becomes green in austral summer due to the favorable conditions and availability of sunlight and water.

Many patches of Moss having different size were observed at Bharti and Fisher Island during the XXX ISEA. The moss patches were categorized and recorded as per their sizes. Many patches were found less than 30 cm<sup>2</sup> size and few were observed more than 30 cm<sup>2</sup> size. Locations of moss patches were recorded as

geo-coordinates. Moss patches having less than 30 cm<sup>2</sup> size were found abundantly at both Islands. Many other researchers have carried out their work on moss species in various parts of Antarctica (Mitra, 1999; Singh and Semwal, 2000; Barman, 2000; Lal, 2004).

### ***Lichens***

Lichen is a combination of two organisms, an alga and a fungus, living together in symbiotic association. The algal component in the lichen is called phycobiont or photobiont while fungus as mycobiont. The phycobiont and the mycobiont lose their original identity during the association and the resulting entity (lichen) behave as a single organism, both morphologically and physiologically.

The lichens can grow on underwater rocks, but not freely in water or on ice. The lichens are widely distributed in almost all the phytogeographical regions of the world. Sufficient moisture, light and altitude, unpolluted air and undisturbed, perennial substratum often favour the growth and abundance of lichens.

By their appearance the lichens can be grouped into three main categories of growth forms:

- **Crustose lichens:** The thallus in crustose lichen is closely attached to the substratum without leaving any free margin. The thallus usually lacks lower cortex and rhizines (root like structure). Such lichens are collected along with their substratum for the detailed study.
- **Foliose lichens:** They are also called as leafy lichens. The thallus in this case is loosely attached to the substratum at least at the margin. Lichens are collected by scraping them from the substratum.
- **Fruticose lichens:** Here the lichen thallus is attached to the substratum at one point and remaining major portion is either growing erect or hanging. The lichen usually appears as small shrub or bush and easy to collect with hand.

Lichens are the symbiotic combination of fungus and algae. The growth rate of lichens is very slow and it is an important indicator of ecological succession in a particular ecosystem.

Buelia species was found dominant at Bharti Island. The patches of Rhizoplaca and Candillaria species were also observed. Few patches of others/unknown species were also found at Bharti Island. Maximum 10-12 lichen patches of Buelia species were observed at a single point at Bharti Island.

At Fisher Island, Buelia species was found dominant following by Rhizoplaca and Candillaria species and others. Few unknown species were also recorded.

Maximum 9-11 patches of *Buelia* species were found at a single point at Fisher Island. Crustose types of Lichens were found abundantly at both Islands of Larsemann Hills.

Abundance & evidence of the presence of *Buelia*, *Rhizoplaca* and few other species were also observed by Singh *et al.* (2007). Similar studies on lichens were also conducted by many researchers in Antarctica (Upreti, 1997; Gupta *et al.*, 1999; Nayaka and Upreti, 2008; Olech and Singh, 2010).

### ***Periphyton***

Few colonized algae groups were noticed attached on wet rocks in the study area. Periphyton are the large and immobile algae. Periphyton may be found during the summer season due to the availability of melted water and sunlight. Gupta and Kashyap (1998) and Singh (2000) elaborated the algal colonization and ecological studies of algal flora in Antarctica.

### ***Macro-fauna***

Antarctica has a very simple ecosystem containing countable species of macro-fauna. Few of them were also observed near Bharti Island during XXX ISEA. More than 43 Adele penguins, 22 Seal, more than 23 Skua, 12 Snow Petrel were observed near Bharti Island during December 2010. Few other macro-fauna species members were also observed and given in Table-7.

**Table- 1:** Phytoplankton diversity of Lakes at Bharti Island, Larsemann Hills

| S.N.                         | Phytoplankton<br>(Ind./m <sup>3</sup> ) | L3              | L5              | L7              |
|------------------------------|-----------------------------------------|-----------------|-----------------|-----------------|
| I                            | Latitude                                | 69° 24' 21.9" S | 69° 24' 26.0" S | 69° 24' 31.9" S |
| II                           | Longitude                               | 76° 11' 13.8" E | 76° 10' 59.0" E | 76° 11' 23.0" E |
| III                          | Altitude                                | 30 m            | 52 m            | 54 m            |
| IV                           | Date                                    | 10.01.2011      | 16.01.2011      | 17.01.2011      |
| <b><i>Plankton group</i></b> |                                         |                 |                 |                 |
| 1                            | <i>Chlorophyceae</i>                    | 400             | 600             | 700             |
| 2                            | <i>Basillariophyceae</i>                | 1200            | 1000            | 1600            |
| 3                            | <i>Cyanophyceae</i>                     | 100             | 80              | 100             |
| 4                            | <i>Rhodophyceae</i>                     | -               | -               | -               |
| 5                            | <i>Others / Unidentified</i>            | 800             | 1000            | 1200            |

**Table- 2:** Zooplankton diversity of Lakes at Bharti Island, Larsemann Hills

| S.N.                     | Zooplankton<br>(Ind./ m <sup>3</sup> ) | L3              | L5              | L7              |
|--------------------------|----------------------------------------|-----------------|-----------------|-----------------|
| I                        | Latitude                               | 69° 24' 21.9" S | 69° 24' 26.0" S | 69° 24' 31.9" S |
| II                       | Longitude                              | 76° 11' 13.8" E | 76° 10' 59.0" E | 76° 11' 23.0" E |
| III                      | Altitude                               | 30 m            | 52 m            | 54 m            |
| IV                       | Date                                   | 10.01.2011      | 16.01.2011      | 17.01.2011      |
| <b>Zooplankton group</b> |                                        |                 |                 |                 |
| 1                        | <i>Protozoa</i>                        | 20              | 20              | 40              |
| 2                        | <i>Rotifera</i>                        | 20              | -               | 20              |
| 3                        | <i>Copepoda</i>                        | 20              | 60              | 40              |
| 4                        | <i>Cladocera</i>                       | 40              | 120             | 60              |
| 5                        | <i>Decapoda</i>                        | -               | -               | -               |
| 6                        | <i>Others / Unidentified</i>           | 160             | 140             | 80              |

(Note- Assessment was executed within the Littoral zone of Lake Ecosystem because of the frozen conditions.)

**Table- 3:** Distribution of moss community at Fisher Island, Larsemann Hills

| S.N. | Latitude        | Longitude       | Patches > 30 cm <sup>2</sup> | Patches <30 cm <sup>2</sup> |
|------|-----------------|-----------------|------------------------------|-----------------------------|
| 1    | 69° 22' 58.7" S | 76° 13' 51.2" E | -                            | 2                           |
| 2    | 69° 22' 58.5" S | 76° 13' 51.6" E | 1                            | -                           |
| 3    | 69° 23' 37.7" S | 76° 14' 06.8" E | 1                            | -                           |
| 4    | 69° 23' 37.7" S | 76° 14' 06.9" E | -                            | 3                           |
| 5    | 69° 23' 37.2" S | 76° 14' 06.5" E | -                            | 1                           |
| 6    | 69° 23' 41.8" S | 76° 16' 16.2" E | 1                            | -                           |
| 7    | 69° 23' 42.6" S | 76° 16' 16.3" E | -                            | 3                           |
| 8    | 69° 23' 36.6" S | 76° 16' 18.1" E | -                            | 1                           |

**Table- 4:** Distribution of moss community at Bharti Island, Larsemann Hills

| S.N. | Latitude        | Longitude       | Patches > 30 cm <sup>2</sup> | Patches <30 cm <sup>2</sup> |
|------|-----------------|-----------------|------------------------------|-----------------------------|
| 1    | 69° 24' 15.9" S | 76° 11' 24.6" E | -                            | 1\                          |
| 2    | 69° 24' 28.1" S | 76° 10' 40.2" E | 2                            | -                           |
| 3    | 69° 24' 28.5" S | 76° 10' 40.4" E | -                            | 3                           |
| 4    | 69° 24' 27.2" S | 76° 10' 28.5" E | 2                            | -                           |
| 5    | 69° 24' 27.5" S | 76° 10' 28.5" E | -                            | 4                           |

| S.N. | Latitude        | Longitude       | Patches > 30 cm <sup>2</sup> | Patches <30 cm <sup>2</sup> |
|------|-----------------|-----------------|------------------------------|-----------------------------|
| 6    | 69° 24' 27.3" S | 76° 10' 28.1" E | 1                            | -                           |
| 7    | 69° 24' 27.9" S | 76° 10' 28.7" E | 2                            | -                           |
| 8    | 69° 24' 35.4" S | 76° 11' 08.2" E | 2                            | -                           |
| 9    | 69° 24' 35.5" S | 76° 11' 07.9" E | -                            | 3                           |
| 10   | 69° 24' 41.2" S | 76° 11' 30.4" E | 1                            | -                           |
| 11   | 69° 24' 41.7" S | 76° 11' 30.3" E | -                            | 2                           |
| 12   | 69° 24' 46.1" S | 76° 11' 51.2" E | 2                            | -                           |
| 13   | 69° 24' 46.3" S | 76° 11' 51.4" E | -                            | 5                           |
| 14   | 69° 24' 46.5" S | 76° 11' 51.0" E | 1                            | -                           |
| 15   | 69° 24' 46.6" S | 76° 12' 30.1" E | 1                            | -                           |
| 16   | 69° 24' 46.2" S | 76° 12' 29.9" E | -                            | 4                           |
| 17   | 69° 24' 31.1" S | 76° 12' 31.5" E | 1                            | -                           |
| 18   | 69° 24' 31.2" S | 76° 12' 31.3" E | -                            | 2                           |
| 19   | 69° 24' 47.2" S | 76° 12' 58.1" E | 3                            | -                           |
| 20   | 69° 24' 47.3" S | 76° 12' 58.5" E | -                            | 6                           |
| 21   | 69° 24' 42.2" S | 76° 12' 30.0" E | 1                            | -                           |
| 22   | 69° 24' 42.2" S | 76° 12' 30.7" E | -                            | 2                           |
| 23   | 69° 24' 36.1" S | 76° 12' 08.7" E | 1                            | -                           |
| 24   | 69° 24' 36.2" S | 76° 12' 08.5" E | -                            | 5                           |
| 25   | 69° 24' 28.3" S | 76° 12' 03.2" E | 2                            | -                           |
| 26   | 69° 24' 23.2" S | 76° 11' 58.7" E | -                            | 3                           |
| 27   | 69° 24' 20.5" S | 76° 11' 56.2" E | 1                            | -                           |
| 28   | 69° 24' 27.0" S | 76° 11' 31.5" E | -                            | 2                           |
| 29   | 69° 24' 20.1" S | 76° 11' 31.7" E | -                            | 1                           |
| 30   | 69° 24' 20.3" S | 76° 11' 31.7" E | -                            | 2                           |
| 31   | 69° 24' 52.3" S | 76° 13' 25.4" E | -                            | 4                           |
| 32   | 69° 24' 39.4" S | 76° 11' 43.3" E | -                            | 3                           |
| 33   | 69° 24' 39.5" S | 76° 11' 43.2" E | 1                            | -                           |
| 34   | 69° 24' 15.8" S | 76° 11' 38.4" E | 1                            | -                           |
| 35   | 69° 24' 15.8" S | 76° 11' 38.5" E | -                            | 3                           |

**Table-5:** Number of Lichen patches at Fisher Island, Larsemann Hills.

| S.N. | Latitude        | Longitude       | Buelia sp. | Rhizo-placa sp. | Candi-lerella sp. | Others |
|------|-----------------|-----------------|------------|-----------------|-------------------|--------|
| 1    | 69° 22' 58.8" S | 76° 13' 51.2" E | 3          | 2               | 3                 | 3      |
| 2    | 69° 22' 58.2" S | 76° 13' 51.3" E | 2          | 2               | 1                 | 1      |
| 3    | 69° 22' 58.7" S | 76° 13' 51.2" E | 1          | 1               | 5                 | -      |
| 4    | 69° 22' 58.4" S | 76° 13' 51.1" E | 3          | -               | -                 | -      |
| 5    | 69° 22' 58.5" S | 76° 13' 51.6" E | 8          | 4               | 1                 | 2      |
| 6    | 69° 22' 58.9" S | 76° 13' 50.8" E | 3          | 2               | -                 | 3      |
| 7    | 69° 23' 37.9" S | 76° 14' 06.9" E | 7          | 3               | -                 | 2      |
| 8    | 69° 23' 37.7" S | 76° 14' 06.8" E | 2          | -               | 5                 | 1      |
| 9    | 69° 23' 37.8" S | 76° 14' 06.9" E | 4          | 1               | -                 | -      |
| 10   | 69° 23' 38.0" S | 76° 14' 06.8" E | 11         | 5               | -                 | 1      |
| 11   | 69° 23' 37.7" S | 76° 14' 06.9" E | 3          | 4               | -                 | 2      |
| 12   | 69° 23' 37.8" S | 76° 14' 07.0" E | 4          | 2               | -                 | -      |
| 13   | 69° 23' 37.6" S | 76° 14' 06.8" E | 2          | -               | 2                 | -      |
| 14   | 69° 23' 37.2" S | 76° 14' 06.5" E | 6          | 2               | 4                 | 2      |
| 15   | 69° 23' 42.1" S | 76° 16' 16.8" E | 11         | 5               | -                 | 2      |
| 16   | 69° 23' 41.8" S | 76° 16' 16.2" E | 3          | 2               | -                 | 1      |
| 17   | 69° 23' 42.6" S | 76° 16' 16.3" E | 3          | 1               | -                 | -      |
| 18   | 69° 23' 38.2" S | 76° 16' 17.6" E | 3          | -               | -                 | -      |
| 19   | 69° 23' 36.6" S | 76° 16' 18.1" E | 9          | 5               | -                 | 1      |
| 20   | 69° 23' 37.2" S | 76° 16' 18.8" E | -          | 2               | 5                 | -      |

**Table- 6:** Number of Lichen patches at Bharti Island, Larsemann Hills

| S.N. | Latitude        | Longitude       | Buelia sp. | Rhizo-placa sp. | Candi-lerella sp. | Others |
|------|-----------------|-----------------|------------|-----------------|-------------------|--------|
| 1    | 69° 24' 16.7" S | 76° 11' 24.2" E | 2          | 1               | -                 | -      |
| 2    | 69° 24' 16.1" S | 76° 11' 24.3" E | 2          | 2               | -                 | -      |
| 3    | 69° 24' 15.9" S | 76° 11' 24.6" E | 1          | 2               | -                 | -      |
| 4    | 69° 24' 16.3" S | 76° 11' 24.3" E | 3          | 1               | 1                 | 1      |
| 5    | 69° 24' 28.1" S | 76° 10' 40.2" E | 1          | 2               | 1                 | -      |
| 6    | 69° 24' 28.5" S | 76° 10' 40.4" E | 2          | 1               | -                 | -      |
| 7    | 69° 24' 28.3" S | 76° 10' 40.7" E | 3          | 2               | 1                 | 2      |
| 8    | 69° 24' 28.1" S | 76° 10' 40.5" E | -          | 1               | -                 | 1      |
| 9    | 69° 24' 27.6" S | 76° 10' 28.4" E | 2          | 2               | 1                 | -      |

| S.N. | Latitude        | Longitude       | Buelia sp. | Rhizo-placa sp. | Candi-lerella sp. | Others |
|------|-----------------|-----------------|------------|-----------------|-------------------|--------|
| 10   | 69° 24' 27.2" S | 76° 10' 28.5" E | 4          | 3               | -                 | 1      |
| 11   | 69° 24' 27.5" S | 76° 10' 28.5" E | 1          | 1               | 1                 | -      |
| 12   | 69° 24' 27.3" S | 76° 10' 28.1" E | -          | 1               | 1                 | -      |
| 13   | 69° 24' 27.9" S | 76° 10' 28.7" E | 2          | 3               | 1                 | 1      |
| 14   | 69° 24' 35.3" S | 76° 11' 08.2" E | 5          | 3               | 1                 | -      |
| 15   | 69° 24' 35.4" S | 76° 11' 08.2" E | 1          | 1               | -                 | 1      |
| 16   | 69° 24' 35.7" S | 76° 11' 08.4" E | -          | -               | 1                 | 1      |
| 17   | 69° 24' 35.5" S | 76° 11' 07.9" E | 3          | 2               | -                 | 2      |
| 18   | 69° 24' 41.4" S | 76° 11' 30.3" E | 4          | 1               | 1                 | 2      |
| 19   | 69° 24' 41.2" S | 76° 11' 30.4" E | 2          | 2               | 2                 | -      |
| 20   | 69° 24' 41.7" S | 76° 11' 30.3" E | 1          | -               | -                 | 2      |
| 21   | 69° 24' 41.5" S | 76° 11' 30.1" E | 6          | 3               | 1                 | 1      |
| 22   | 69° 24' 46.1" S | 76° 11' 51.2" E | 1          | 1               | 1                 | -      |
| 23   | 69° 24' 46.3" S | 76° 11' 51.4" E | -          | -               | 1                 | 1      |
| 24   | 69° 24' 46.7" S | 76° 11' 51.8" E | 3          | 3               | -                 | 2      |
| 25   | 69° 24' 46.5" S | 76° 11' 51.0" E | 10         | 2               | 1                 | 2      |
| 26   | 69° 24' 45.9" S | 76° 11' 50.8" E | 4          | 3               | 2                 | -      |
| 27   | 69° 24' 46.6" S | 76° 12' 30.1" E | 2          | 1               | 1                 | 1      |
| 28   | 69° 24' 46.1" S | 76° 12' 30.6" E | 3          | 2               | 2                 | -      |
| 29   | 69° 24' 46.5" S | 76° 12' 30.0" E | 5          | 2               | 1                 | 1      |
| 30   | 69° 24' 46.2" S | 76° 12' 29.9" E | -          | 1               | 1                 | -      |
| 31   | 69° 24' 31.3" S | 76° 12' 31.6" E | 2          | 1               | -                 | -      |
| 32   | 69° 24' 31.1" S | 76° 12' 31.5" E | 4          | 3               | 2                 | 2      |
| 33   | 69° 24' 31.5" S | 76° 12' 31.0" E | 2          | 3               | -                 | 2      |
| 34   | 69° 24' 31.2" S | 76° 12' 31.3" E | 4          | 2               | 2                 | 1      |
| 35   | 69° 24' 47.7" S | 76° 12' 58.1" E | 2          | 1               | 2                 | -      |
| 36   | 69° 24' 47.2" S | 76° 12' 58.1" E | 12         | 3               | -                 | 2      |
| 37   | 69° 24' 47.5" S | 76° 12' 58.2" E | 6          | 2               | 3                 | 1      |
| 38   | 69° 24' 47.3" S | 76° 12' 58.5" E | 1          | 3               | 2                 | -      |
| 39   | 69° 24' 42.3" S | 76° 12' 30.2" E | 3          | 2               | 2                 | 1      |
| 40   | 69° 24' 42.2" S | 76° 12' 30.0" E | 1          | 2               | 3                 | -      |
| 41   | 69° 24' 42.7" S | 76° 12' 30.4" E | -          | 2               | 1                 | -      |
| 42   | 69° 24' 42.2" S | 76° 12' 30.7" E | 2          | 3               | 2                 | -      |

| S.N. | Latitude        | Longitude       | Buelia sp. | Rhizo-placa sp. | Candi-lerella sp. | Others |
|------|-----------------|-----------------|------------|-----------------|-------------------|--------|
| 43   | 69° 24' 36.1" S | 76° 12' 08.7" E | 8          | 2               | 1                 | 1      |
| 44   | 69° 24' 36.4" S | 76° 12' 08.8" E | 2          | 2               | 2                 | -      |
| 45   | 69° 24' 36.2" S | 76° 12' 08.5" E | 2          | 1               | 3                 | 2      |
| 46   | 69° 24' 36.1" S | 76° 12' 08.6" E | 3          | 2               | 4                 | 1      |
| 47   | 69° 24' 28.2" S | 76° 12' 03.3" E | 2          | 4               | 3                 | 2      |
| 48   | 69° 24' 28.1" S | 76° 12' 03.3" E | 3          | 2               | 2                 | -      |
| 49   | 69° 24' 28.3" S | 76° 12' 03.2" E | 1          | 1               | 2                 | -      |
| 50   | 69° 24' 28.2" S | 76° 12' 03.5" E | 4          | 2               | 2                 | 1      |
| 51   | 69° 24' 23.4" S | 76° 11' 58.8" E | 1          | -               | 2                 | -      |
| 52   | 69° 24' 23.2" S | 76° 11' 58.7" E | 2          | 3               | 2                 | -      |
| 53   | 69° 24' 23.1" S | 76° 11' 58.8" E | 3          | 2               | 3                 | 1      |
| 54   | 69° 24' 23.2" S | 76° 11' 58.5" E | 1          | 2               | 1                 | -      |
| 55   | 69° 24' 20.5" S | 76° 11' 56.2" E | 3          | 3               | 2                 | -      |
| 56   | 69° 24' 20.4" S | 76° 11' 56.2" E | 2          | 1               | 2                 | 1      |
| 57   | 69° 24' 20.4" S | 76° 11' 56.3" E | 5          | 3               | 3                 | -      |
| 58   | 69° 24' 27.1" S | 76° 11' 31.6" E | 2          | 2               | 3                 | 2      |
| 59   | 69° 24' 27.0" S | 76° 11' 31.5" E | 2          | 2               | 1                 | -      |
| 60   | 69° 24' 27.3" S | 76° 11' 31.4" E | 4          | 3               | 4                 | 2      |
| 61   | 69° 24' 20.1" S | 76° 11' 31.7" E | 3          | 4               | 4                 | -      |
| 62   | 69° 24' 20.3" S | 76° 11' 31.7" E | 7          | 3               | 4                 | 1      |
| 63   | 69° 24' 20.1" S | 76° 11' 31.6" E | 2          | -               | 3                 | 1      |
| 64   | 69° 24' 52.2" S | 76° 13' 25.3" E | 11         | 2               | 2                 | 2      |
| 65   | 69° 24' 52.3" S | 76° 13' 25.4" E | 8          | 2               | 3                 | -      |
| 66   | 69° 24' 52.3" S | 76° 13' 25.3" E | 3          | 2               | 3                 | -      |
| 67   | 69° 24' 39.4" S | 76° 11' 43.3" E | 4          | 2               | 3                 | 1      |
| 68   | 69° 24' 39.5" S | 76° 11' 43.3" E | 6          | 3               | 2                 | 2      |
| 69   | 69° 24' 39.5" S | 76° 11' 43.2" E | 2          | 2               | 3                 | -      |
| 70   | 69° 25' 25.6" S | 76° 13' 07.5" E | 9          | 4               | 3                 | 1      |
| 71   | 69° 25' 25.6" S | 76° 13' 07.6" E | 6          | 4               | 5                 | -      |
| 72   | 69° 24' 15.8" S | 76° 11' 38.4" E | 10         | 4               | 2                 | 2      |
| 73   | 69° 24' 15.8" S | 76° 11' 38.5" E | 6          | 3               | 3                 | -      |
| 74   | 69° 24' 16.1" S | 76° 11' 38.4" E | 2          | 2               | 2                 | -      |
| 75   | 69° 24' 16.1" S | 76° 11' 38.2" E | 1          | 1               | 3                 | -      |

**Table- 7:** Preliminary observations for macro-faunal diversity near Bharti Island (30 ISEA-Dec 2010)

| S.N. | Animal observed  | Number of sights | Total no. of individuals |
|------|------------------|------------------|--------------------------|
| 1    | Adele Penguins   | 4                | 43+                      |
| 2    | Emperor Penguins | 1                | 1                        |
| 3    | Crabeater Seal   | 6                | 22+                      |
| 4    | Leopard Seal     | 4                | 7                        |
| 5    | Skua             | 11               | 23+                      |
| 6    | Snow Petral      | 6                | 12+                      |
| 7    | Albatross        | 1                | 1                        |
| 8    | Tern             | -                | -                        |
| 9    | Whale            | 1                | 1                        |
| 10   | Dolphin          | 1                | 3                        |

## Conclusion

Biological diversity is the base of every ecosystem including Antarctica. However, Antarctica has very simple ecosystem with limited species of flora and fauna. Phytoplankton and zooplankton observed in the aquatic ecosystem of freshwater lakes of Bharti Island can serve as indicator for further pollution studies and to know the status of lake ecosystem. Moss and Lichens has maximum tolerance capacity against UV radiation, so these will help for radiation research. Besides, mosses always indicate the gaseous pollutants in air. Macro-faunal species data may serve reference for further studies in Larsemann Hills, east Antarctica.

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