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Review Article

Faunal Diversity in Antarctica: Contributions of Zoological Survey of India

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Antarctica, the fifth largest continent of the planet covers an area of about 14 million square kilometres. Topographically it is divided into two geographic regions: West Antarctica and East Antarctica. It is also divided into three main ecological zones with distinctive climatic and biotic characteristics: the Continental, Maritime and Sub-Antarctic zone. Only about 2% of ice-free area; harsh climatic conditions; combinations of freezing temperatures, poor soil quality, lack of moisture and sunlight inhibit the faunal composition in the continent. Over 150 years of biological researches on Antarctic region recorded more than 1500 species of invertebrates and about 200 species of vertebrates. The major common groups of invertebrates known to occur are Protozoa, Acarina, Nematoda, Collembola, Rotifera and Tardigrada. Vertebrate fauna includes different species of fishes, birds, mammals etc. Though Indian Scientific Expedition to Antarctica started in 1981, Zoological Survey of India joined the mission of Antarctic Expedition in 1989. Since then, thirteen scientists successfully participated in thirteen different expeditions. Their sincere endeavour and zeal to work in the extreme inhospitable climatic conditions of the continent resulted in the description of 5 new species, first records of 5 families, 25 genera and 92 species of different invertebrate and vertebrate groups. Though some works have been done on taxonomic and ecological studies on different invertebrate groups by ZSI scientists, yet more studies are needed to explore the terrestrial and moss inhabiting invertebrate fauna from the continent.

Keywords: Antarctica; Faunal Diversity; New Species; New Records; Zoological Survey of India

Introduction

Antarctica is the southernmost pristine and beautiful continent of the earth, surrounded by three oceans: the Pacific Ocean, the Atlantic Ocean and the Indian Ocean. Practically it's a white icy continent of which 98% of its land area is covered by ice and remaining 2% is the exposed part, occupied by rocks and lakes of different sizes. This highest, coldest and windiest part of the planet is a unique place of the earth having six months continuous day and another six months continuous night in a year. Topographically, it consists of two parts: East and West Antarctica divided by the Transantarctic Mountain chain (Fig. 1). East Antarctica represents about two-third of the entire landmass of the continent and is more inhospitable than West Antarctica. The Antarctic region has been subdivided into three main ecological zones: the Continental Antarctic, the Maritime Antarctic and the sub-Antarctic with distinctive climatic and biotic characteristics.

The severe harsh climatic conditions do not allow the extensive vegetation in Antarctica, as well as inhibits the diversity of animal inhabitants in the continent. Marine animals remarkably outnumber the terrestrial animals in Antarctica. Most of the invertebrates occur in Antarctica *viz.* Protozoa, Mites, Nematodes, Collembola etc. live in the moss beds and melt water lakes. Nematodes occupy about 22% amongst the invertebrate fauna of the continent. The flightless midge *Belgica antarctica* is the largest purely terrestrial animal in Antarctica, measuring up to 6 millimeters in length. Marine invertebrates are dominated by sea anemones, star fishes and shrimp-like creatures called Krill. Antarctic vertebrates mainly

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include Patagonian tooth fish, birds like Penguin, Skua, Albatross, Snow Petrel, etc. and mammals such as Seals, Whales, etc.

Faunal Diversity of Antarctica

Terrestrial animals of Antarctica are confined to microbes, a few groups of small invertebrates like Protozoa, Rotifera, Nematoda, Mites, etc. and some of the vertebrate groups like birds and mammals. A perusal of literature reveals that lakes of maritime and sub-Antarctic islands were more intensively surveyed than continental Antarctica. A total of 387 invertebrate fauna have so far been recorded in the sub-Antarctica, 127 in maritime Antarctica and 107 on the continent itself; mostly microscopic which were found in the soil, plant litter, moss, algae, lichen, peat, birds' litter and in the micro-climate under rocks (May, 1988, Laws, 1989). Block (1992) published a voluminous annotated bibliography of Antarctic invertebrates which include both terrestrial, as well as, freshwater species. That comprehensive bibliography of Antarctic invertebrate fauna covered over 1400 references and more than 1100 species of terrestrial and freshwater free-living animals and some ectoparasites from the maritime, sub-Antarctic and the continental Antarctic zones. Ingole and Perulekar (1987 and 1990) studied on composition and spatial distribution of micro-fauna of 10 freshwater lakes at Schirmacher Oasis, East Antarctica. Arif (1995) reported 137 species of Arthropods recorded from Schirmacher Oasis, which belongs to Acarina (70 species of mites), Mallophaga (37 species of biting lice), Collembola (20 species of springtail), Anoplura (5 species of sucking lice), Diptera (2 species of midges), Siphonoptera (1 species of fleas) and Coleoptera (2 species of beetles probably alien or known from islands near the Antarctic Peninsula). He also revealed that mites are the most diverse and well known group in the region. Acarina also included feather mites on Antarctic birds and a specialised group which live in the nasal passage of seals. Predator mite i.e. the fast moving yellow mite (*Gamasellus racovitzi*) and pink soil mite (*Nanorchestes antarcticus*) also occur in Antarctica (Laws, 1989).

Richter *et al.* (1990) reported some unidentified mites and springtail from Schirmacher Oasis. Hazra (1994) newly recorded five genera of nematodes from this region. Arif (1995) reported some groups of invertebrate fauna such as Earthworm, Nematode, Mite, Collembola, Diptera (adult and larvae) and Lepidoptera (moth). These collections were mostly made from soil and moss of lake areas, green houses of Russian and Indian stations. Richter (1907) recorded the terrestrial protozoa for the first time from the continent. Smith (1987) listed 124 Protozoan species from sub-Antarctic and maritime-Antarctic islands. Ingole and Perulekar (1987) were the first to report protozoa from Schirmacher Oasis. They also recorded only one species of ciliate, *viz.*, *Oxytricha fallax* Stein and noted that protozoa are the most dominant fauna comprising 22.31% of the total lacustrine microfauna of this region. Mitra (1999) reported 16 species of Protozoa for the first time from this area. Rotifers, commonly called as 'wheel animalcules' or 'rotatoria', a group of small microscopic animals was also reported from Antarctica. The first Antarctic rotifer was recorded by Murray (1910). Sudzuki (1964) recorded 13 species of rotifers from moss. Mitra (1999) reported one rotifer species, *Philodina gregaria*, collected from 5 lakes and one swampy area of Schirmacher Oasis which is the first report of this from this region. Ramazotti (1972) revealed that seven species of rotifers, reported from Antarctica are also available in high altitude of Himalaya. Venkataraman (1995) recorded two Tardigrade species *viz.*, *Hypsibius chilensis* and *Macrobiotus polaris* for the first time from Antarctica. Terrestrial nematodes were first described from the maritime Antarctic zone by De Man (1904) and from the sub-Antarctic zone by Jagerskjiold (1905). The first valid description of nematode from continental Antarctica was made by Steiner (1916). Tilbrook (1970) stated that 'the presence of nematodes in the maritime Antarctic region has been reported on many occasions, but nothing has been published on their taxonomy'. Spaull (1972) described the new genus *Antarctenchus* and new species *Antarctenchus hoperi* from the continent. Maslen (1980) recorded 40 species of nematodes from the Maritime zone of which 34 were endemic, 10 species recorded from Continental zone out of them seven were endemic and 22 species from Sub-Antarctic zone of which 12 were endemic to the region. Hazra (1994) recorded five nematode genera for the first time from Schirmacher Oasis. Ghosh *et al.* (2000) recorded two genera and two species of

nematodes from Antarctic region and three genera and species from Continental Antarctica for the first time. Ghosh *et al.* (2005) described a new tylenchid nematode *Antarctenchus motililus* from Schirmacher Oasis. Bohra *et al.* (2010) recorded 5 new nematode species from East Antarctica. The first mite species discovered from the Antarctic region was a Cryptostigmatid, *Oribata Antarctica*, collected in the Belgica expedition during 1897-1899. Pugh (1993) opined that in the 100 years of Antarctic expedition 528 species of Acari have been reported from Antarctica and the southern Ocean. Three new mite species were described by Sanyal *et al.* (2002) from mosses and soil collected from the mainland Antarctica. Sanyal and Gupta (2005) described one new Acari species from the continent. The credit for the discovery of insect from Antarctica which included Collembola goes to Willem (1901). Block (1980) pointed that Collembola together with Acari have penetrated to terrestrial habitats further south than any other arthropods. Wallwork (1969) revealed that collembolan fauna encountered so far from Antarctica are endemic. Krills (*Euphausia superba*) perform a significant role in the Southern Ocean food web. Most of the larger animals in Antarctica are directly or indirectly so dependent upon krill for their food that without krill the entire Antarctic Ecosystem would totally collapsed. Antarctic vertebrates mainly include Patagonian tooth fish (Fig. 5), birds (Penguin, Skua, Albatross, and Snow Petrel etc.) and mammals (Seals, Whales etc.). There are 17 species of penguins in the world, six of which are found in Antarctica *viz*. Emperor (Fig. 6), Adelie, Chinstrap, Gentoo, Macaroni and Rock hopper penguins.

Contribution of ZSI to Antarctica Expeditions

In 1989, Professor Mohammad Shamim Jairajpuri, the then Director of the Zoological Survey of India (ZSI) was the first who thought to explore the faunal diversity of Antarctica. Total thirteen scientists of ZSI attended the expeditions till to date. Their sincere endeavour and zeal to work in the extreme harsh climate of the continent have resulted in documentation of fauna and discovery of few species of invertebrates from Antarctica.

During the expeditions, the scientists made extensive studies on taxonomy and ecology of different invertebrates as well as vertebrate groups in Schirmacher Oasis and Larshmann Hills of East Antarctica. Observations and monitoring on avian fauna were also done during voyage and in the mainland area. Five invertebrate species have been described; 43 invertebrates 44 vertebrate species have been reported from Antarctica (Table 1).

Major Contributions

Exploration of faunal diversity of moss, algae and lichen inhabiting terrestrial invertebrates of Schirmacher Oasis and Larsemann Hills of East Antarctica were studied by ZSI scientists. Studies relating to ecology of terrestrial nematodes, mites and collembola along with the effects of physico-chemical factors, *viz.*, temperature, relative humidity, pH and organic carbon, nitrate and potassium, etc. were also conducted. During expeditions, soil samples and moss turfs from different locations of Schirmacher Oasis; different islands *viz.*, Bharti, Fischer, McLeod, Broknes, Stornes, etc. in the Larsemann Hills were collected. Extensive surveys were also carried out at different lakes and water bodies for studies on aquatic fauna. As a result, four species of mites and one nematode species are described as new to science. Seventeen species of Protozoa, one Rotifera, two Tardigrada, 15 Nematoda, five Collembola, one Diptera and 12 Acari species of invertebrates were reported from the continent. Protozans are the most dominant invertebrate fauna in East Antarctica. The Protozoan species, *Difflugia lucida* was recorded for the first time from Antarctica (Barman, 2000). The dominance and diversity of five Testacean species (Protozoa: Rhizopoda), namely *Arcella arenaria* Greeff, *Arcella* sp., *Assulina muscorum* Greeff, *Assulina* sp. and *Corythion dubium* Taranek (Fig. 2) from eight lakes in Schirmacher Oasis were reported by Chatterjee *et al.* (2000). Hazra and Mitra (2002) reported that the genera *viz.*, *Parmulina, Difflugia, Nebella, Oxytricha* and *Stylonychida* (Fig. 2) were found highly restricted in their distribution pattern; on the contrary *Arcella arenaria* and *Assulina muscorum* were the ubiquitous species. They also reported that the genus *Parmulina* is cosmopolitan in distribution, not only reported from Maritime Antarctica and Sub-Antarctic zone but also from other parts of the globe.

Hazra (1994) reported five genera of nematodes *viz.*, *Tylenchorhynchus, Dorylaimellus,*

Table 1: Species described and reported by ZSI scientists

	Described species
Nematode	*Antarctenchus motililas* Ghosh *et al.*, 2005
Mites	*Proctolaelaps antarcticus* Sanyal and Gupta, 2005
	Haplochthonius antarcticus Sanyal *et al.*, 2002
	H. longisetosus Sanyal *et al.*, 2002
	H. maitri Sanyal *et al.*, 2002
	Reported species
Protozoa	*Arcella arenaria* Greeff, 1866
	Arcella catinus Penard, 1890
	Arcella sp.
	Assulina muscorum Greeff, 1888
	Assulina sp.
	Centropyxis aerophila Deflandre, 1929
	Centropyxis sp.
	Collopoda sp.
	Corythion dubium Taranek, 1871
	Difflugia lucida Penard, 1890
	Diplochlamys sp.
	Euglypha sp.
	Nebela sp.
	Oxytricha fallax Stein, 1859
	Parmulina sp.
	Stylonychia sp.
	Trinema sp.
Rotifera	*Philodina gregaria* Murray, 1910
Tardigrada	*Hypsibius chilensis* Plate, 1888
	Macrobiotus polaris Murray, 1910
Nematoda	*Aporcelaimellus* sp.
	Dorylaimellus sp.
	Dorylaimoides sp.
	Dorylaimus sp.
	Eudorylaimus sabulophilus Tjepkema, Ferris and Ferris, 1971
	Helicotylenchus diagonicus Darling and Thorne, 1959
	Helicotylenchus Dihystera (Cobb, 1893) Sher, 1961
	H. exallus Sher, 1966
	Helicotylenchus sp.
	Mononchus sp.
	Paramylonchulus sp.
	Plectus telekii Mulk and Coomans, 1978
	Rhabditis sp.
	Rotylenchus sp.
	Tylenchorhynchus sp.
Collembola	*Calx* sp.
	Cryptopygus antarcticus Willem, 1901
	Isotoma sp.
	Sphaeridia sp.
	Xenella sp.
Diptera	*Forcipemyia* sp.
Acari	*Acarus siro* Linnaeus, 1758
	Chelacaropsis moori Baher, 1949
	Hypoaspis oblonga Halbert, 1915
	Hypoaspis sp.
	Maudheimia petronia Wallwork, 1962
	Nanorchestes antarcticus Strandtmann, 1963
	Paratydeus sp.
	Pronematus sp.
	Pediculaster mongolichus Mahunked, 1970
	Raphignathus sp.
	Suidasia nesbitti Hughes, 1948
	Tyrophagus longior Grevais, 1862
Birds	*Aptenodytes patagonicus patagonicus* Miller, 1778 - (King penguin)
	A. forsteri Gray, 1844 - (Emperor penguin)
	Catharacta skua antarctica Brunnich, 1764 - (Antarctic skua)
	Catharacta skua maccormicki Saunders, 1893 - (South polar skua)
	Daption capense capense Linnaeus, 1758 - (Cape Petrel)
	Diomedea epomophora Forster, 1785 - (Royal Albatross)
	D. exulans exulans Linnaeus, 1758 - (Wandering Albatross)
	D. chlororhynchus Gmelin, 1789 - (Yellow-nosed Albatross)
	D. chrysostoma Forster, 1785 - (Grey-headed Albatross/ Grey-headed Mollymawk)
	D. immutabilis Rothschlid, 1893 - (Laysan Albatross)
	D. melanophris Temminck, 1828 - (Black-browed Albatross)
	Falco tinunculus objiurgatus Linnaeus, 1758 - (Indian Kestrel)
	Fulmarus glaciafoides Linnaeus, 1761 - (Antarctic Fulmar/Southern Fulmar)
	Holobaena caerulea Gmelin, 1789 - (Blue Petrel)
	Macronectus giganteus Gmelin, 1789 - (Southern Giant Petrel)
	Oceanites oceanicus oceanicus Kuhl, 1820 -

	(Wilson's Strom Petrel)
	Pachyptila belcheri Mathews, 1912 - (Thin-billed Prion)
	P. turtur Kuhl, 1820 - (Fairy Prion)
	P. vittata vittata Forster, 1777 - (Broad-billed Prion)
	Pagodroma nivea Forster, 1777 - (Snow Petrel)
	Pelecanoides urinator urinator Gmelin, 1789 - (Common Diving Petrel)
	Phaethon setheurus indicus Linnaeus, 1758 - (Short-tailed Tropic bird)
	Phalacrocorax atriceps nivalis King, 1828 - (Blue eyed Shag)
	Phoebetria fusea Hilsenberg, 1822 - (Sooty Albatross)
	P. palpebrata Forster, 1785 - (Light-mantled Sooty Albatross)
	Procellaria aequinoctialis aequinoctialis Linnaeus, 1758 - (White-chinned Petrel)
	P. cinerea Gmelin, 1789 - (Grey Petrel/Brown Petrel/ Pediunker)
	Pterodroma brevirostris Lesson, 1831 - (Kerguelen Petrel)
	P. mollis Gould, 1844 - (Soft-plumaged Petrel)
	Puffinus carnipes Gould, 1844 - (Flesh-footed Shear Water/Pale-footed Shear Water)
	P. gravis O'Reilly, 1818 - (Great Shearwater/ Greater Shearwater)
	P. griseus Gmelin, 1789 - (Sooty Shearwater)
	P. pacificus Gmelin, 1789 - (Wedge-tailed Petrel)
	P. puffinus puffinus Brunnich, 1764 - (Manx Sher Water)
	Pygoscelis adelie Homborn and Jacquinot, 1841 - (Adelie penguin)
	P. antarctica Forster, 1781- (Chinstrap penguin)
	Sterna vittata Gmelin, 1789 - (Antarctic Tern)
	Sula capensis Lichtenstein, 1823 - (Cape Ganet)
	S. dactylatra melanops Lesson, 1831 - (Masked Booby)
	Thalassoica antarctica Gmelin, 1789 - (Antarctic Petrel)
Mammals	*Delphinus delphis* Linnaeus, 1758 - (Common dolphin)
	Hydruga leptonyx Blainville, 1820 - (Leopard seal)
	Lobodon carcinophajus Homborn and Jacquinot, 1842 - (Crab-eater seal)
	Megaptera novaeangliae Borowski, 1781 - (Humpback whale)

Aporcelaimellus, Dorylaimoides and *Paramylonchulus* for the first time from Schirmacher Oasis. He also studied the population ecology of soil nematode fauna in relation to some edaphic factors in the region. The study showed that the nematode population was maximum (22.27%) in January and minimum (2.38%) in February, 1994. The genus *Tylenchorhynchus* was the most dominant one in comparison to others. Peak population of the nematodes was associated with higher levels of temperature, nitrate, organic carbon and relative humidity. During 1995-1996, five nematode genera *viz., Helicotylenchus, Mononchus, Dorylaimus, Rhabditis* and *Rotylenchus* were collected from 15 lakes and swampy areas in Schirmacher Oasis. Amongst them, two genera *viz., Rhabditis* and *Rotylenchus* were recorded for the first time from whole Antarctic region; the remaining three were recorded for the first time from Continental Antarctica (Ghosh *et al.,* 2000). Ghosh *et al.* (2005) described a new species *Antarctenchus motililas* (Fig. 4) from Schirmacher Oasis. Bohra *et al.* (2010) reported five nematode species *viz., Helicotylenchus dihystera, H. diagonicus, H. Exallus, Eudorylaimus sabulophilus* and *Plectus telekii* for the first time from East Antarctica.

Venkataraman (1995) recorded two species of Tardigrades *viz., Hypsibius chilenensis* and *Macrobiotus polaris* and a Rotifer species, *Philodina gregaria.* Three new mite species *viz., Haplochthonius antarctius, H. matri* and *H. longisetosus* belonging to the family Haplochthoniidae under the order Oribatida of the class Acarina were

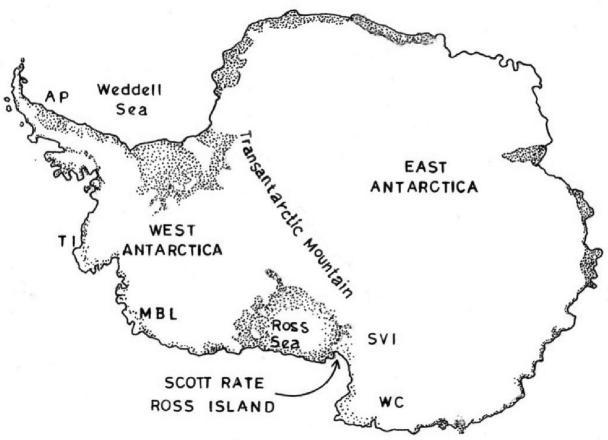


Fig. 1: East and West Antarctica

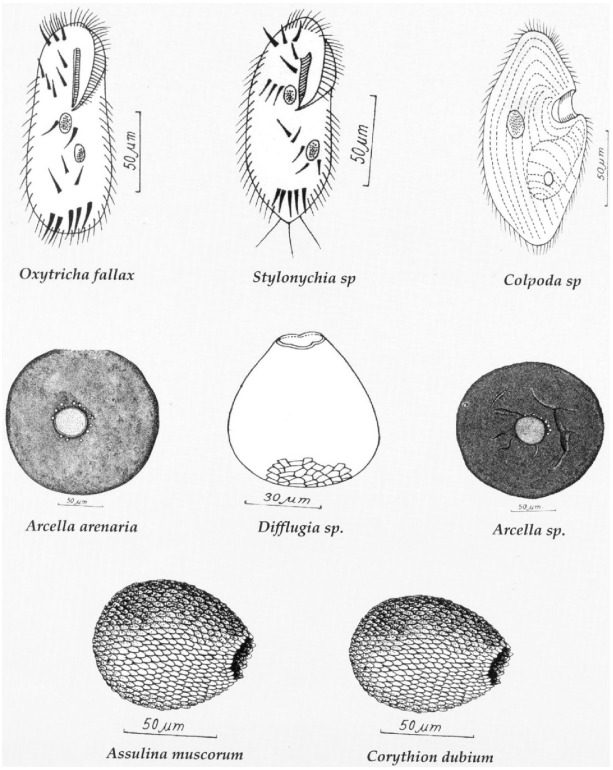
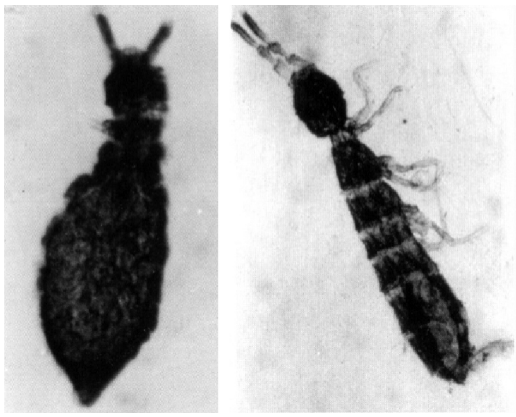


Fig. 2: Protozoa species

described by Sanyal *et al.* (2002) from mosses and soil collected from the mainland Antarctica. The family Haplochthoniidae was recorded for the first time from Antarctica. Sanyal and Gupta (2005) described one new Acari species, *Proctolaelaps antarcticus* (Mesostigmata: Ascidae) from Antarctic continent. The family Paratydeidae, six genera (*Chelacarposis, Pronematus, Paratydeus, Pediculaster, Suidasia, Proctolaelaps*) and seven species (*Chelacarposis moorei, Pronematus* sp., *Paratydeus* sp., *Pediculaster* sp., *Raphignathus* sp., *Suidasia nesbitti, Proctolaelaps antarcticus*) were also recorded for the first time from Antarctica. Sanyal and Hazra (2008) reported that the two arthropod groups *viz.*, Collembola (Insecta) and Mite (Acari) were found abundantly in moss-turf and soil in Sub-Antarctic and Maritime-Antarctic zones. The genus *Calx* of Collembola was newly recorded by them from Antarctica. The families, *viz*., Cheylelidae, Pygmephoridae and Saproglyphidae and two genera, *viz*., *Acarus* and *Hypoaspis* of mite were first recorded from the mainland Antarctica by them. Four genera *viz*., *Xenella, Isotoma, Calx* (Fig. 3) and *Sphaeridia*; one species, *Cryptopygus antarcticus* of Collembola were also recorded from East Antarctica.



Calx sp *Isotoma* sp

Fig. 3: Collembola species

Amongst vertebrates, 40 species of birds and four species of mammals were recorded from the continent by ZSI scientists. Observations on birds and mammals were also carried out during voyage to Antarctica. The details of observation and information on occurrence, abundance, distribution and behaviour of 46 birds were done by Chattopadhyay (1995) and maximum numbers of birds were observed between Latitude 47°S and 55°S. Venkataraman and Hazra (2005) studied on behaviour of skua using voice-recorder and found that when the recorded voices were played near the nest with chickens present, they started striking the tape recorder. When the voice of Adelie penguin was played, they started challenging with open wings raised over the back. Chandra (2007) presented the distribution, habit and abundance of 26 species of birds at various locations during his onward voyage to Antarctica between 50°19' to 69°51' Latitude (S) & 10°05' to 16°00' Longitude (E) and also return voyage from 68°07' to 37°58' Latitude (S) & 18°06' to 28°06' Longitude (E). The observations on South Polar Skua (Fig. 7) regarding their habit, nesting sites and population in Schirmacher Oasis, East Antarctica were also studied. Ultra structure studies of hairs of mammals and feathers of birds (*viz.*, Snow Petrel, Penguin and South Polar Skua) were also done (De and Mitra, 2010).

Conclusion

The terrestrial invertebrate fauna reported from West Antarctica including the Antarctic Peninsula are more in number than East Antarctica. East Antarctic fauna has been poorly studied during last 100 years, probably

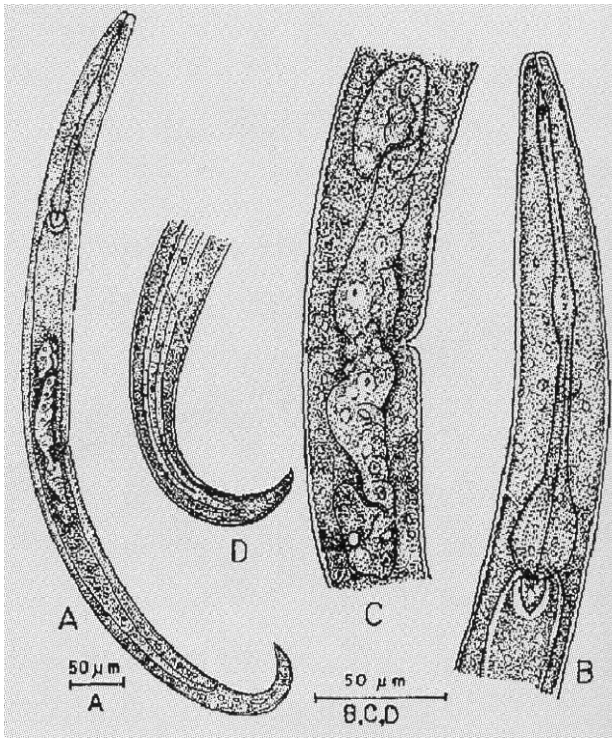


Fig. 4: *Antarctenchus motililas* Ghosh *et al.*, 2005

Fig. 5: Patagonian tooth fish

Fig. 6: Emperor penguin with chick

Fig. 7: South Polar Skua

due to harsh and inhospitable climatic conditions of this part of the continent. Based on literature studies it was observed that among the terrestrial and freshwater invertebrate fauna, described and recorded so far from Antarctica, the mites are maximum in number (over 27%), followed by Diptera (19-20%), Protozoa (18-19%), Collembola (17-18%), Nematoda (10-11%), Rotifera (8-9%) and Tardigrada (7-8%).

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