

# **LIVING RESOURCES OF ANTARCTIC - INDIA'S CONTRIBUTION TO EXPLORATION AND FUTURE PLANS FOR EXPLOITATION**

**ARUN PARULEKAR**

National Institute of Oceanography  
Dona Paula, Goa 403 004

## **INTRODUCTION**

The Antarctic living resources, in its totality, is a paradox. While the icy continent, both qualitatively and quantitatively presents the most impoverished manifestation of life, the encircling Southern Ocean, is probably the biologically most luxuriant province on the surface of the earth.

Biological research conducted over last few decades has revealed that the maritime Antarctic is well endowed with characteristics, essential for the propagation and sustenance of vast living resources. The Southern or the Antarctic Ocean, bounding the Antarctic continent, possesses a strong developed system of currents, with associated upwelling of nutrient-rich bottom waters. Abundant nutrients coupled with long periods of sunlight, during the austral summer, turns the icy cold Southern Ocean into a lush green pasture of phytoplankton. The rate and magnitude of phytoplankton production is as much as nine to ten times the average of world oceans, during the corresponding time scale. The phytoplankton supports correspondingly large crop of zooplankton, about half of which is krill, the primary food of fishes, squids, penguins and other seabirds, seals and whales.

## **ANTARCTIC FOOD CHAIN**

The Antarctic marine food chain is dominated by carnivores (Table 1). Being short-stepped, the food chain is closely interlinked and, accordingly, very fragile in nature. While the production at phytoplankton level, due to limited number of grazers or herbivores, always remains surplus, the high production of zooplankton, including krill, level is preyed upon by a large number of predators, and accordingly any disproportionate increase in the population size of a carnivore viz; whales, seals, seabirds, squids and fishes, may tilt the natural balance, in a short time. This is in striking contrast to the long food chain, comprising of herbivores, primary carnivores, secondary carnivores and tertiary carnivores, as observed to be functional in tropical and temperate seas. As such, maritime Antarctic, a high-latitude ecosystem, characterized by

extremes of environmental conditions of pronounced oscillations in solar radiations; low seawater temperatures and the freezing of seawater during winter, has low species diversity, short food chain and very high abundance of few species. The short food chain signifies the heavy dependence of numerous organisms on krill and on unusually high abundance of carnivores, a symbol of high predator-prey dependence.

Further, the heavy dependence of continental ecosystems on the marine ecosystems, for nutrient replenishment (Table 1), while highlighting the magnitude of impoverishment of oasis, limnetic and glacial ecosystems, also reflects on the delicate ecological balance as it prevails in the Antarctic environments.

### ANTARCTIC LIVING RESOURCES — POTENTIAL & LEVEL OF EXPLOITATION

In recent years, the vast qualities of renewable resources of krill coupled with heavy decline in whale stock, has generated an enthusiastic attention of the world community, towards the harvesting and utilization of Antarctic marine living resources. Exploitation of living wealth of the Southern ocean is still in the form of experimental fishing.

Quantitative estimates of living resources of the Southern Ocean, as assessed by direct method and by extrapolation are staggeringly high (Table 2). When compared to any available estimate of living resources from any of the world oceans, the productive capacity of the Southern Ocean is phenomenally high. While phytoplankton produced in large quantities, only during summer, provides 80 to 90 percent of primary production or organic carbon fixation in Antarctic waters, the krill forming the key organism, is the main herbivore.

In recent years, a total of 200,000 tons of krill, are estimated to be annually harvested from the Southern Ocean. Most of this catch is from the Western or Atlantic Ocean sector of the Antarctic. The catch rate differs in areas as also from year to year ; but the overall average reported so far, is 8-12 tons per hour of towing time with a maximum haul of 36 tons in 8 minutes. Other type of living resources, being exploited include seaweeds to the tune of 20,000 tons per year, mainly from restricted areas off Kerguelen, Argentina, Tasmania and New Zealand. Other exploited resource is the squids (about 10 to 20 thousand tons per year) which mostly predate on krill, are estimated to consume about  $100 \times 10^6$  million metric tons of krill each year. In turn, squids are found in great quantity in the dietary of seals and sperm whales.

Amongst the finfishes, which are harvested currently, at an average rate of 1,20,000 tons per year, the Southern Poutasson, the Patagonian Hake and two species of Antarctic cod, hold high potential. The present state of knowledge about the exploitable stock of squid, fish and marine mammals of the Southern Ocean is rather poor, for starting commercial-scale fishing. Moreover, the stocks of fish in Antarctic waters are of high average age and slow to reproduce and, accordingly, the harvesting of such species may cause irreversible damage to marine ecosystem in general and the food chain, in particular. In recent years, crabeater seals, with astoundingly high population growth, are projected as a high potential living resource of the Antarctic.

Most of the Antarctic living resources and particularly the krill resources, are currently harvested only during the fair season in austral summer. The possibilities of exploiting some of the squid and fish resources, during the severe Antarctic winter, are being explored. In future, the management and conservation of the Antarctic living resources will assume great importance as the commercial exploitation of krill gathers momentum. Since krill is the key organism, the harvesting unless judiciously done, will drastically reduce the availability of other renewable resources and possibly retard their recovery from the danger of overexploitation. To prevent any major ecological imbalance in the highly productive Antarctic marine ecosystems, it is very essential to collect baseline information towards the monitoring of the Southern Ocean, which holds great promise for the production and exploitation of marine living resources.

### INDIA'S CONTRIBUTION TO RESEARCH ON ANTARCTIC LIVING RESOURCES

The launching of the First Indian Scientific Expedition to Antarctica (1981-1982) heralded the era of Antarctic biological research in India, and, since then, an ongoing research programme, covering different aspects of oceanography, marine biomass, limnology, glacial and terrestrial biology, is underway. From time to time, there is augmentation towards need based diversification.

By adopting the ecosystem approach, involving trophic ecology - food chain concept, and further extrapolation through ecological efficiency, the Indian scientists have, so far, intensively explored an area of more than  $0.9 \times 10^6$  km<sup>2</sup>, between Lat.47° - Lat.72°S and Long.12° - 38°E. Diverse ecosystems, viz; open sea, subantarctic, pack ice, fast ice, polynya, icy shelf, lakes and oasis, have been studied through summer 1982 to 1988 and the winter of 1984—1986.

Studies so far conducted, encompasses the different aspects of the ecology and biomass production in microbes, primordial forms, like, moss, lichen and lower invertebrates; chlorophyll estimates, phytoplankton; zooplankton; krill resources; benthos; nekton; seabirds and marine mammals. For microbiological investigations, the present data points are 343 in summer and 116 in winter. Similarly, for primordial forms, number of observations carried out, so far, are 389 in summer and 70 in winter. Chlorophyll measurements, which is an index of biological productivity are 608 and 167, respectively, during summer and winter. Phytoplankton, including ice-bound epontic algae, has been studied through 599 summer observations and 169 winter observations. For zooplankton, total number of observations, are 386 with a break-up of 340 in summer and 46 in winter. As far as the studies on krill resources are concerned, our data base with 223 summer and 30 winter observations, is rather wide. Observations on sea-floor or benthic resources are only 124 (majority of which are in summer). Distribution, abundance and biomass production of seabirds and marine mammals, has been observed through 5524 and 469 observations, respectively. However, only 2% observations cover the winter season.

Thus, as a result of seven years of data collection efforts, the total number of observations on different aspects of living resources of Antarctic, presents a staggering figure of 9217. However, it also presents a number of lacunae due to discontinuity in observations. A relative appraisal of different research investigations reveals that biological research in marine, glacial, limnetic and oasis ecosystems of Queen Maud Land, Antarctica is of continuing nature and has generated voluminous and purposeful data in the area of, both applied and basic research. In spite of wide scope and relevance of Antarctic living resources to Indian economy, our contributions, so far, are relatively discontinuous and far from expectations.

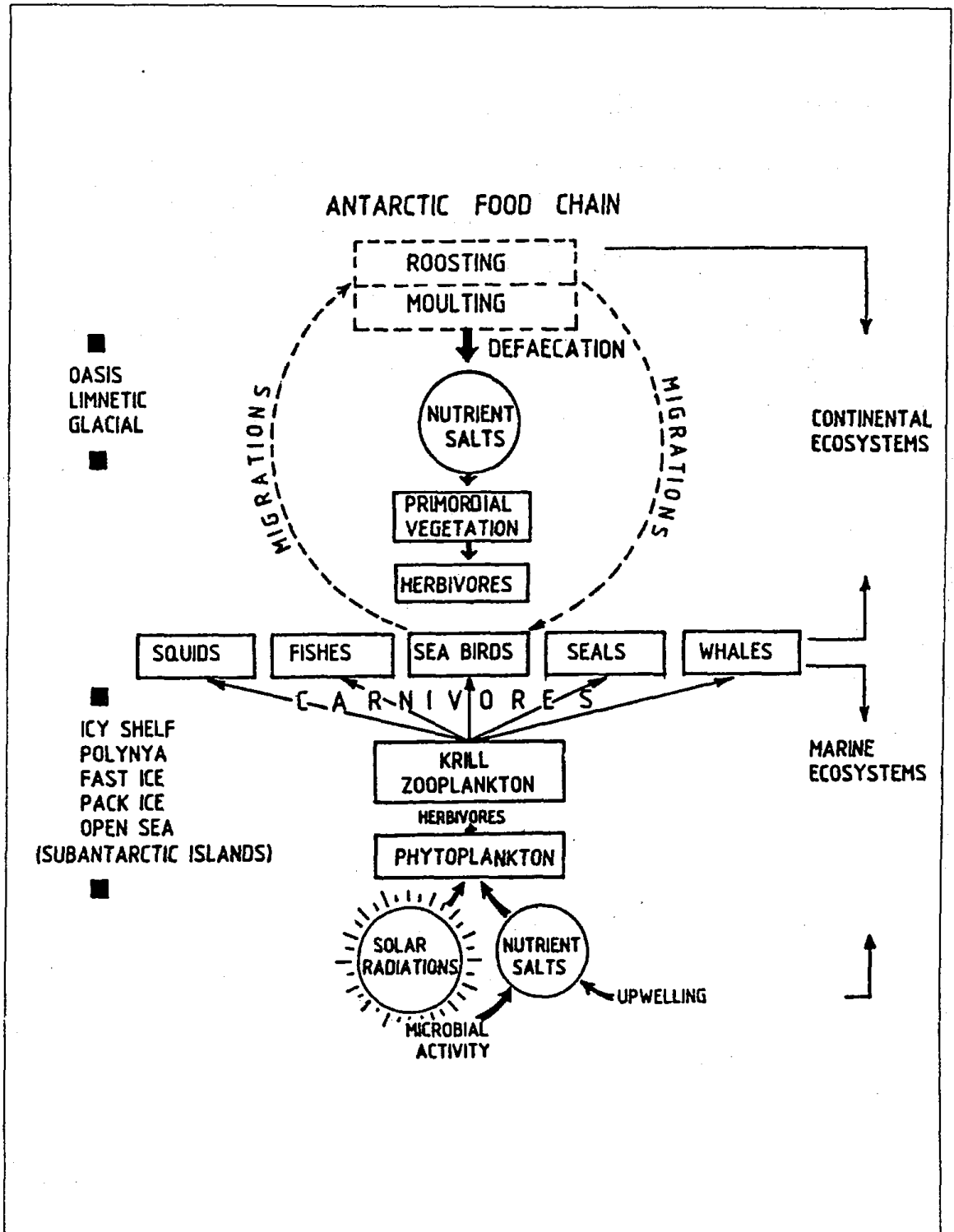
#### FUTURE PLANS FOR EXPLORATION AND EXPLOITATION OF ANTARCTIC LIVING RESOURCES

As far as India is concerned, the exploration of Antarctic living resources, especially, from the maritime Antarctic, has started, only since 1982. Though India's contribution to Antarctic biological research is of recent origin, these efforts are unique as they pertain to a scientifically less known and relatively less explored region, known as the Indian Ocean sector of the Southern Ocean. Increasing demand for food from the sea will make the Indian biologists concentrate on the highly productive maritime Antarctic, with its astonishingly high standing stock of self-generating living resources and its potential economic importance. The holistic approach pursued by Indian biologists to study the ecology and productivity potential of Antarctic ecosystems, will culminate in the realistic assessment of potential resources which in turn will herald the commercial exploitation of Antarctic living wealth, in the years to come.

Accordingly, a ten year perspective plan, is drawn and presented here (Table 3). The salient features of the proposed plan of work, are :

1. Studies on ecosystem characterization, productivity measurement and ecophysiology & basic studies should be the mainstay of Indian Antarctic Living Resources Programme.
2. Resource surveys through experimental fishing, acoustic methods, remote sensing and tagging should be given the priority.
3. Besides, the ongoing summer studies, winter investigations in the ice free areas, north of 60°S, should be started, and, strengthened.
4. Experimental exploitation, for working out the technical and economic feasibility, should start in less than 3 years from now. Depending on the feasibility report, commercial scale fishing is projected to commence after five years from now. This is expected to allow sufficient time for the development of infrastructural facilities.
5. Observational strategy will cover 220 stations in open waters and 100 stations in pack ice during summer and 100 stations in open water during winter. Sampling during summer will be on a 14 meridional sections, at 2° interval between 35 and 70°S latitude and during winter at 1° meridional interval, in the area between 35 and 60°S latitude. Target area, for investigation, will be 35-70°S & 10-40°E.
6. Being a time targeted and priority oriented task, the survey of living resources, should find prominent place under the Indian Antarctic science programme.

Table 1. Antarctic Food Chain



## ANTARCTIC LIVING RESOURCES

TYPE	ESTIMATED <sup>⊕</sup> STANDING STOCK (million metric tons.)	EXPLOITATION/ <sup>⊕</sup> UTILIZATION (million metric tons.)
Phytoplankton	6080 - 15,200	8500 - 11,700
Seaweeds	4 - 40 kg/m <sup>2</sup> ⊗	0.02 ⊗
Krill & Zooplankton	183 - 1350	0.2
King Crabs & Stone Crabs	3.5 - 4.5	-
Bivalves	0.8 - 2.0	-
Gastropods	0.02 - 0.95	-
Squids	10 - 12.5	0.01
Fishes	11 - 16	0.12
Seabirds	0.27 - 0.80	-
Seals	5.5 - 7.2	*
Whales	1.9 - 3.0	*

⊕ SOURCE : SOUTHERN OCEAN - CCAMLR CONVENTION AREA  
- FAO SPECIES IDENTIFICATION SHEETS - VOL I & II - 1985

⊗ RESTRICTED AREA OFF: NEW ZEALAND, TASMANIA, ARGENTINA  
& KERGUELEN

\* BAN IN FORCE. POACHING SUSPECTED

**BIOLOGICAL PRODUCTIVITY & LIVING RESOURCES OF SOUTH INDIAN OCEAN & INDIAN OCEAN SECTOR OF ANTARCTIC WATERS**  
 PERSPECTIVE PLAN ( 1988 - 1998 )

OBJECTIVES : LIVING RESOURCES - EXPLORATION, BIOMASS ESTIMATES & EXPLOITATION TRIALS

TARGET AREAS : 35 - 70° S & 10 - 40° E

OBSERVATIONAL STRATEGY : SUMMER : 220 STATIONS IN OPEN WATER

190 STATIONS IN PACK ICE

14 MERIDIONAL SECTIONS (2° APART) BETWEEN 35 & 70° S LATITUDE

WINTER : 100 STATIONS IN OPEN WATER

1° APART MERIDIONAL SPACING

