

**Environmental studies for the assessment  
of myctophid resources in the Arabian  
Sea**

*Submitted*

*to*

**Centre for Marine Living Resources and  
Ecology (CMLRE)  
Ministry of Earth Sciences  
Government of India  
Kochi**

**11 January 2008**

Title of the project: **Environmental studies for the assessment of myctophid resources in the Arabian Sea**

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11 January 2008

## 1. Executive Summary

Arabian Sea is a very special region of the world ocean as it is situated in the tropical belt, land-locked in the north and forced by seasonally reversing monsoon winds. In addition it is one of the highest biologically productive regions of the world ocean and also houses a permanent oxygen minimum zone. Though we have gained sufficient knowledge about the vertical distribution and horizontal variability of the zooplankton in the Arabian Sea and its coupling to the phytoplankton biomass based on the previous programmes in the Arabian Sea such as GLOBEC and JGOFS, our understanding about the Myctophid in the meso-pelagic layer is far from complete. We do not yet understand how Myctophid biomass is sustained on an annual basis. It is in this context that the present proposal is conceived.

The broad goals of the Environmental studies for the assessment of myctophid resources in the Arabian Sea are to:

1. Examine the upper-ocean processes that regulate the spatio (basin-wide)-temporal (seasonal-scale) variability of chlorophyll and biological productivity.
2. Understand the biogeochemistry and the biological productivity that sustains the myctophid population in the meso-pelagic layer.

The proposed programme envisages collection of high-resolution *in situ* physical and biogeochemical data along three basin-wide zonal transects namely, southern (Off Kochi-Maldives-Somalia, along 7°N), central (Off Goa-Yemen, along 14°N), and northern (Off Gujarat-Oman, along 21°N) during 3 seasons spring intermonsoon, summer, and winter monsoons. In addition, the archived CTD data and ARGO data will also be made use of to give climatological context. Additionally, remote sensing data on chlorophyll pigment concentrations, SST, SSH anomaly and sea surface winds will also be used. This is a multi-disciplinary programme in which researchers from different disciplines will collaborate to achieve the project goal.

## 2. Background

Arabian Sea is biologically one of the most productive regions of the world's ocean and its geographical location makes this basin a unique oceanographic entity. Located in the tropical region and bounded in the north by land mass, it is forced by seasonally reversing monsoon – weak (~5m/s) northeasterly winds (winter or northeast monsoon) during November to February and strong (~15m/s) southwesterly winds (summer or southwest monsoon) during June to September. Consistent with the wind reversal surface currents of the Arabian Sea also undergo seasonal reversal. A strong seasonality is also seen in the mixed-layer depth and phytoplankton biomass. The development of seasonal western boundary current – Somali Current – and the associated upwelling along the coastal regions of Somalia, Arabia and the southern part of the west coast of India are complex. The intense winds of the Findlater Jet and the associated wind curl drive upward Ekman pumping. The upwelling along the coast of Arabia extend several hundred km offshore (Bruce, 1974; Smith and Bottero, 1977; Swallow, 1984; Bauer et al., 1991). Another interesting feature is the presence of permanent oxygen minimum zone (OMZ) which occurs between 150-1000m depth (Wyrki, 1971 & 1973; Qasim, 1982; Swallow, 1984).

The Arabian Sea Process Studies undertaken under the Joint Global Ocean Flux Studies (JGOFS) during nineties (both international as well as national programme) revealed several aspects of Arabian Sea which were either less known or unknown (see for e.g., Krisnhaswami and Nair, 1996 and the papers therein; Smith et al., 1998 and the papers therein). Though we gained substantial understanding about the vertical distribution of deep-living meso-zooplankton and their spatial variability in the Arabian Sea, our understanding about the Myctophid (*Benthoosema*) occurring in the Deep Scattering Layer (DSL) is still rudimentary. During US GLOBEC (Global Ocean Ecosystem Dynamics Research) studies in the Arabian Sea (GLOBEC, 1993), it was estimated that about 100 million tones of

Myctophid stock is available in the central and western Arabian Sea. There exists a potential to develop Myctophid as a fishery resources for extraction of crude oil and preparation of animal and aquaculture feed, though it is not preferred as edible item due to its high lipid content in the meat. Since the Myctophid has a very short life span of less than one year, it is presently not fully understood how such a huge biomass is sustained on an annual basis. The motivation of the present project is to understand the environmental factors that are responsible the sustenance of Myctophid biomass.

### 3. Objectives

Overall goals of the Environmental studies for the assessment of myctophid resources in the Arabian Sea are to:

1. Examine the upper-ocean processes that regulate the spatio (basin-wide)-temporal (seasonal-scale) variability of chlorophyll and biological productivity.
2. Understand the biogeochemistry and the biological productivity that sustains the myctophid population in the meso-pelagic layer.

### 4. Data collection and analysis

<b>Number</b>	<b>Season</b>	<b>Period</b>	<b>Preferred period for measurement</b>
<b>1</b>	Spring Inermonsoon	March-May	April
<b>2</b>	Summer monsoon	June-September	July-August
<b>3</b>	Winter monsoon	November-February	December-January

To meet the project objectives, *in situ* measurements will be carried out to cover 3

seasons as detailed in the table. Depending on the availability of ship time efforts will be made to collect as much data as possible so as to cover all the seasons.

## 5. Area of Study and Station location

To meet the project objectives multi-disciplinary stations will be occupied along 3 basin-wide transects (Fig.1). The 3 East-West transects are designated as southern (Off Kochi-Maldives-Somalia, along 7°N), central (Off Goa-Yemen, along 14°N), and northern (Off Gujarat-Oman, along 21°N). Near the coast, both eastern and western boundary of the Arabian Sea high spatial resolution (half-a-degree) stations will be occupied while in the open Arabian Sea sampling will be carried out at one-degree interval for *in situ* measurements of physical and biogeochemical parameters.

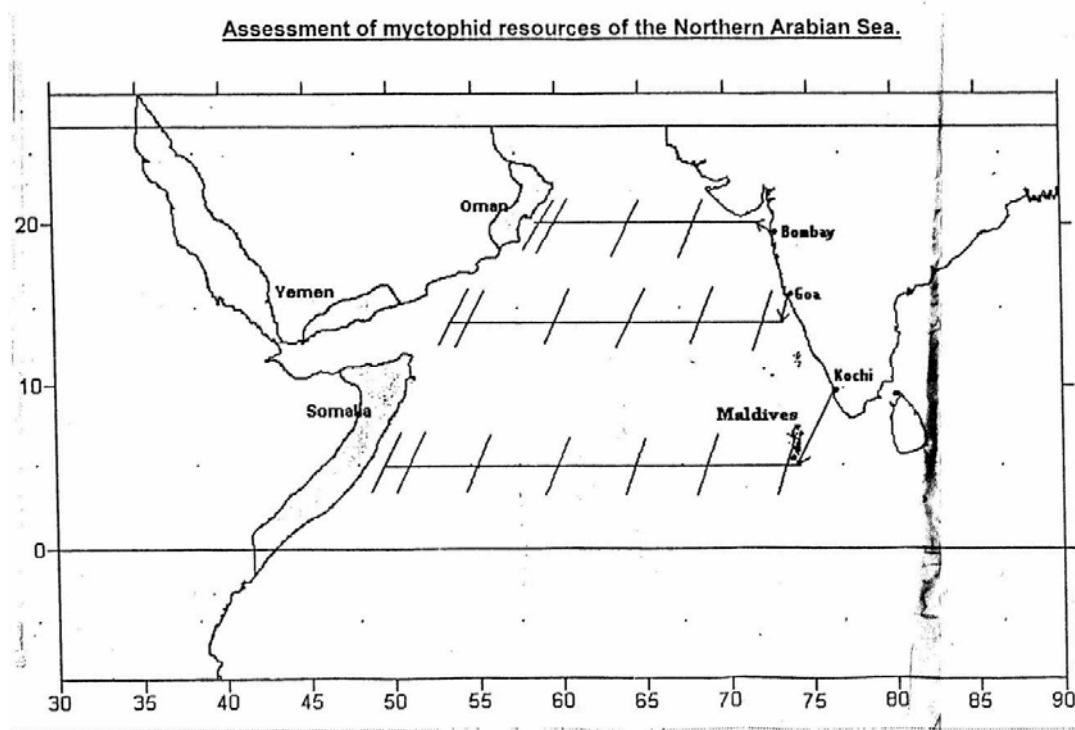


Fig.1 Station location for *in situ* measurements

## 6. Parameters to be measured

Shipboard CTD will be operated up to 1500m depth and using Rosette sampler

water samples will be collected for analysis of physical, chemical and biological parameters. Surface currents along the track will be measure using shipboard ADCP while surface meteorological parameters will be measured along the track using shipboard automatic weather station.

1. Temperature profile
2. Salinity profile
3. Sea surface temperature (SST)
4. Wind speed and direction
5. Air temperature and wet bulb temperature
6. Atmospheric pressure
7. Current speed and direction (ADCP)
8. Chlorophyll *a*
9. <sup>14</sup>C based Primary production rate
10. Phytoplankton
11. Mesozooplankton
12. Microzooplankton
13. Dissolved oxygen
14. TCO<sub>2</sub>
15. pH
16. Alkalinity
17. Nitrate
18. Phosphate
19. Silicate

## **7. Project Members**

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## 8. Duration & Time schedule: 5 years

Time schedule	2007-2008		2008-2009		2009-2010		2010-2011		2011-2012	
	Q1& Q2	Q3& Q4	Q1& Q2	Q3& Q4	Q1& Q2	Q3& Q4	Q1& Q2	Q3& Q4	Q1& Q2	Q3& Q4
Recruitment of project personnel		→								
Procurement hardware, equipments and spares etc		→								
<i>In situ</i> Data collection			→							
Analysis & Synthesis			→							
Publications & Report preparation							→			

## 9. Budget (in lakhs)

Head	Year 1 2007- 2008	Year 2 2008- 2009	Year 3 2009- 2010	Year 4 2010- 2011	Year 5 2011- 2012	Total
Equipment, components, spares, and maintenance	-----	12	-----	-----	-----	12.0
Computer, peripherals, computer furniture, data and software	-----	2.0	----	-----	-----	2.0
Manpower Research Fellows – 6 (Rs.8000+HRA)	1.75	6.63	7.0	7.45	7.45	30.28
Travel & allowances (including domestic and foreign)	1.0	3.0	3.0	3.0	2.94	12.94
Consumables	1.0	2.0	2.0	2.0	1.0	8.0
Contingency	1.0	2.5	2.0	2.0	2.0	9.5
Overheads	0.45	1.25	1.25	1.25	1.25	5.45
<b>Grand Total</b>	<b>5.20</b>	<b>29.38</b>	<b>15.25</b>	<b>15.70</b>	<b>14.64</b>	<b>80.17</b>

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