



सत्यमेव जयते

Ministry of Earth Sciences (MoES) **Government of India**

Dr. Hashim Manjebrayakath

Organizational setup

Ministry of Earth Sciences

Centre for Marine Living Resources and Ecology

Director

Vessel Management

R & D Activities

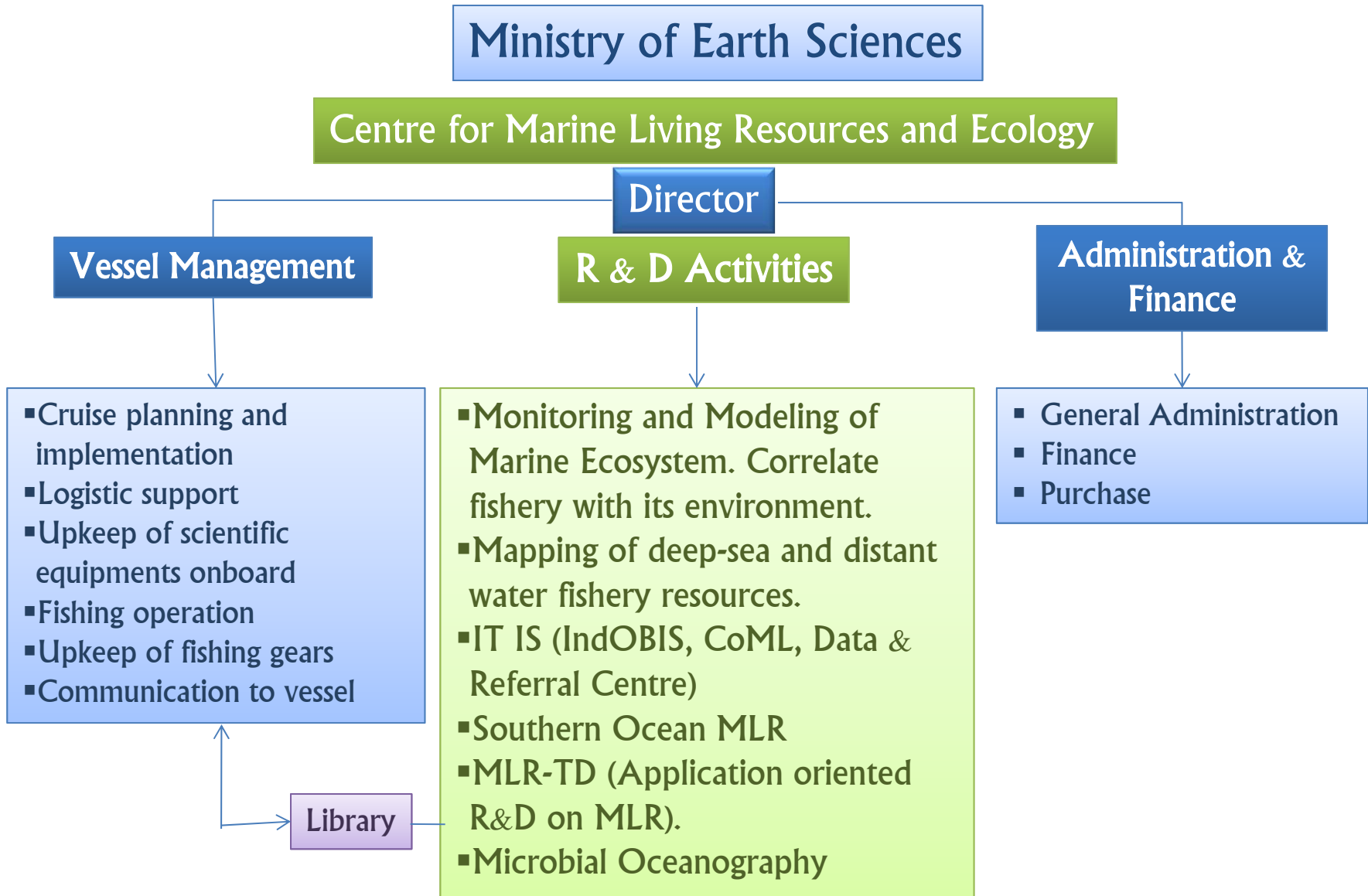
Administration & Finance

- Cruise planning and implementation
- Logistic support
- Upkeep of scientific equipments onboard
- Fishing operation
- Upkeep of fishing gears
- Communication to vessel

- Monitoring and Modeling of Marine Ecosystem. Correlate fishery with its environment.
- Mapping of deep-sea and distant water fishery resources.
- IT IS (IndOBIS, CoML, Data & Referral Centre)
- Southern Ocean MLR
- MLR-TD (Application oriented R&D on MLR).
- Microbial Oceanography

- General Administration
- Finance
- Purchase

Library



Marine Living Resource Programme

- Monitoring and Modelling of Marine Ecosystem. Correlate fishery with its environment (MMME).
- Mapping of deep-sea and distant water fishery resources (DS&DWF)
- IT IS (IndOBIS, CoML, Data & Referral Centre)
- Southern Ocean MLR (SO-MLR)
- MLR-TD-(Application oriented R&D on MLR)
- Microbial Oceanography (MO)

Projects under MLRE

MMME Projects

- ✓ Monitoring environment and productivity patterns of the Indian EEZ - Arabian Sea, Bay of Bengal and Andaman Waters
- ✓ Meso-scale eddies dynamics & biogeochemistry in Bay of Bengal
- ✓ Trace metal in southern peninsular India
- ✓ Time series studies on the bio-geochemical aspects in the estuarine and coastal waters of Kochi (Southwest coast of India)
- ✓ Correlating Living Resources to the environment through biological models on food-web
- ✓ Prediction of pelagic fishery
- ✓ Gelatinous zooplankton along western Bay of Bengal & Eastern Arabian Sea
- ✓ Monitoring and surveillance of HAB
- ✓ Marine Benthos of Indian EEZ

IT IS Projects

- ✓ Indian Ocean Biogeographic Information System
- ✓ Census of Marine Life
- ✓ FORV Data Centre
- ✓ FORV Referral Centre

Southern Ocean MLR

DS&DWF- Projects

- ✓ Mapping of demersal fishery resources between 200 to 1000 m depth zones of Indian EEZ
- ✓ Myctophid resources : Central and Western Arabian Sea
- ✓ Tuna Fishery Forecast System

MLR-TD - Projects

- ✓ MLR Technologies for Lakshadweep & Andamans
 - Hatchery technology for ornamental fish culture
 - Ornamental fish culture, breeding & rearing
 - Hatchery technology for crustaceans.
 - Black-lip Pearl oyster farming and pearl production
- ✓ Sonic Characterization of marine species
- ✓ Miniaturization of archival tags

Microbial Oceanography

- ✓ Microbial Carbon pump and tropho-dynamic
- ✓ System biology approach for ecosystem function
- ✓ Single cell separation & phage biodiversity

Institutes associated with MLR studies

- ✓ National Institute of Oceanography (NIO), Goa & Kochi
- ✓ Kerala University of Fisheries and Ocean Sciences (KUFOS), Kochi
- ✓ Central Marine Fisheries Research Institute (CMFRI), Kochi
- ✓ Central Institute of Fisheries Technology (CIFT), Kochi
- ✓ Goa University, Goa
- ✓ Andhra University, Vishakapatnam
- ✓ Indian National Centre for Ocean Information Services (INCOIS), Hyderabad
- ✓ Cochin University of Science & Technology (CUSAT)
- ✓ Centre for Advanced Studies (CAS), Annamalai University
- ✓ Kerala University
- ✓ IISER, Kolkatta
- ✓ Fishery College, Mangalore
- ✓ Central institute of Fisheries Education (CIFE), Mumbai
- ✓ Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu
- ✓ Madurai Kamaraj University, Tamil Nadu
- ✓ Pondicherry University, Port Blair, Andaman
- ✓ Adikavi Nannaya University
- ✓ NBFGR, Kochi
- ✓ Dept of Electronics-CUSAT, Kochi
- ✓ IISER, Kolkatta
- ✓ Dept. Biotechnology, CUSAT
- ✓ NCAAH-CUSAT , Kochi
- ✓ Amritha Institute
- ✓ VIT, Vellore.

FORV Sagar Sampada

**Owned by MoES and Managed by CMLRE is
dedicated for MLR Research activities**

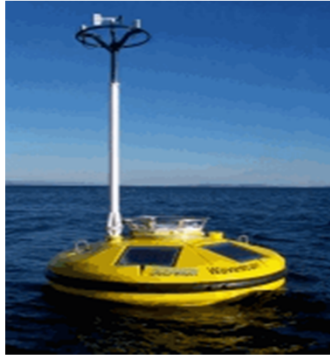
Scientific Facilities

| | |
|---------------------------|--------------------|
| CTD | – SeaBird SBE 911 |
| plus | |
| ADCP | - VM Broad band- |
| RDI OS II 75KHz | |
| Autoanalyser | – Skalar 6 channel |
| C ¹⁴ Technique | – Primary |
| productivity | |
| MPN, Bongo &VELNet | – Secondary |
| Productivity | |
| Fishery | – Expo Model Trawl |
| (Fish), HSDT (CV) | |
| Echo Sounder | - EK – 60 (38KHz, |
| 120KHz, 200KHz) | |
| SONAR | - SX 90 Split Beam |

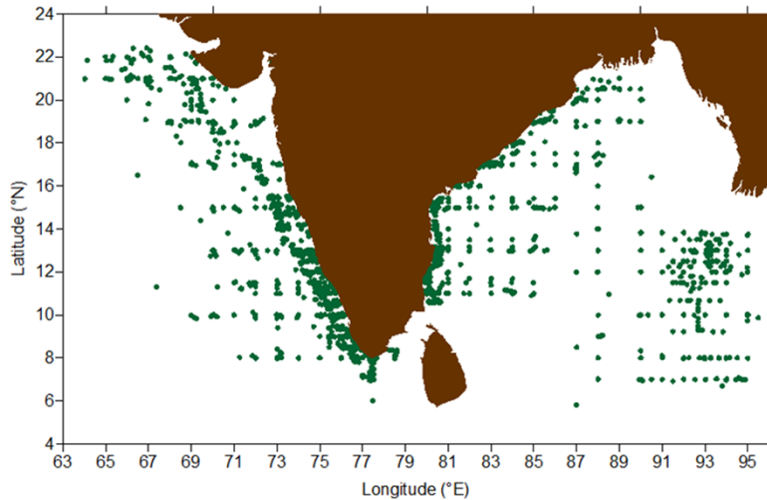
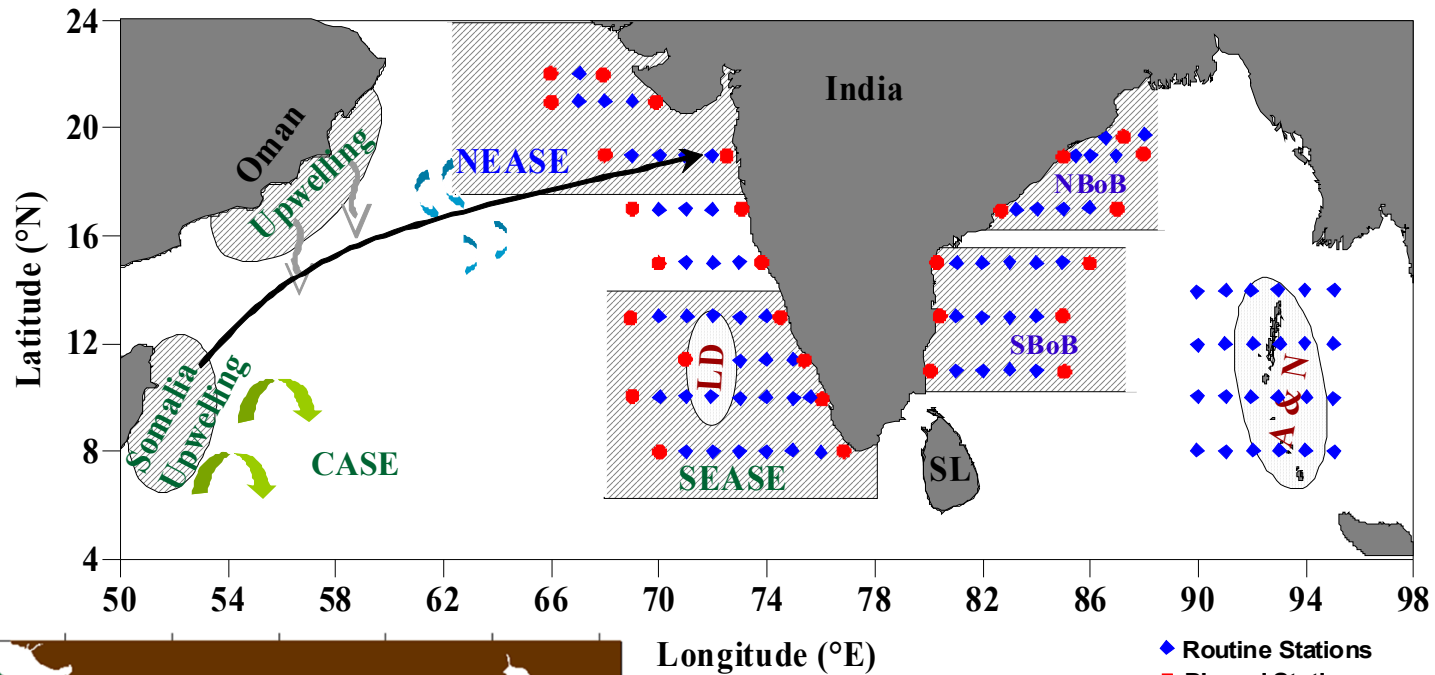


Total No. of Cruises conducted- 331

Oceanographic Research



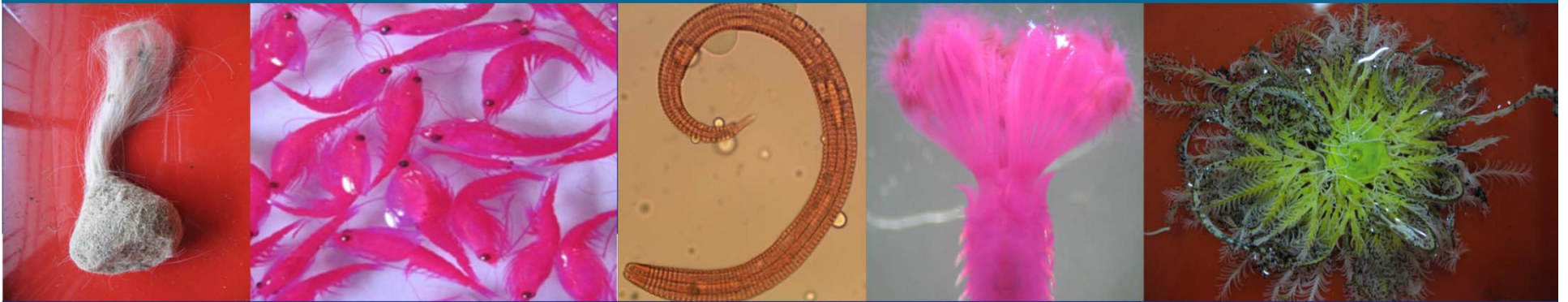
Ecosystems



FORV Sagar Sampada based In-Situ observations in Indian waters on MLR since 1998

- ❖ Seasonally reversing circulation pattern
- ❖ Summer monsoon upwelling in the SEASE
- ❖ Winter cooling and convective mixing in the NEASE
- ❖ High biological production in the Arabian Sea
- ❖ Intense & wide spread open ocean OMZ
- ❖ Cyclonic gyres and eddies in the BOB
- ❖ Oligotrophy around the Andaman & Nicobar Islands

MARINE BENTHOS OF THE INDIAN EEZ



Background

- Studies on marine benthos prior to 1998 were restricted to shelf and inshore regions.
- **The MLR project on Marine Benthos** – Initiated during 1998 with the following objectives:
 1. To understand the quantitative and qualitative composition of benthos on spatial and temporal scales.
 2. To understand and document the benthic diversity
 3. Creation of database on the marine benthos of the Indian EEZ.

Participating Institutes

1. Dept. of Marine Biology, Cochin University of Science & Technology (CUSAT-MB)
2. National Institute of Oceanography
3. Dept. of Marine Living Resources (MLR-AU) and the Marine Biology Division, Dept. of Zoology (MB-AU), Andhra University.
4. Centre for Advanced Studies (CAS), Annamalai University
5. Department of Ocean Studies and Marine Biology, Pondicherry University, Andaman

Sampling design and analysis

Sampling devices for Epifauna



Sampling devices for infauna



Sampling design and analysis



Smith-McIntyre Grab ready for deployment



Smith-McIntyre Grab with full bite of sediment



Sieving of sediment samples



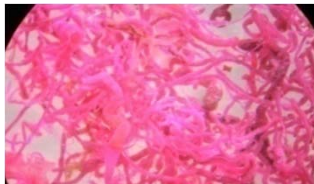
Sediments retained in the sieve



Examination of samples



Preserved sediment samples



- Samples collected from predetermined transect (1° interval) and depths
- Macrofauna separated using **500 micron** and **300 micron** (in recent studies)
- Staining using Rose Bengal (1 gl⁻¹)
- Group level sorting under stereo-zoom microscope
- Faunal densities were converted to **Individuals/m²**
- Biomass values expressed as wet weight in **g/m²** (Molluscs: shell on weight)
- Sediment texture analysis by using **Particle Size Analyser**
- Estimation of **organic carbon** follows El Wakeel & Riley (1957)

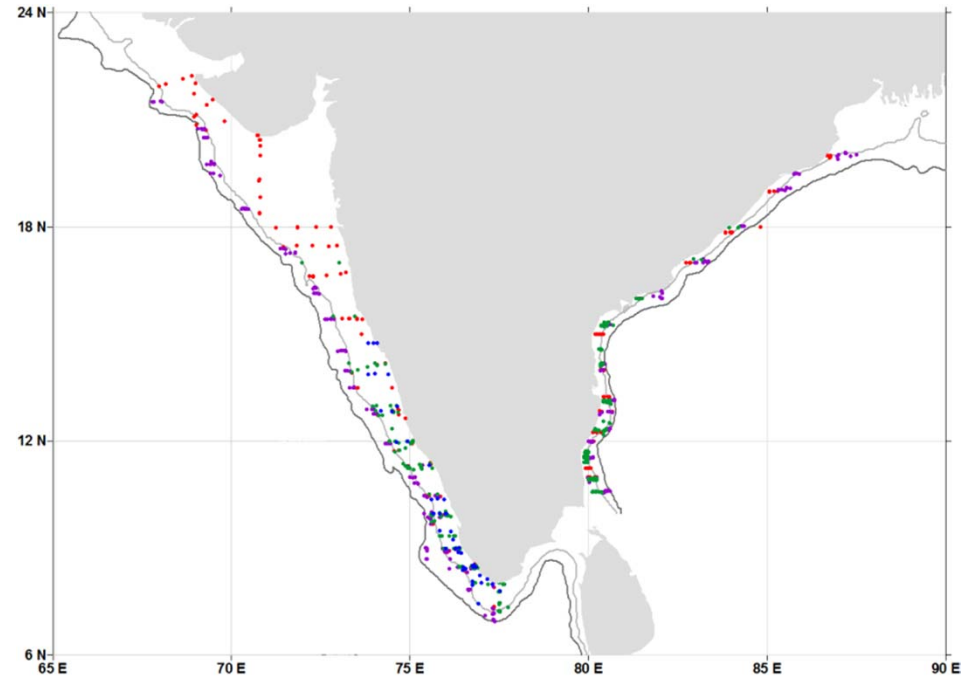
Taxonomic identification of polychaetes:

1. Fauchald K. 1977. The polychaete worms. Definitions and keys to the orders, families and genera. Natural History Museum of Los Angeles County: Science Series 28:1-188.
2. Fauvel P. 1953. The fauna of India including Pakistan, Ceylon, Burma and Malaya. The Indian press limited: Allahabad. p 507.
3. Day JH. 1967. A monograph on the polychaeta of Southern Africa, Part 1 (Errantia) and II (Sedentaria). Trustees of the British Museum (Natural History), London. p 878.
4. Imajima M. 1990-1992. Spionidae (Annelida, Polychaeta) from Japan: I-IX. *Bulletin of the National Science Museum. Series A*, 16-18.

And other recent taxonomic revisions/descriptive works.

Programme overview (1997-2012)

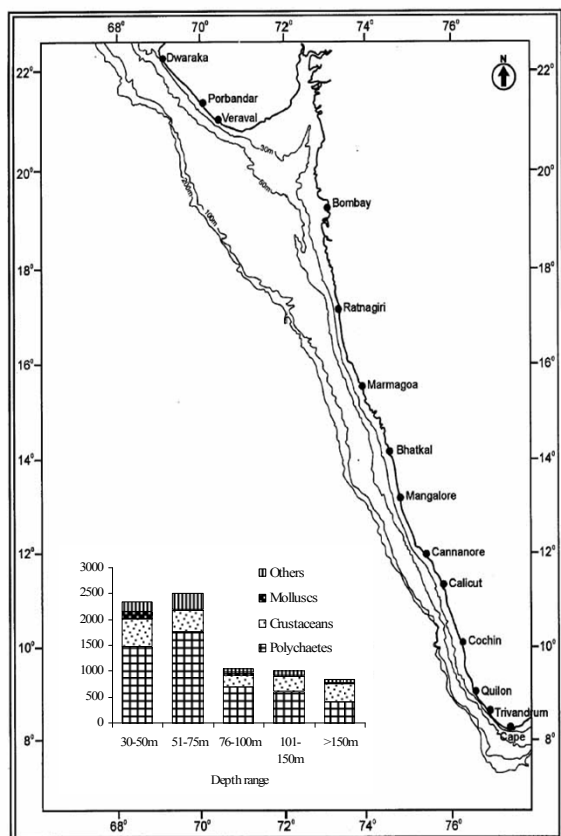
- Data generated on benthos (**macro, meio and microfauna**)
 - **Eastern Arabian Sea (EAS)**
 - Shelf (30-200m)
 - Slope (200-1000m)
 - **Western Bay of Bengal (WBoB)**
 - Shelf (30-200m)
 - Slope (200-1000m)
- Initiated investigations on benthos around the **Andaman & Nicobar Islands** continental shelf (50-200m) with focus on **macrofauna**
- Preliminary studies on **impact of closed fishing season** on macrofauna of SEAS.



Biodiversity documented:

| | | |
|--------------------|----------|------------|
| Polychaete | : | 437 |
| Crustaceans | : | 156 |
| Molluscs | : | 102 |
| Nematodes | : | 320 |
| Echinoderms | : | 120 |
| Others | : | 93 |

Macrobenthos of Eastern Arabian Sea – Shelf (30-200m)



Joydas, T.V. & R. Damodaran, 2014. Infaunal macrobenthos of the oxygen–minimum zone on the Indian western continental shelf. *Marine Ecology*, 35: 22-35

Joydas, T.V. & R. Damodaran, 2013. Testing depth–related multivariate patterns of macrofauna on the Indian continental shelf using reduced taxonomic resolution and data transformation. *Journal of the Marine Biological Association of the United Kingdom*, 93 (1): 37-45.

Joydas et al, 2009. Polychaete community structure of Indian west coast shelf, Arabian Sea. *Current Science*, 97 (5): 634-636.

Joydas, T.V. & R. Damodaran, 2009. Infaunal macrobenthos along the shelf waters of the west coast of India. *Indian Journal of Marine Science*, 38(2): 191-204.

Jayaraj et al. 2008. Response of infaunal macrobenthos to the sediment granulometry in a tropical continental margin-southwest coast of India. *Estuarine, Coastal and Shelf Science* 77:743-754.

Jayaraj KA, Jayalakshmi KV, Saraladevi K. 2007. Influence of environmental properties on macrobenthos in the northwest Indian shelf. *Environmental Monitoring and Assessment* 127(1-3):459-475.

Mean macrofaunal biomass

: 6.84 gm⁻²

Mean Macrofaunal density

: 1546 Individuals m⁻²

Total No. of polychaete species

: 218

Macrobenthos of Eastern Arabian Sea – Slope (200-1000m)

Study was conducted during 2002-2007
Mean macrofaunal biomass : 3.94 gm⁻²
Mean Macrofaunal density : 446 Ind. m⁻²
Total No. of polychaete species : ~200
Strong influence of OMZ on macrofauna was observed

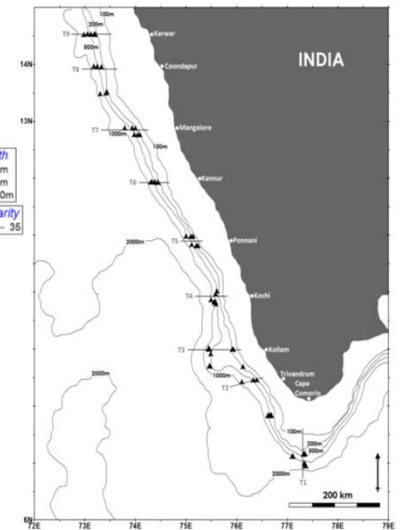
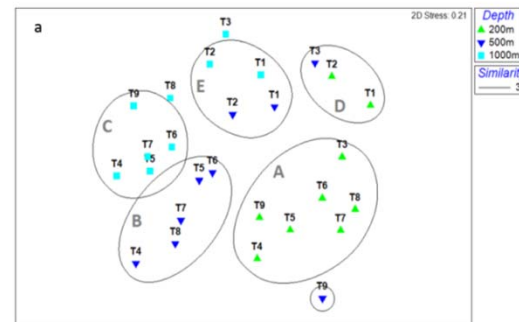


Polychaete community structure in the South Eastern Arabian Sea continental margin (200–1000 m)

K.U. Abdul Jaleel^{a,*}, P.R. Anil Kumar^b, K. Nousher Khan^b, Neil S. Correy^a, Jini Jacob^a, Rosamma Philip^b, V.N. Sanjeevan^a, R. Damodaran^b

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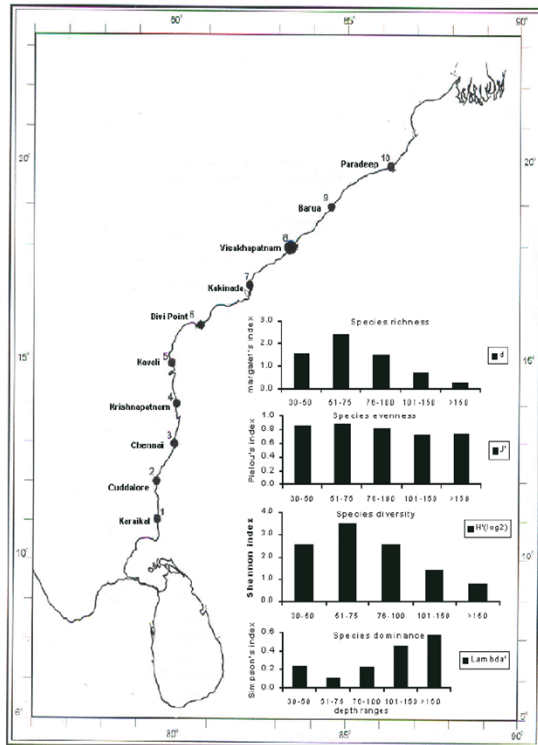
^b Department of Marine Biology, Microbiology & Biochemistry, School of Marine Sciences, Cochin University of Science & Technology, Kochi 682016, India



Abdul Jaleel, K.U. *et al.* 2014 *Deep-Sea Research I* 93 60–71

- Polychaete communities in the SEAS margin were spatially heterogeneous.
- Patterns were affected by impingement of OMZ and sediment texture.
- Shelf-edge sediments impacted with OMZ dominated by smaller species.
- Beyond the OMZ (deeper and southern regions), evenness and diversity increased.

Macrobenthos of Bay of Bengal: Shelf & Slope



Vol. 341: 59–73, 2007

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Mar Ecol Prog Ser

Published July 4

Macrobenthic community structure of the northeast Indian shelf, Bay of Bengal


T. Ganesh, A. V. Raman*

Marine Biological Laboratory, Department of Zoology, Andhra University, Waltair, Visakhapatnam 530003, India

ABSTRACT: Knowledge of tropical benthic fauna is limited. Two cruises (January 1999 and July 2000) were made covering 24 stations along 5 transects between 16° and 20°N in shelf waters (depth 30 to 200 m) in the Bay of Bengal off northeast India. Altogether 62 infaunal samples (Smith-McIntyre grab 0.1 m²) and 32 epibenthos (through a naturalist dredge 40 × 40 cm) were collected that revealed 169 species representing 15 diverse groups. Gastropods, bivalves, polychaetes and decapods constituted the bulk of the population. Polychaetes were by far the most dominant group (64.98%) among the infauna followed by amphipods (25.23%), which were numerically more abundant (mean 1080 ± 292 ind. m⁻²) at 51 to 75 m than at greater depths (345 ± 185 ind. m⁻² at >150 m). Biomass was higher (wet weight 6.94 ± 4.8 g m⁻²) at 51 to 75 m than at 101 to 150 m (1.08 ± 1.23 g m⁻²). There was a preponderance of decapods (26%), gastropods (20.7%), bivalves (8.3%) and several (28.3%) large-sized polychaetes (e.g. *Dionatra neanolitana*, *Funice indica*, *Pista* sp.) in the dredge hauls (mean

- 15 diverse groups were encountered with 169 species
- Polychaetes were the dominant group (65%) followed by amphipods (25%)
- Infaunal diversity was higher at 51 to 75 m depth range
- Salinity, temperature, mean particle diameter, sand and depth influenced infaunal distribution

Macrobenthos of Bay of Bengal: Shelf & Slope

marine ecology 

Marine Ecology. ISSN 0173-9565

REGULAR PAPER

Macrobenthic composition of the southeast continental shelf of India

Seerangan Manokaran, Syed Ajmal Khan & Parameswari S. Lyla

Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, Tamilnadu, India

Keywords
Continental shelf; dissolved oxygen; India; macrobenthos; polychaetes; temperature.

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Accepted: 11 August 2013

doi:10.1111/maec.12107

Abstract
Macrobenthic faunal composition was studied at six different depth ranges (30–50, 51–75, 76–100, 101–150, 151–175 and >176 m) in five transects (off Karaikkal, Parangipettai, Cuddalore-SIPCOT, Cheyyur and Chennai) in the continental shelf of southeast coast of India. Eleven diverse taxa were found, comprising 113 species of polychaetes, 14 species of bivalves, 10 species of amphipods and 'others' (five tanaids, five crabs, four isopods, three echinoderms, two shrimps, two cnidarians, two fishes and one cephalochordate). Polychaetes were the dominant taxa, constituting 88.5% of the total abundance of species (seven per 0.2 m² at 2 m² at 30–50 m in Cheyyur).

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ARTICLE PREVIEW

marine ecology 

Marine Ecology. ISSN 0173-9565

ORIGINAL ARTICLE

Macrobenthos relative to the oxygen minimum zone on the East Indian margin, Bay of Bengal

Akkur V. Raman¹, Rayaroth Damodaran², Lisa A. Levin³, Thiruchitrabalam Ganesh^{1,4}, Yannamani K. V. Rao⁵, Sateesh Nanduri¹ & Rakesh Madhusoodhanan^{1,5}

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² School of Marine Sciences, Cochin University of Science and Technology, Kochi, India
³ Center for Marine Biodiversity and Conservation, Integrative Oceanography Division, Scripps Institution of Oceanography, La Jolla, CA, USA
⁴ Department of Ocean Studies & Marine Biology, Pondicherry University, Port Blair, India
⁵ Department of Biology, University of Bergen, Bergen, Norway

In memoriam John S Gray, Marine Biologist

Keywords
Bay of Bengal diversity; East Indian margin; faunal assemblage; macrobenthos; oxygen minimum zone.

Correspondence
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Accepted: 15 March 2014

doi:10.1111/maec.12176

Abstract
The Bay of Bengal remains one of the least studied of the world's oxygen minimum zones (OMZs). Here we offer a detailed investigation of the macrobenthos relative to oxygen minimum zone [OMZ – DO (dissolved oxygen), concentration <0.5 ml l⁻¹] at 110 stations off the North East Indian margin (16° and 20° N) featuring coastal, shelf and slope settings (10–1004 m). Macrobenthos (>0.5 mm) composition, abundance and diversity were studied in relation to variations in depth, dissolved oxygen, sediment texture and organic carbon. Using multivariate procedures powered by SIMPROF analysis we identified distinct OMZ core sites (depth 150–280 m; DO 0.37 ml l⁻¹) that exhibited dense populations of surface-feeding polychaetes (mean 2188 ind. m⁻²) represented by spionids and coarctids (96%). Molluscs and crustaceans were poorly represented except for amphipods. The lower OMZ sites (DO > 0.55 ml l⁻¹) supported a different assemblage of polychaetes (cirrat-

S. Manokaran, S. Ajmal Khan and P.S. Lyla, 2013. Macrobenthic composition of the southeast continental shelf of India. *Marine Ecology*. doi: 10.1111/maec.12107.

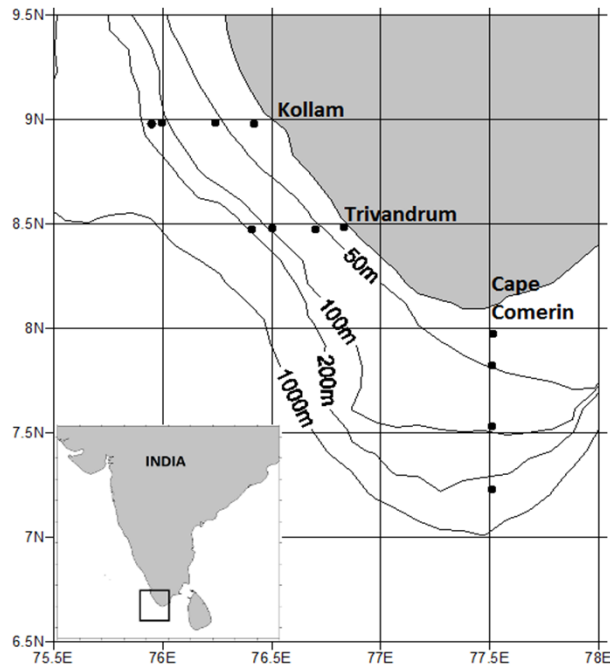
S. Raja, P.S. Lyla and S. Ajmal Khan, 2013. Diversity of amphipods in the continental shelf sediments of southeast coast of India. *J. Mar. Biol. Ass. India*, 55 (1),35-41

Recent Research Focus

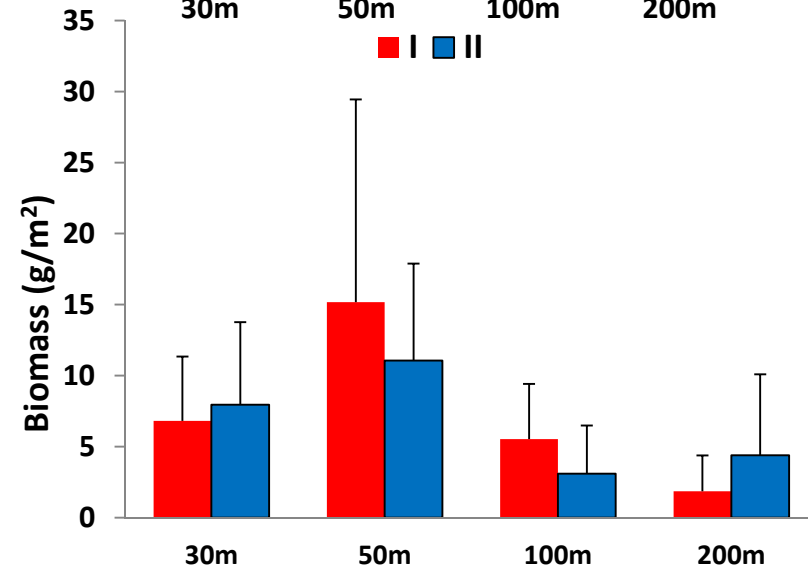
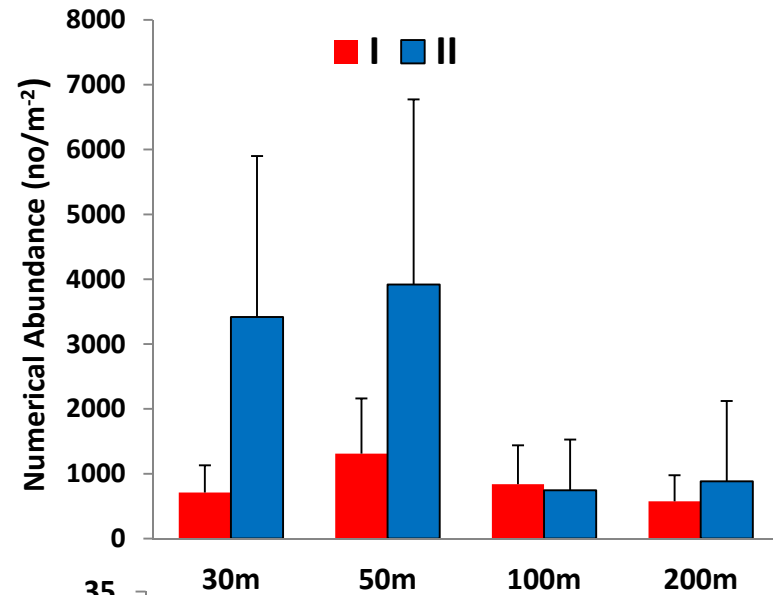
(2012-2017)

- Detailed study on the bio-composition and abundance of benthos of the continental margin up to depths of 2500 m.
- Studies on impact of closed fishing season on the benthic standing stock and community in SE Arabian Sea (SEAS)
- Generation of benchmark data on benthos around Andaman & Nicobar Islands
- Initiation of studies on decadal changes in benthos of SEAS shelf
- Impact of shelf hypoxia on macrofauna of the SEAS
- Studies on diversity and biogeography of epifauna
- Bioregionalisation of marine benthos and associated diversity patterns

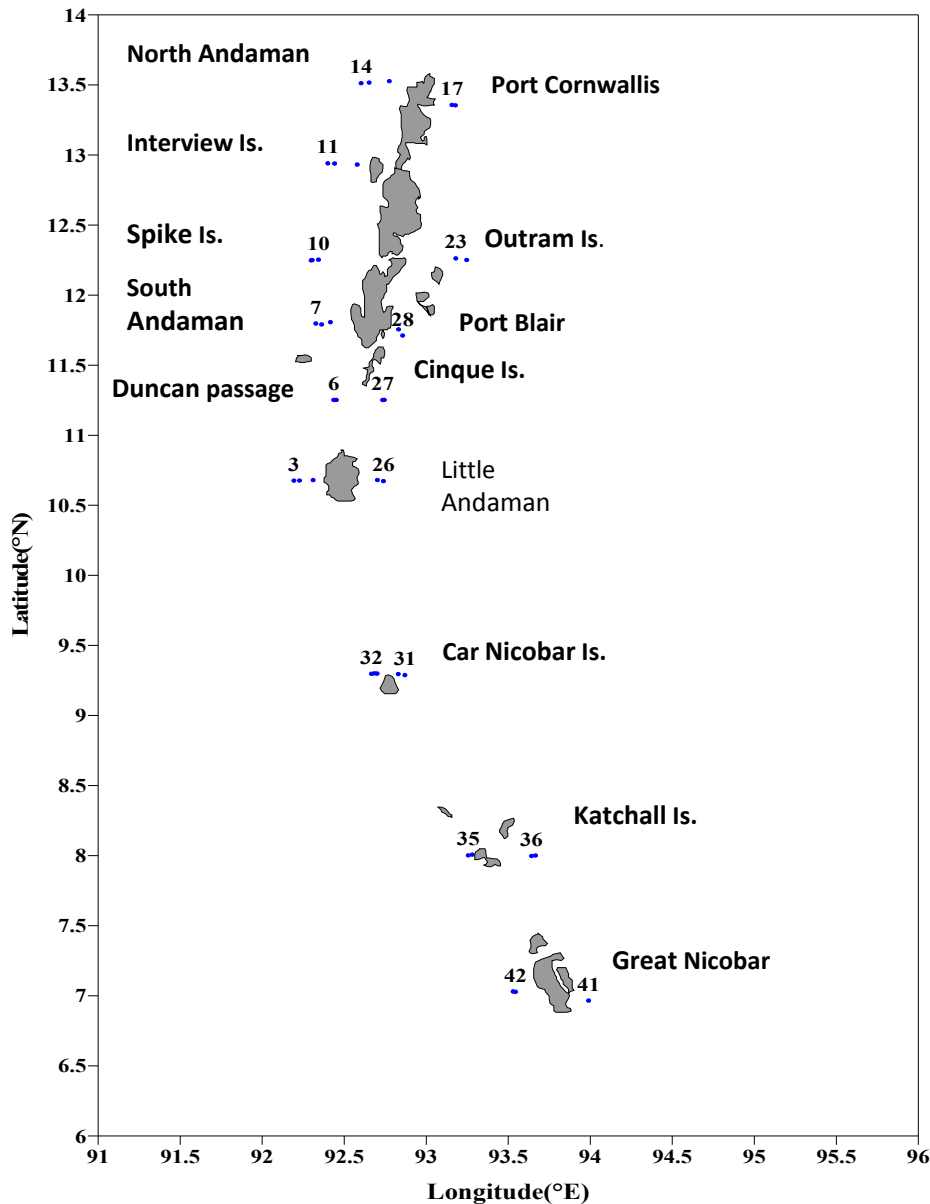
Changes in macrofauna during monsoon and trawl-ban



- Significant increase in macrofaunal density post-ban
- Proportionate increase in biomass not observed
- Presence of more numbers of smaller polychaetes (post-ban)
- Trawl ban coincides with breeding season of dominant polychaetes of SEAS



Macrobenthos of Andaman & Nicobar Islands

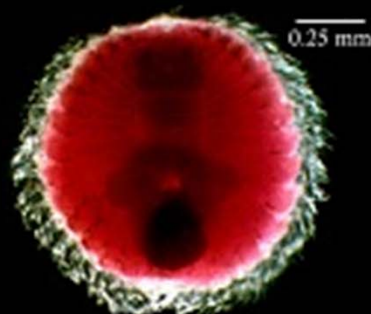


- Mean density: 904 ind. /m²
- Mean biomass: 5.4 g/m²
- 23 taxa were encountered
- Major groups: Polychaetes, Amphipods & Isopods
- 311 polychaete species identified
- **Region characterized by high species richness & diversity**

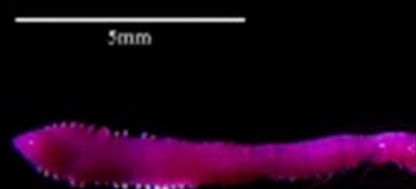
Benthic biodiversity of Indian EEZ

Total no. of sites surveyed: 1040
Total no. of species recorded: 1568

| Number of marine benthic invertebrate species recorded | Arabian Sea (shelf & slope) | Bay of Bengal (shelf & slope) | Andaman & Nicobar Islands (shelf) |
|--|-----------------------------|-------------------------------|-----------------------------------|
| | 1436 | 1285 | 466 |



Palmyreuphrosyne indica



Pettobonella shompens



Armandia sampadae

Species new to science: 12



Pseudochromadora sp. nov.



Asteroschema sampadae



Scaptrella sp. nov.

Common constraints in sampling of marine benthos (in our experience)

Collection

- For deep-sea fauna large areas need to be sampled with duplication (or triplicates).
- On-board processing (sieving) of bulk sediments is extremely strenuous – and also needs to be done cautiously.

Analysis

- Separation of fauna from sediments requires **staining** – when overdone, this can hinder with discriminating morphological features (essential for taxonomic identification)
- **Taxonomic expertise** for most benthic groups is scarce, with fewer people taking up systematics as a field. resulted in a **lack of proper taxonomic keys & references**

A photograph of a large ocean wave crashing, with a rainbow visible in the mist and spray. The text "THANK YOU" is overlaid in white capital letters at the bottom center of the image.

THANK YOU