

# Biological Communities Associated with the Indian Ocean Seamounts

Baban Ingole

National Institute of  
Oceanography,

Dona Paula, Goa 403 004,  
India



# Outline

- ✓ What we know about the Indian Ocean seamount biology? - (available data as well as New data)
- ✓ Identify the gaps
- ✓ Proposed national & international studies.

INDIA

Worlds second largest & second high grade manganese nodule deposit.

Over 10000 seamounts – many have potential of cobalt rich

Mid Ocean Ridge system – potential for sulphide deposits

*CIOB*

In last 25 years >70 deep-sea expeditions.

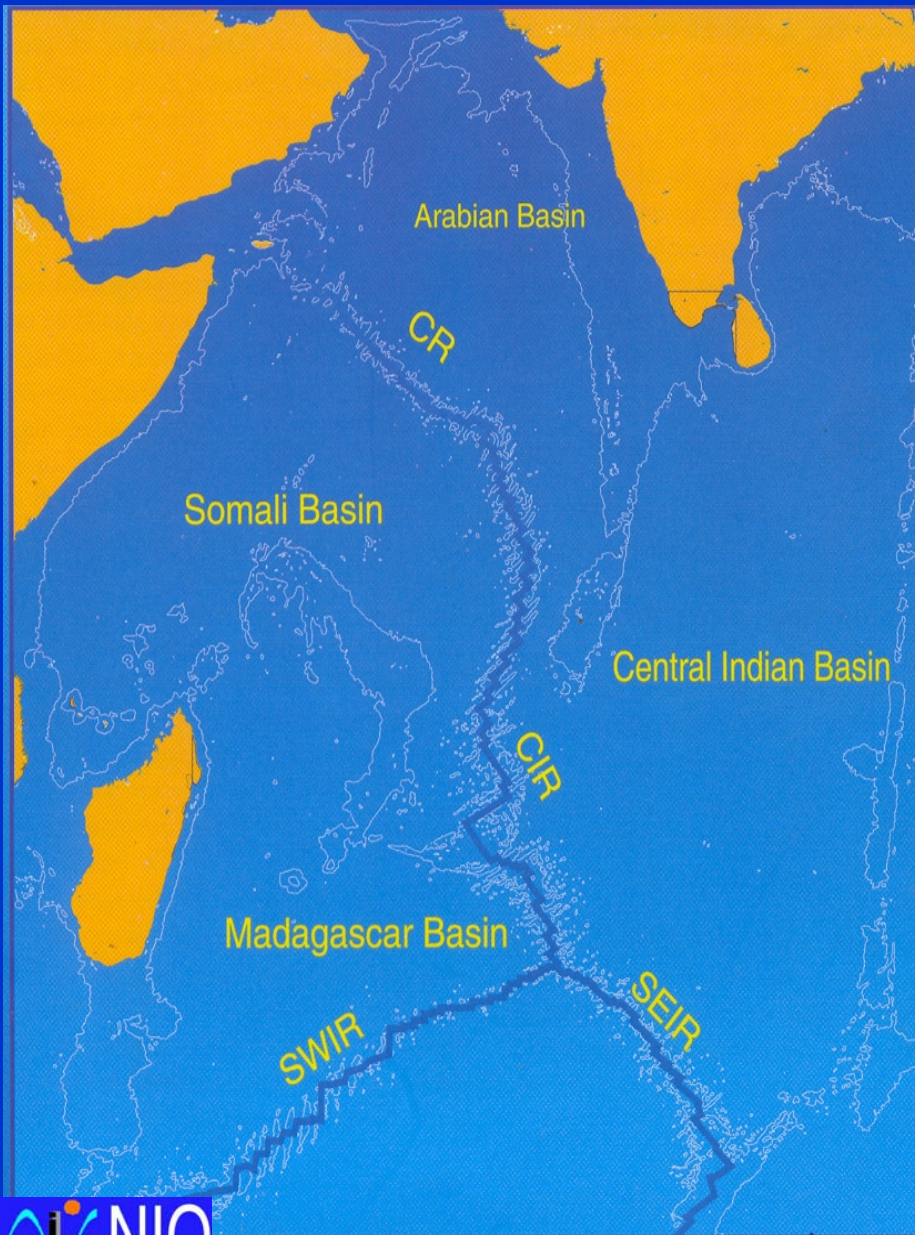
400 seabed samples & 55000 still photo & few kms of deep tow photography for benthic studies

Potential for many new spp.

But non of the study was aimed at seamount biology



# Area of interest

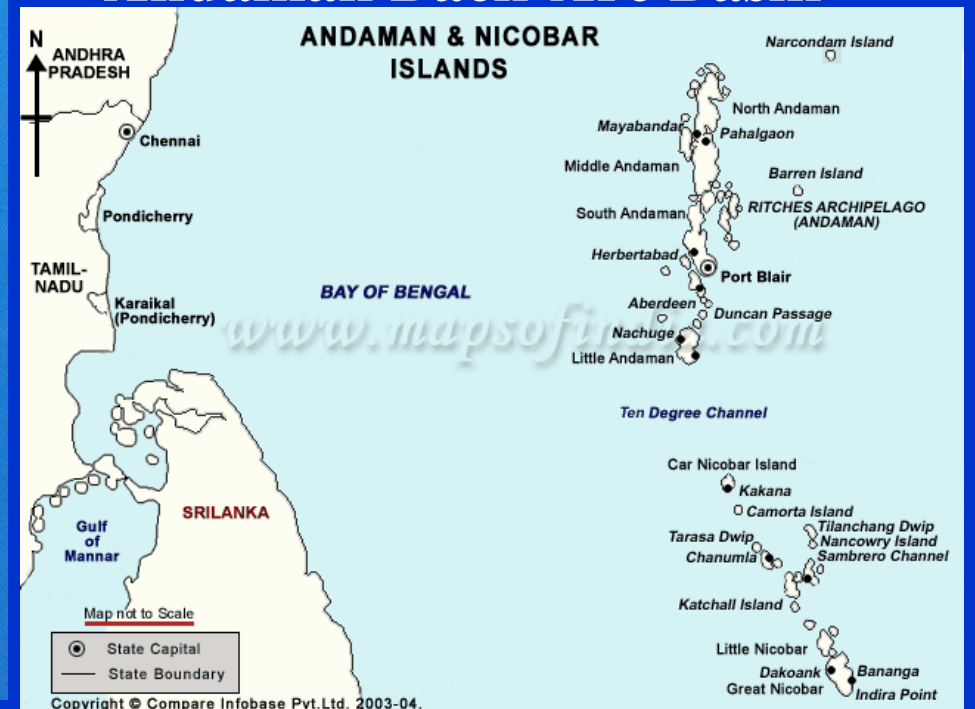


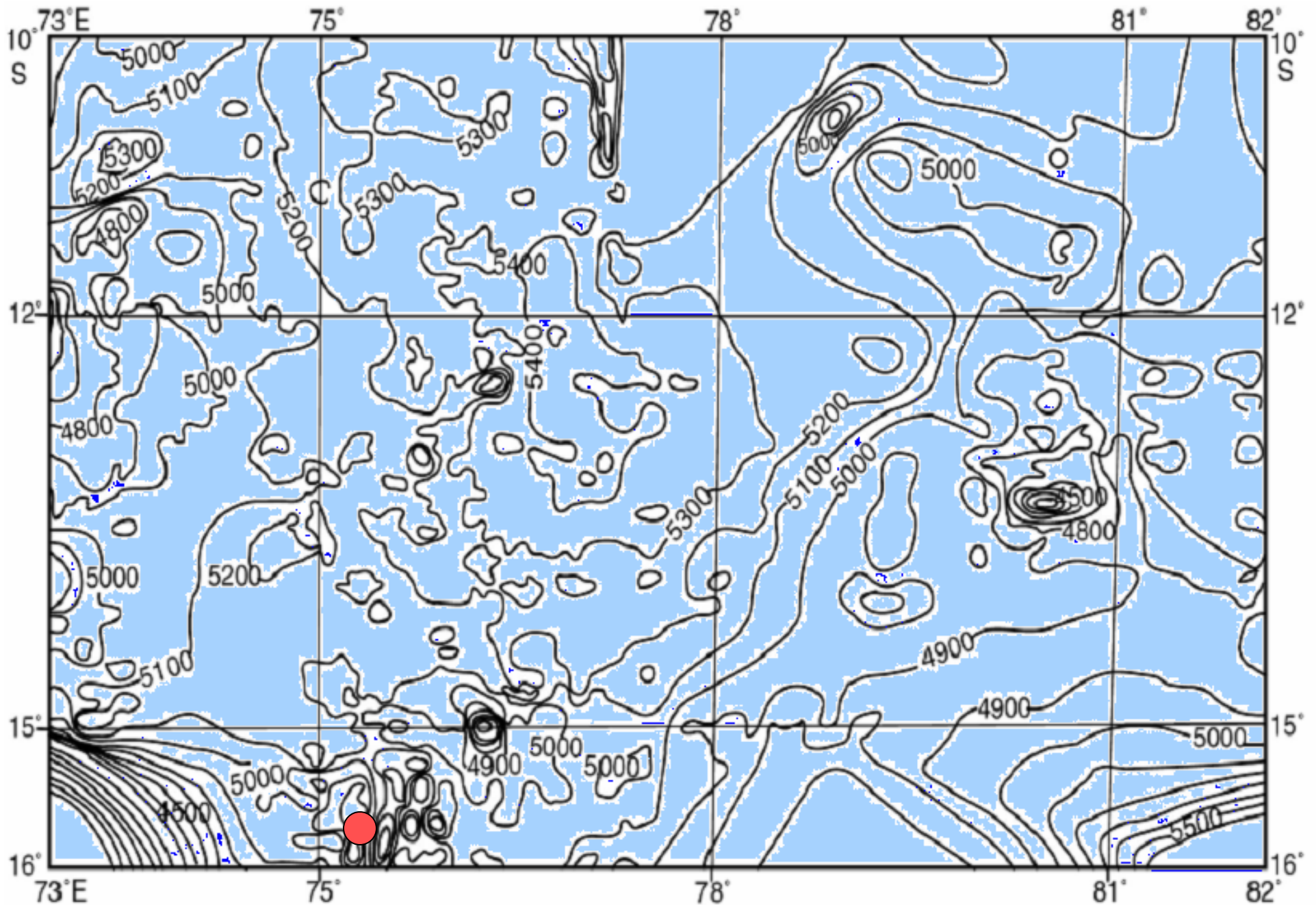
Central Indian Ocean Basin  
(CIOB)

Somali Basin; Madagascar  
Basin; Arabian Sea; Central  
Indian Ridge (CIR); Carlsberg  
Ridge (CR)

Rodriguez Triple Junction

Andaman Back-Arc Basin

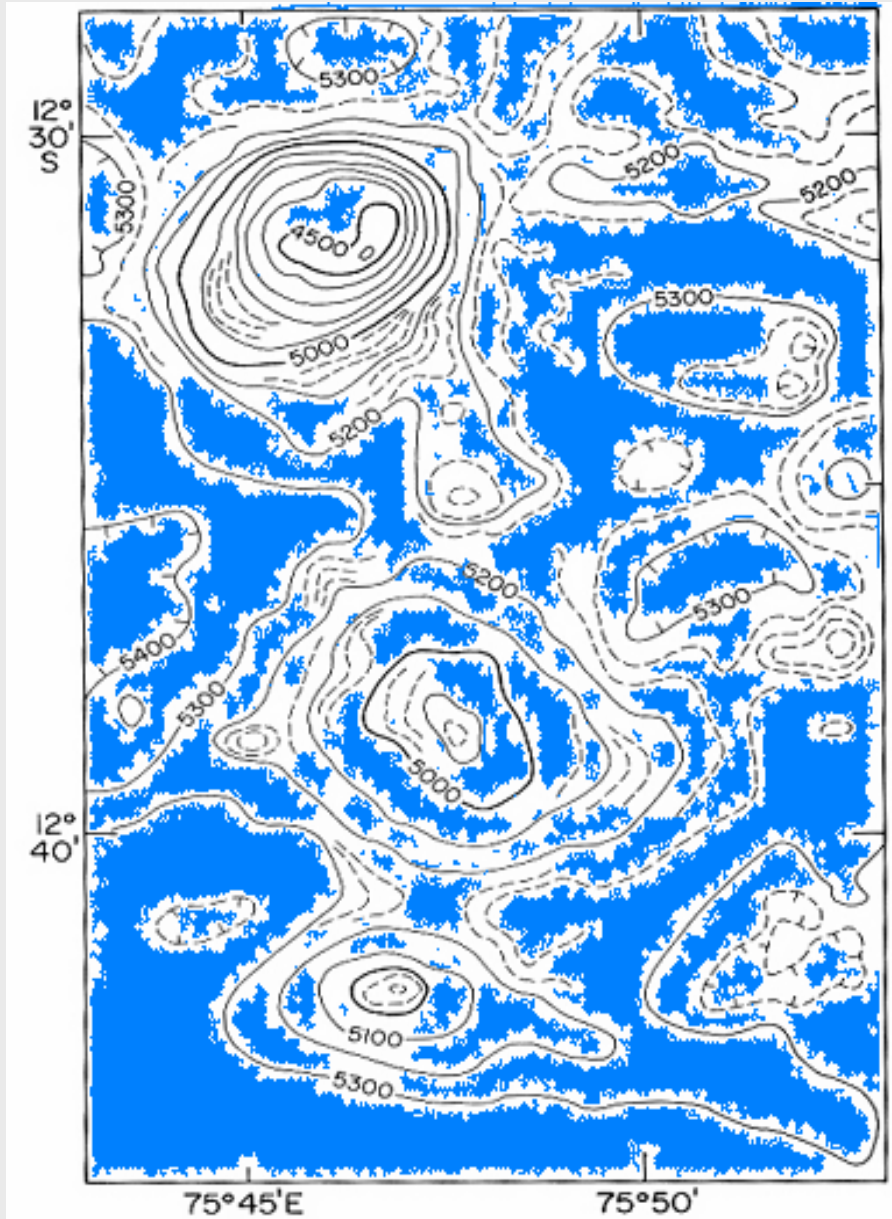
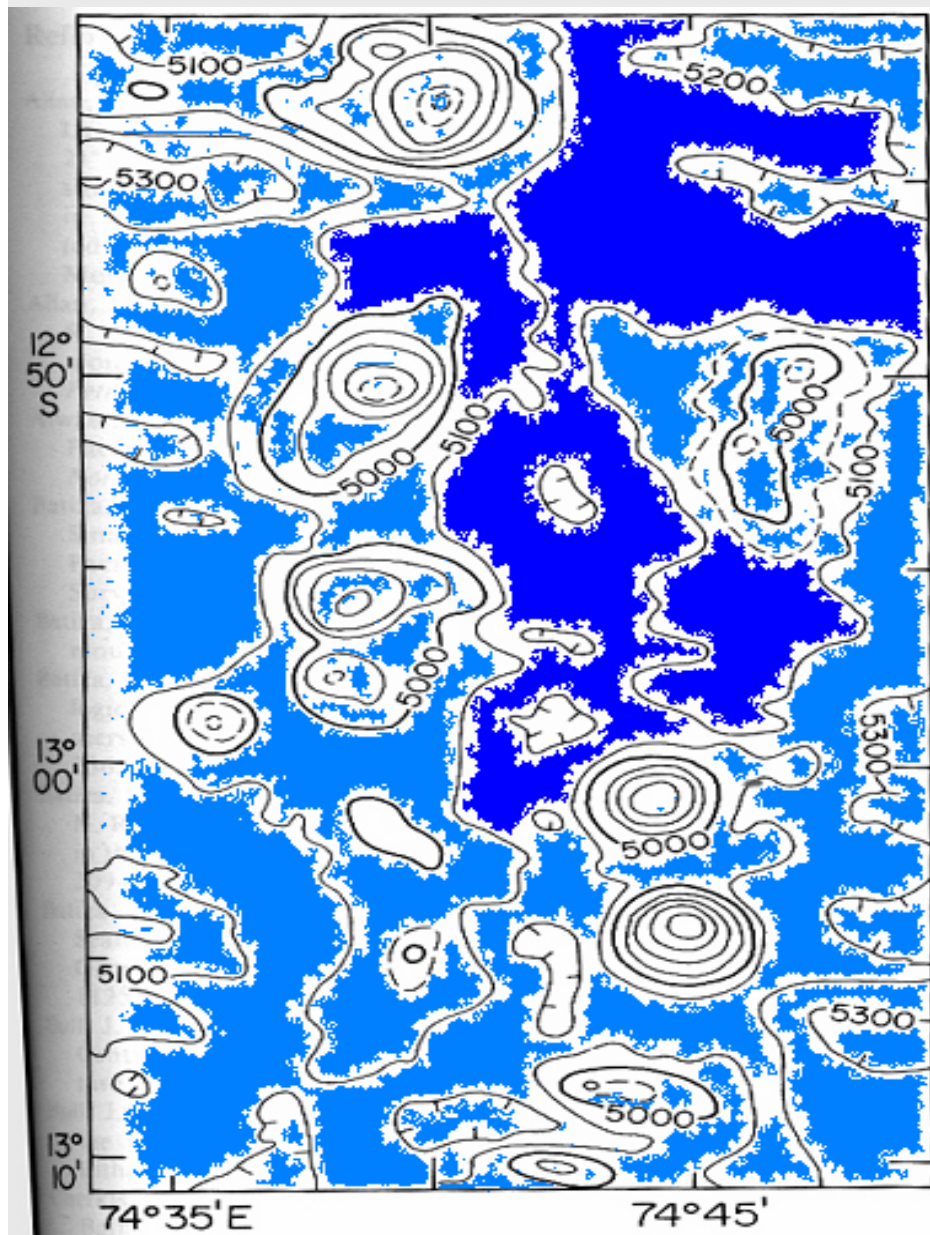


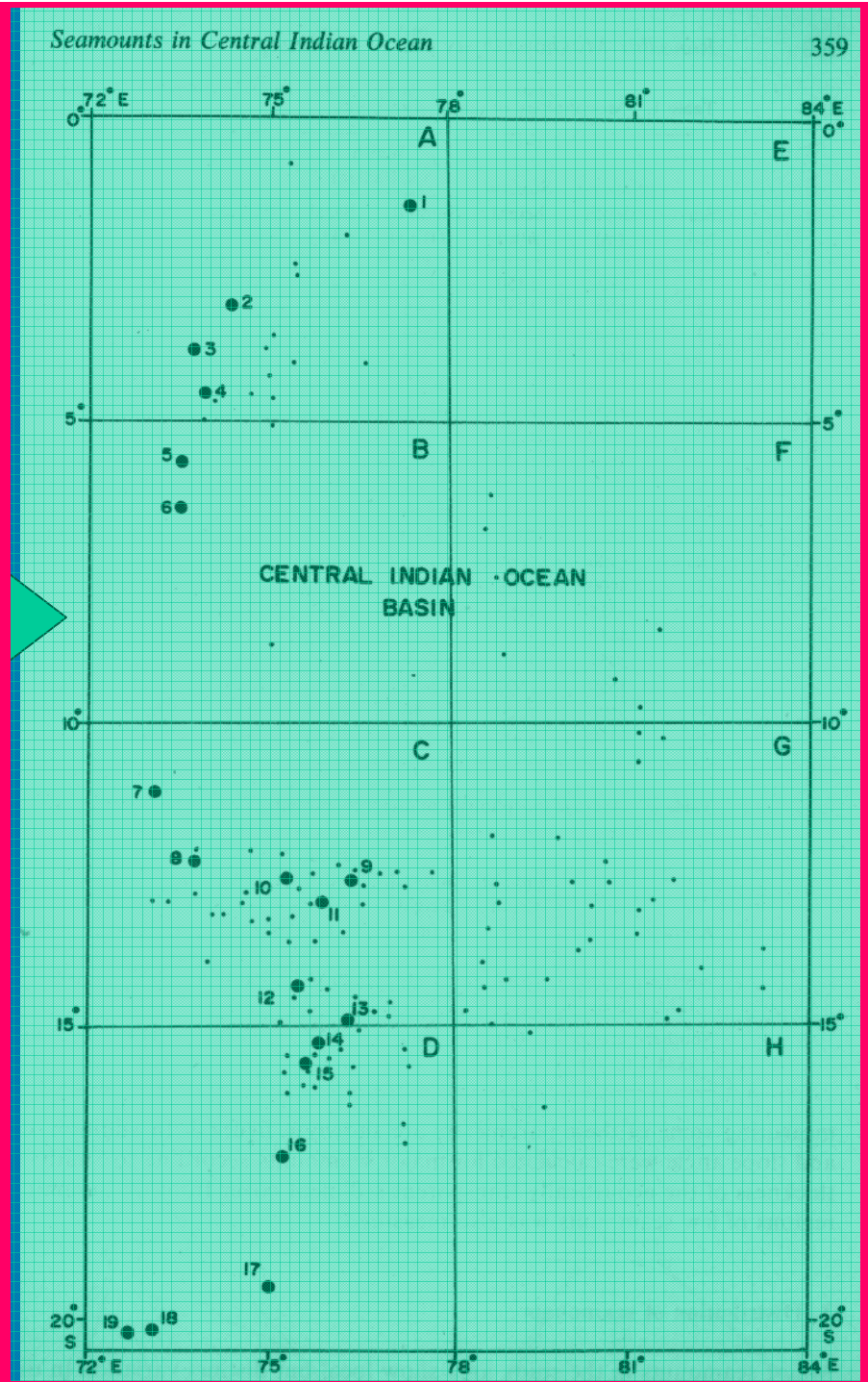
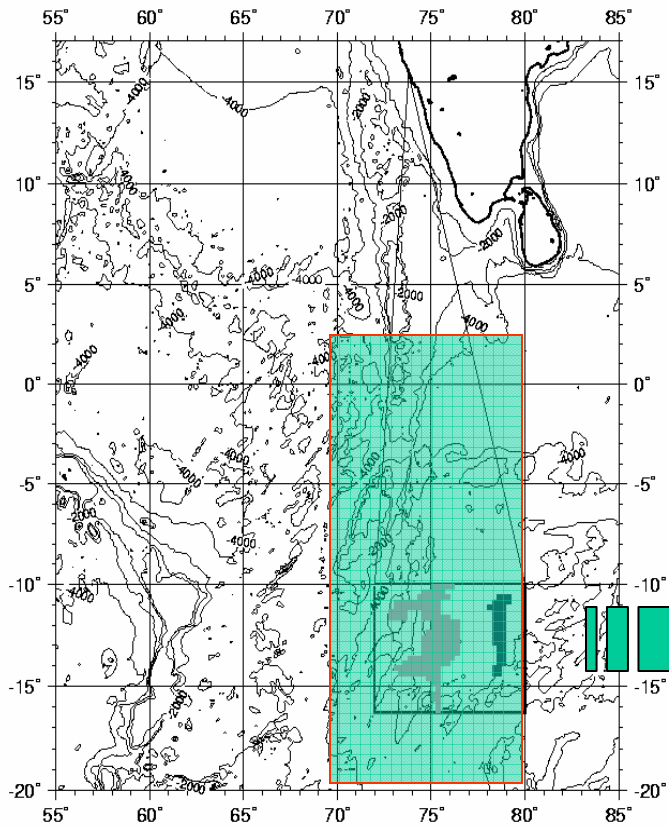


**Bathymetry and morphology of the central Indian Ocean** (Kodagali & Raju, 1992)



# BASINAL SEAMOUNTS AND SEAMOUNTS CHAINS OF THE CENTRAL INDIAN OCEAN (Mukhopadhyay et al 2002)





**In facts app. 6000  
seamounts of small (> 100  
m), medium (>500m) and  
large (>1500m) are  
recorded from Indian  
Ocean nodule field**

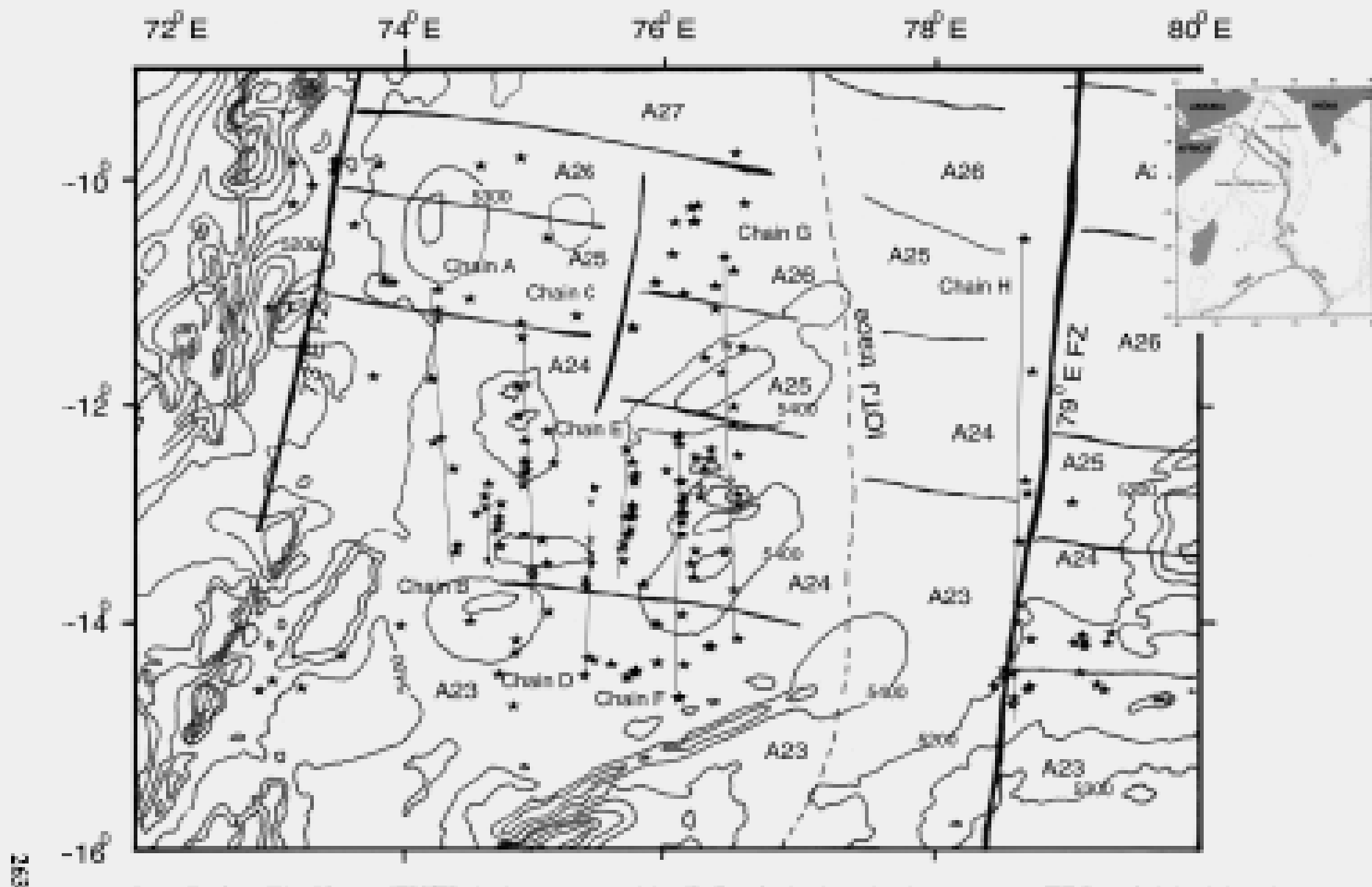
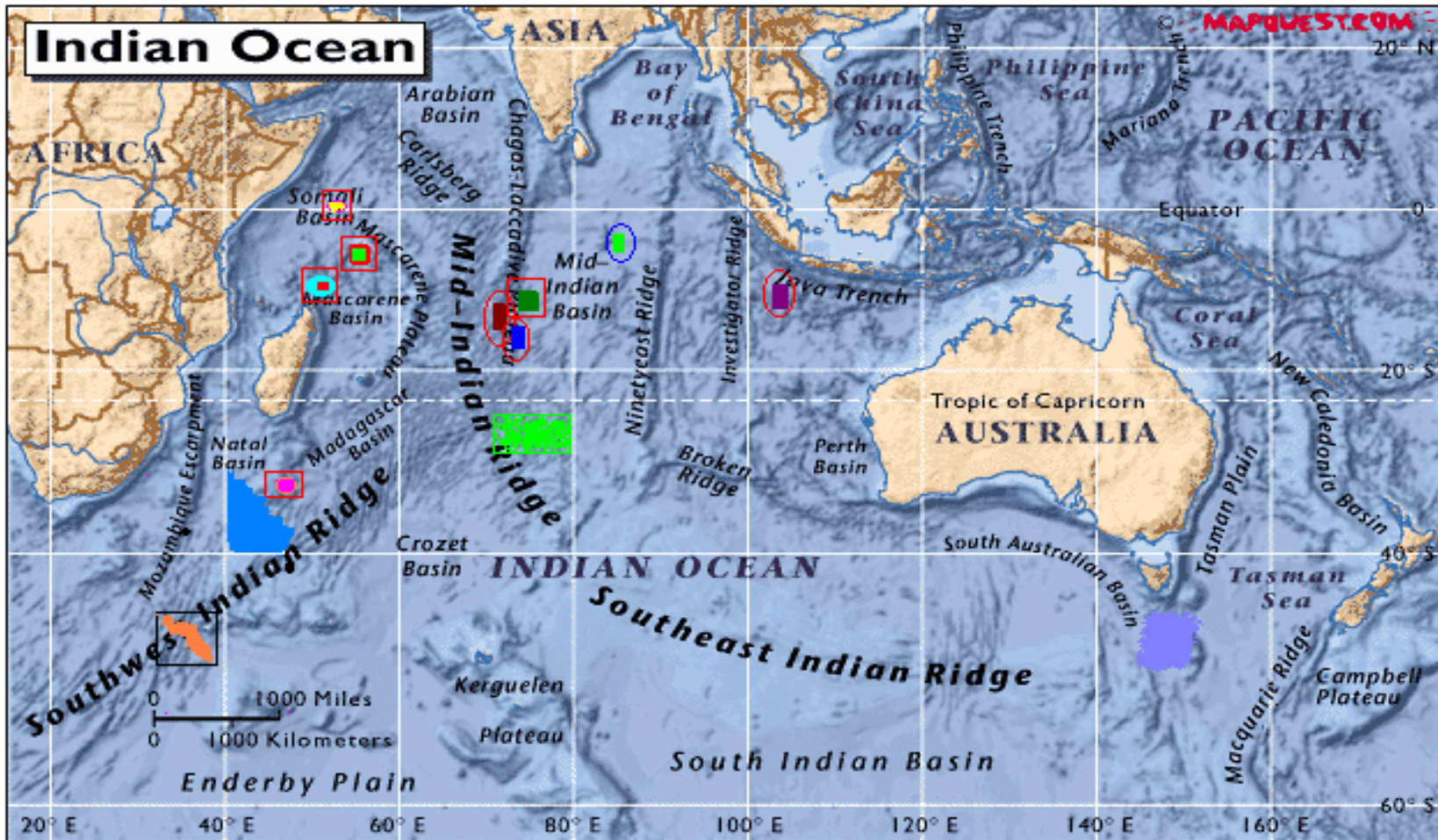
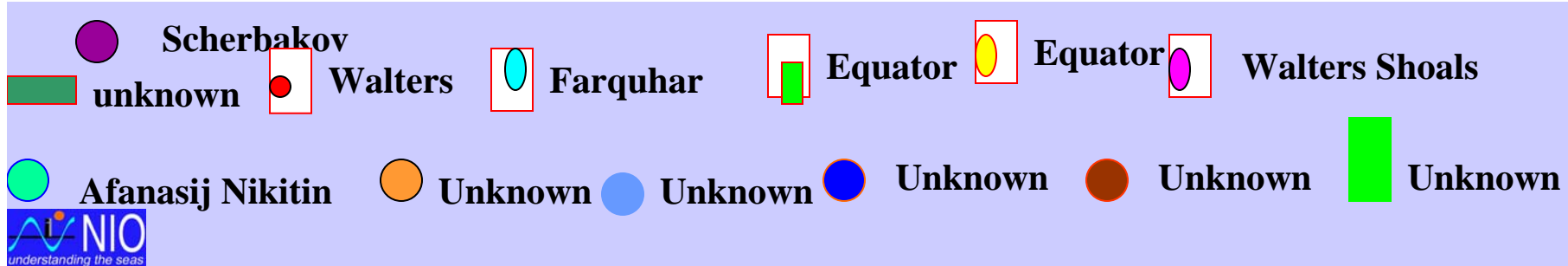


Figure 1. Generalized satellite (NOAA SEIBSTER) bathymetry map of the CIOI tectonic plate; the major fracture zones, TT-1a, and eight chains of seamounts.

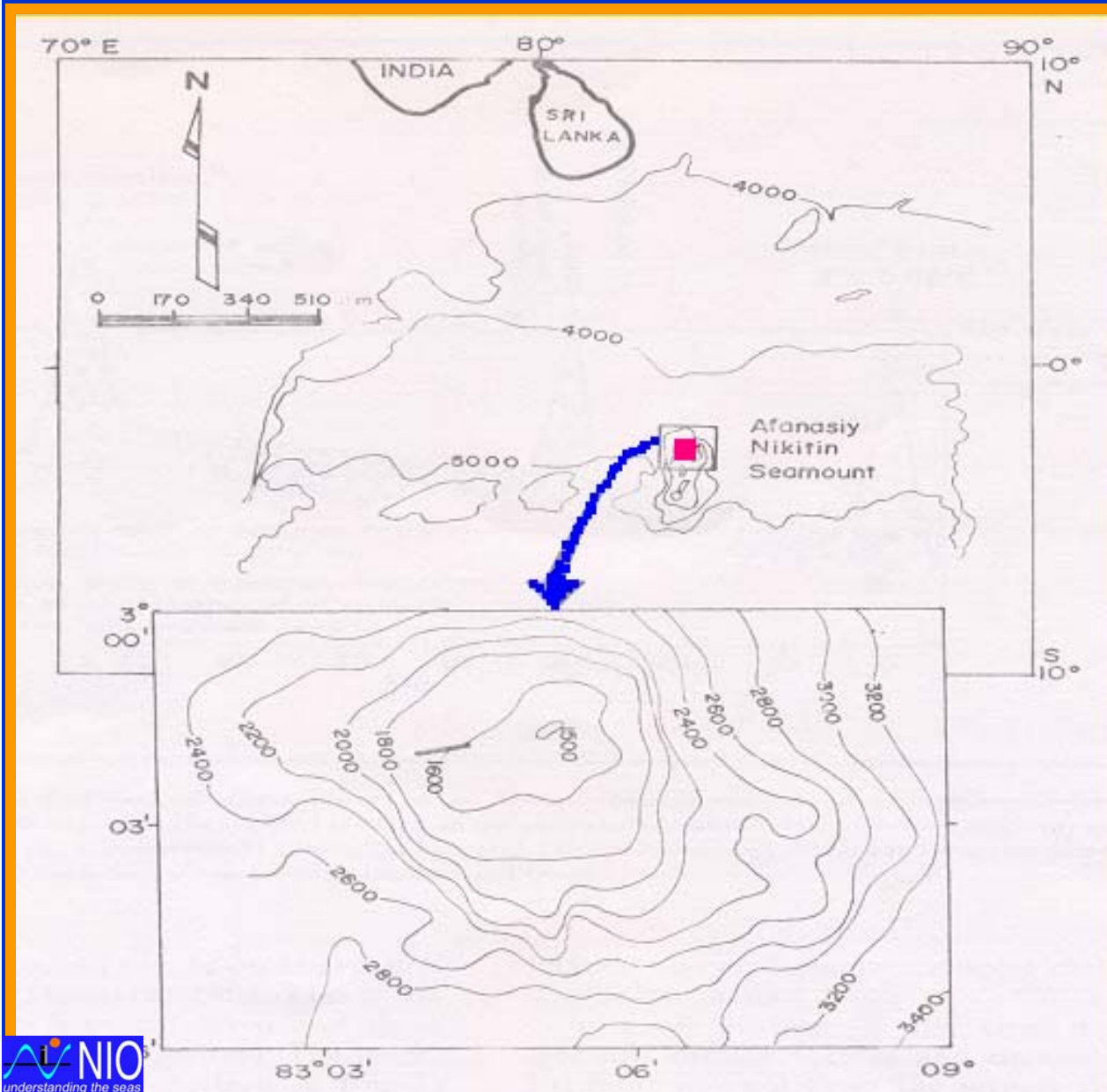




Among >10000 seamounts, biological features are known only from 16; mainly from the fishery surveys



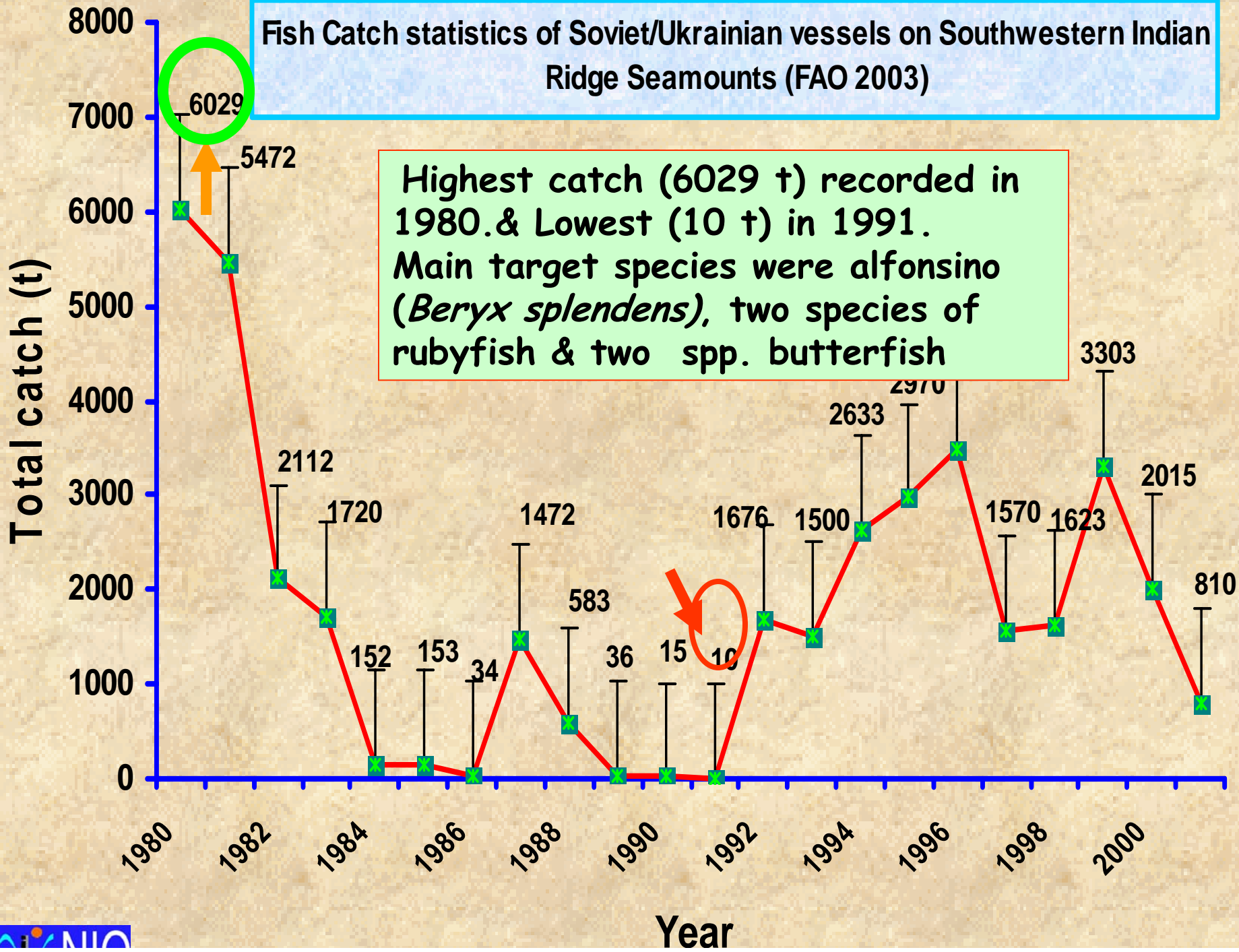
# Afanasiy-Nikitin seamount in the CIOB



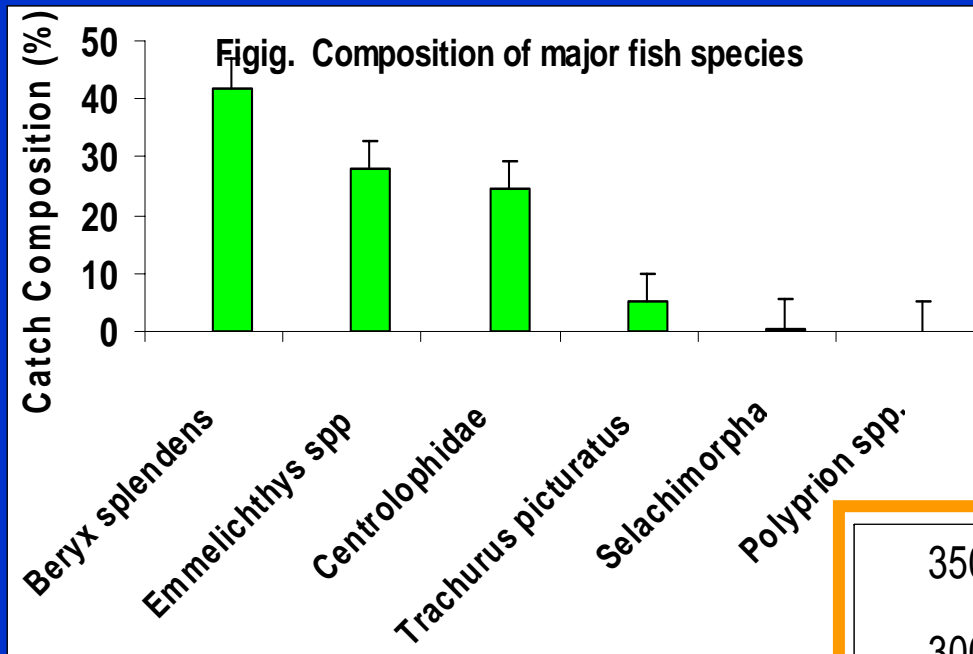
- Many of the rock samples have thick coating of ferromanganese oxides.
- Cobalt Crust
- dredging & sediment sampling indicated presence of highly diverse in benthic communities

Fish Catch statistics of Soviet/Ukrainian vessels on Southwestern Indian Ridge Seamounts (FAO 2003)

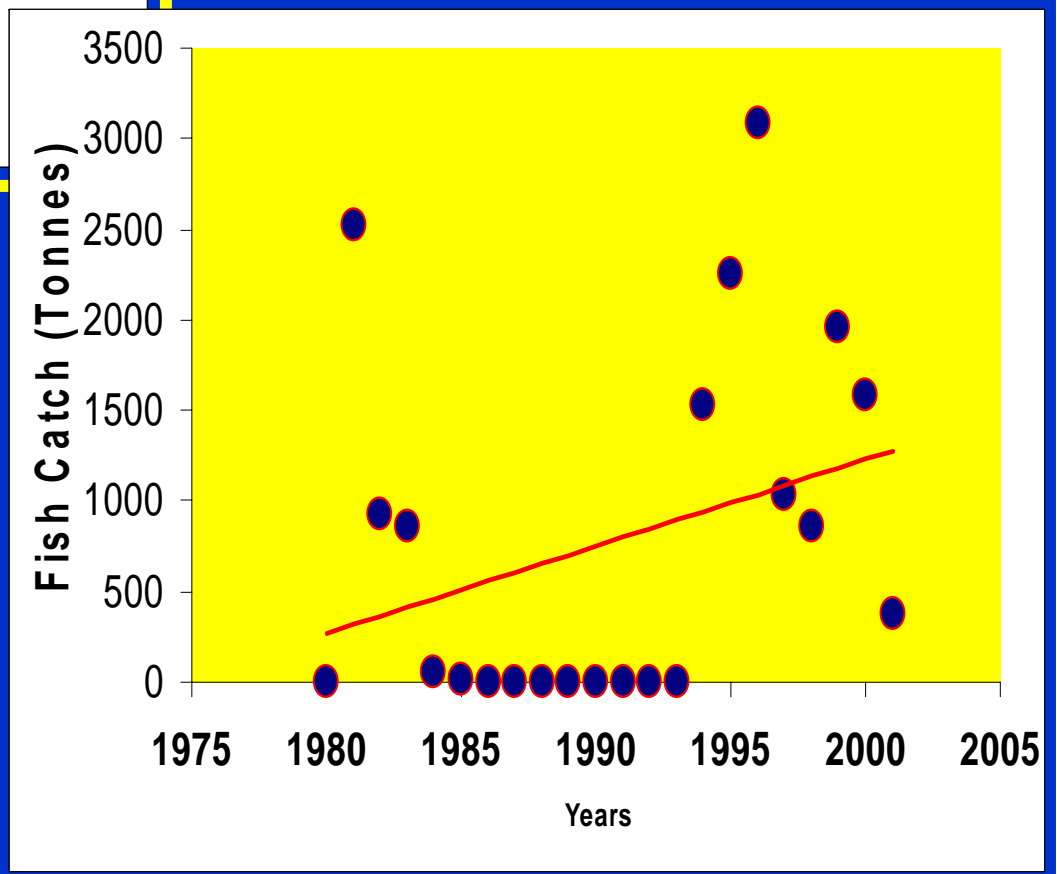
Highest catch (6029 t) recorded in 1980. & Lowest (10 t) in 1991. Main target species were alfonsino (*Beryx splendens*), two species of rubyfish & two spp. butterflyfish





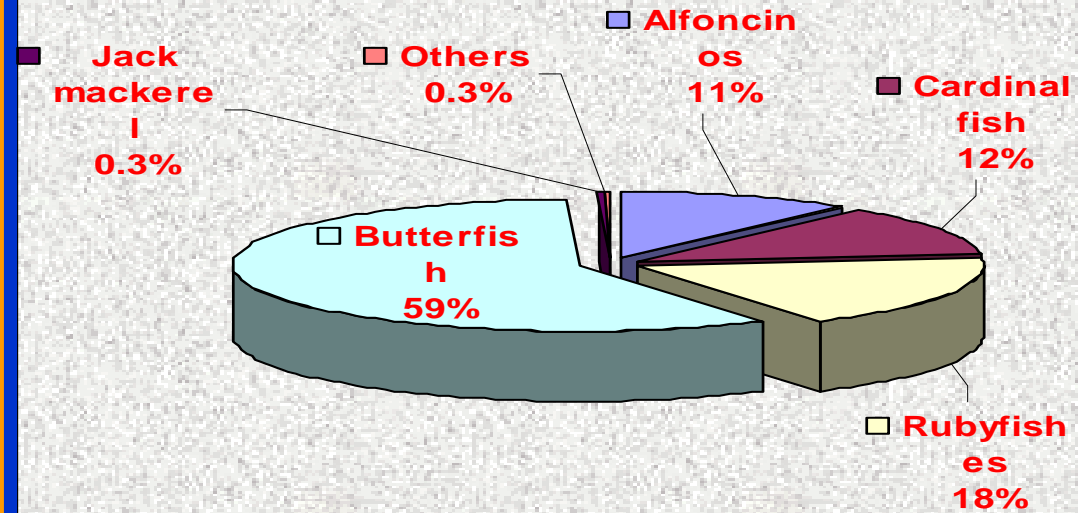


*Alfonsino, Beryx splendens,* accounted for 45% of the total average catch.

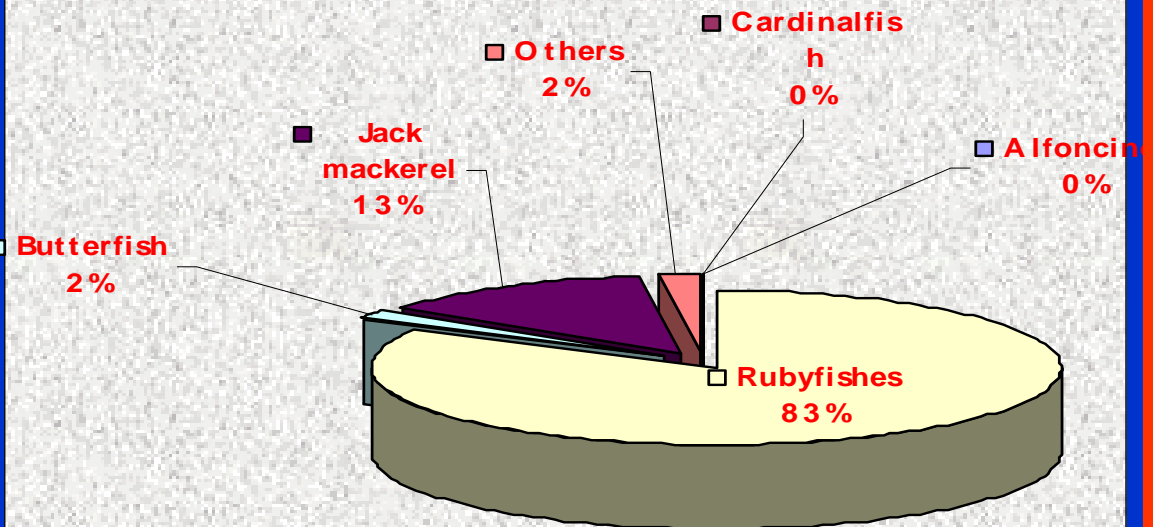


Trawl surveys conducted in 1980-1981 at the Southwest Indian Ridge seamounts suggested that individual seamount may have different catch composition (Nikolaj et al., FAO 2003)

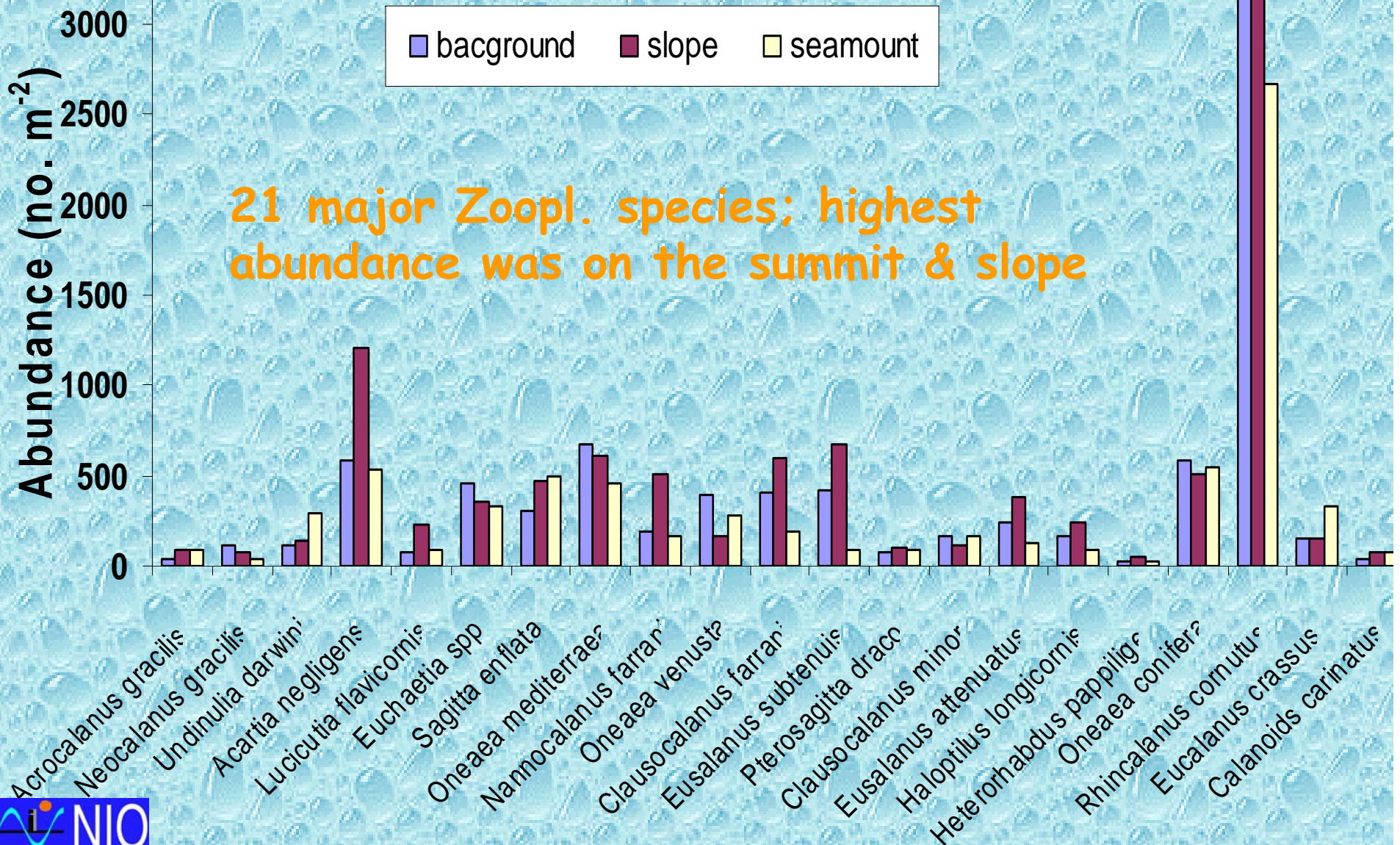
Seamounts (120)



Seamounts(150)

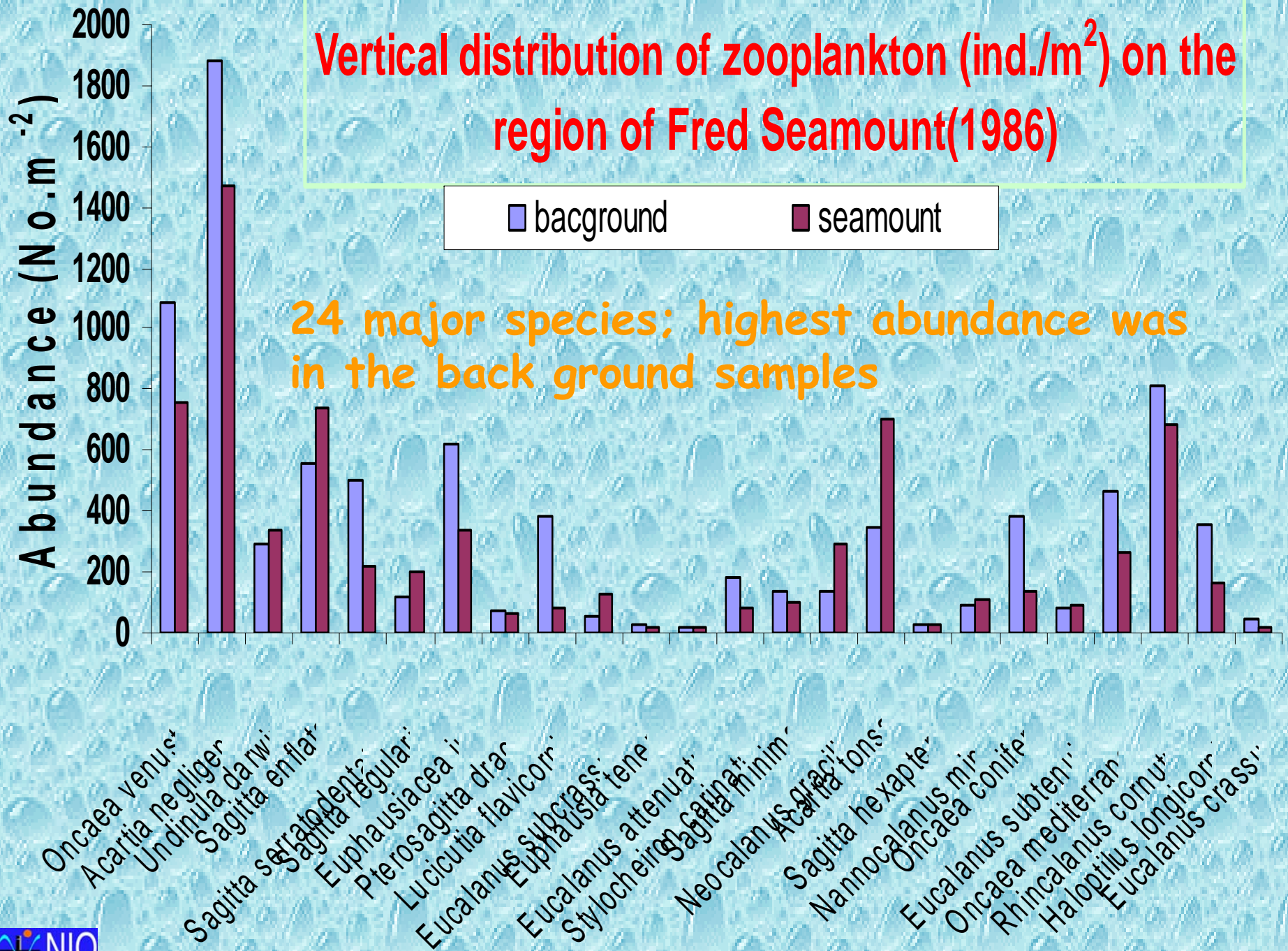


# Vertical distribution of zoopl. (ind./m<sup>2</sup>) on the region of Equator Seamount (Voronina & Timonin, 1986)

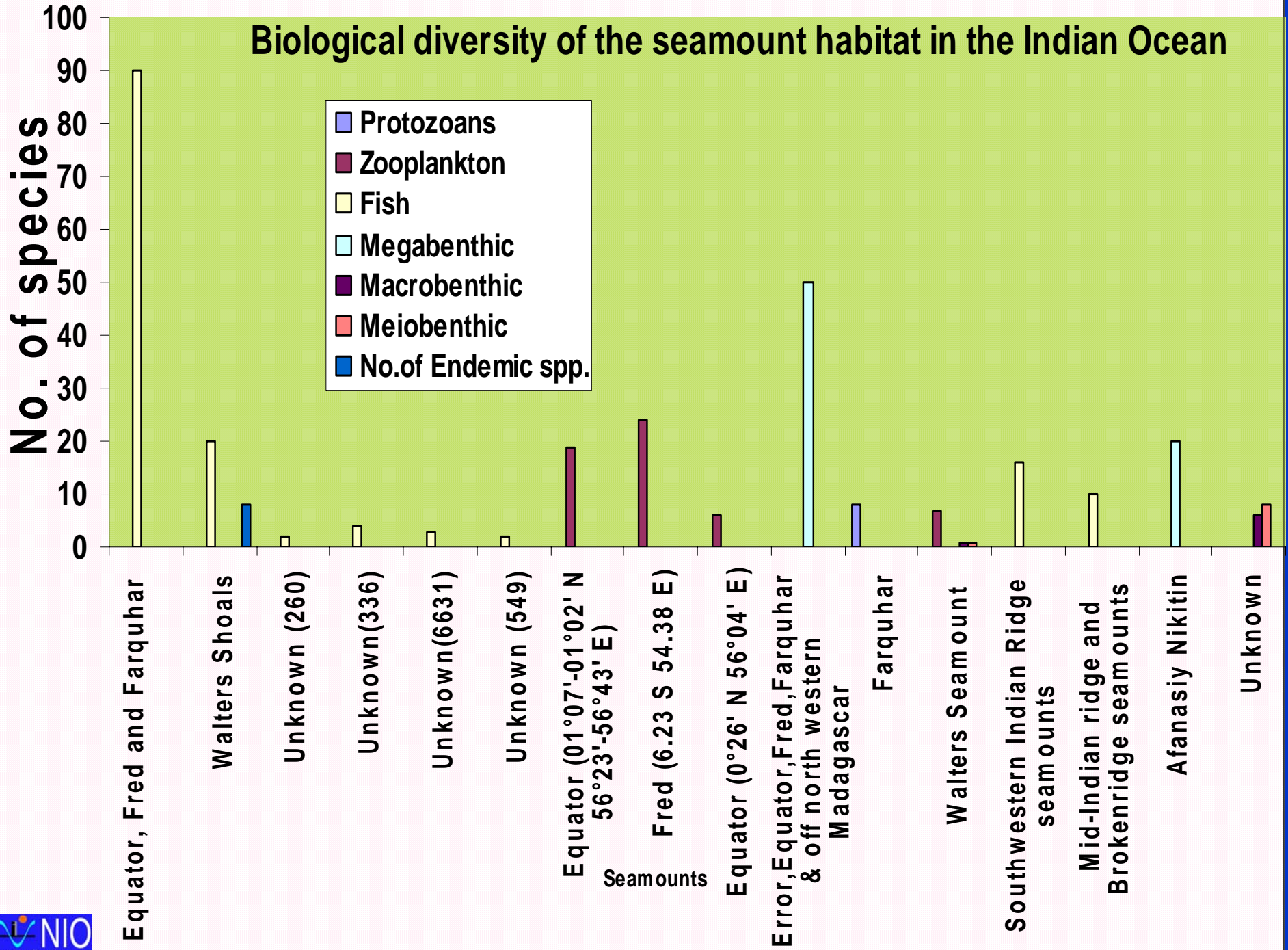


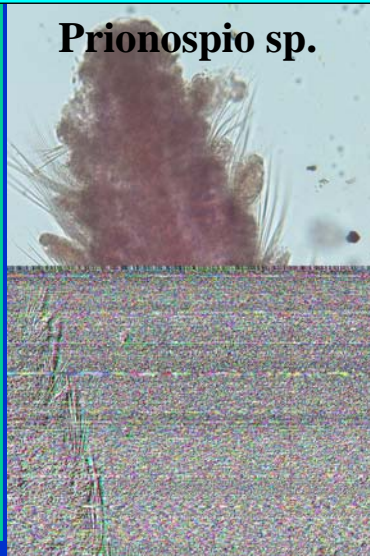
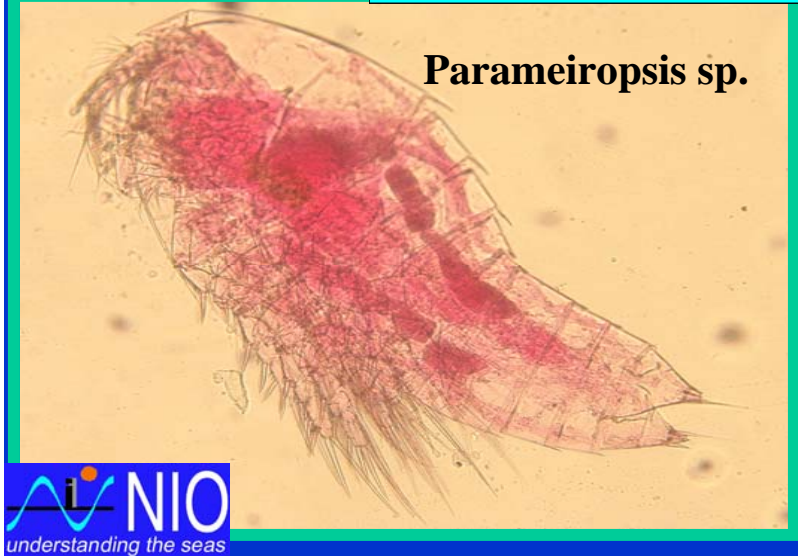
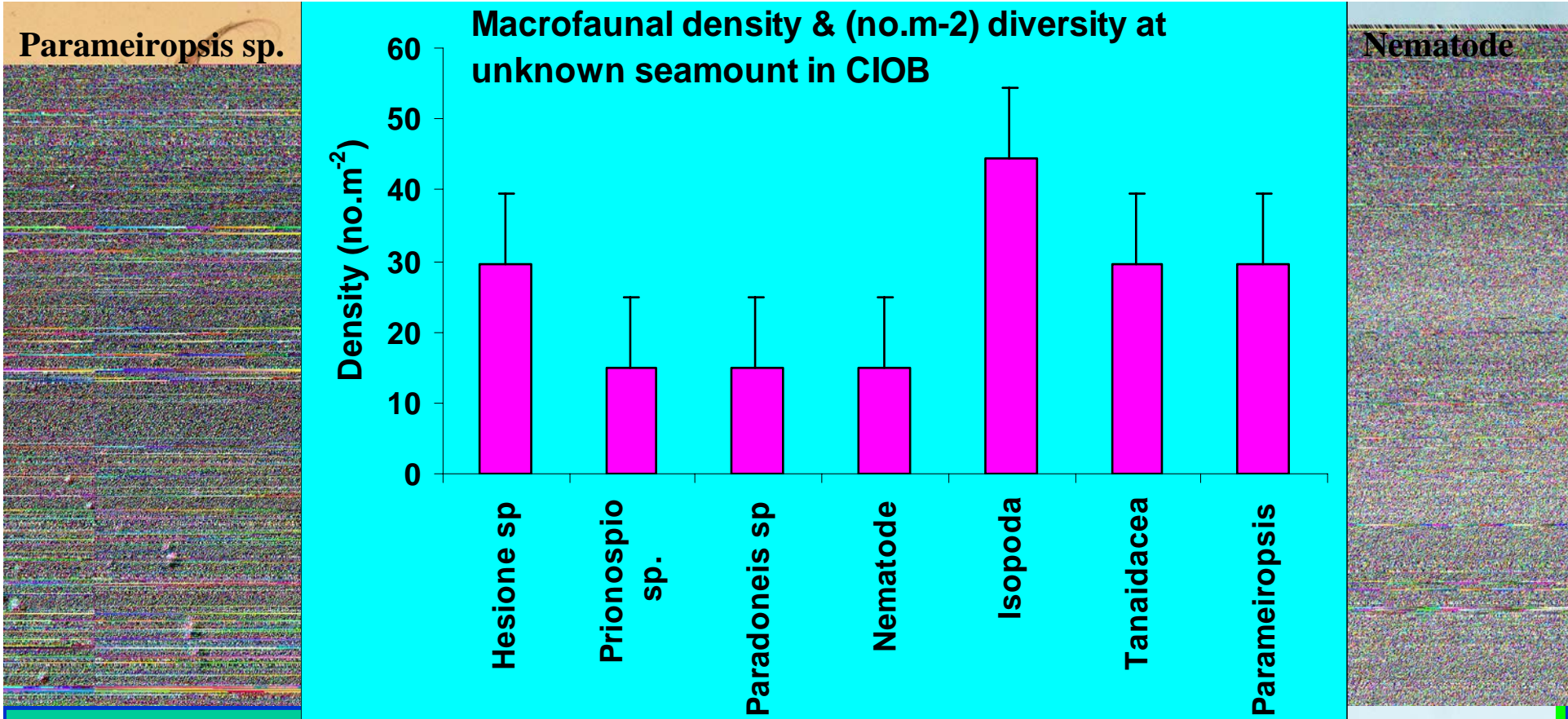


# Vertical distribution of zooplankton (ind./m<sup>2</sup>) on the region of Fred Seamount(1986)



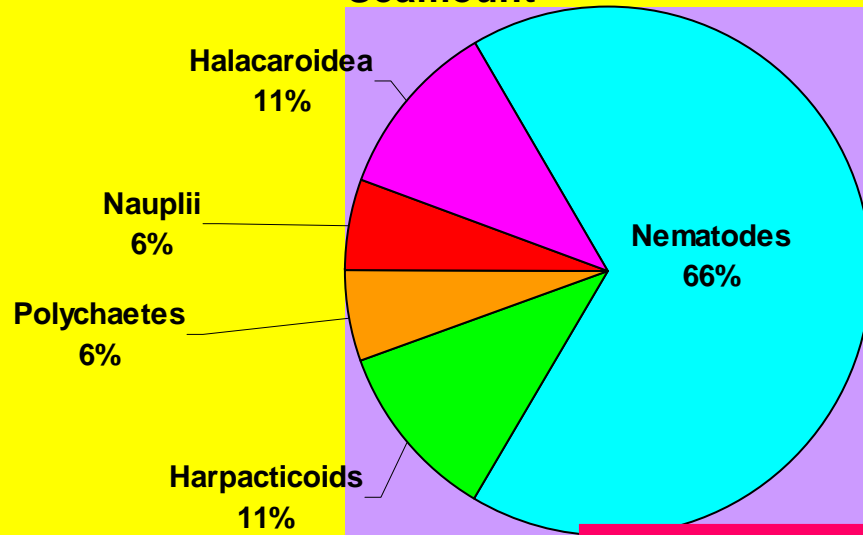
## Biological diversity of the seamount habitat in the Indian Ocean





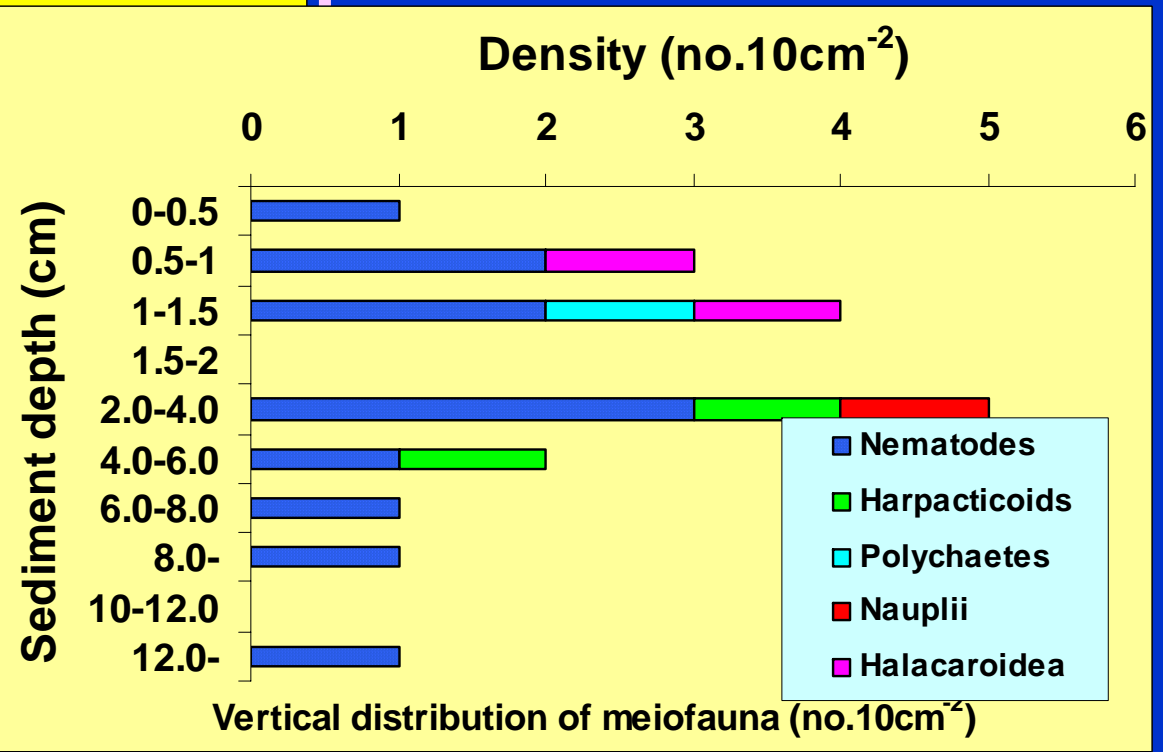


**Meiobenthic composition at CIOB Seamount**



Fauna recovered in top 12 cm although core obtained up to 25 cm sed. depths.

Nematodes dominated (66%)

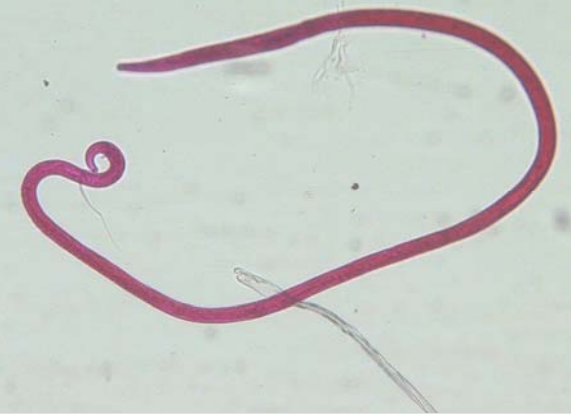




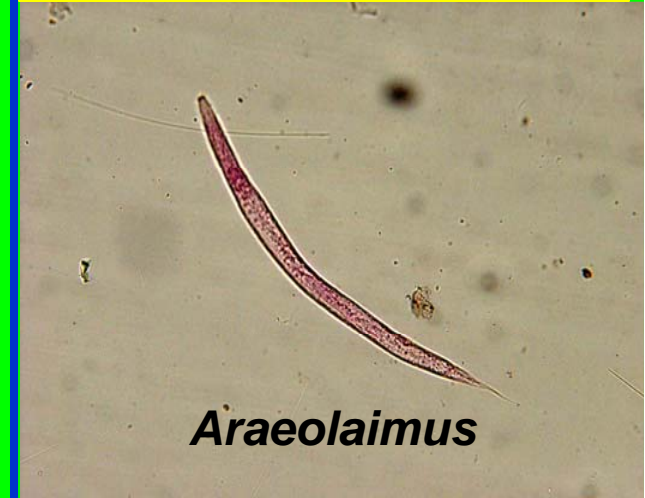
**Halalaimus**

**Nematode genera (13)  
from unknown Seamount  
in CIOB**

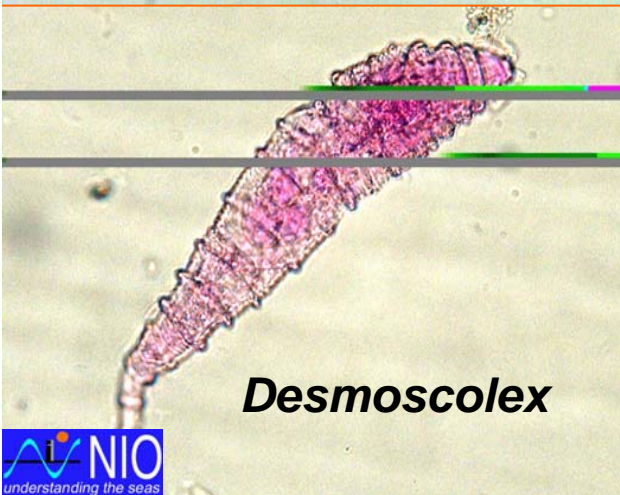
- ✓ **Halalaimus**
- ✓ **Eumorpholaimus**
- ✓ **Araeolaimus**
- ✓ **Linhystra**
- ✓ **Diplopeltula**
- ✓ **Rhabditis**
- ✓ **Paraethmolaimus**
- ✓ **Sabatieria**
- ✓ **Odentophora**
- ✓ **Axonolaimus**
- ✓ **Spiliphera**
- ✓ **Unidentified-1**
- ✓ **Unidentified-2**



**Sabatieria**



**Araeolaimus**



**Desmoscolex**



**Spiliphera**

# Selective deposit feeders 62%.

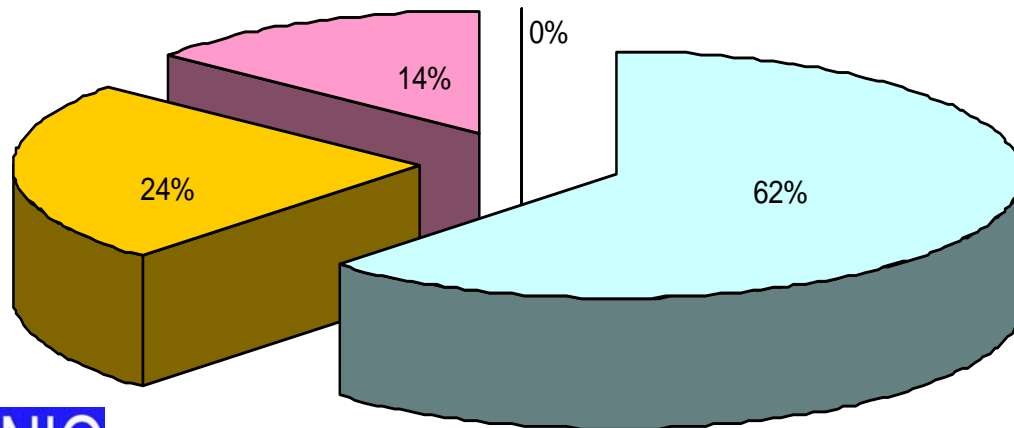
# No Predatory omnivores.

# High abundance and diversity in the 2-4cm depth.

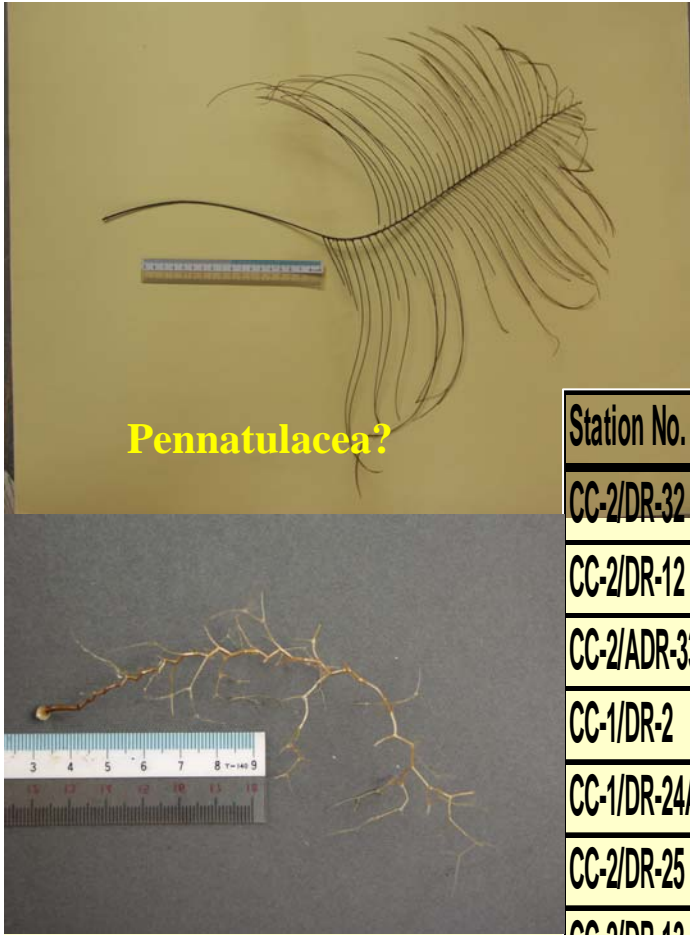
# *Rhabditis* and *Paraethmolaimus* recorded only from seamount region.



□ Selective deposit feeders      ■ Non-selective deposit feeder  
■ Epistrate feeder              □ Predatory Omnivores







Pennatulacea?

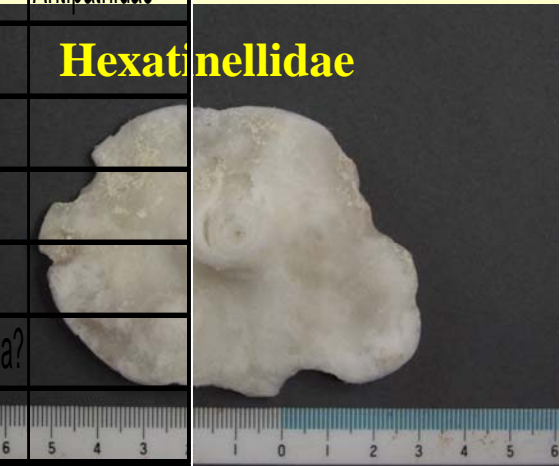


Megafauna of the Afanasiy Nikitin seamount

Station No.	Phylum	Class	Subclass	Order	Family
CC-2/DR-32	Porifera	Hexactinellida			
CC-2/DR-12	Porifera	Hexactinellida			
CC-2/ADR-33	Porifera	Hexactinellida			
CC-1/DR-2	Arthropoda	Crustacea	Cirripedia	Thoracica	Scalpellidae
CC-1/DR-24A	Cnidaria	Anthozoa	Zoantharia	Antipatharia	Antipathidae
CC-2/DR-25	Cnidaria	Anthozoa	Zoantharia	Antipatharia	Antipathidae
CC-2/DR-13	Cnidaria	Anthozoa	Zoantharia	Antipatharia	Antipathidae
CC-2/AR-11	Cnidaria	Anthozoa			Hexactinellidae
CC-1/DR-23	Echinodermata	Crinoidea			
CC-1/DR-23A	Echinodermata	Crinoidea			
CC-2/AR-11	Echinodermata	Ophiuroidea			
CC-2/AR-11	Cnidaria	Anthozoa	Octocorallia	Pennatulacea?	
CC-1/DR-2	Unidentified				



Octocorallia



Hydroid

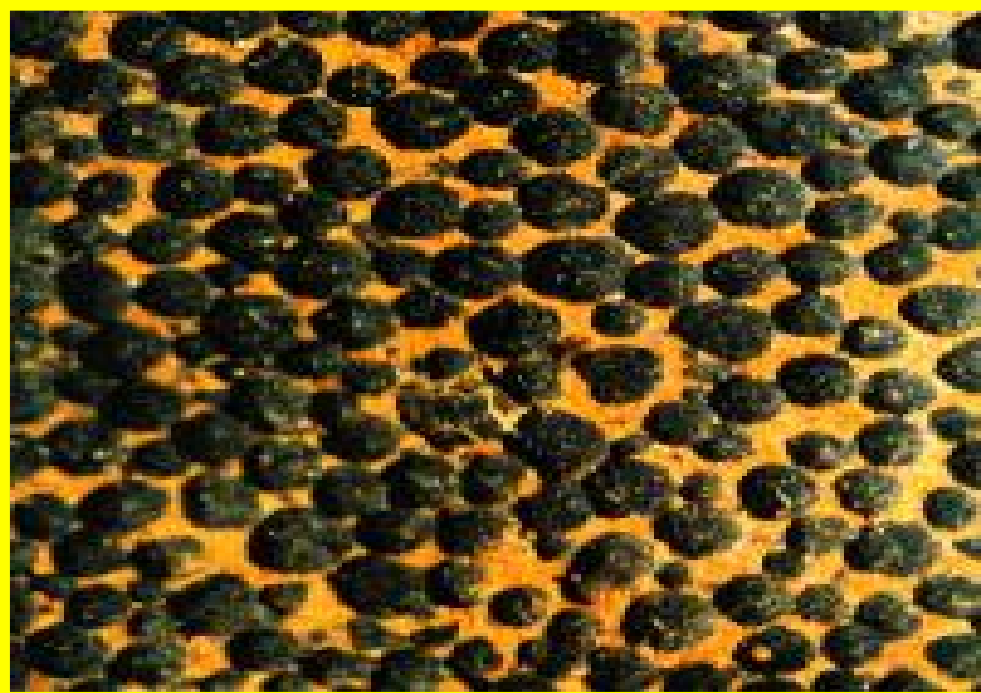
Serpent star

*Ophiura* sp.?

*Hyalonema* sp

Shrimp

# *Environmental Impact of deep-sea mining*



**Indian nodule area  
150,000 sq.km  
2700 km away**





# Objectives

- ✓ to assess the potential impact of nodule mining on marine ecosystem
- ✓ to provide scientific inputs for design and operation of deep-sea mining system

International commitment



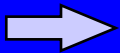
# SCHEMATIC OF SAMPLING IN DISTURBANCE AREA



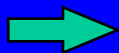
Disturbance  
area



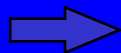
Sediment  
traps



Sediment  
cores



CTD & water  
samples



# Parameters Analysed

## Biology

- *Surface productivity*
- *Microbiology*
- *Biochemistry*
- *Meiofauna*
- *Macrofauna*
- *Megafauna*

## Physics

- *Currents*
- *Temperature*
- *Conductivity*
- *Meteorology*

## Geology

- *Seafloor features*
- *Sediment thickness*
- *Topography*
- *Sediment sizes*
- *Pore water and sediment chemistry*
- *Geotechnical props.*
- *Stratigraphy*



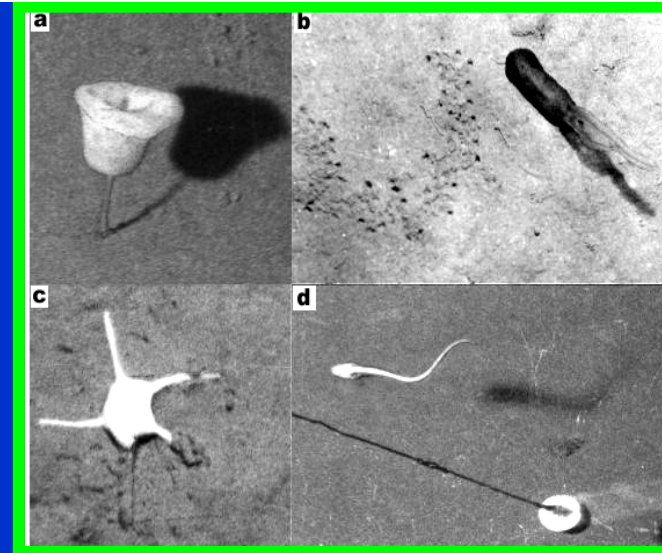
## Chemistry

- *Metals*
- *Nutrients*
- *DOC*
- *POC*



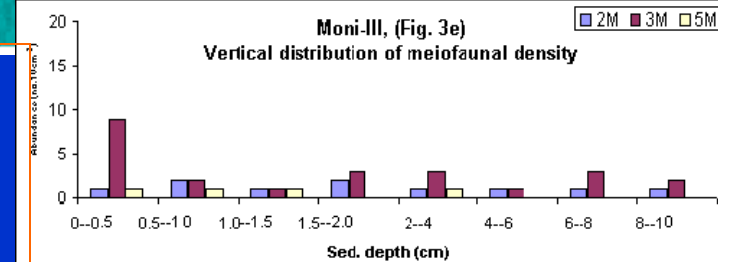
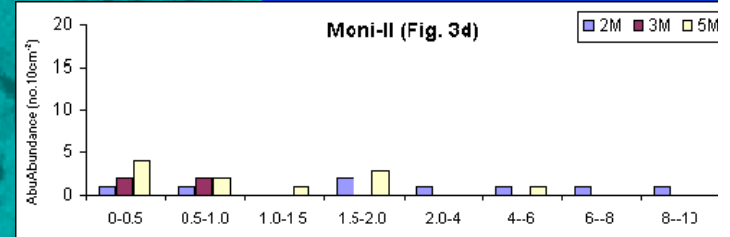
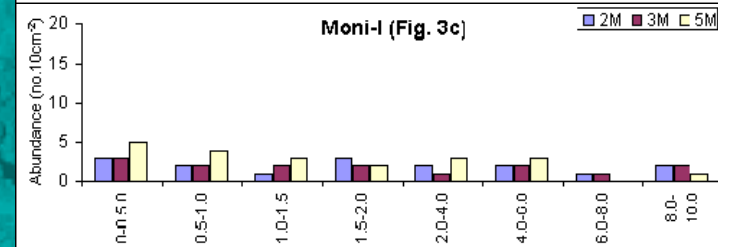
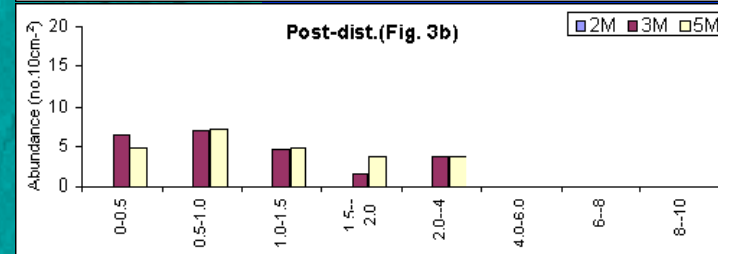
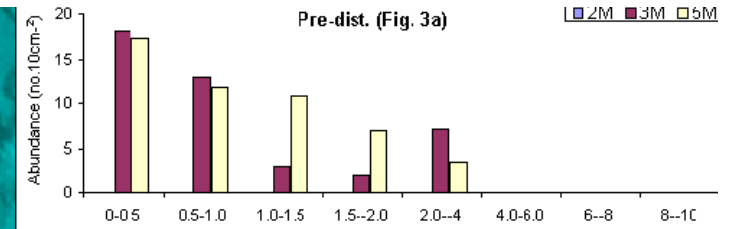
# Baseline conditions

Av. Nodule size	:	~ 4 cm
Av. abundance	:	1-5 kg/sq.m.
Sediment type	:	Clayey silt
Water content	:	High (300-600 %)
Sediment type	:	Clayey silt
Sediment flux	:	7-16 g/m <sup>2</sup> /y.
Biogeochemistry	:	Nutrient rich
Microbial biomass	:	High (10 <sup>9</sup> g <sup>-1</sup> )
Meiofauna	:	07 taxa
Macrofauna	:	11 taxa





Sledge mark of the disturber & sediment lumps on the side



	<u>Pre-dist. (Jun 97)</u>	<u>Post-dist. (Aug 97)</u>	<u>Mon-I (Apr 01)</u>	<u>Mon-II (Jun 02)</u>	<u>Mon-III (Apr 03)</u>
<b>Abund.</b> (no. 10 cm-2)	<b>46</b>	<b>23</b>	<b>11</b>	<b>6</b>	<b>11</b>
<b>Groups</b>	<b>11</b>	<b>4</b>	<b>9</b>	<b>6</b>	<b>10</b>

Some recovery seen.....natural conditions taking over



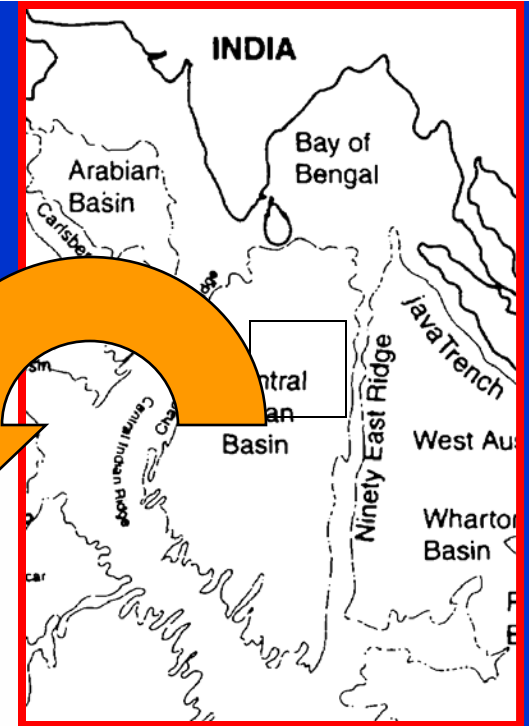
## Faint trace of disturber track with a holothurian



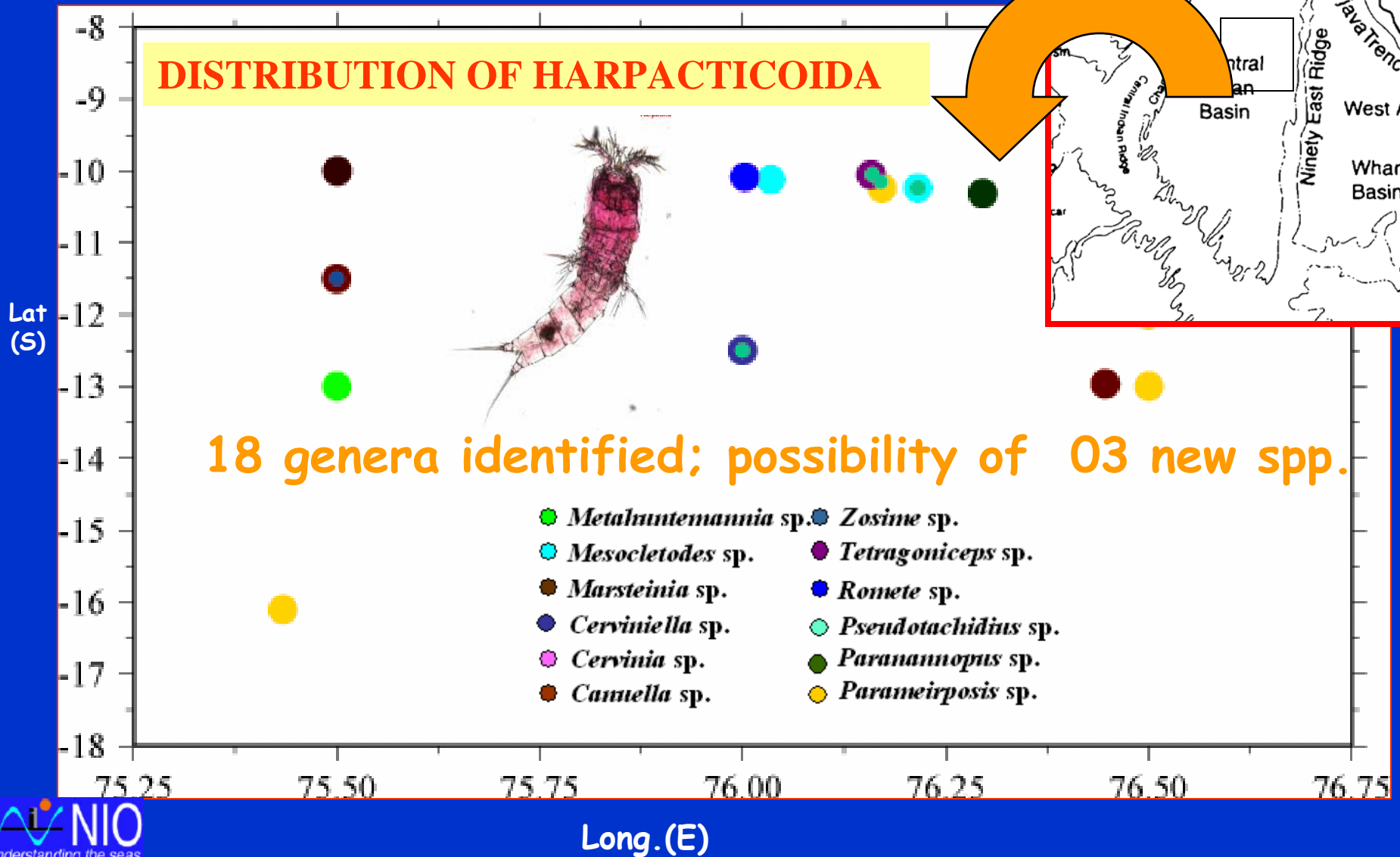
Holothurians were the major constituents of the megafauna (15 spp. during all three INDEX phases. A majority of the sea cucumber species are deposit feeders, can react rapidly to the fall of fresh phytodetritus arriving at the seafloor & may recolonize the disturbed area faster compared to other spp.



# Abyssal fauna (NEW DATA)

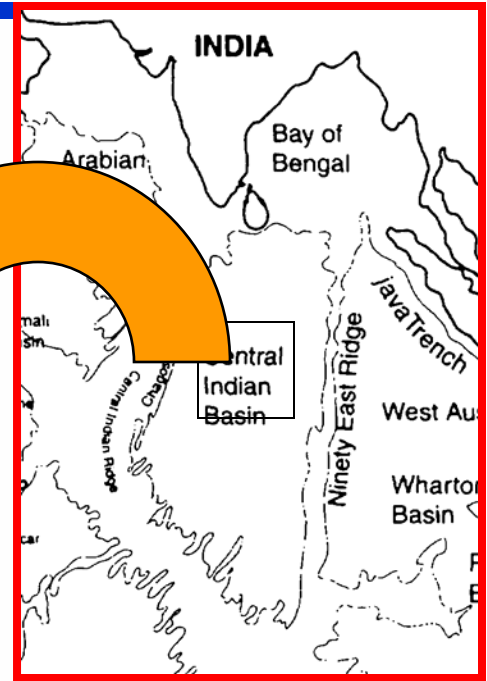
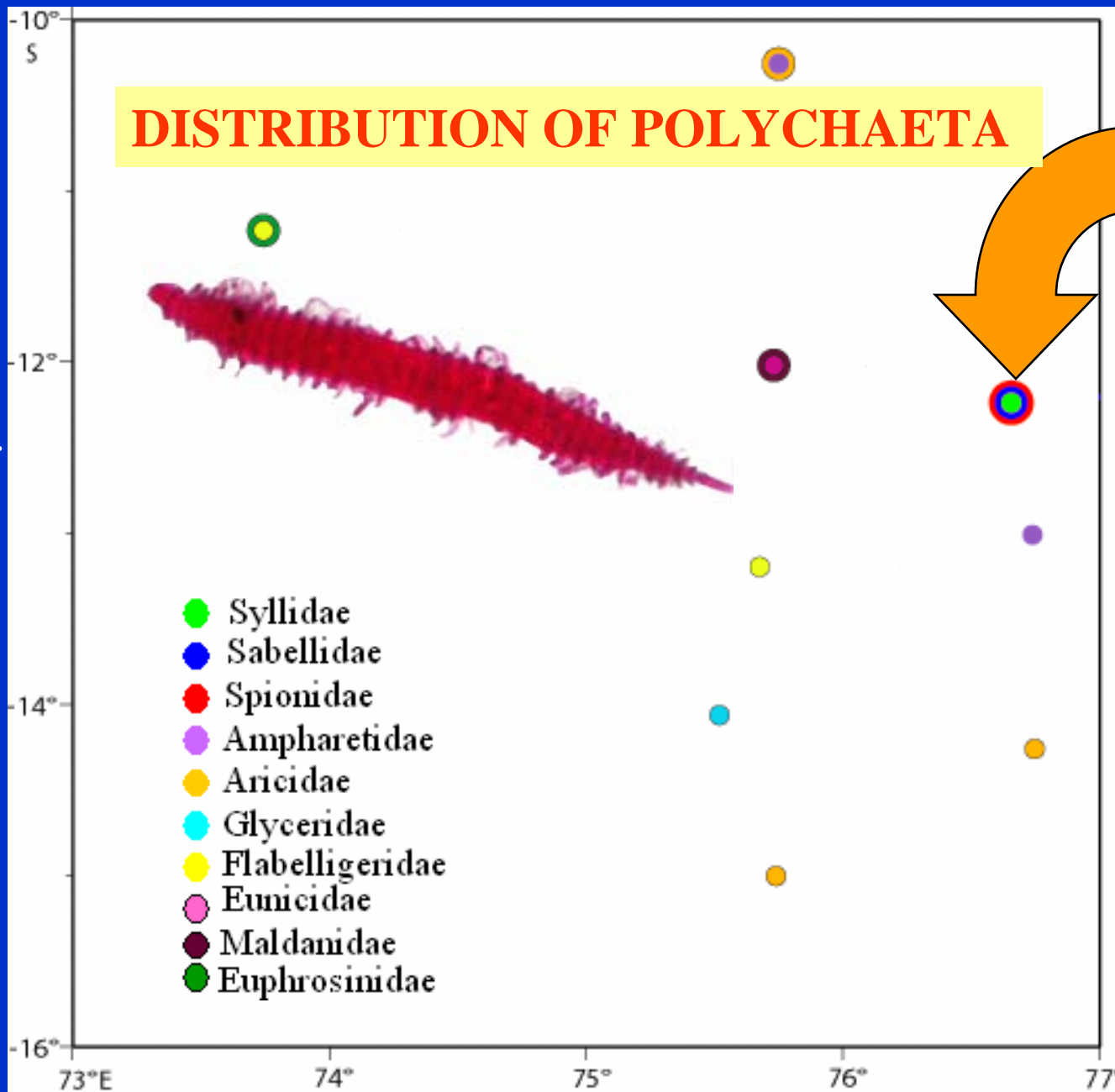


## DISTRIBUTION OF HARPACTICOIDA



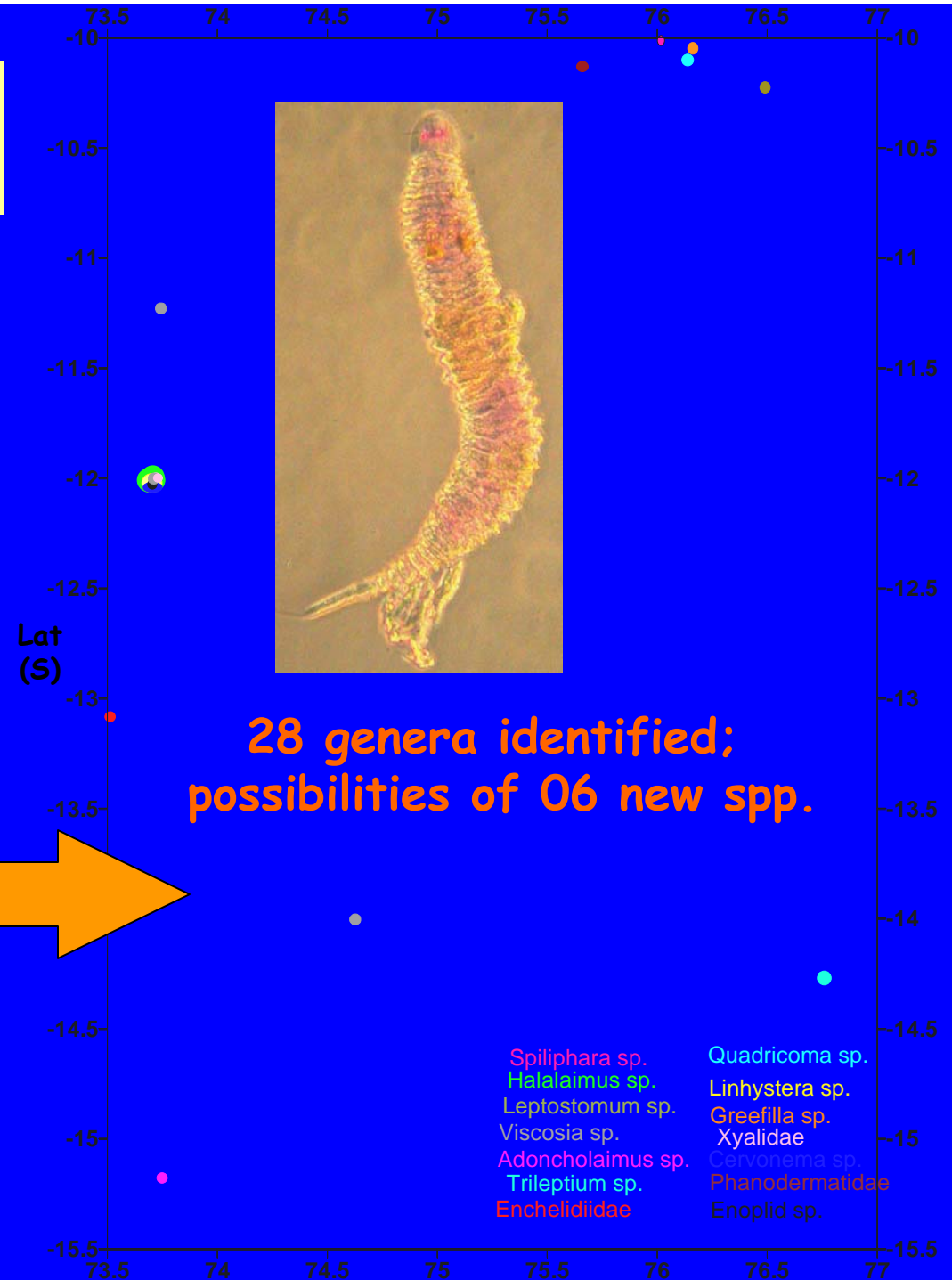
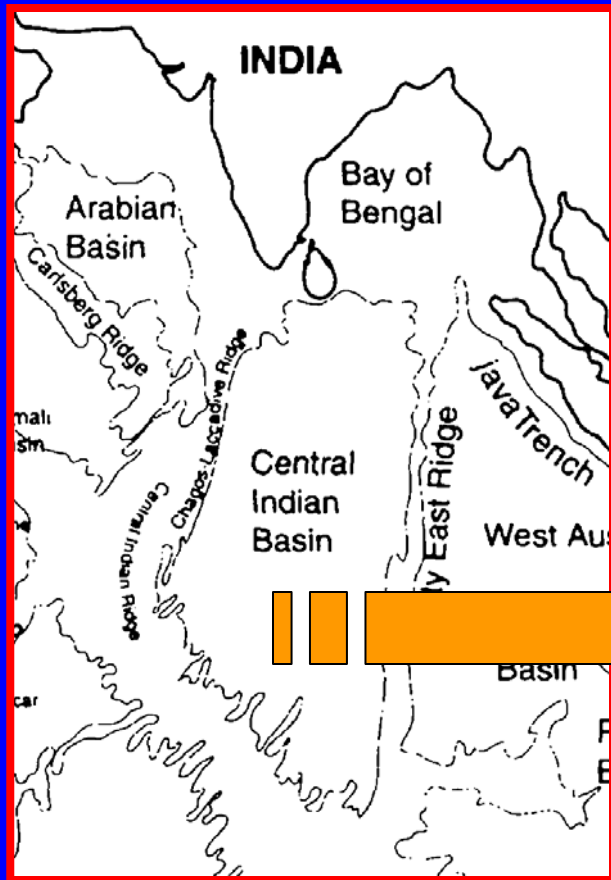
## DISTRIBUTION OF POLYCHAETA

Lat  
(S)



20 species  
belonging to  
ten families

# DISTRIBUTION OF NEMATODES IN CIOB





# Statement of environmental impact assessment

- Baseline data in proposed mining area
- Criteria for selection of test and reference sites
- Results of simulated impact experiment
- Expected environmental impact due to mining
- Parameters for monitoring impacts



## Phases and milestones of the project

Activity	Period	Remarks
• Baseline data collection	1996 - 1997	Completed
• Selection of T & R sites	1997	Completed
• Benthic Disturbance and impact assessment	1997-2001	Completed
• First monitoring studies	2001-2002	Completed
• Second monitoring studies	2002-2003	Completed
• Third monitoring	2003-2004	Completed
• Environmental variability study	2003-2005	Ongoing
• Modeling of sediment plume	2003-2006	Ongoing
• Creation of database	2002-2007	Ongoing

# Creation of environmental database

## Features

- *Interactive data retrieval and comparison*
- *Multi-disciplinary data set*

- ✓ *Water Column*
- ✓ *Benthic*
- ✓ *Photo/Video*

## Applications

- *Ecological models*
- *Mining design*

Microsoft Access - [chemw] : Table

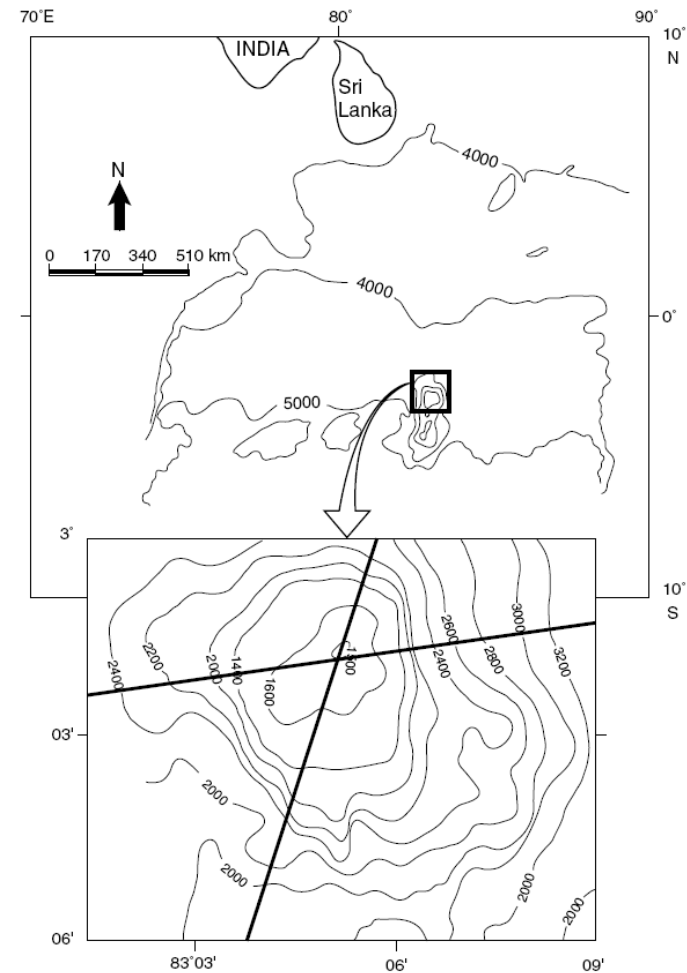
num3	sample	longitude	latitude	ship	cruise	condition	depth	ph	eh	alkal	oxygen	no2	no3	po4	sio2
1	CTD01	78.99167	-9.0015	SK	SK120	Baseline	5	8.15	0	2.632	5.03	0	0	0.03	0
2	CTD01	78.99167	-9.0015	SK	SK120	Baseline	15	8.24	0	2.265	4.82	0.06	0	0.26	1
3	CTD01	78.99167	-9.0015	SK	SK120	Baseline	25	8.07	0	2.333	4.75	0.06	0.2	0.54	1.5
4	CTD01	78.99167	-9.0015	SK	SK120	Baseline	45	7.92	0	2.36	2.8	0.34	9.6	0.87	8
5	CTD01	78.99167	-9.0015	SK	SK120	Baseline	75	7.81	0	2.382	1.67	0.05	18.2	1.25	13
6	CTD01	78.99167	-9.0015	SK	SK120	Baseline	100	7.8	0	2.381	1.55	0	19.9	1.14	18
7	CTD01	78.99167	-9.0015	SK	SK120	Baseline	143	7.71	0	2.379	1.44	0	21.9	1.98	22
8	CTD01	78.99167	-9.0015	SK	SK120	Baseline	200	7.7	0	2.393	1.64	0	23.6	1.86	27
9	CTD01	78.99167	-9.0015	SK	SK120	Baseline	300	7.72	0	2.402	2.35	0	22.5	1.84	22
10	CTD01	78.99167	-9.0015	SK	SK120	Baseline	500	7.65	0	2.565	2.38	0	26.6	1.88	34
11	CTD01	78.99167	-9.0015	SK	SK120	Baseline	600	7.64	0	2.373	2.09	0	29.6	3.04	47
12	CTD01	78.99167	-9.0015	SK	SK120	Baseline	1000	7.61	0	2.449	2.15	0	32.7	3.19	91
13	CTD01	78.99167	-9.0015	SK	SK120	Baseline	1500	7.65	0	2.591	2.96	0	32.4	3.21	101
14	CTD01	78.99167	-9.0015	SK	SK120	Baseline	2000	7.67	0	2.505	2.92	0	32.6	3.05	106
15	CTD01	78.99167	-9.0015	SK	SK120	Baseline	2500	7.63	0	2.452	2.81	0	32.7	2.81	108
16	CTD01	78.99167	-9.0015	SK	SK120	Baseline	5229	7.67	0	2.447	3.67	0	30.3	2.49	101
17	CTD03	78.975	-10.99167	SK	SK120	Baseline	3	8.19	0	2.476	5.04	0	0	0	0
18	CTD03	78.975	-10.99167	SK	SK120	Baseline	25	8.19	0	2.321	5.1	0	0	0	0
19	CTD03	78.975	-10.99167	SK	SK120	Baseline	50	8.15	0	2.293	4.68	0	0	0.1	0.5
20	CTD03	78.975	-10.99167	SK	SK120	Baseline	75	8.02	0	2.295	2.91	0.1	5.1	0.42	7
21	CTD03	78.975	-10.99167	SK	SK120	Baseline	100	7.96	0	2.326	2.81	0.06	9.3	0.64	11
22	CTD03	78.975	-10.99167	SK	SK120	Baseline	140	7.88	0	2.437	2.26	0.81	12.6	0.91	9
23	CTD03	78.975	-10.99167	SK	SK120	Baseline	220	7.78	0	2.362	2.35	0	19.9	1.2	26
24	CTD03	78.975	-10.99167	SK	SK120	Baseline	300	7.73	0	2.373	1.85	0	23.2	1.43	27
25	CTD03	78.975	-10.99167	SK	SK120	Baseline	400	7.7	0	2.376	2.27	0	24.4	1.37	25
26	CTD03	78.975	-10.99167	SK	SK120	Baseline	500	7.69	0	2.37	2.53	0	26.1	1.68	29
27	CTD03	78.975	-10.99167	SK	SK120	Baseline	800	7.61	0	2.412	1.97	0	36.6	2.48	67
28	CTD03	78.975	-10.99167	SK	SK120	Baseline	1000	7.61	0	2.464	2.1	0	37.3	2.16	83
29	CTD03	78.975	-10.99167	SK	SK120	Baseline	1500	7.62	0	2.461	2.47	0	38.1	2.39	101
30	CTD03	78.975	-10.99167	SK	SK120	Baseline	2000	7.66	0	2.461	3.34	0	36.6	2.5	108
31	CTD03	78.975	-10.99167	SK	SK120	Baseline	3000	7.7	0	2.483	4.28	0	34.6	2.45	121
32	CTD03	78.975	-10.99167	SK	SK120	Baseline	5000	7.7	0	2.487	4.22	0	34.4	1.95	119
33	CTD05	79.16167	-12.94833	SK	SK120	Baseline	3	8.21	0	2.174	5.23	0	0	0.04	0
34	CTD05	79.16167	-12.94833	SK	SK120	Baseline	10	8.2	0	2.273	5.13	0	0	0.07	0

Record: 1 of 502  
Datasheet View



# Proposed seamount study

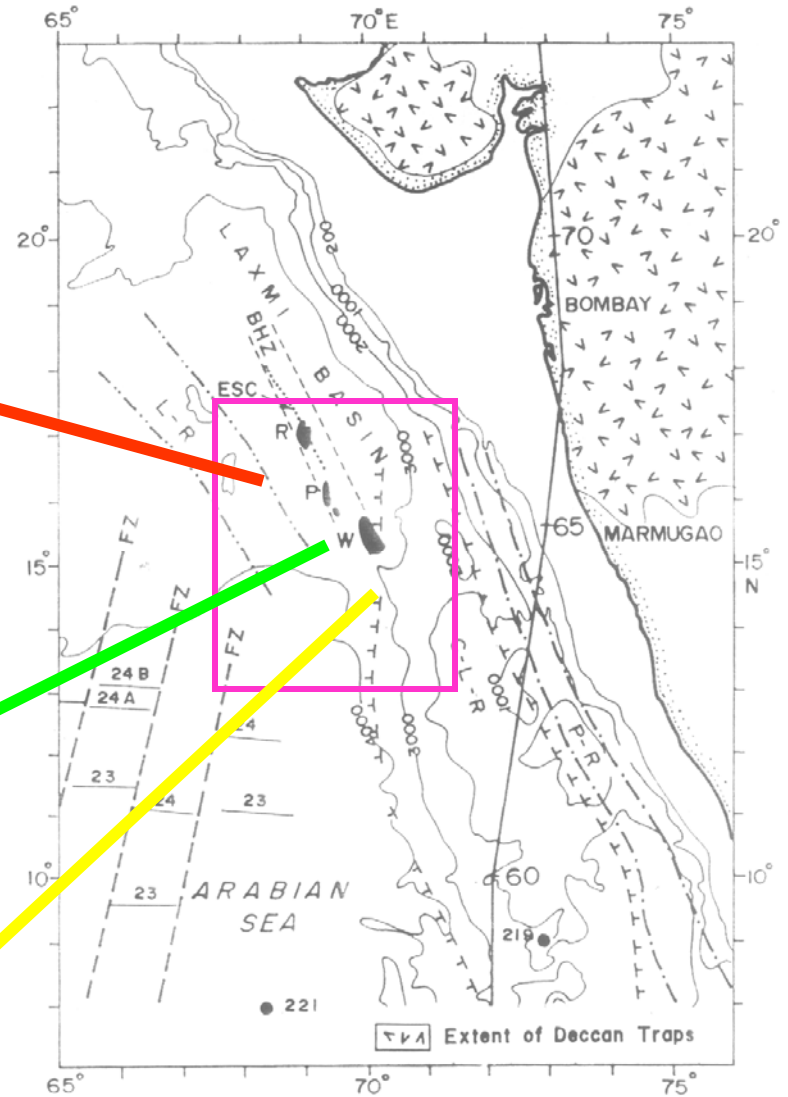
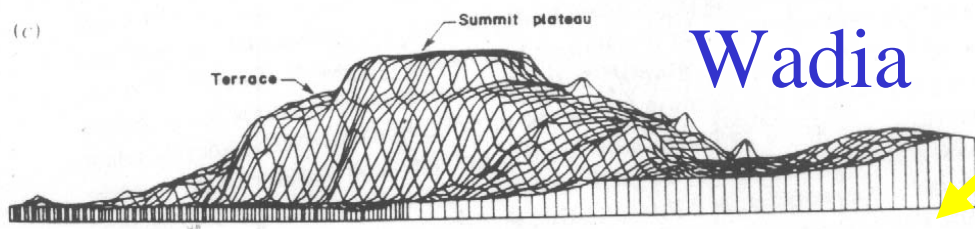
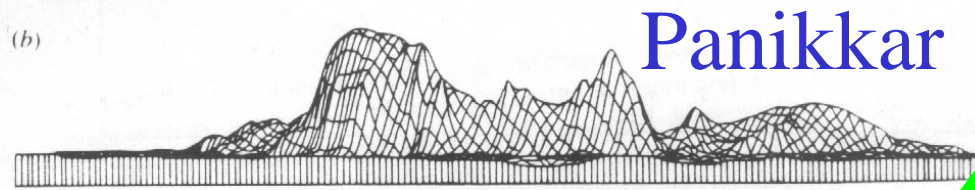
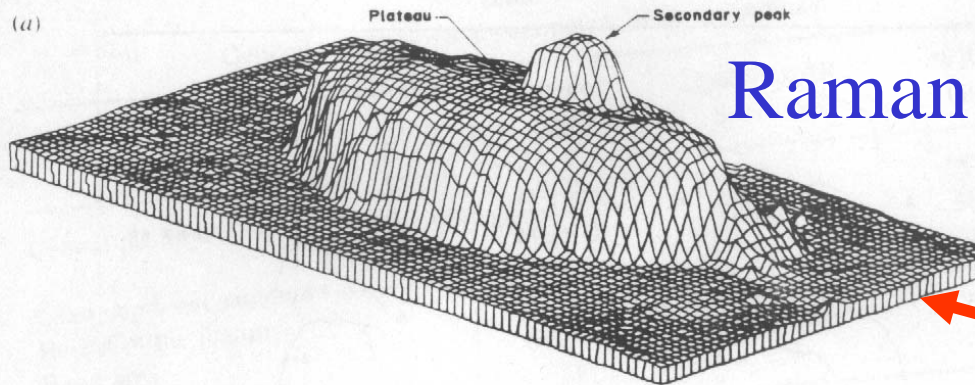
Based on the detailed bathymetry, geology and geomorphology of some of the seamounts in the equatorial Indian Ocean & CIOB region as well as Arabian Sea, a multidisciplinary oceanographic survey have been proposed by NIO Goa for aiming at four EEZ (Raman, Panikkar, Wadia & Sagarkanya); few open ocean (such as Afanasiy Nikitin) seamounts in the Indian Ocean



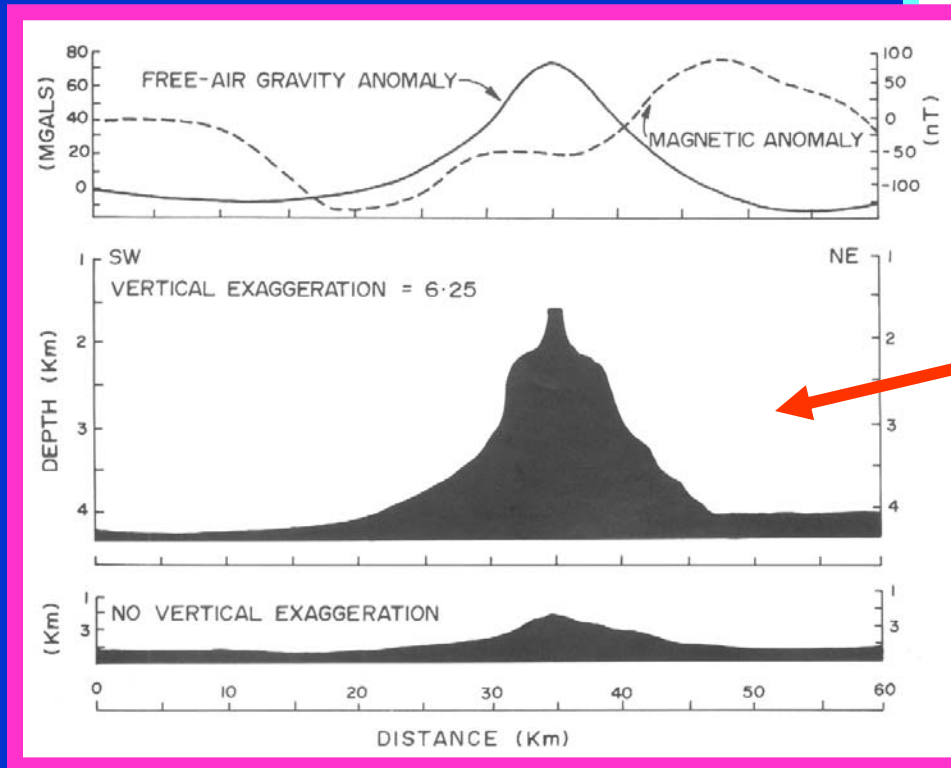
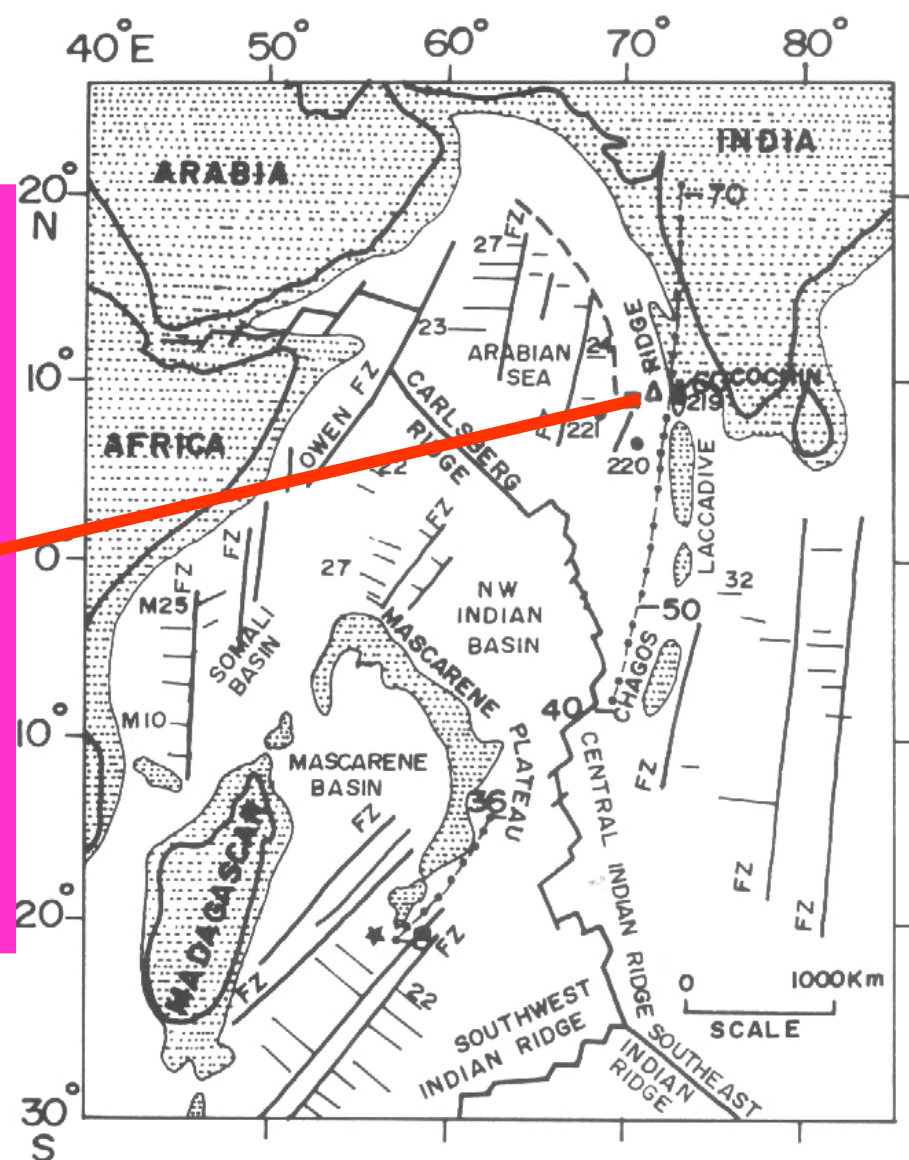
Location of the Afanasiy-Nikitin Seamount in the Equatorial Indian Ocean. The open square in

# Seamounts in the Arabian Sea

Swath Bathymetry of Seamounts in the Arabian Sea



The Deep Sea Drilling Project sites are located in the vicinity



# Sagarkanya seamount

Some of us present here are working for a joint proposal for Indian Ocean seamount study





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