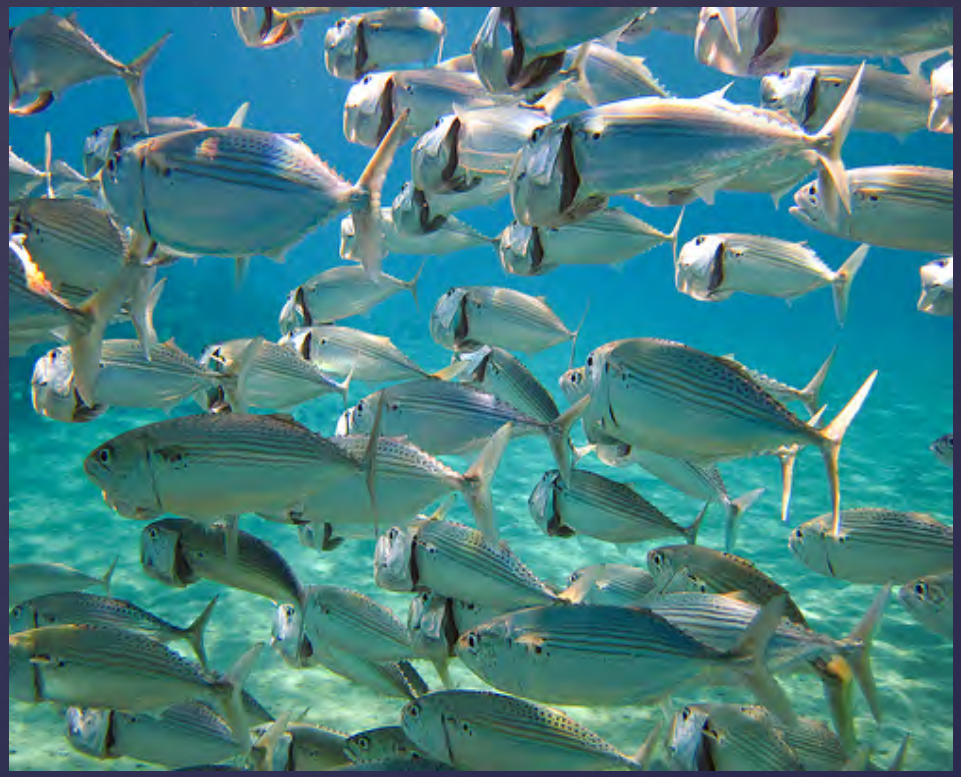
# Factors for the fluctuations in Oil Sardine and Mackerel fishery - South West coast of India : perspectives of fishery scientist and fishermen

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# Study Area


Dubái
دبي
Karachi
کراچی
Lucknow
ASSAM
NAGALAND
BIHAR
MEGALAYA
MANIPUR
Mascate
مسقط
Emiratos Árabes Unidos
Bangladesh
MADHYA PRADESH
JHARKHAND
TRIPURA
GUYARAT
Ahmedabad
India
BENGALA OCCIDENTAL
MIZORÁN
CHHATTISGARH
Surat
Myanmar (Birmania)
Omán
ORISSA
Chiang Mai
เชียงใหม่
MAHARASTRA
Naipyidó
Mumbai
TELANGANA
Hyderabad
GOA
KARNATAKA
ANDHRA PRADESH
Golfo de Bengala
Bangalore
Chennai
Mar Arábigo
Mysuru
TAMIL NADU
Cochin
KERALA
Sri Lanka
Mar de Laquedivas
Colombo
ACEH
Medan

# Introduction

Worldwide the fishery sector has been approached on a commercial line by big companies rather than forming a livelihood for fishermen. Of late the fishery has been under severe stress due to overfishing and over exploitation. Except for the fishing community nobody is concerned over sustainable and long-lasting fishing. In recent decades, major fishery has declined globally and government and policymakers are now concerned about the depleting living resources. Fishery oriented nations started adopting mitigation measures so that this gift of nature is not depleted and is conserved for coming generations.

This paper evaluates current trends in small pelagic along the coast of Kerala, southwest coast of India in relation to the factors driving the fishery from the studies of scientists on physical and biological environment . The fishery data is approached from the perspectives of fishery scientists, policy makers and traditional fishing community**.**

Climate change is a growing concern across the globe due to its multidimensional impact on the environment and humans. Many fisheries have declined Worldwide due to heavy fishing pressures. Kripa et.al 2015 and Manjusha, et.al 2013 discussed various factors for the vagaries during past 3 decades for the major pelagic fishes (oil sardine , mackerel and whitebait) and pointed out that sea water warming is advantageous for oil sardine extending its distribution northwards and eastwards.

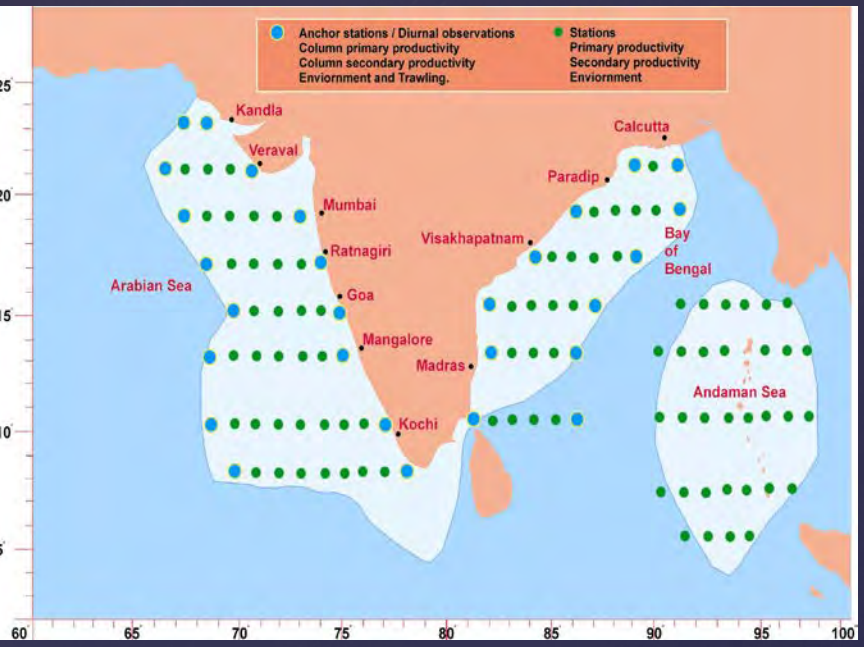
# Material and methods

The Oceanographic and Biological properties were taken from the studies of the collections taken during the multidisciplinary investigations on the Project Marine living resources of the Exclusive Economic Zone (EEZ) of India. The Phytoplankton and Zooplankton data presented here is from the studies of the author and colleagues of the National Institute of Oceanography, India (Stephen, 2010). The fishery data was obtained from the reports of Central Marine Research Institute (cmfri), India. Policies of Kerala Govt. in fishery sector is also incorporated. Frequent interaction with the fishermen also contributed to the interpretations.

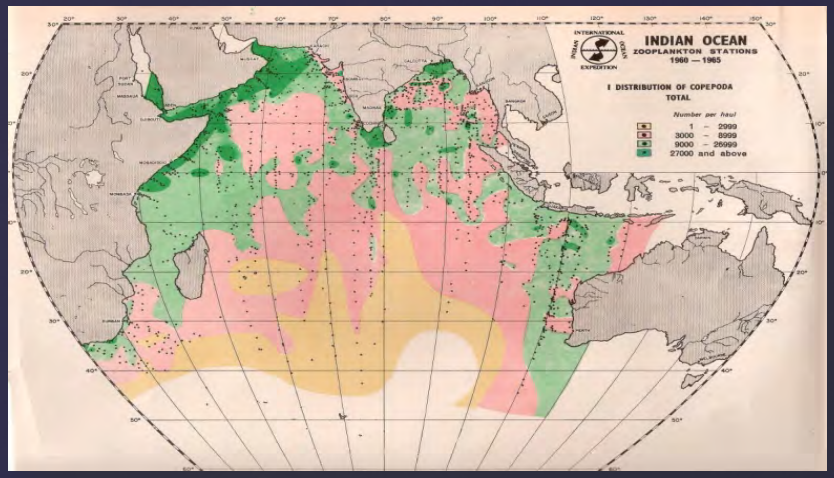
Kerala state with 3600sqKm of EEZ has 222 marine fishing villages. The number of craft operating are 19,173, of which 7 % are mechanized, 44 % Motorized, and 49% are non motorized.

Of late, Govt is taking several steps for increasing production and ensuring sustainable exploitation, the most important is the **47 day trawling ban from June 15$^{th}$ to July 31$^{st}$ every year**. During this period, Mechanised trawlers suspend operations in the 12 nautical mile region of the EEZ. This seasonal fishing holiday was introduced in 1988 to protect the commercially important fish species during their spawning season to facilitate replenishment of stocks and effective management of fishery resources.

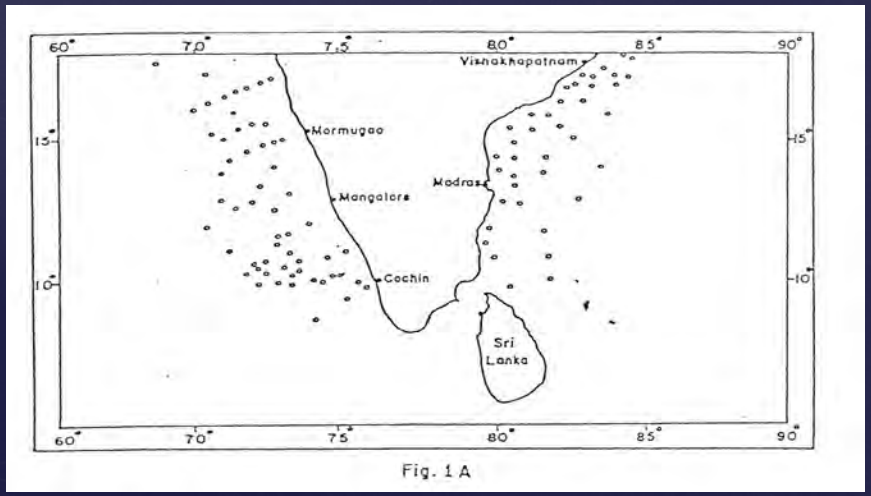
## Stations covered during MR-LR (1998-2010)



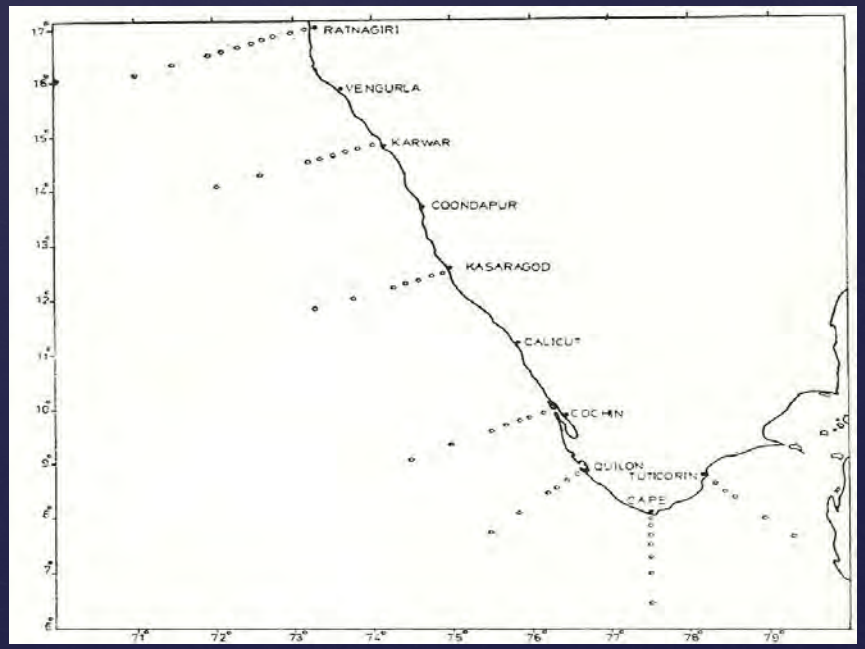

## International Indian Ocean Expedition (IIOE) zooplankton stations – Distribution Copepoda



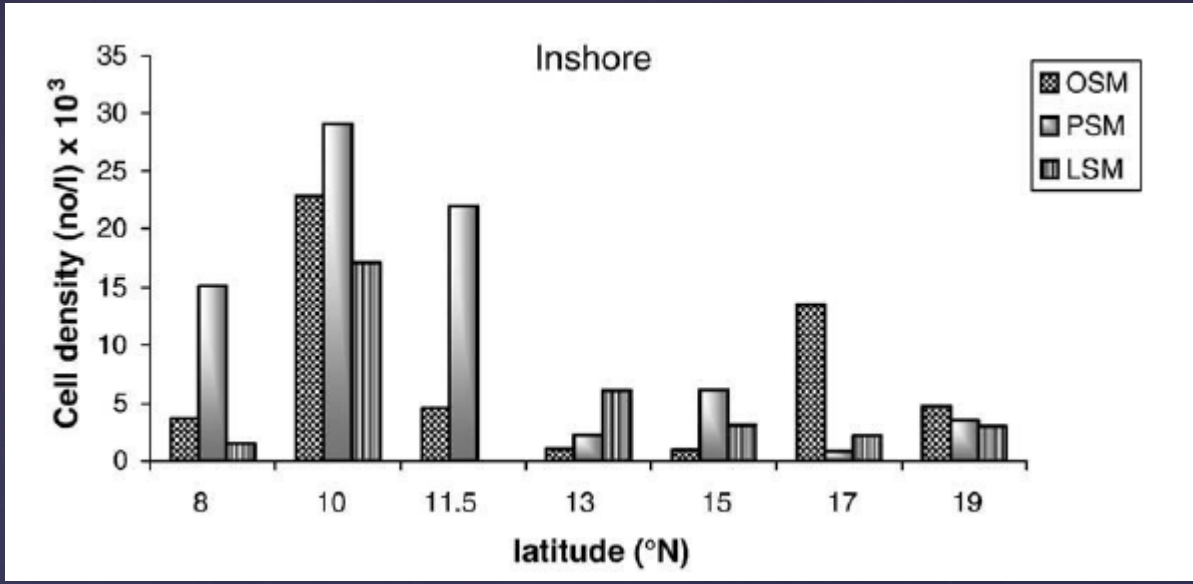

## Zooplankton stations covered during 1980's




## Zooplankton stations covered during 1970's (UNDP/FAO – Pelagic Fishery Project)



**Latitudinal distribution of phytoplankton cell density (no./l)×103 during onset (OSM), peak (PSM) and late (LSM) summer monsoon.**




Trichodesmium erythraeum (blue green algae) was the dominant species at all the stations. The highest cell density
(22.8 ×103cells/L) in the surface waters of the inshore stations was recorded at 10°N (off Kochi).

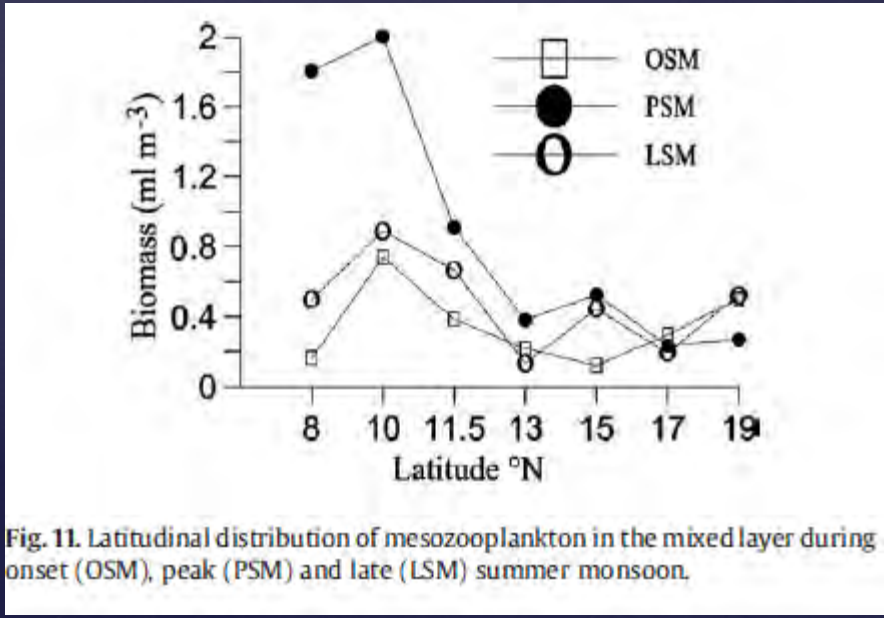
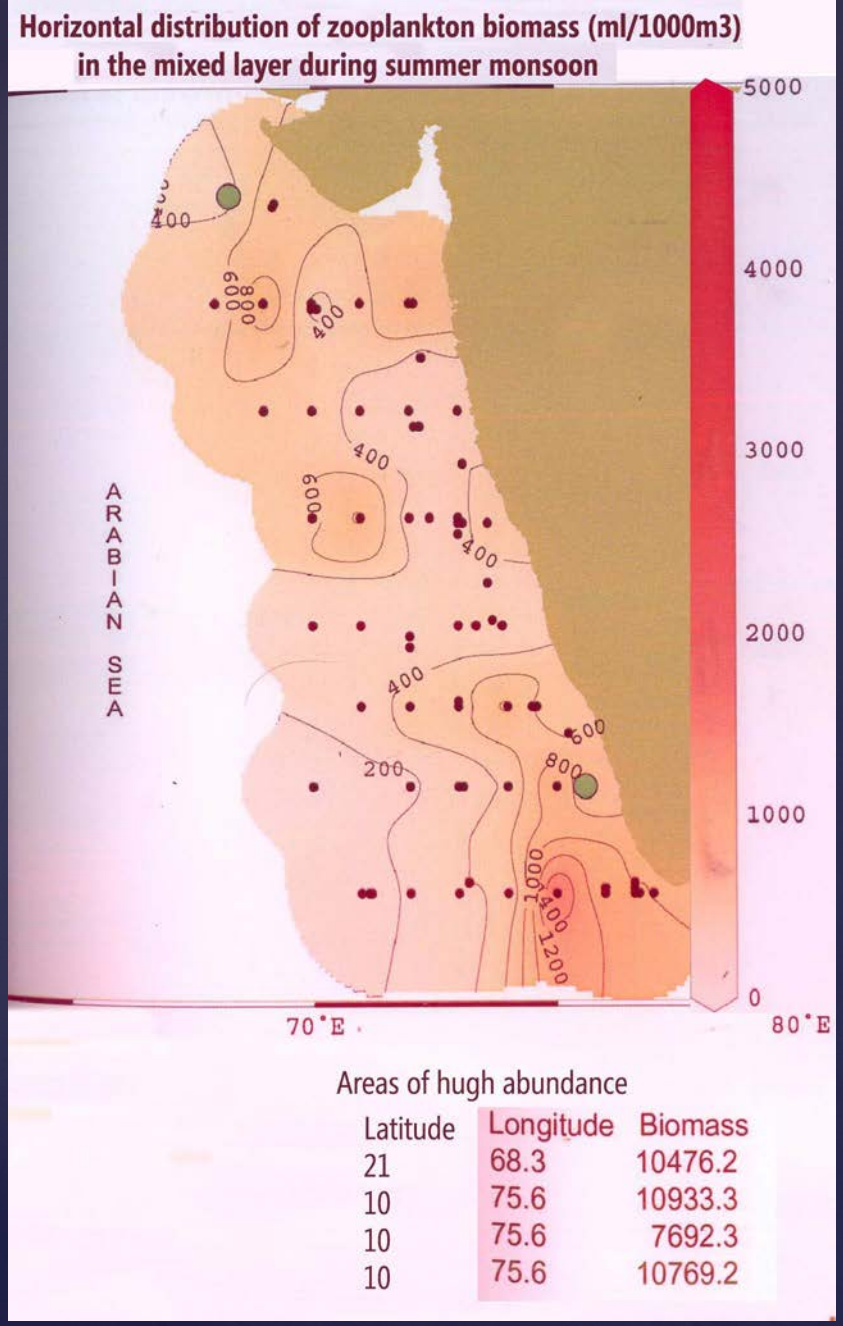



Fig. 11. Latitudinal distribution of mesozooplankton in the mixed layer during onset (OSM), peak (PSM) and late (LSM) summer monsoon.

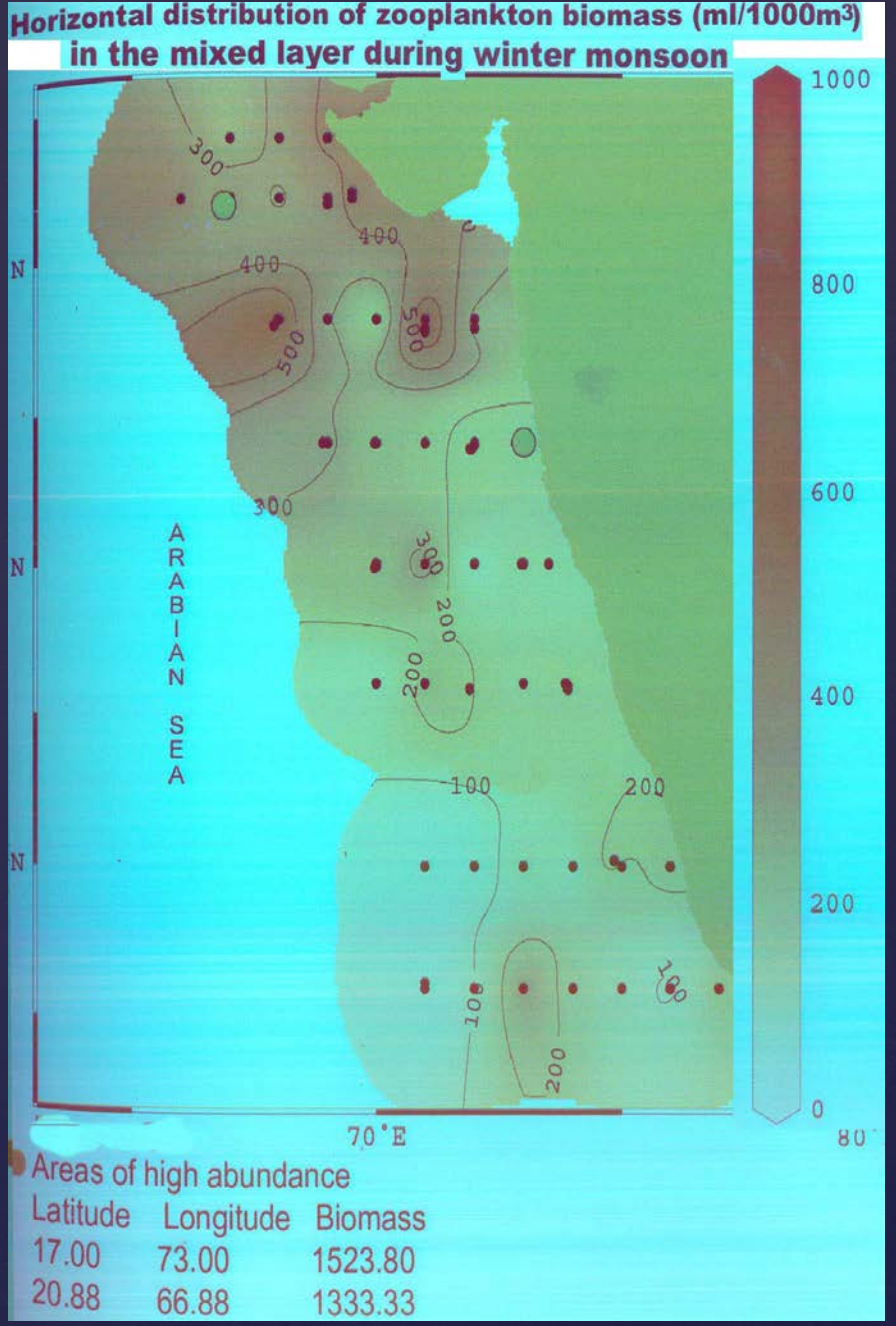
During OSM, the mesozooplankton biomass in the mixed layer ranged between 0.04 to 0.95 ml m− 3. In the inshore stations, the range was from 0.12 to 0.74 mlm− 3, while on the offshore stations it varied from0.11 to 0.22 ml m− 3. The meso zooplankton biomass in the mixed layer was high at 8°N and 10°N transects.

Habeeb Rahman et. al 2010




Areas of hugh abundance

| Latitude | Longitude | Biomass |
|---|---|---|
| 21 | 68.3 | 10476.2 |
| 10 | 75.6 | 10933.3 |
| 10 | 75.6 | 7692.3 |
| 10 | 75.6 | 10769.2 |

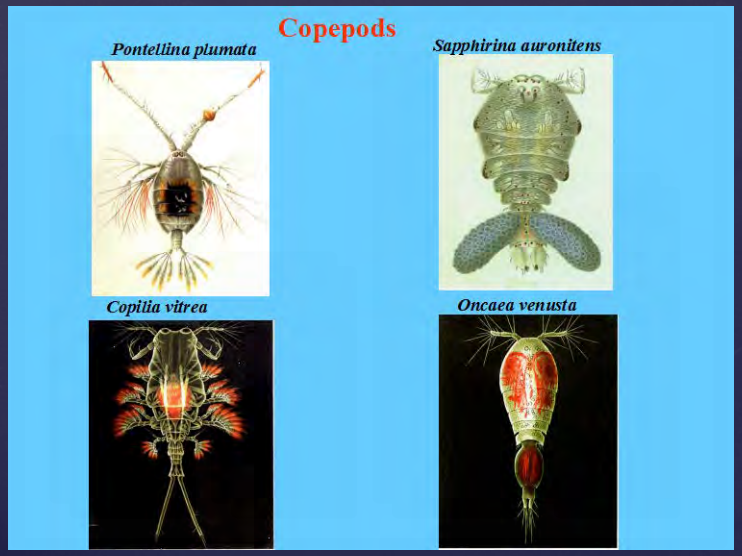



Areas of high abundance

| Latitude | Longitude | Biomass |
|---|---|---|
| 17.00 | 73.00 | 1523.80 |
| 20.88 | 66.88 | 1333.33 |

**Coastal areas from 9.00° North to 12° North presented rich zooplankton biomass during 1998-2010**

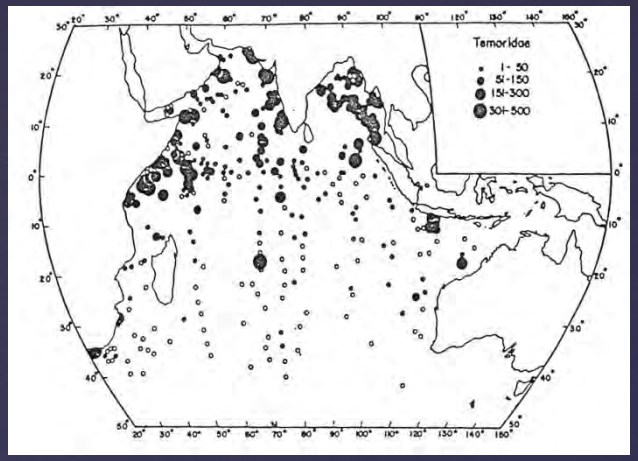
## *T. turbinata* an example of change in community



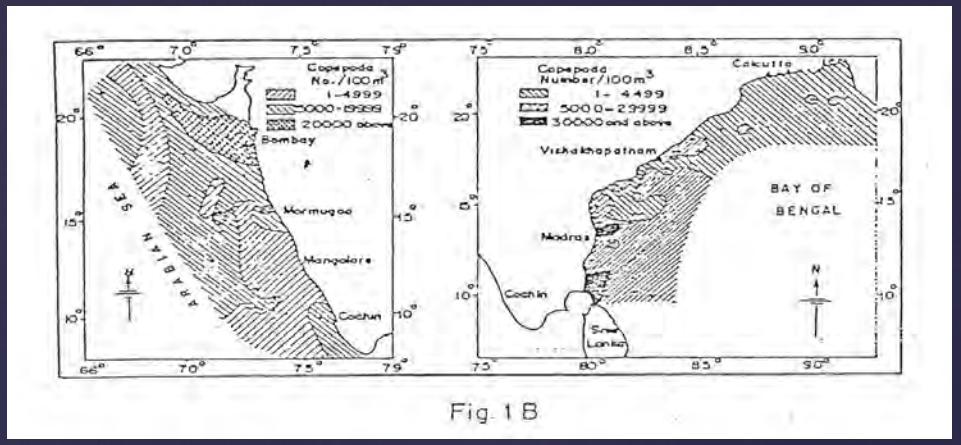

The south west monsoon is the most important metrological phenomenon that plays key role in the prosperity of west coast. Usually mackerels become abundant after the summer monsoon . With the onset of monsoon large scale upwelling is established in the shelf and slope wares. This is followed by biological production sequence which is repeated every year.

With the enrichment of nutrients phytoplankton blooms get established along the coastal waters. This is followed by an up surging of zooplankton especially copepods. The routine observations for the past 4 decades of copepods revealed a drastic decline in copepod *Temora turbinata*. This has prompted me to look into the associated features.

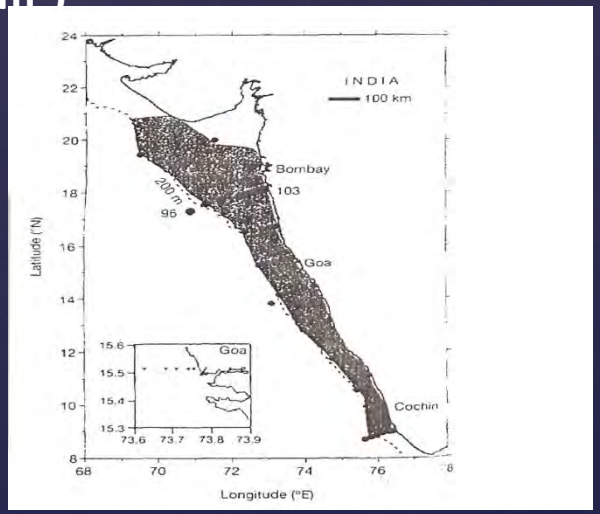
The number of *Temora* population was found decreasing in the period 1998-2010




**Distribution of *T. turbinata* – IIOE collections (600-1000/100m$^3$)**



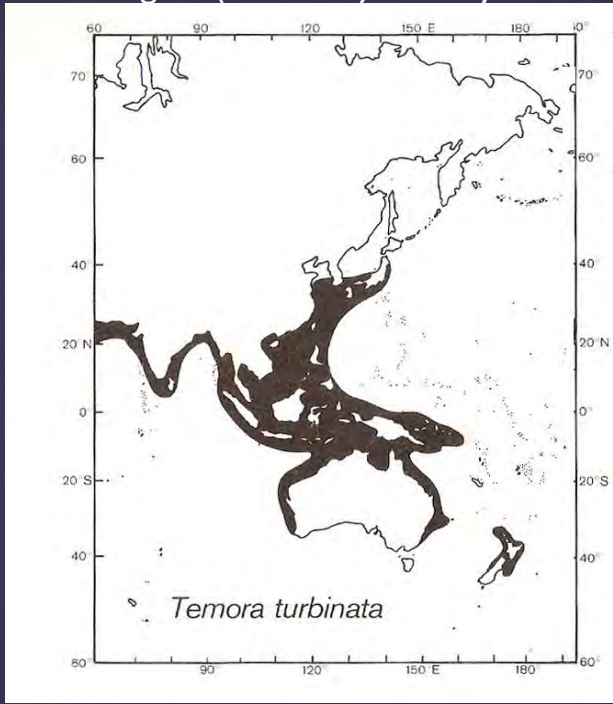

**High density areas of swarms of *T. turbinata* Indian coastal waters (5000-20000/100m$^3$)**




**Zone of severe hypoxia SWM 1999 (Naqvi et al., 2000)**

*T. turbinata* density 20-160/100m$^3$ in 1998-2010 samples whereas during 1970-80 the density was 5000-2000/ 100m3

Distribution of *T. turbinata* in coastal waters Indo West Pacific region (Bradford, 1977)




- The map shows the distribution in coastal waters. This forms a major food for pelagic fishes like mackerels.

- *T. turbinata* has been recognized as an opportunistic herbivorous species following pulses of diatom blooms reported by me and others. Swarms are observed in recently upwelled waters. This is followed by abundance of carnivores mainly *Euchaeta* spp. and *Candacia* spp.

In fading phase small carnivores – *Oithona* and *Oncaea* dominate. Smaller herbivores – Paracalanidae, and larger Eucalanidae supplement.

The study of copepods during 1998 to 2005 showed a glaring decrease in the abundance of the species during SW monsoon. This sweeping change persisted throughout the period of study.

This can be a milestone in realizing the alteration of calanoid community in coastal environments. Since these samples are from different strata (0-1000m) existence of diapause in the species is ruled out. In another updwelling copepod *Calanoides carinatus* exhibits diapause and sink to deeper layers after upwelling subsides off Oman. Whether there is lateral movement into inshore waters is yet to be proved. A “regime shift” in geographical distribution cannot be ruled out. As the map shows the species is abundant in the coastal waters it constitute main food for pelagic fishes.

# ZOOPLANKTON ESPECIALLY COPEPOD SPECIES CAN ACT AS SENTINELS TO THE MARINE BIOGEOCHEMICAL CYCLES

A northward shift and re-orientation in tropical copepods due to climate change and global warming are reported from Atlantic and Pacific

Long experience with copepods of Indian Ocean shows significant changes in the community structure of copepods in active upwelling coastal waters

The study of copepods during 1998 to 2005 showed a drastic decrease in the abundance of the species during SW monsoon. This sweeping change persisted throughout the period of study. This can be a milestone in realizing the alteration of calanoid community in coastal environments. Since these samples are from different strata (0-1000m) existence of diapause in the species is ruled out unlike *Calanoides carinatus* which sink to deeper layers after upwelling off Oman. Whether there is lateral movement into inshore waters is yet to be proved. A “regime shift” in geographical distribution can be expected.

The **main drivers** of fishery in coastal waters are the following;

# MUD BANKS OF KERALA


- A unique phenomenon in the littoral zones of Kerala, Southwest India
- Occur during the roughest summer monsoon, as a calm pool like area towards the coast where the outer periphery turbulent with strong winds and high waves

- This happens when the fishermen don't dare to go fishing due to severe roughness of the sea.

- From time immemorial **mud banks** appear intermittently 5 m to 10 kms long and several meters wide.

- This area is like a sheet with black muddy waters full of biological life and supporting rich fishery of oil sardines, Mackerel, lesser sardine, thread fins and at times lots and lots of prawns for a short period of a week.

- Fishermen go out in the calm waters and return with bountiful catch during the lean months of heavy monsoon. The news spreads like wild fire and immediately transforms the entire coast line to a festive mood. A single cast of net can yield a bumper harvest of different fishes. The fisher folk pray to the Sea Goddess for the appearance of mud banks locally called **chakara** , which brings good luck for the fishing community. During the heavy monsoon when unable to go the coastal people ardently pray for the appearance of mud banks.

- This makes the area one of the most productive marine regions of the world.

- Many studies were conducted, but the mystery of this enigma has not been fully resolved and recently the scientists of National Institute of Oceanography conducted an intensive study and the results are being published.

- Mud banks is an important drive of physical and biogeochemical processes for bringing a good fishery and lot of money for the fishing community, southwest coast of India.

- **Coastal Upwelling** driven biological production forms by annual seasonal physical process is a regularly occuring along west coast of India. Manjusha et. al 2014 and Vivekanandan 2013 given emphasis to upwelling and fish production.
- The **coastal upwelling** index (CUI) during south west monsoon increased by nearly 50% in 1998 -2007.
- This elevated chla concentration in monsoon with an increase of 200% in annual average chla.
- This sustained high oil sardine during post monsoon season.
- Abundance in oil sardine use to replace presence of lesser sardine and mackerel.

Increasing sst in northern Indian Ocean is well evident *in situ* and satellite dat PrasannaKumar *et al* 2009

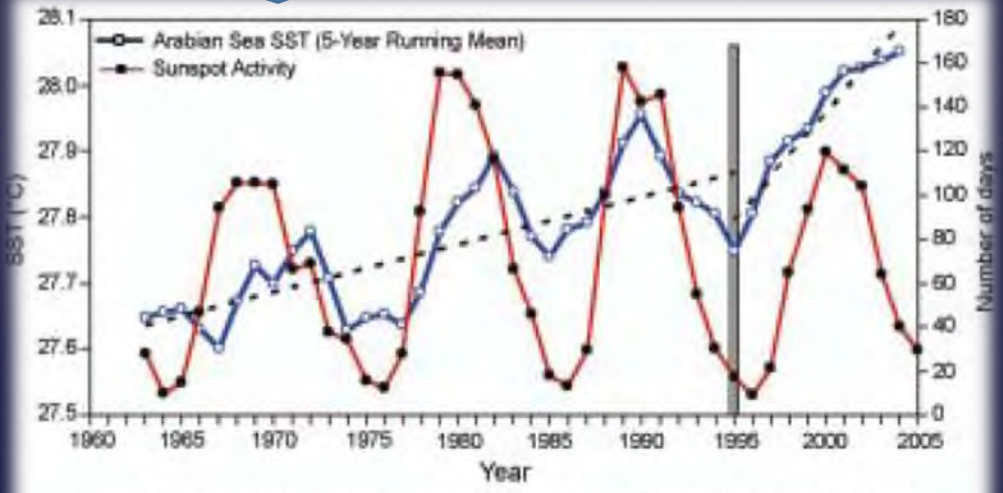


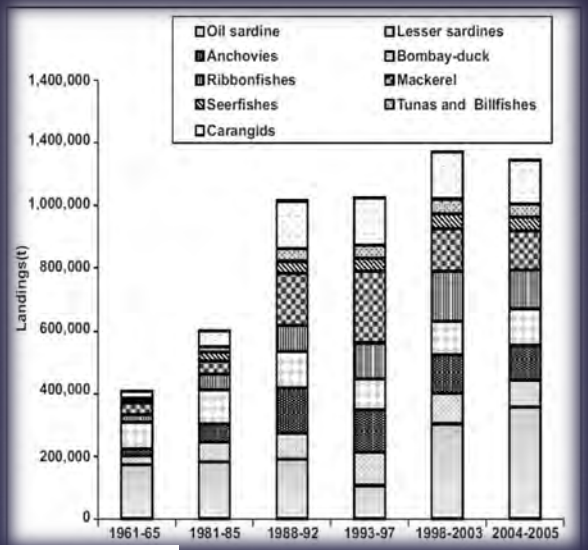
Figure 1. Five-year running mean of sea surface temperature (SST, °C) of the Arabian Sea (hollow circles) averaged over the basin (0°-25°N, 45°-80°E) and the sunspot activity (dark circles). Broken-line is the trend line of SST

The average sst during 2000 to 2005 is 28.5°C High SSt (30.6°C) was observed 2002 and 2003. During upwelling period sst in mixed layer was high compared to 1975. From 2005 onwards also increase of sst was observed from satellite data.

**Major Fishery along the EEZ of West coast of India**

| Northwest | Southwest |
|---|---|
| Elasmobranchs, Catfishes, Croakers, Ribbonfishes, Carangids, Seerfishes, Bombay duck, Perches, Pomfrets, Mackerel, Tunas, Cephalopods, Penaeid shrimps, Non-penaeid shrimps | Elasmobranchs, Catfishes, Whitebaits, Perches, Carangids, Tunas, Cephalopods, Seerfishes, Mackerel, Oil sardine, Other sardines, Croakers, Penaeid shrimps, Ribbonfishes |

Madhuprathap et.al 2010



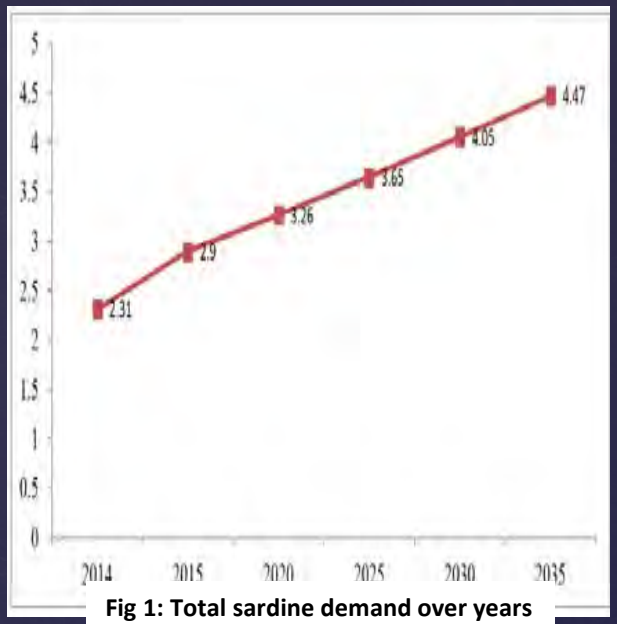




Fig 1: Total sardine demand over years

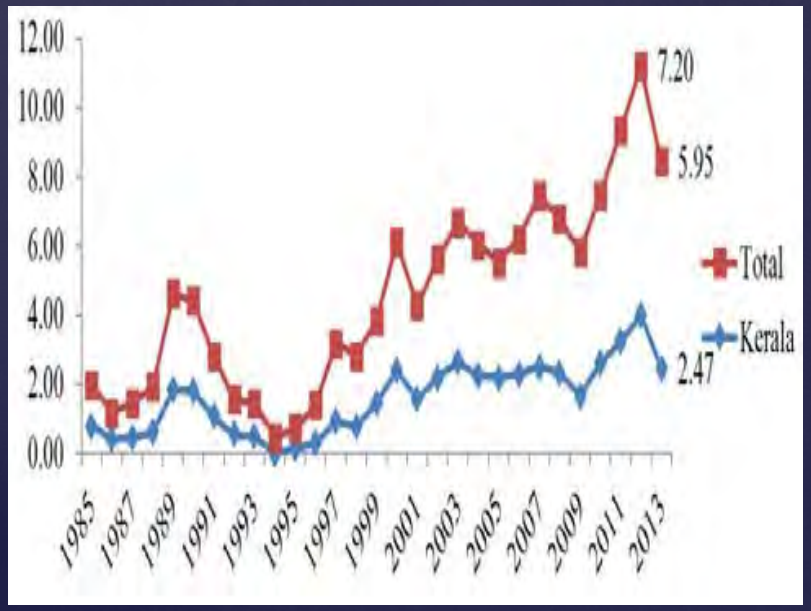



Fig 2: Sardine supply in Kerala vis-à-vis India (lakh tonnes)

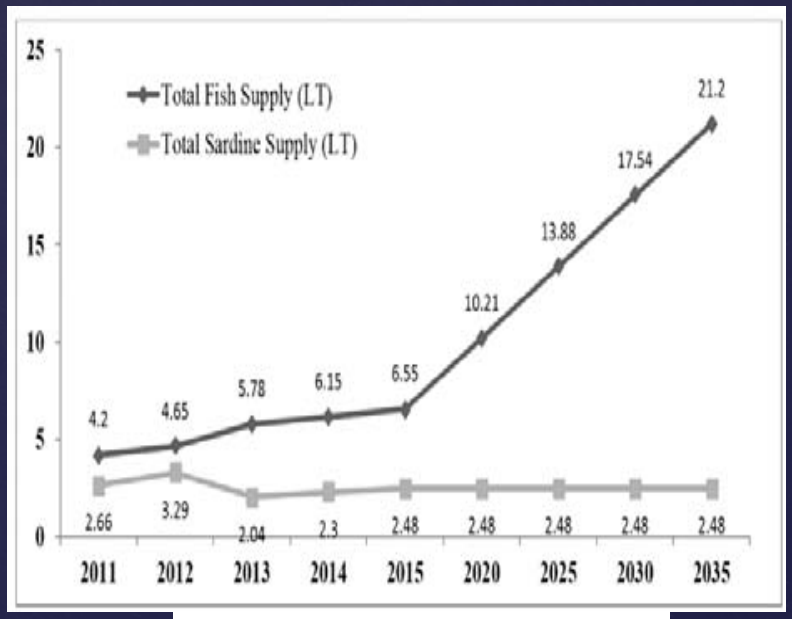



Fig 3: Fish Supply in Kerala (Projected)

**Fig 1, Fig 2 & Fig 3 taken from cmfri Report, 2016**

# Mackerel

**Cmfri report 2015**

Mackerel catch during 2015 was 70079 t which accounted for 14.5% of the total Kerala marine fish production. Landings showed a gradual increase from 2012 to 2015 and has exceeded the average production (64629 t) for the five year period, 2007-11. Recruitment was observed in April-May period and only 2% of estimated numbers in the landings off Kochi were below minimum legal size (140 mm) compared to 11% in 2014

Indian chub mackerel was first found in Gujarat coast in 2015, later it appeared in other areas of the west coast of India up to Kanyakumari. This year, the species is reported only from Kerala waters. The fish is caught mainly by ring seines and trawls and small quantities by hooks and lines operated around knolls, said E M Abdussamad, Principal Scientist, CMFRI said. A scientific article was published in the Indian Journal of Fisheries based on this study.

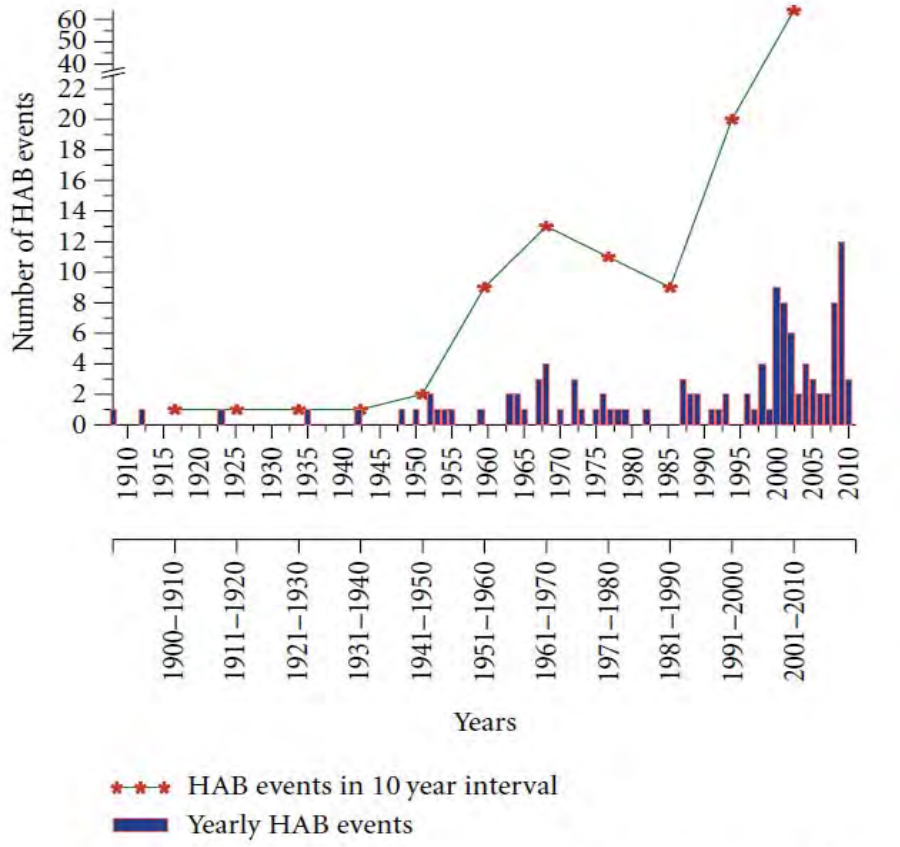
**Scomber indicus, a new species of mackerel (Scombridae: Scombrini) from Eastern Arabian Sea**

Abdussamad, et.al (2016) *Scomber indicus, a new species of mackerel (Scombridae: Scombrini) from Eastern Arabian Sea.* Indian Journal of Fisheries, 61 (3). pp. 1-10.

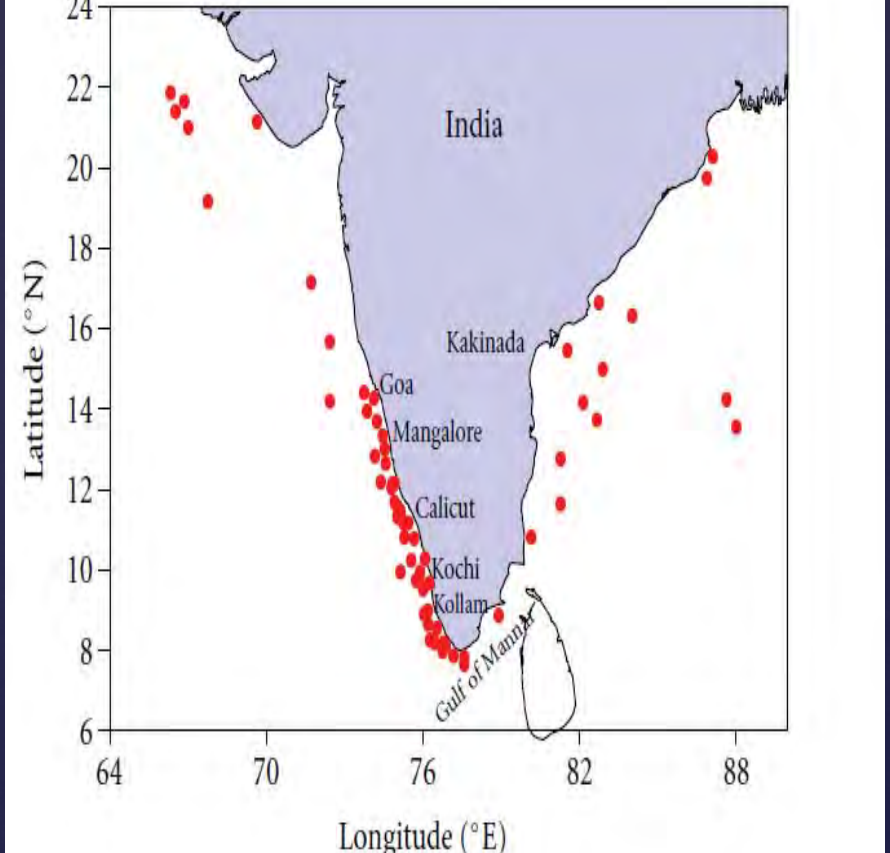
Fishery scientists expect that this species may in future replace the Indian macakerel.

# Harmful Algal Blooms

HAB are noticed increasing in the last two decades and are causing mortality to fish (Padmakumar et al., 2012). One of the reasons attributed is warming of surface waters. Trichodesmium erythraeum and Gymnodinium spp blooms causes red water phenomenon resulting in mass mortality of fishes.




Frequency of occurrence of harmful algal blooms during the last century.




(c) 1998–2010

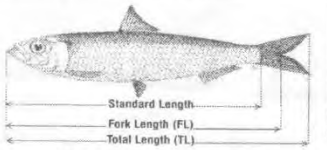
# Government policies

- Treating the oceans with reverence is the general rule of the fishing community.
- They practice a self imposed ban even before the Govt. regulation of 47 days during June- July without fishing.
- This is in conjunction with the productive monsoon months when the sea becomes highly nutrient with phytoplankton bloom and concurrent zoo plankton abundance.
- With the phytoplankton bloom follows red water phenomenon some times with mass mortality and bad smell emanates from the sea.
- This is also the time when the fishes spawn and the fish larvae are released.
- They observe this ban until the fish fry reach juvenile stage. Thus they preserve and conserve the resources for posterity. This unwritten law helps sustainable yield for coming generations. ( Swathi & Babu 2006, Sahadevan 2016 )
- Indigenous Technical Knowledge (ITK) plays a key role in perpetuating ocean wealth ( Purushan, 2015 & Babu, 2016) from interaction with fishing community.
- This is passed to generations through folk lore, myths, customs and proverbs; but not all have scientific rationale.
- In the past few decades commercialism flourished in the fishing field , so fully equipped big companies started sweeping adult, egg bearing & juvenile fishes. So govt. has to prevent it by law.

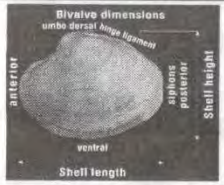
- The minimum legal size has been fixed and a ban for 47 days implemented for mechanized boats so as to conserve fishery.
- Reducing the size of mechanized boats and regulating mesh size of the net has been fixed by CENTRAL INSTITUE OF FISHING TECHNOLOGY.

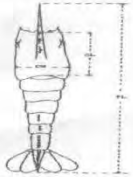
## MINIMUM LEGAL SIZE (M.L.S) FIXED BY Govt. of India

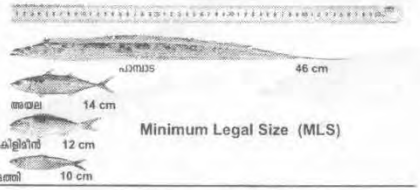
| Sl.No. | Species Name | Common name | Fish Name in Malayalam | Minimum legal size |
|---|---|---|---|---|
| | **Major Pelagic Fish Stocks** | | | |
| 1 | *Sardinella longiceps* | Oil Sardine | മത്തി / നെയ്ച്ചാള | 10 cm TL |
| 2 | *Rastrelliger kanagurta* | Indian Mackerel | അയല | 14 cm TL |
| 3 | *Euthynnus affinis* | Little tuna | കേര / ചൂര | 31 cm FL |
| 4 | *Auxis thazard* | Frigate tuna | എലിചൂര / ഉരുളൻ ചൂര | 25 cm FL |
| 5 | *Trichiurus lepturus* | Ribbon fish | പാമ്പാട | 46 cm TL |
| 6 | *Decapturus russelli* | Indian Scad | തിരിയാൻ / ചാമ്പാൻ | 11 cm TL |
| | **Major Demersal Fish Stocks** | | | |
| 7 | *Nemipterus japonicus* | Thread fin bream (Yellow) | കിളിമീൻ / പുതിയാപ്പ കോര | 12 cm TL |
| 8 | *Lactarius lactarius* | White fish | പരവ / അടവ് | 10 cm TL |
| | **Major Crustacean Stocks** | | | |
| 9 | *Panulirus homarus homarus* | Scalloped spiny lobster | കടൽ കൊഞ്ച് | 200 g |
| 10 | *Panulirus polyphagus* | Mud spiny lobster | കടൽ കൊഞ്ച് | 300 g |
| 11 | *Panulirus ornatus* | Ornate spiny lobster | കടൽ കൊഞ്ച് | 500 g |
| 12 | *Thenus unimaculatus (-T.orientalis)* | Sand lobster | അടിപ്പൻ | 150 g |
| | **Major Molluscan Stocks** | | | |
| 13 | *Paphia malabarica* | Short neck clam | കള്ളി കക്ക | 2 APM |
| 14 | *Villorita cyprinoides* | Black clam | കറുത്ത കക്ക | 2 APM |




Pictures Courtesy : CMFRI






DISCES

**നെറ്റ്ഫിഷ് – എം.പി.ഇ.ഡി.എ.**
(വാണിജ്യ വ്യവസായ മന്ത്രാലയം, ഭാരത സർക്കാർ)
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| Indigenous Technical Knowledge | Scientific rationale |
|---|---|
| Presence of dark patches in the water with ripples indicates a good catch of mackerel | The dark patches indicate the presence of mackerel shoals in the daytime. The colour change is due to the change in light penetration through the shoal. |
| Flipping and splashing noise in the water indicates the presence of thick shoals of oil sardine. | This is attributed to the group behaviour of sardines .When sardines move in groups they produce jerking movements and splashing noise. |
| Series of air bubbles coming from below and bursting at the surface indicates the availability of oil sardine. | These air bubbles are believed to be released by oil sardines while feeding on muddy bottoms, which in turn give an indication of the bottom shoals. |
| Presence of strong fishy odour at sea gives a sign of big concentration of fishes. | When there is a big concentration of fishes, a strong fishy odour originates from the mucus they discharge and this enables the fishermen to spot the shoals. |
| Jumping of prawns and fishes is an indication of good catches. | An indication of the presence of predator fishes. |
| The formation of mud banks, Chakara in Malayalam is a good sign of high catch of fish and prawns. | Mud banks is formed due to the upwelling of water resulting in the lifting of nutrient rich bottom water. The water in this mud banks are calm. This leads to the segregation of fishes and prawns, which results in a good catch. |
| Use of lantern lights at night in shrimp farms attracts the prawn seeds to the farms. | During night, the post larvae of the prawn get attracted to the light as they are photo-tactic. |

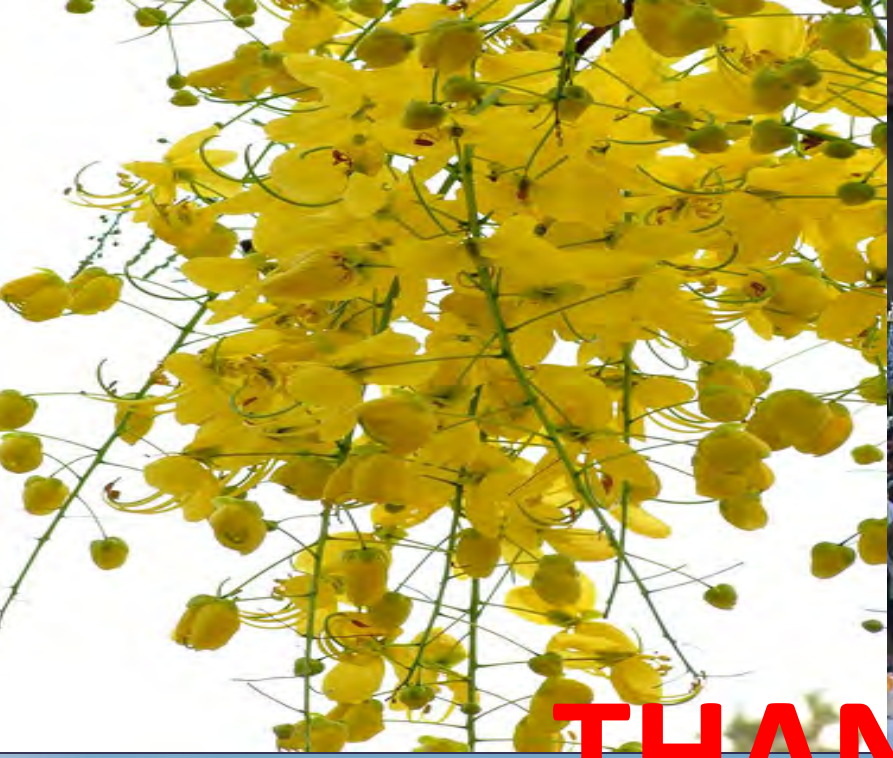
# Conclusion

The peak for zooplankton biomass and maximum fish catch goes in synchrony until recently, but in last decade fluctuations were evident in the EEZ of India. If copepods bloom early then it will reflect on abundance and distribution of pelagics (Vivekanandan 2009-2010).

From the north Pacific Lindy and Dakin 2005 reported the disappearance of *Centropages cherchie* and *Temora stylifera* . The glaring decline of *Temora turbinata,* the abundant coastal upwelling copepod was observed which is related to mackerel fishery (Stephen 2010). This kind of changes can result in mismatch between prey and predators.

This study reveals that the density of large herbivores are on the decrease whereas many carnivores and omnivores tend to increase. The incidents of HAB is on the increase. Main pelagic fishery has shown changes. All this factors points to phenomenal changes in the biological sequence in the EEZ of India. Further monitoring encompassing all aspects of the ecosystem is the need of the hour.

In the absence of long –term collections from Indian Ocean the data derived from different programmes over many decades are highly relevant in assessing the effect of climate change on phytoplankton spp., copepod species and pelagic fishes.



# THANK YOU