

Decline in Mackerel Fishery, west coast of India; its relation to the diminishing density of an upwelling copepod : A multi-decadal study

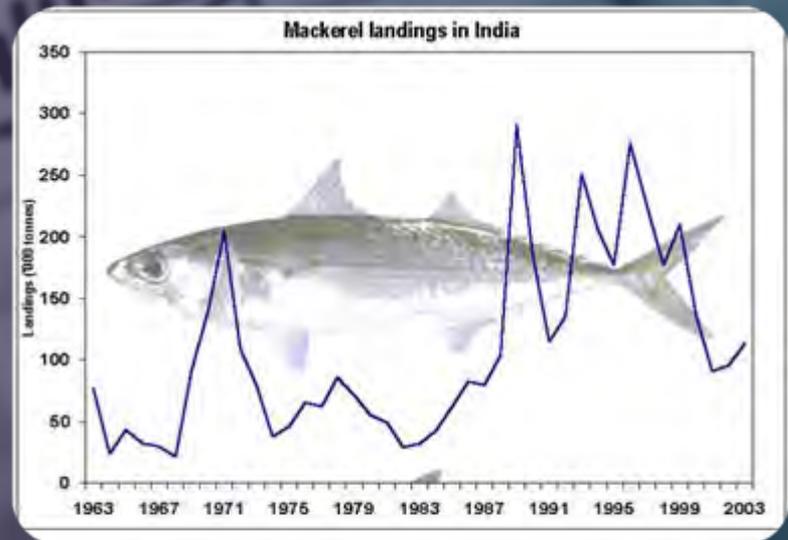
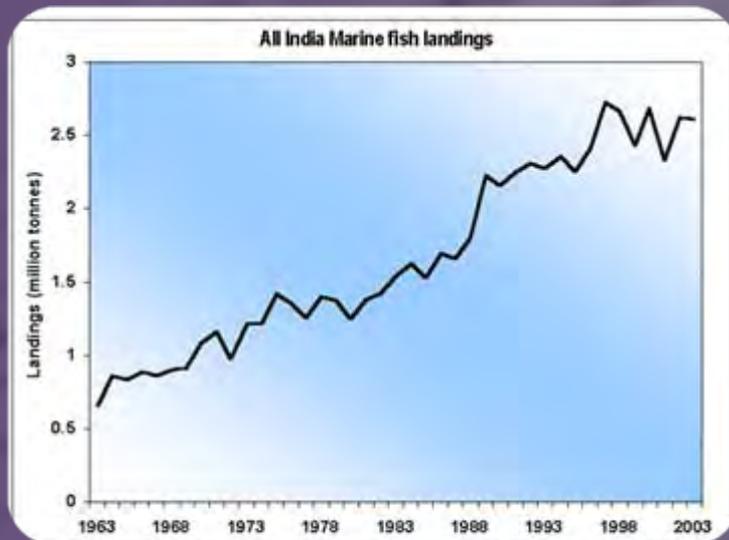
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The fishery scientist in India who met in Kochi during the Asian Fisheries Science Forum - symposium in 2007 - were highly alarmed about the large scale disappearance of Indian Mackerel (*Rastrelliger kanagurta*) from the coastal waters.



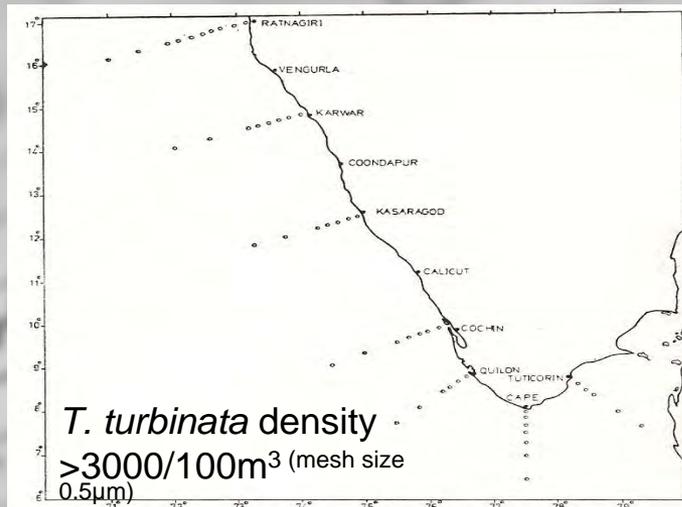
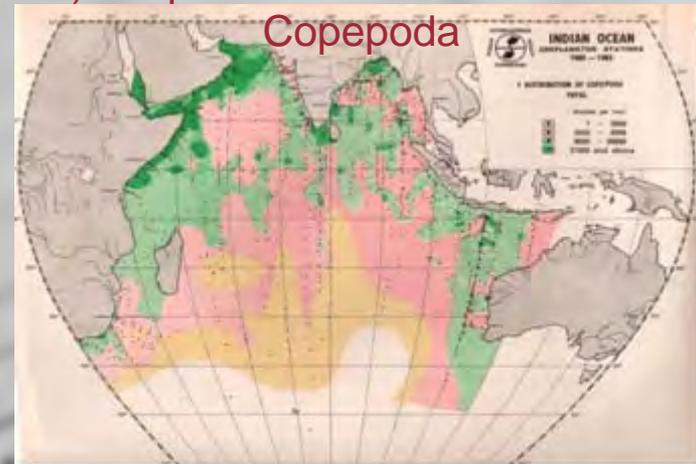
The vanishing mackerel is a severe blow in the domestic scenario of common people along west coast of India. Rice and fish curry form the staple food in an average house hold. Mackerels and sardines are the affordable and most favoured nutritious food from very early days. Even before the omega-3 factor gained attention the peasant community consumed mackerel. But recently mackerel has become a scarce commodity and price is very high.



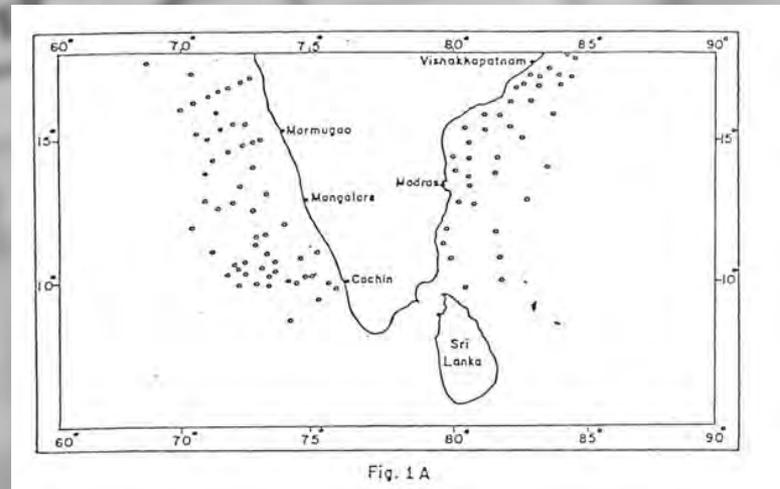
Data considered

1. IIOE (1960-65),
2. UNDP/FAO(1970-75)
3. NIO cruises (1980-90)
4. MR-LR (1998-05)

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



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



Zooplankton stations covered during 1980's

High density areas of swarms of *T. turbinata* Indian coastal waters (5000-20000/100m³)

Distribution of *T. turbinata* – IOE collections (600-1000/100m³)

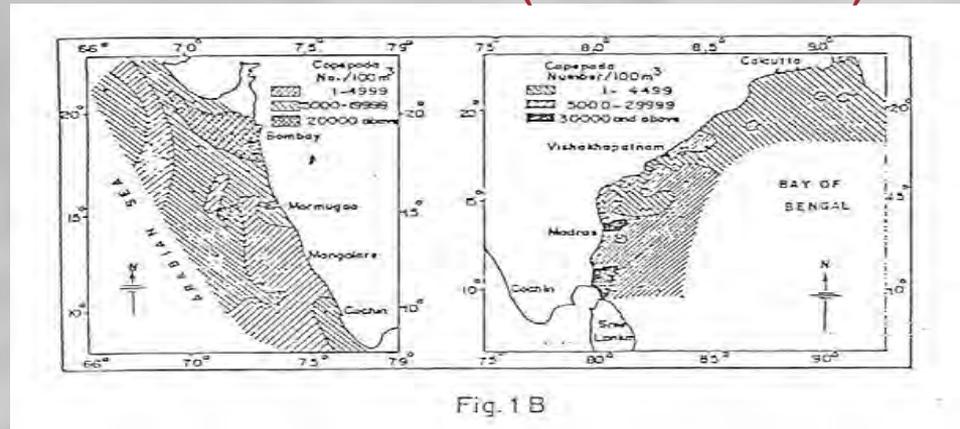
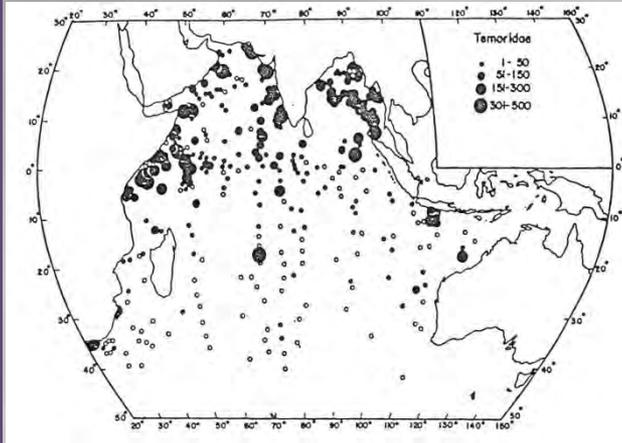
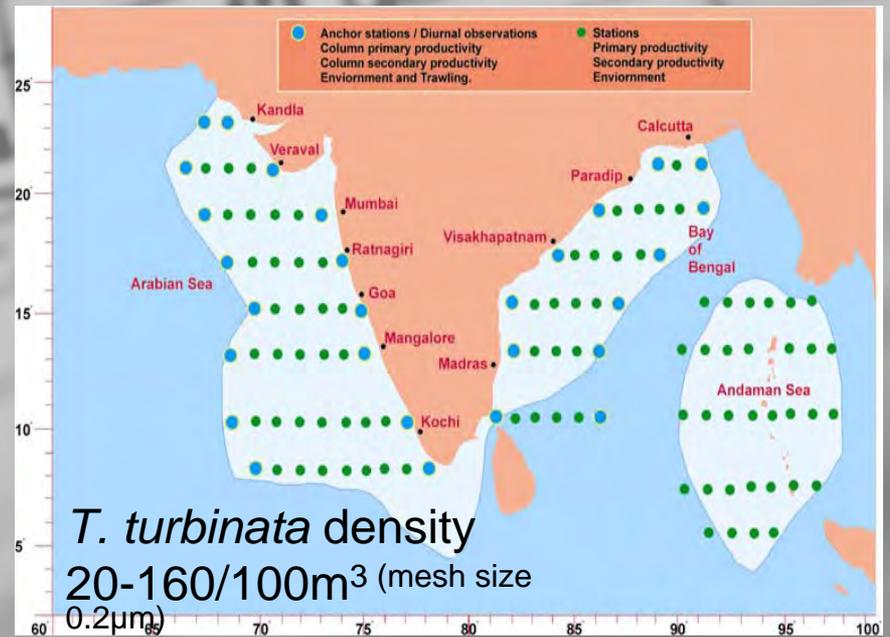
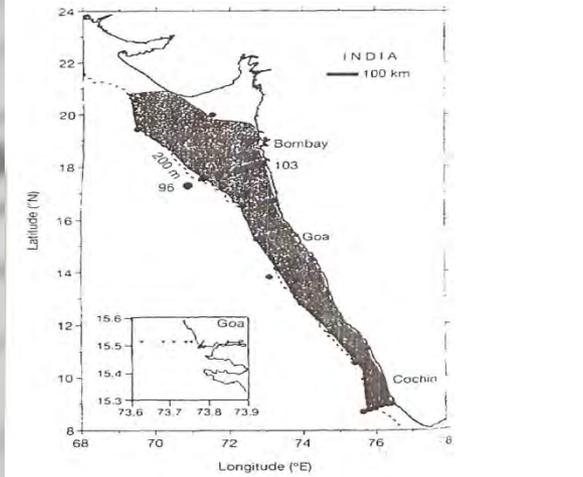


Fig. 1B

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



Stations covered during MR-LR (1998-2005)

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

Temperature profile in upper 50 meter 1970 - 1975 (Stephen 1979)

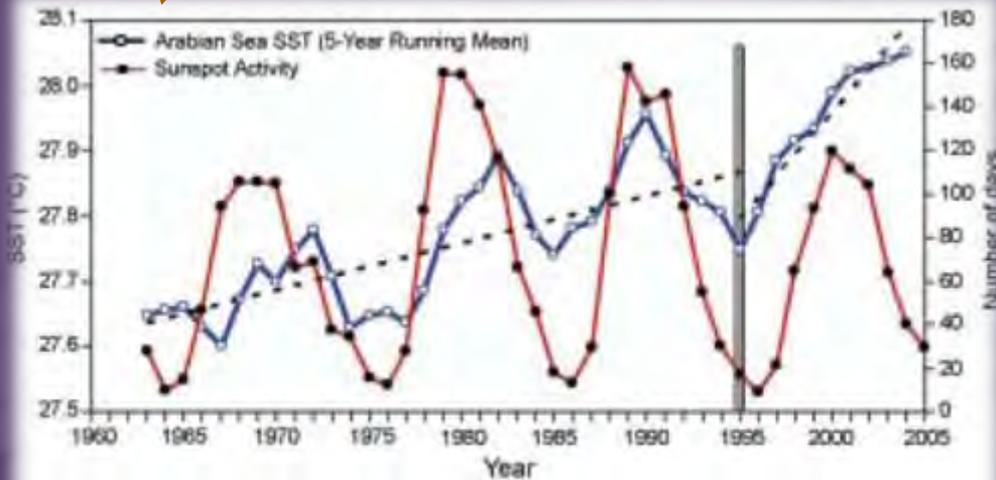
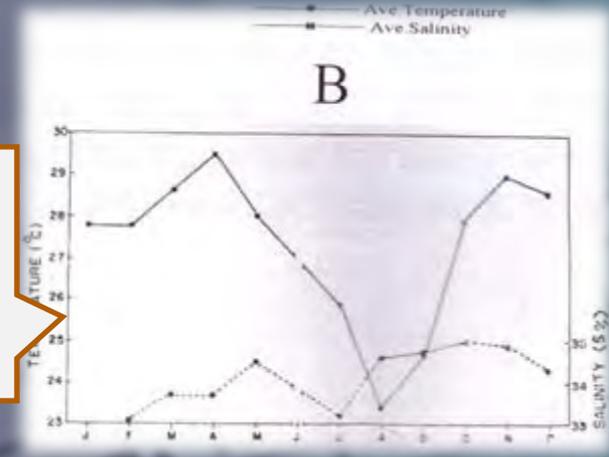


Figure 1. Five-year running mean of sea surface temperature (SST, °C) of the Arabian Sea (hollow circles) averaged over the basin (0°-25°N, 45°-80°E) and the sunspot activity (dark circles). Broken-line is the trend line of SST

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.

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 bloms get established along the coastal waters. This is followed by an upsurging 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.

Copepods

Pontellina plumata



Sapphirina auronitens



Copilia vitrea

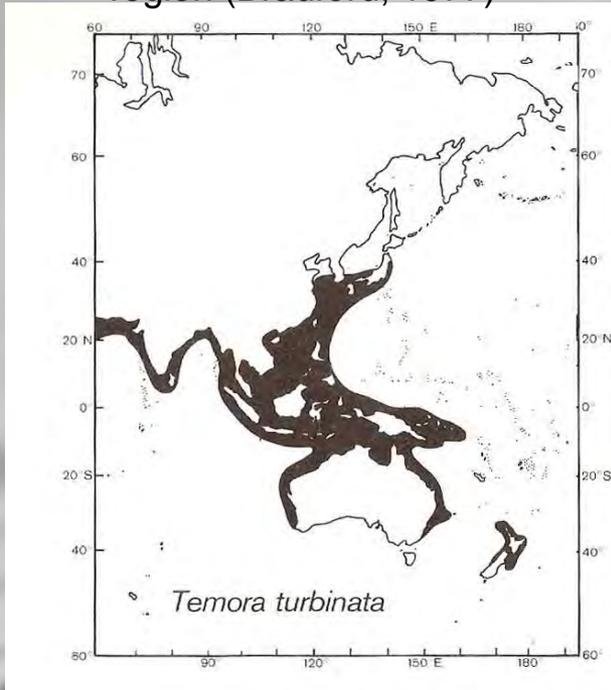


Oncaea venusta



The number of *Temora* population was found decreasing in the period 1998-2005.

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 *Oncaea* dominate. Smaller herbivores – *Gandacia* spp. and 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 upwelling 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

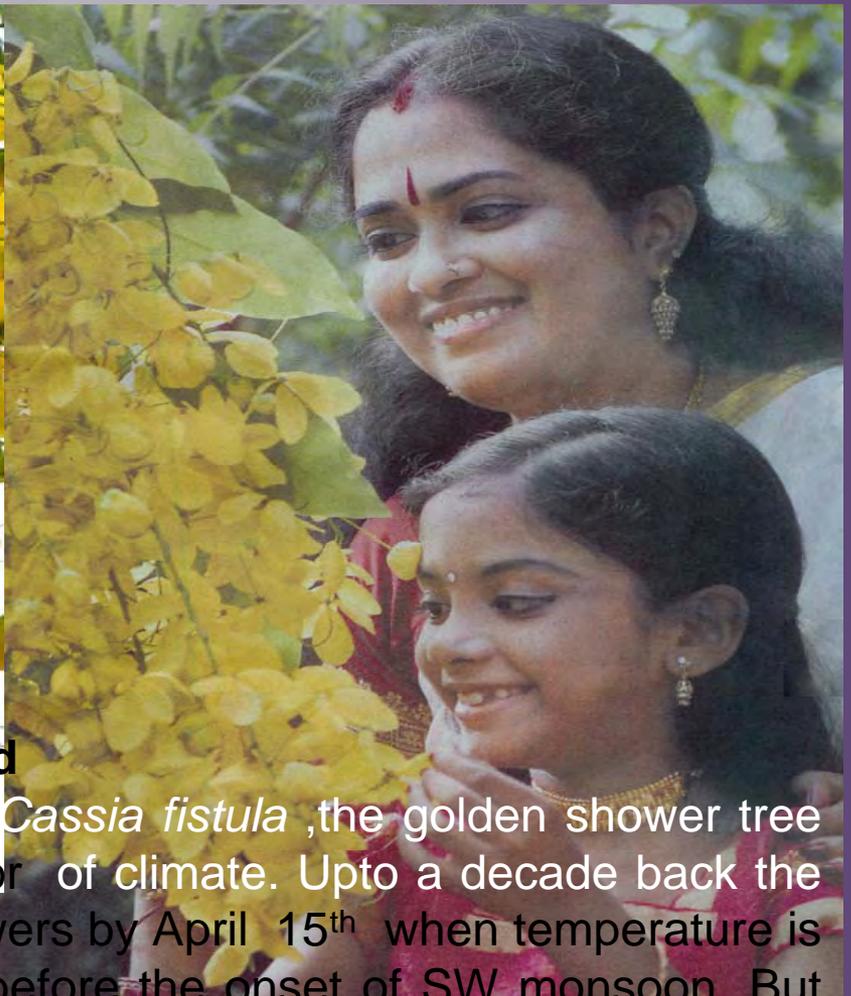
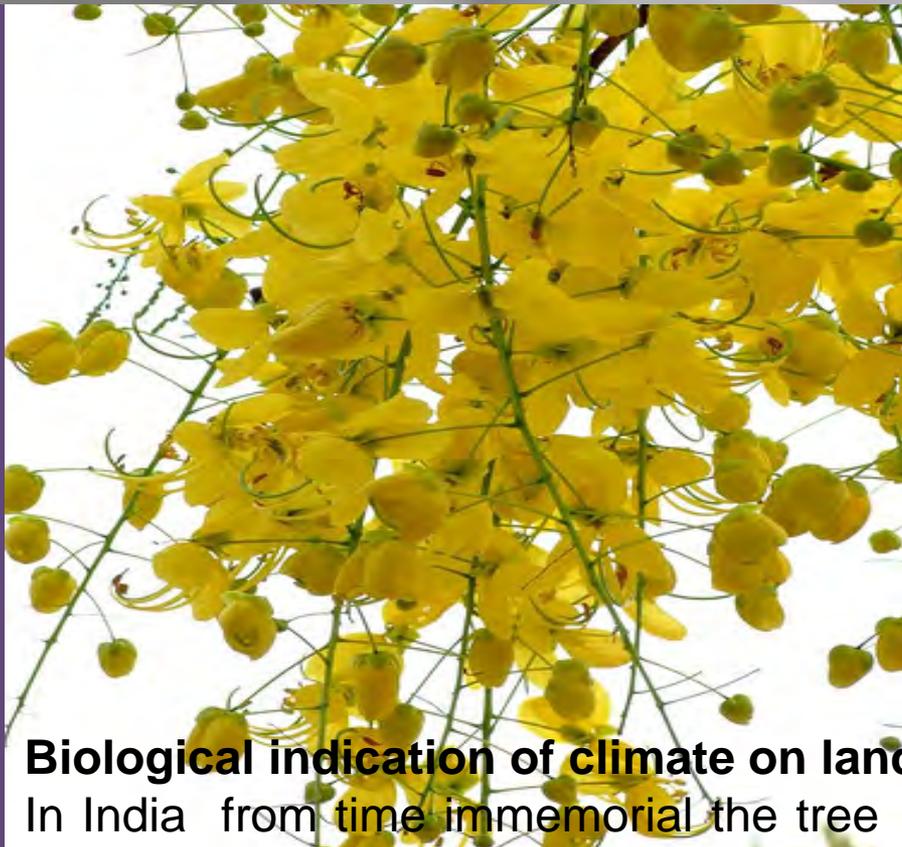
The study of copepods during 1998 to 2005 showed a drastic decrease in the abundance of the species during SW monsoon. This sweeping change persisted throughout the period of study. This can be a milestone in realizing the alteration of calanoid community in coastal environments. Since these samples 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.

A recent report of mass mortality of fish in Kerala from **paddy cum fish culture fields** due to increase in water temperature.



Key issues emerged

1. Is the zone of hypoxia “dead zones” during SM leads to depletion of dominant copepods
2. Is it similar to the drop in Gobiid population in Atlantic due to delayed appearance of *Calanus finmarchicus*
3. Lack of long term collections like Calcofi, CPR and COPEPOD which enable us to identify regime shift are the main lacunae from Indian Ocean
4. This study brings into focus the need to extend sustained effort to understand the biogeochemical cycles specifically in economically and ecologically sensitive areas
5. The scenario of global warming implies changes in biological systems which calls for sharper and intensive monitoring to track major species through future multidisciplinary survey



Biological indication of climate on land

In India from time immemorial the tree *Cassia fistula*, the golden shower tree or Indian Laburnum is a unique indicator of climate. Upto a decade back the tree bears bunches of golden yellow flowers by April 15th when temperature is highest and generally occurs 45 days before the onset of SW monsoon. But now the flowering is erratic and almost year round - a signal of increased atmospheric temperature through out the year. This picture shows the festival of farmers worshiping Mother Earth before planting rice and food grains and this flower is indispensable for this ritual and indicates prosperity and fertility.

In India the terrestrial as well as the aquatic and marine environment exhibit impact of global warming

THANK YOU