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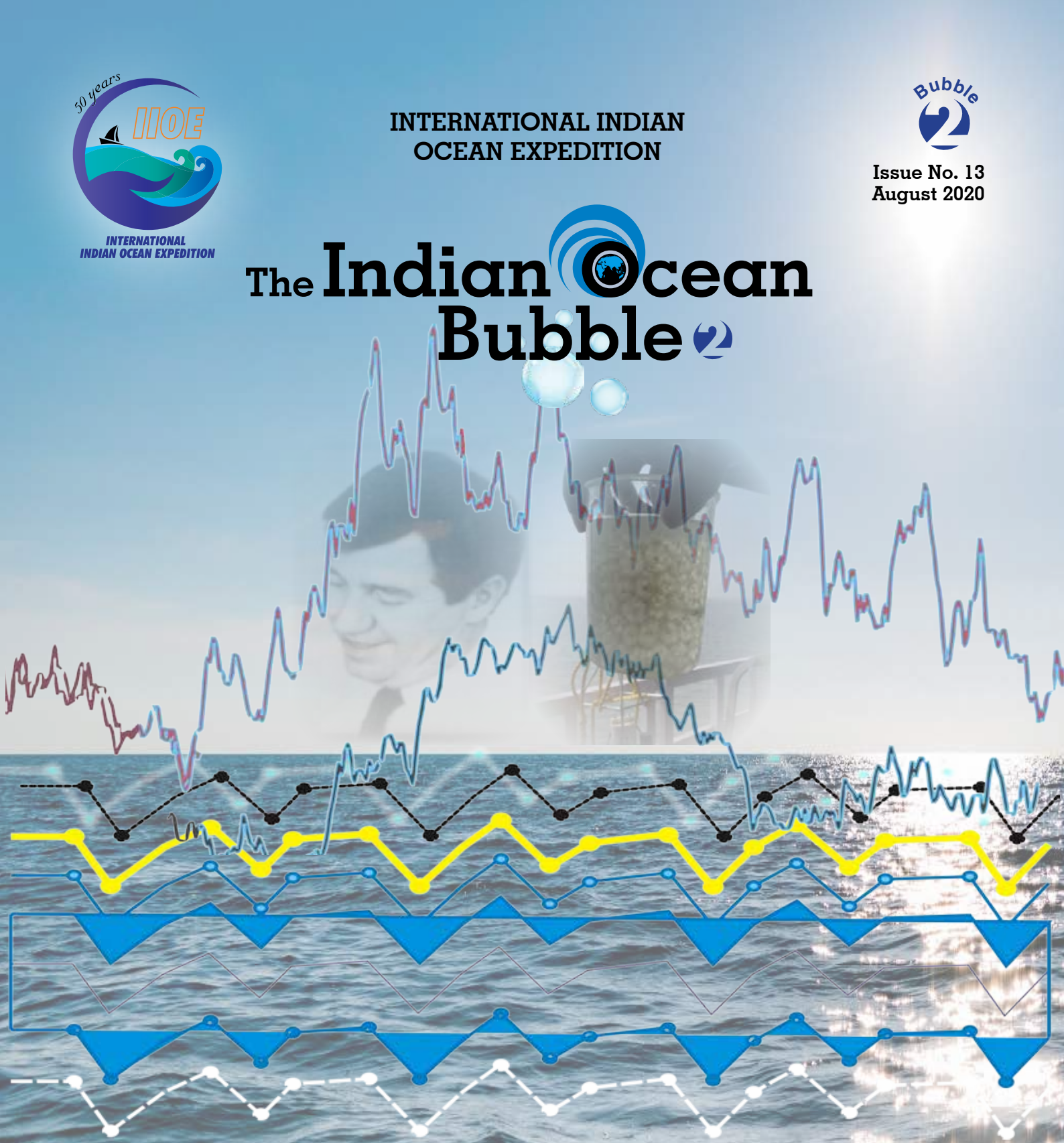
The Indian Ocean Bubble 2



IN THIS ISSUE

Current Affairs - Programmes/Committees

Our changing IIOE-2

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We live in changing times; some changes such as Climate are relatively slow while the other new 'C' word (we hardly dare mention it) are devastatingly quick. We were due to meet in Goa in March to discuss the latest developments in our understanding of the Indian Ocean. That was postponed due to "C" because of the newly emerging pandemic and most of us now find ourselves in splendid isolation at home. That is scary particularly when Governments talk about possible duration of one year for this isolation for some of us!

However, back to IIOE-2. This was set up as a 5 year programme to improve our understanding of the Indian Ocean. Those 5 years are almost complete and the sponsors have agreed an extension till 2025. Part of the rationale for this extension was to enable IIOE-2 to contribute to the UN Decade of Ocean Science for Sustainable Development (2021-2030). The UN Decade initiative supports the efforts to reverse the cycle of decline in ocean health and create improved conditions for sustainable development of the Ocean. See https://oceandecade.org for details.

We were due to discuss how we might contribute to the UN Decade at the postponed Goa Meeting. We are likely to pick this issue up once the Goa meeting is resurrected, but we don't know when that can happen! Meanwhile, we are keen that we do not waste too much time. So, we have some questions to put to all of you: (i) how might IIOE-2 change to contribute to the new UN Decade initiative? And (ii) what is needed to bring about the change(s) you suggest? (iii) What resources are needed? Please note that while the IIOE2 Core Group is looking at how IIOE-2 Science Plans and Implementaion Strategy align with the Ocean Decade document, it would be interesting to hear your views.

Please think about this and respond using the fora of "Ocean Bubble-2" and/or the monthly "IIOE-2 News Letter" to air your views.

In the meanwhile 'Stay Well and Stay Safe".

In Memorium - Tribute

Professor Trevor Platt, FRS, FRSC (1942-2020) – A Special Heartfelt Remembrance

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The authors are Indian scientists that closely worked with Professor Platt

Photo: Glen Harrison (L), Alan Longhurst (C), Trevor Platt (R) at the Bedford Institute of Oceanography, 1984. (Source: BIO-Review, 1984)

In ancient Indian tradition, students earn their education through the "Gurukula" system, wherein students have to stay away from home for a significant period along with their Guru (Teacher), so as to spend more time with the teacher to acquire not just the academic knowledge but also to learn the way of life, that would help them to walk the journey of life gracefully under any circumstances. In today's world, it's rare to find such gurukulas but Gurus of ancient calibre still exist. In the year 2005, under the NF-POGO visiting professorship programme few fortunate students from various states of India along with some students from neighbouring countries were assembled at the regional centre of National Institute of Oceanography Kochi, India and this centre was like gurukul for all those students for 3 month training period. That's where we got to meet our Gurus Prof. Trevor Platt and Dr. Shubha.

A real teacher is he who is very selfless and who loves his student's even more than a father can love his child (Swami Rama- Living with the Himalayan Masters). This definition of teacher by Swami Rama is so appropriate for Prof. Trevor and every student from this programme got to witness this quality of teacher in our mentor Prof.Platt. Majority of us (trainees/students) were just fresh entries into the research and were taking our baby steps in our respective research areas. In other words, our so called gurukul was full of immature, stupid but young energetic minds so one can imagine what level of immaturity expression used to happen from our side and other side our Guru with mountain of knowledge, patience, wit and tremendous convincing power. He knew the art to deal with each individual based on their strength and weakness and that how he manages to create waves of positive energies as the training days were progressing. In general, after the end of any training programme, few contacts, collaborations and friendship get built up and as the time passes slowly, these contacts and connections gets faded, but in our case , it's been more than 15 years and the network of alumni is still intact and contributing significantly in ocean atmospheric research. Present day all those trainees of that programme are doing extremely well in different fields of ocean sciences, some are leading national programmes; some are representing India in SAARC whereas others contributing in space research, coastal research and also polar research. All these researchers

have one thing in common in them and that is the gratitude towards the guru Prof Trevor Platt, whos teachings and presence shaped their lives one or other way. We all know that this loss is irreplaceable but we also know that he and his teachings will always be there within us and it will express while dealing our next generation researcher.

Prof. Trevor Charles Platt was one of the pioneering researchers in the fields of ocean colour remote sensing and primary productivity modelling. He strengthened and encouraged the research force in developing countries like India. He unfortunately sustained a vertebral fracture sustained during his visit to India in 2017 which caused a prolonged illness to which he succumbed on 6 April 2020 in Plymouth, UK. He is survived by his wife, Dr. Shubha Sathyendranath, who remained a pillar of strength in all his endeavours. They travelled together thoroughout the length and breadth of the planet to train young minds. Here, we attempt to pay tribute to his contribution by providing a glimpse of his stellar professional life during which he also secured personal bonds with the people who worked with him.

Trevor was born on 12 August 1942 at Salford, England. He completed his graduation from the University of Nottingham in the UK, and an MA at the University of Toronto in 1965 with the thesis 'Computer analysis of beam handling system for a linear accelerator'. Soon after he began his professional career at the Bedford Institute of Oceanography (BIO) in Dartmouth, Nova Scotia . He was awarded his doctorate in biology for the thesis 'Some effects of spatial and temporal heterogeneity on phytoplankton productivity' at Dalhousie University in 1970. He took over as Head of Biological Oceanography section at BIO in 1972 and later became Acting-Director of the institute in 1976. He continued to serve as Head of Biological Oceanography till the year 2000 also continued to work in served the section till 2005. During 2005-2008 he worked at the Coastal Ocean Science section of BIO. He served as Professional Fellow at Plymouth Marine Laboratory, UK from until his demise .

Trevor's skills and interests varied widely and can barely be fathomed with this non-exhaustive list: thermodynamics of the open ocean ecosystem; influence of physical structure of marine environment on populations living in it , physiological ecology of marine phytoplankton, size structure of marine communities, theoretical ecology, ocean carbon cycle and climate change; submarine optics, with a particular emphasis on the importance of microorganisms forlight penetration in the sea, remote sensing of ocean colour,and the ecological approach to fisheries management. His ability to deliver justice to these topics allowed him to publish over 320 academic publications that have been cited more than 22,000 times.

As impressive is his list of awards and honours. Before he turned 40, he was honoured with the APICS-Fraser Gold Medal for "outstanding research by a young scientist" in 1981. In 1984 he received the Rosenstiel Award fromUniversity of Miami for demonstrating how phytoplankton population dynamics control productivity. He was presented the G. Evelyn Hutchinson Award by the American Society for Limnology and Oceanography (ASLO) in 1988 for his outstanding contributions to developing the interface between the physics and biology of the ocean. This soon followed by his being recognized as Fellow of the Royal Society of Canada (FRCS) in 1990 followed by receiving A.G. Huntsman Award for Excellence in the Marine Sciences in 1992. In the year 1998, he was recognized as Fellow of the Royal Society (FRS). He was awarded the Timothy R. Parsons medal for excellence in ocean sciences, in 2006. The Department of Fisheries and Oceans, Canada awarded him with the Prix de Distinction in the same year and with the Prix d'Excellence following year. He was one of the scientists honoured for their contributions to the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC). The IPCC shared the 2007 Nobel Peace Prize with US Vice-President Al Gore due to their joint outstanding efforts of him in evaluating climate change.

Trevor served ASLO as a member-at-large twice (1974-1977, 1986-1989), as well as the President during 1990-1992. He chaired many high-level groups and committees at the Scientific Committee on Oceanic Research (SCOR), NATO and the International Council for the Exploration of the Seas (ICES). Hewas one of the founder members of the International Ocean Colour Coordinating Group (IOCCG) and served as the first Chairman for 10 years (1996-2006). He had been closely associated with the Partnership for Observation of the Global Ocean (POGO), first as a visiting Professor in 2005 and between 2008 and 2015 as its Executive Director.

As an ardent supporter of capacity building, he pushed for many initiatives that still live on and keep producing bright minds in the field of oceanography. Under his supervision of POGO, the first unique 3-month capacity building programme was held in 2005 at the National Institute of Oceanography, Kochi (India) aimed at introducing especially young researchers from India and Indian Ocean rim countries, to regional primary productivity modelling

Similarly, he initiated the Centre of Excellence programme in association with Bermuda Institute of Ocean Sciences, Bermuda (2008-2012) and later with Alfred Wegener Institute, Germany (2013 onwards). His untiring pursuit of ecosystem-based management of fisheries and aquaculture with the help of ocean colour remote sensing culminated in the SAFARI (Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery) symposium at Kochi in 2010. It was in recognition to his efforts towards capacity building in the year 2014, that he was awarded the Jawaharlal Nehru Science fellowship, to work 'on the ground' in India. Due to being unwell, he participated in SAFARI-2 symposium in 2018 remotely. Nevertheless, he played a key and active role in its organization in the preceding months. Even when health didn't permit any travel, he remained in regular contact with scholars that he continued to mentor through video conferencing.

Trevor was a guide and godfather to most people who met him even once. He was a gentleman full of knowledge but had a no-nonsense approach towards work. He would not have to make a motivational speech for anyone, but you would get motivated by his attitude toward work. He was a man of ideas and we will be definitely missing that flow of ideas now. With Trevor's demise, it remains to be seen, whether this eventful era of refined scientific leadership defined by novel ideas, capacity building, humour, vision, intelligence and humility comes to an end or whether these qualities will increase manifold through his teachings that survive within all those blessed students across the world…those who got the opportunity to get trained by him. His physical absence is an irreplaceable loss to all his students and followers but Trevor will always live in the works and actions of researchers such as the authors for his wit , his love of music (very fond of guitar!), and for the scientific vigour that he nurtured all these years.

Ocean Voice - Opinions/Discussion

Do Eastern and Western Equatorial Indian Oceans Contribute Differently to the Monsoon?

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Prof. Murtugudde specialises in Earth System Modelling and Predictions and specifically focuses on Climate Impacts and the Ocean's Role in Climate Variability

The Equatorial Indian Ocean is unique because it doesn't have a dominant upwelling signal in the east like the other two tropical oceans. The thermocline is tilted up from east to west in contrast to the Pacific and Atlantic Oceans. What does this mean in terms of the role of the eastern vs. western equatorial Indian Oceans in subseasonal-to-seasonal timescale variability of the monsoon?

Just focusing on the boreal summer and the Indian Summer Monsoon (ISM), southwesterly winds dominate the western equatorial Indian Ocean (WEIO) whereas the eastern equatorial Indian Ocean (EEIO) experiences predominantly westerly winds. As Fig. 1 shows, the WEIO has a strong seasonal signal in wind KE whereas the EEIO has a significant intraseasonal variability (ISV) through much of the year.- 2010. The impact of the trend in MOC seen above in GECCO2 leads to the mid-depth warming trend in the western and eastern IO. The role of MOC changes driven by the Southern Ocean warming on the upper ocean are critical for future projections of tropical climate modes and the monsoons.

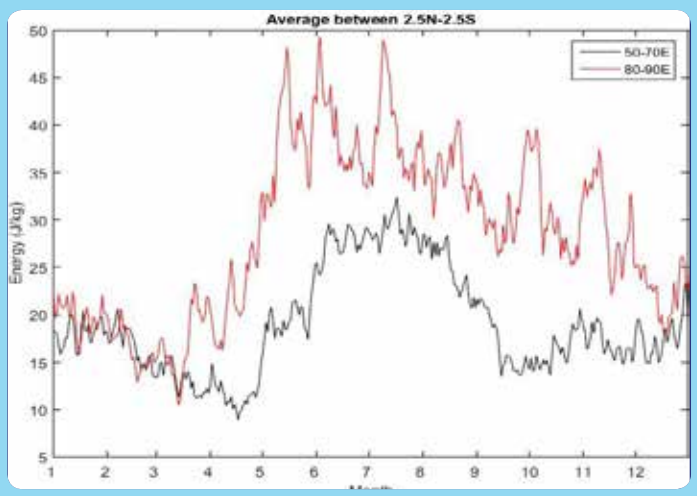

Figure 1: Kinetic energy of surface winds in the eastern and western equatorial Indian Ocean.

Clearly, both the monsoon season (May-September) and the MJO season (October-April) produce strong ISVs in the surface winds in the EEIO. Combined with the Kelvin waves that arrive in the EEIO as Wyrtki jets during May and November and the subseasonal Kelvin waves, the EEIO has a much larger ISV than WEIO. The seasonal cycle of the rainfall shows that the ITCZ tries to follow the sun across the equator but it gets suppressed over the WEIO due to cold SSTs associated upwelling. The marine ITCZ persists through the summer months in the southern tropical Indian Ocean because of the warm SSTs. A continental convergence zone gets established as the ISM trough. The ISVs emanate from the marine ITCZ and travel north over the central and eastern Indian Ocean (see https://scied.ucar.edu/docs/where-monsoons-are-found).

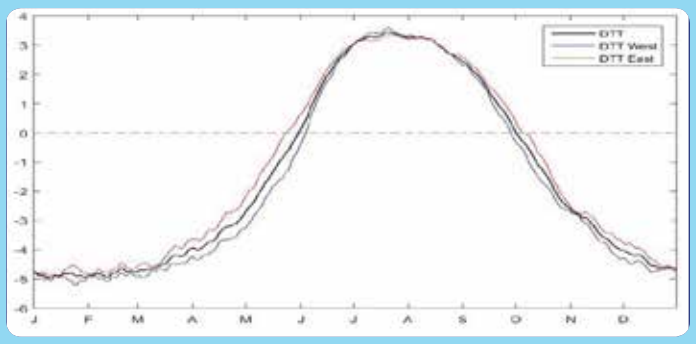

Figure 2: The tropospheric temperature gradient for the Indian Ocean and for the eastern and western halves.

If we look at the tropospheric temperature gradient for the western and eastern boxes as well the entire box as defined in Goswami and Xavier (2005; https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2005GL023216), we see that the eastern half experiences a reversal of the north-south gradient earlier than the west during the onset and later during the withdrawal (Figure 2). It is important to understand what this implies in terms of the roles of WEIO and EEIO in the monsoon onset. Especially since the monsoon trough migrates northwestward from the northwestern tropical Pacific Ocean which is also the direction of the 10-20 day monsoon intraseasonal oscillations (MISOs). In addition, it is noted that early northward propagating activities tend to correspond to an early monsoon onset (https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-13-00214.1).

Numerous studies exist on the impact of Wyrtki Jets and MJOs on the EEIO. The EEIO is of course the centre of action during an IOD. What role if any does EEIO in the ITCZ split, monsoon onset and withdrawal, the MISOs, and so on remain largely unexplored. The stark difference in the equatorial SSTs in the east and west is also as expected with an upwelling-induced cooling in WEIO that is much weaker in EEIO (Figure 3). And of course the WEIO is warming nearly 30% more than the EEIO. The anti-ocean-dynamical thermostat in the Indian Ocean as opposed to the Pacific Ocean ocean ocean dynamic thermostat?

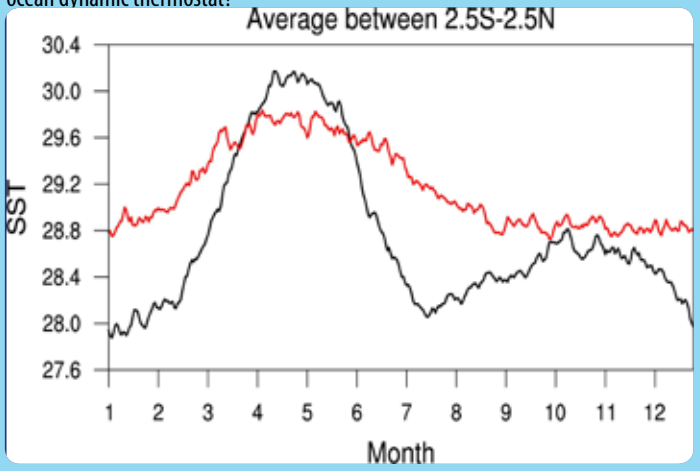

Figure 3: Sea surface temperatures in the eastern (red) and western (blue) equatorial Indian Ocean.

Is the EEIO a passive player in the ITCZ dynamics or is it an active participant? The high mean SSTs imply that even small SST anomalies can generate coupled climate feedbacks. It has been argued that a weakening of the meridional SST gradient in the North Indian Ocean has weakened the Indian monsoon (https://journals.ametsoc.org/jcli/article/19/10/2036/31037/Weakening-of-North-Indian-SST-Gradients-and-the). Two things need to be considered in this context. First, the dynamic and

thermodynamic responses of the Indian monsoon to regional and global warming remain to be understood and thus the cause and effect of the meridional SST gradient needs further resolution. The second issue is that the warming in the WEIO and EEIO are not occurring at the same rate. The gradient argument may thus need to consider the two impacts separately since the role of WEIO and EEIO may be distinct and occurring via different mechanisms. The moisture supply and the low-level jet dominate the west but the ITCZ and the ISVs dominate the east.

Many of these issues can be addressed with model sensitivity experiments but the observational programs must keep these questions in mind as well.

Ocean Vision

Census - Marine Biology

Swarms of gelatinous zooplankton witnessed in the estuarine waters of Sundarban, Bay of Bengal and their environmental implications

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The authors currently focus on studying marine faunal diversity along the eastern Indian coast and seasonal dynamics of microzooplankton and its role in the pelagic food web

Preface

This article reports the occurrence of gelatinous swarm in the estuarine waters of Sundarban, Bay of Bengal and highlights the impact it has on the mesozooplankton community and the pelagic food web in that region. It also predicts the important hydrographical characters which might have led to the swarm. The first author is pursuing her PhD at Zoological Survey of India, Kolkata and is enrolled under University of Calcutta.

Gelatinous zooplankton, extend systematically across several phyla including Cnidaria, Ctenophora, Chaetognatha, Mollusca (pteropods), and Chordata (pelagic tunicates). Swarms of gelatinous zooplankton lay great pressure on marine planktonic food webs, especially in areas important for commercial fisheries (Purcell et al. 2001). Swarms occur when a certain population (of zooplankton) receives favourable environment for its growth and proliferation, during such conditions the swarming population overpowers other species by evading predators, exploiting food reserves and rapidly reproducing. Gelatinous zooplankton aggregations are observed frequently throughout world oceans, seas, estuaries and coastal waters in different seasons and regions varying in abundance and species composition (Pitt et al. 2018). Estuarine and coastal ecosystem are constantly experiencing anthropogenic pressure of climate change, over-fishing, exploitation of resources, pollution and introduction of invasive non-indigenous species (Halpern et al. 2008). Fluctuating abundance of gelatinous zooplankton has been related to climatic alterations (Eriksen et al. 2012). In this scenario, our study aims to provide a better understanding of the conditions that promoted gelatinous zooplankton swarms in the estuarine waters of Sundarban and its impact on mesozooplankton community structure and pelagic food web.

The Sundarban mangroves, located in the northern coastal region of Bay of Bengal, is subjected to mixing of fresh water discharge from rivers and marine water of the open Bay, creating a brackish ecosystem with variable salinity in different seasons. A winter survey was conducted along the estuarine and coastal waters of Sundarban mangrove in the year 2018. Mesozooplankton samples were collected from surface and sub-surface depths using WP-Plankton Net (Hydro BIOS, Diameter: 60 cm; Mesh size: 300 µm) connected with a digital flow meter to record the amount of water filtered through the net. Photographs of live gelatinous zooplankton samples were taken in-situ. Mesozooplankton samples were preserved in 4% buffered formaldehyde. Water samples for microzooplankton was collected using Niskin sampler and back washed through 200 µm mesh size plankton net and preserved in 1% acidic Lugol's Iodine solution. A SBE Seabird Portable CTD was used to obtain profiles of temperature, salinity and Photosynthetic Active Radiation (PAR). Dissolved oxygen (DO) was estimated by Winkler's method (Carpenter 1965). Chlorophyll (Chl) a and micronutrients such as nitrate, nitrite, ammonia, phosphate and silicate were analysed spectrophotometrically (Strickland & Parsons 1972; Parsons et al. 1984). The mesozooplankton specimens were identified up to species level using Leica Stereo microscope (Leica EZ4) and Leica Stereo zoom microscope (Leica M125 C). Microzooplankton samples were counted and studied under inverted microscope Leica MC-120, Leica camera and the software (LAS 4.12.0), using Sedgewick-Rafter counting chamber.

The winter survey exhibited distinct features about the geographical isolation of some areas of Sundarban mangroves. The estuarine mangrove region had cooler, high saline waters with low DO, Chl a and nutrients (except ammonia) and comprised of a discrete mesozooplankton community which was dominated by gelatinous zooplankton while the coastal region was found to possess warmer, low saline waters with higher DO, Chl a and nutrient concentration (except ammonia) that harboured a mesozooplankton community dominated by crustacean zooplankton; which was dissimilar to that observed in the estuarine stations. Mean surface mesozooplankton biomass and abundance was higher in the estuarine stations than in the coastal stations. The dominant mesozooplankton taxa in the estuarine region were Ctenophora and Cnidaria while in the coastal region it was Copepoda. The gelatinous swarm was due to aggregation of ctenophores in great abundance and was mainly contributed by *Pleurobrachia pileus* (Fig. 1). Other ctenophore species encountered in the swarming stations included *Pleurobrachia globosa, Beroe*

Swarm of ctenophore Pleurobrachia pileus observed in the estuarine waters of Sundarban, Bay of Bengal. Photo: Jasmine Purushothaman.

Bycatch of fish and other invertebrate fauna from a ctenophore swarm station of Sundarban. Photo: Jasmine Purushothaman.

gracilis and *Beroe ovata*. The coastal region was dominated by copepods such as *Acartia (Acartia) danae, Acrocalanus longicornis, Labidocera acuta* and *Oithona similis*. *Ctenophore B. gracilis* can be presumed to be an invasive species in the estuarine swarm stations. Its presence in this area could be related to its feeding habit; since it feeds solely on *P. pileus* and *P. pileus* was present in abundance in this region (Greve & Reiners 1988). B. gracilis is generally noticed after the outburst of *P. pileus* (Kuipers et al. 1990); restoring the mesozooplankton community structure with copepods and phytoplankton, which had collapsed owing to ctenophore swarm. The gelatinous swarm led to reduction in fish catch, due to clogging of fishing net by the ctenophore species and causing skin irritation to the fishermen. Only, 11 species of fish belonging to 8 families were observed in the swarming stations (Fig. 2). Thus, the gelatinous swarm had negatively impacted the fishery community and decreased the fish catch substantially.

Swarming of ctenophores in the estuarine stations led to higher mean surface mesozooplankton biomass and abundance than in the coastal stations. Gelatinous zooplankton can survive better in low DO and nutrients than their crustacean counterparts. The high abundance of ctenophores in stations with low DO confirms their ease to endure hypoxia. Furthermore, escaping ability of copepods to evade their predators might have decreased in such condition of low DO and nutrients and so they were grazed efficiently by the gelatinous groups; which led to their decreased abundance in swarming stations. Gelatinous zooplankton like ctenophores and hydrozoans turn over large amounts of ammonia (Biggs 1977), this was also revealed in our study as high ammonia concentration in swarming stations. High ammonia could also be related to eutrophication in the estuarine waters. The hydrographical parameters of low sea surface temperature, DO, nutrients, Chl a and high salinity were the prominent factors for creating an ambient swarming condition in which gelatinous zooplankton could easily thrive, since they are tolerant to anomalous environmental conditions. Hence, our result indicates to a link between gelatinous swarm and eutrophication in the estuarine region, which led to reduction in fish catch.

The Bay of Bengal is a less documented area of the Indian Ocean regarding gelatinous zooplankton taxonomy and ecology. Considerable amount of work has to be done to understand the hydrographical elements and their dynamics favouring gelatinous zooplankton swarms and the ecological and economical pressure it imposes on the ecosystem and pelagic food web. Such insights will be helpful for future management and mitigation to reduce harmful effects on the ecosystem and fisheries.

Acknowledgements

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Indo-Pacific Fish Conference and the Australian Society for Fish Biology

4 - 8 July 2022, Auckland, New Zealand

- **As a result of the COVID-19 pandemic and the subsequent postponement of the 2020 World Fisheries Conference and the 2020 International Coral Reef Conference to 2021, the Indo-Pacific Fish Conference in Auckland, New Zealand, has been postponed until 4-8 July 2022**
- **The deadline for the IPFC Bleeker Awards for distinguished contributions to Indo-Pacific Ichthyology has been extended to 29 October 2021**

https://www.ipfc11-asfb.ac.nz/

Call for Contributions

Informal articles are invited for the next issue. Contributions referring Indian Ocean studies, cruises, conferences, workshops, tributes to other oceanographers etc. are welcome. Articles may be up to 1500 words in length (MS-Word) accompanied by suitable figures, photos (separate .jpg files).

Deadline: 30th November 2020

Send Your Contributions as usual to **iioe@incois.gov.in**

Editorial Committee : Satheesh C. Shenoi, Satya Prakash, T.M. Balakrishnan Nair, Celsa Almeida

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