INTEGRATED MARINE BIOGEOCHEMISTRY: INSIGHTS

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Overview

Marine biogeochemistry is the science which deals with the relationship between organisms (both microscopic and macroscopic) and its environment through tracing the transport and cycling of chemical elements such as carbon, nitrogen, phosphorus, sulfur, and iron. The oceans play a decisive role in the exchange of carbon with the atmosphere and utilize a substantial proportion of the carbon dioxide by its biota. These biogeochemical processes and anthropogenic perturbations lead to climate change.

Oceanography is a multidisciplinary interactive science. It is mostly fostered by researchers from the nations bordering temperate and higher latitude seas at the neglect of tropical seas. Recent investigations by researchers from the Indian Institutions are adding a wealth of new information disseminated in various journals. While the Marine Science curriculum in the Indian universities is limited to teaching these broad principles of oceanography from the temperate seas, probably because of acute manpower shortage of scientific expertise in this area, a serious gap exists in appraising the young researchers of what is happening in the waters lapping their Indian shores. Under the GIAN program we aim to address the current issues relevant to Indian Seas. It is hoped this might foster two way collaboration between young Indian researchers and leading research centers elsewhere as a means of technology transfer and to be a portal for globalization of scientific training.

During this project the contrasting differences between the temperate seas and the tropical seas, in particular the uniqueness of the Indian seas will be discussed. For example the physical, chemical and biological wheels (or pumps) turn faster in the warm tropical waters compared to others. The east coast of India receives 123 x 1010 m^3 river water much larger than the west coast (Shetye et al., 1999). Marked gradients in the hydrographical features, annual particle flux pattern and geochemistry of sediments exist between these two bodies of water. The average primary production for the Arabian Sea is 0.076 gCm^{-2} day^{-1} (Desai et al. 2000) and 0.3 gCm^{-2} day^{-1} for the Bay of Bengal (Pant, 1992). Marine productivity seems to play a dominant role in the organic matter fluxes (Unger et al., 2005). The flux of particulate matter contributed varies spatially and seasonally (Ittekkot et al., 1991) and very high organic carbon fluxes of more than 3 g m^{-2} y^{-1} are reported from the Bay of Bengal (Ramaswamy and Nair 1994). Burial of carbon (organic and calcium carbonate) affect the carbon in the ocean and atmosphere systems (Berner, 1991).

Associated with the input from some of the world's largest rivers in the Bay of Bengal, a strong stratification develops and prevents deepening of the mixed layer (Prasanna Kumar et al., 2002). The river run off results in an annual sediment supply, and the bay receives a huge amount of terrestrial/fluvial organic carbon making up ca. 1 - 2% of the total suspended matter load during the high discharge period (Ittekkot et al., 1985).

The question whether the Arabian Sea is a sink or source for atmospheric carbon dioxide and other green house gases was a central issue (Schwartz et al 2009). The results of JGOF highlight that the benthic system of the Arabian Sea is highly dynamic, with evidence of strong benthic–pelagic coupling displayed as a cross-basin trophic gradient and in benthic response to seasonal variability in productivity and Carbon flux. Of significance is the benthic biogeochemical processes, particularly within the oxygen minimum zone, the associated denitrification flux of 1.1–10.5 Tg N yr^{-1} (Cowie, 2005), phosphogenesis, and fluxes of trace metals, nutrients and dissolved organic matter (Unger et al., 2005). It is important to investigate the origin of the organic matter i.e. whether it is supplied by particles sinking vertically (0.73 mmol N m^{-2} d^{-1}) from the euphotic zone above rather than from lateral transport of organic matter from elsewhere in the Arabian Sea (less than 01 mmol N m^{-2} d^{-1}). Also, other features

of interest from a biogeochemical point are the upwelling of bottom waters, low oxygen zones in the Arabian Sea (probably associated with denitrification (Morrison et al., 1999, Devol et al., 2006). In view of the above, critical evaluation of the biogeochemistry of the Indian Seas, source-to-sink sedimentary systems and carbon burial in the Indian Seas would be important. Because of these unique features of the Indian Seas, some of the tenets about the structure and functioning of the temperate seas may not be valid in toto. Well trained young researchers will be able to appreciate the significance of constructing a good research questions and developing hypotheses in tropical marine biogeochemistry.

Dr. Subba Rao an internationally acclaimed academician, researcher and practitioner with proven knowledge, experience, and demonstrable ability in teaching, consultancy, research, and training in the field of biological oceanographer will deliver lectures and discuss cases during the course.

Modules	**A: Global primary production, Discovery of Picoplankton, Physiology of Primary Production and Aeolian Dust: Algal Response to Trace Metals : 21 November, 2016 to 6 December, 2016** Lecture 1 and 2: Global primary production Tutorial 1 and 2: Global primary production Lecture 3 and 4: Discovery of Picoplankton Tutorial 3 and 4: Discovery of Picoplankton Lecture 5 and 6: Phycotoxins: Domoic Acid and Diarrhetic Shellfish Poisoning Tutorial 5 and 6: Phycotoxins: Domoic Acid and Diarrhetic Shellfish Poisoning Lecture 7 and 8: Physiology of Primary Production Tutorial 7 and 8: Physiology of Primary Production Lecture 9 and 10: Ballast water introductions Tutorial 9 and 10: Ballast water introductions **B: Phycotoxins, Impact of Natural disasters and mega engineering projects on coastal ecosystems, Ballast water introductions and Biotechnological applications of microalgae : 21 November, 2016 to 6 December, 2016** Lecture 1 and 2: Phycotoxins: Domoic Acid and Diarrhetic Shellfish Poisoning Tutorial 1 and 2: Phycotoxins: Domoic Acid and Diarrhetic Shellfish Poisoning Lecture 3 and 4: Aeolian Dust: Algal Response to Trace Metals Tutorial 3 and 4: Aeolian Dust: Algal Response to Trace Metals Lecture 5 and 6: Impact of Natural disasters and mega engineering projects on coastal ecosystems. Tutorial 5 and 6: Impact of Natural disasters and mega engineering projects on coastal ecosystems Lecture 7 and 8: Ballast water introductions Tutorial 7 and 8: Ballast water introductions Lecture 9 and 10: Long-term changes in the Arabian Gulf region Tutorial 9 and 10: Lithogenic fractions **Number of participants for the course will be limited to fifty.**
You Should Attend If…	▪ you are a student of M.Sc. / Ph.D. / Faculty member in Marine Geology / Geoinformatics / Biological / Biochemical / Fisheries Sciences of Mangalore University OR Affiliated / Autonomous Colleges OR from sister Universities in the State of Karnataka.
Fees	**Two week's module: Rs. 2000/- per student** The above fee includes all instructional materials, computer use for tutorials, 24 hr free internet facility.

The Faculty

Dr. Subba Rao an internationally acclaimed academician, researcher and practitioner with proven knowledge, experience, and demonstrable ability in teaching, consultancy, research, and training in the field of biological oceanography, will deliver lectures and discuss cases in the course. He has pursued his scientific research at the Andhra University (India), Common wealth Scientific and Industrial Research Organization (CSIRO, Australia), The Johns Hopkins University (USA), Bedford Institute of Oceanography (Canada), and Kuwait Institute for Scientific Research (KISR, Kuwait). Presently he is an Adjunct Research Professor at Centre for Global Health, Dept. of Medicine in the University of New Mexico, U.S.A.

Dr. K. S. Jayappa is a Professor in the Post-Graduate Department of Marine Geology, Mangalore University. His research interests are: Physical Oceanography; Estuarine and Coastal Processes; Coastal Geomorphology; Coastal Sedimentation, and GIS Applications in Coastal Geomorphological and Management Studies. He is a recipient of Prof. Satish Dhawan Young Engineers State Award (2007) from the Govt. of Karnataka for his contribution in the field of Earth Sciences. He has completed Nine Research Projects funded by ISRO, UGC, DST, BRNS, MoES and have Two ongoing Projects sponsored by SAC, ISRO. Guided successfully Four Ph.Ds and Seven are in progress. Published > 30 Research Papers in refereed Journals, two books, 12 Chapters in Edited Books. Conducted Three National Level Conferences and Two Workshops. Reviewed > 50 research papers submitted for publication in National and International Journals.

Objectives

i) To arrive at perceptive new concepts on global phytoplankton production & distributions, photosynthetic functioning of lagoons, estuaries, and biological oceanography of the Gulf of Maine,
ii) To explain about new methodology of culturing, quantifying and measuring the photosynthetic production and a new class of picoplankton,
iii) To understand the need for utilization of cultures as analogues of natural algal blooms, and for standardization of primary production methodology and application of necessary techniques,
iv) To emphasize the relation between variability in the distribution of trace metals and differential growth response of phytoplankton this will account for differences in species succession,
v) Phycotoxins: Domoic Acid and Diarrhetic Shellfish Poisoning,
vi) To explain the impact of Natural disasters and mega engineering projects on coastal ecosystems, and
vii) To reveal the impact of Ballast water introductions from one ocean to another.

Course Co-ordinator

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