Project Endorsement Form

1. PROJECT TITLE

Full title	Impact of climate variability on the Indian Ocean : Role of Gelatinous zooplankton structuring food web structure and community assemblages
Acronym	
Website	
Keywords (up to 10, describing the project research)	Climate change impacts, Gelatinous zooplankton, Arabian Sea, Bay of Bengal, Spatio-temporal variation, Morpho-taxonomy
New initiative or continuing programme?	Continuing initiative

2. APPLICANTS

Lead applicant / Project Leader / key research contact person:

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Last name	Sivasankaran
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Other key participants / research team leaders: *(repeat as needed)*

First name	Bijoy Nandan
Last name	Sivasankaran
Role in the project	Principal investigator
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First name	Harikrishnan
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First name	Sanu
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Institutional or personal website	www.cusat.ac.in

N.B.: Please note that all these names and contact details will be added to the IIOE-2 membership database.

3. ABSTRACT– Brief description of the project: *(1/4 page maximum)*
This will be placed on the IIOE-2 Website after endorsement.

The marine trophic environment is strongly getting influenced by various anthropogenic, physico-chemical and climate change issues, possibly altering the biological productivity (food web structure, community patterns and feeding mechanisms etc.), creating microhabitats with predatory and nutrient limiting or controlled food webs that leads to mass alteration in standing crop (carbon) and resources at the primary, secondary and tertiary level. Studies have indicated that gelatinous zooplankton; a crucial secondary consumer (some radiolarians and foraminifera, medusae, siphonophores, ctenophores, chaetognaths, pteropods, heteropods, appendicularians, salps, doliolids, and pyrosomes) has potentially increased their abundance in major oceans mainly due to climate change scenarios, possibly causing imbalances in the trophic structuring. But there is no serious scientific information from the Indian ocean region. So, it is imperative to develop a sound knowledge on the distribution, community structure and species status of the gelatinous plankton in relation to the prevailing environmental characteristics so as to predict the population structure of these planktonic groups influencing the tropic structure in the Indian Ocean. Thus, the specific objectives of the proposal are to conduct in-depth taxonomic and systematic analysis of gelatinous plankton in the Arabian Sea by classical and molecular methods, understanding the spatio-temporal pattern in the community structure of plankton in the prevailing environmental characteristics for the period; to trace the possible influence of climate change (physical forcing's and chemical attributes) on the distribution and population character of gelatinous plankton species. This pioneering study will fill the lacunae in our understanding of marine diversity, specific to gelatinous plankton from the Indian Ocean delineating its morphological and genetic information along with its community structure. It would also test the hypothesis that increasing abundance of gelatinous plankton is associated with climate change scenarios.

4. LINKS TO IIOE-2 SCIENCE PLAN :*(1/2 page maximum)*
How do you anticipate your project to contribute to the IIOE-2 strategy and science delivery, with reference to which (either one or more) of the six IIOE-2 Science Plan themes that your project responds. Please state the specific issues and questions addressed by your project in the context of the IIOE-2 Science Plan themes and key issues.

The current proposal comes under the theme 4 of IIOE-2 Science plan; Circulation, Climate variability and Ecosystem response. For long time period, relatively there is little knowledge on the climate induced variability and distribution pattern of marine gelatinous zooplankton community. Recently, the frequency of blooming (an abnormal increase in seasonal populations) is generating a world-wide discussion about

gelatinous zooplankton population explosions in all oceans (Condon et al., 2013). It seems, according to reports, that these abnormal increases arise in areas that have been subjected to overharvesting and environmental perturbations. The ecology of gelatinous zooplankton fauna has been altered by the climate which in turn had caused temporal shifts in bloom formation and trophic mismatches in the food web. Biodiversity assessment is not valid, without having a proper knowledge on the species characteristics; its morphology, the pattern of distribution and abundance, succession and related information. It is irony that off late, most of the research is oriented to general ecological, microbiological and molecular aspects of organisms, grossly neglecting the science of taxonomy. Further information on the systematic and molecular characterization of gelatinous zooplankton is usually neglected in most of the studies despite of its role in energy transfer in marine trophic webs. Most of the information on the siphonophores are available from the world oceans including Atlantic, Pacific and Mediterranean sea (Purcell, 2012;Condon et.al,2012).But only scattered information available on gelatinous zooplankton species including the aspect of climate change as well as molecular taxonomy, from the Indian ocean. Sampathkumar (2012) recorded 115 species of gelatinous zooplankton from the Indian EEZ of which 11 species of Scyphomedusae, 22 species of Hydromedusae, 17 species of Siphonophores, 5 species of Ctenophore, 9 species of Doliolids, 17 species of Salps, 15 species of Appendicularians and 19 species of Chaetognaths were recorded. Hundred and sixteen valid species, one variety and three doubtful species known from the Indian Ocean, of which 89 occur in the Indian seas, have been reported by Daniel in 1985. Works and reports of Siphonophores from Indian waters were those by Sundara Raj (1927), Leloup (1934) and Daniel and Daniel (1963) from the Madras Coast; Daniel (1966, 1974) from the West and East Coasts of India and Rengarajan (1973, 1975 and 1983) from the West Coast of India. Studies regarding substantial molecular analysis of gelatinous species were also rather limited from Indian Ocean since the prevalent studies that too limited, were from Atlantic Ocean. Ortman*et.al* (2010) reported 231 sequences for a portion of the mitochondrial Cytochrome Oxidase I (mtCOI) gene obtained from 95 species of Medusozoans including; 84 hydrozoans (61 siphonophores, eight anthomedusae, four leptomedusae, seven trachymedusae, and four narcomedusae), 10 scyphozoans (three coronatae, four semaeostomae, two rhizostomae, and one stauromedusae), and one cubozoan from several areas of Atlantic ocean.Erin,2000 did the molecular phylogeny of 5 species of Nacromedusae 18s gene sequence and cloning the ITS1 gene of each individual. However a paucity of information on gelatinous zooplankton in the southern hemisphere outside of the Southern Ocean still persists (Lindsay et.al, 2014).Therefore the present study involving the impact of climate change on proliferations of gelatinous zooplankton combined with its taxonomy, genetic characterization is relevant in this context.

Specific objectives of the study:

- Characterise the taxonomy, species structure and genetic status of gelatinous plankton
- Assess the community structure of gelatinous plankton in the Indian ocean
- Understanding the spatio-temporal pattern in the community structure of plankton in the prevailing environmental characteristics for the period; to trace the possible influence of climate change (physical forcing's and chemical attributes) on the distribution patterns and population character of gelatinous plankton species.

5. REGION(S) OF STUDY

Provide a description of 'where' the research is to be conducted (for field based activities) and/or the region or regions to which the research pertains (you are encouraged to consider providing a figure as an addendum to your proposal).

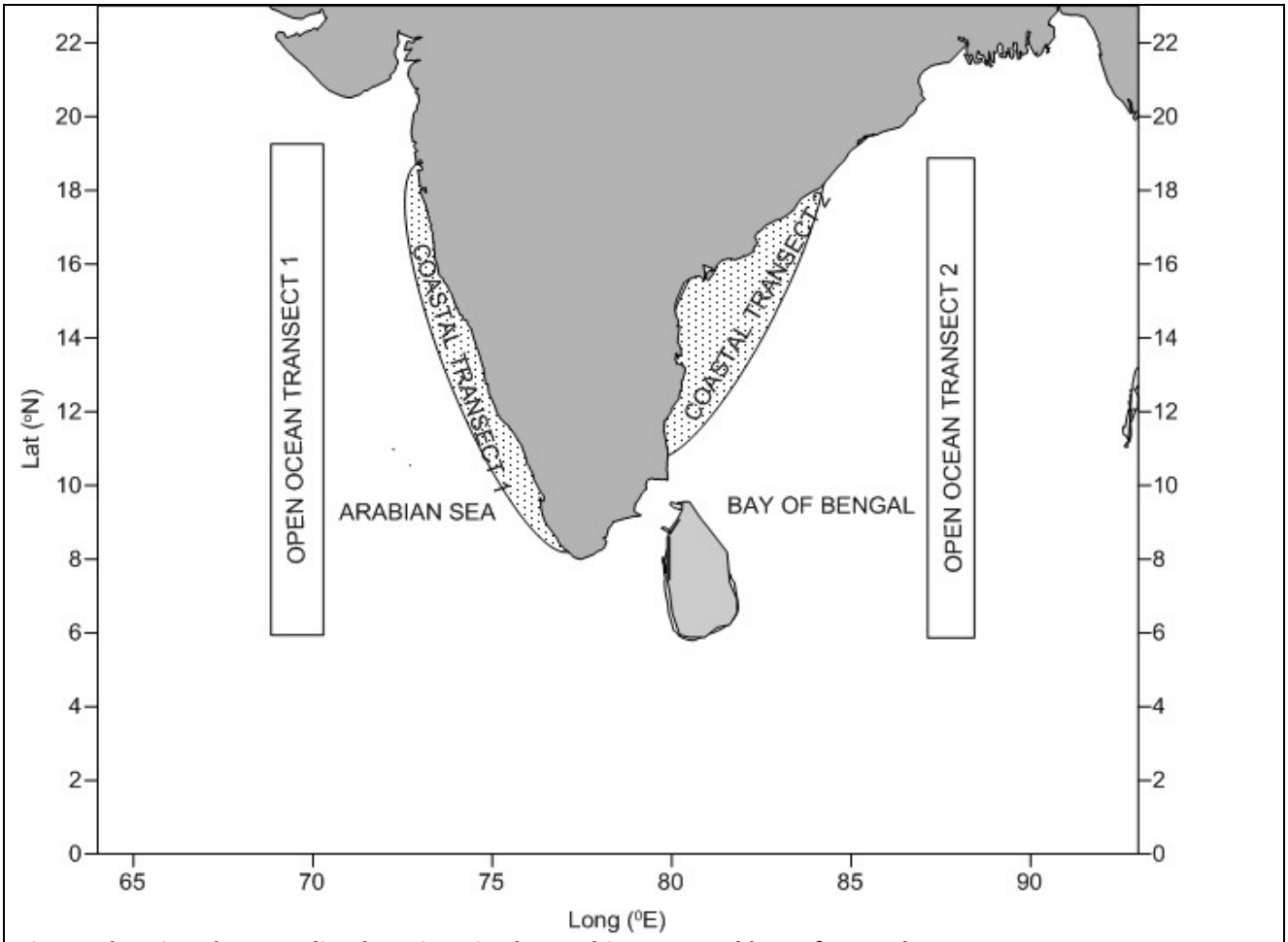

Figure showing the sampling locations in the Arabian Sea and bay of Bengal.

Sampling will be carried out along Arabian Sea and Bay of Bengal regions. One open ocean and one coastal transect will be fixed for both the basins.

6. TIMETABLE OF THE PROJECT

Start date: to be decided	End date: to be decided

7. LINKAGES WITH OTHER PROJECTS / PROGRAMMES / INITIATIVES

Is the project part of a related national or multi-national activity?
If yes, provide the related activity title and website for reference, if available:

This project is related to a completed project in 2016-17 on studies on pelagic plankton (copepods) in the southern Arabian sea and the Lakshadweep islands and coastal region of west coast of India funded by Dept. of Biotechnology and University Grants Commission. The study mainly covered morpho-taxonomic

characterisation of over 150 species of copepods and equal number DNA based molecular data on these species from the Indian Ocean and also the physico chemical factors influencing their abundance pattern and species structure. During this work, from 2012- 17 periods, carried out in the western Arabian Sea and the Lakshaweep islands sixteen species of gelatinous plankton were characterized under the order Siphonophore, of which 10 species are new reports to the Indian Ocean. The species diversity and abundance of siphonophores in the study area showed great variation between different regions. Among the Lakshadweep islands, Kavaratti Island contain more species of siphonophores compared Kalpeni and Minicoy. The species , *Muggiaea atlantica* Cunningham, 1892 was recorded in the western Arabian sea during the study. From the islands, *Heteropyramis alcala*, Alvarino and Frankwick, 1983 was present in both Kavaratti and Minicoy Islands. *Ceratocymba dentata* (Bigelow, 1918) was only found in Minicoy Island, *Lensia hardy* Totton, 1941 was present only in Kalpeni Island where as 12 species were observed from Kavaratti Island. The sixteen species identified in the present study belonged to nine genus coming under 3 different families of a single suborder in the order Siphonophore. However, detailed studies are required to assess the species structure and assemblages of the gelatinous plankton in the Indian Ocean which is very scanty ; and relate to their increasing presence in the region possibly replacing the other planktonic species; the current patterns, physical and chemical factors also structuring the gelatinous plankton and their increasing abundance is to be ascertained.

Is your project part of, or affiliated to, another SCOR, IOC or IOGOOS activity or project?
If "yes", please indicate which activity or project:

No

8. DATA MANAGEMENT

1. Will new data be collected as part of this project (yes or no?

yes

2. Contact information if any, of the person in charge of the data management from whom the metadata can be accessed by interested IIOE-2 stakeholders.

Please note that for all IIOE-2-endorsed projects, IIOE-2 will have developed its own metadata portal. Once the project is endorsed, the project leader will be asked to provide the metadata information of the project.

Dr. S. Bijoy Nandan, Professor & PI, Dept. of Marine Biology, Microbiology & Biochemistry, School of Marine Sciences, Cochin University of Science & Technology , Cochin 682016.

9. FUNDING

Please note that IIOE-2 strongly encourages funded/resourced projects. However, IIOE-2 may endorse projects yet to receive funding/resourcing if IIOE-2 endorsement can be clearly shown to significantly aid in prospects for funding/resourcing.

Has funding and resources to successfully achieve and undertake the project been obtained? Indicate the sources of funding and resources that have been approached and/or secured.

The field work access for the study may be provided under the IIOE-2. The analysis and data preparation can be conducted by the PI associated with the DBT and UGC project team of students.

10. BENEFITS FROM IIOE-2 ENDORSEMENT *(1/4 page maximum)*

Specify why you are seeking endorsement and how the activity would benefit from endorsement, and how the IIOE-2 SC could assist in the implementation of your project.

It is becoming increasingly evident that, the marine food web has shown indications of alteration particularly by climate change, which in turn is noticeably characterized by swarming of zooplankton and blooms especially gelatinous zooplankton. Even though they form the keystone species in the marine ecosystems, less focus has been given on the climate issues responsible for its proliferation. Moreover its taxonomy and molecular analysis is still relatively desultory in nature compared to many other groups or taxa of organisms, due to a combination of limited taxonomic expertise and sampling artefacts. In addition, the knowledge on its species diversity and population assemblages is still very nascent in the Indian Ocean region. Majority of the case studies reveals vague information on the distribution type of various gelatinous zooplankton species. In this context, preliminary work has been carried out by the P.I. in the western Arabian sea and the Lakshadweep islands sixteen species were characterized under the order Siphonophore, of which 10 species are new reports to the Indian Ocean. So, further studies are required to fill the lacunae in our understanding of marine diversity, specific to gelatinous plankton from the Indian Ocean delineating its morphological and genetic information along with its community structure. World oceans are reported to be losing many species of meso and micro planktonic groups and their ecological niche replaced by the pervading gelatinous species possibly altering food web structure. It is also reported that intense climate variabilities have suitably established, the gelatinous taxa over the conventional species coupled with the predatory nature of these organisms. This study would also test the hypothesis that increasing abundance of gelatinous plankton is associated , with climate change factors.

11. OPTIONAL: OTHER COMMENTS/INFORMATION/MATERIAL *(length and detail may be at the discretion of and as deemed necessary by the applicant)*

Please feel free to provide any other comments, information or materials that you feel relevant to your proposal for the IIOE-2 Steering Committee's information and benefit. You may provide this as general information or provide the additional comments/information/materials as relevant to any of the specific Sections above.

Majority of case studies reveals vague information on the distribution type of various gelatinous zooplankton species, due to a combination of limited taxonomic expertise and sampling artifacts. The size

or life history stages are also seldom recorded though both depth distributions and environmental niche preferences could well vary according to these factors. Although gelatinous zooplankton aggregations are natural phenomena in pelagic ecosystems, the evidence for increased occurrences of gelatinous zooplankton blooms due to climate and global change is accumulating. Many studies in an around the world oceans have reported blooms of gelatinous zooplankton (Purcell, 2012; Condon.*et.al* ,2012).A "true" 'bloom' is an abnormal increase in seasonal populations and might have several causes. Recently spectacular blooms of gelatinous zooplankton species have been reported from Black sea of Eastern Mediterranean sea and North West Atlantic ocean that may be subjected due to overharvesting and environmental perturbations. Studies on gelatinous zooplankton in the Southern Hemisphere outside of the Southern Ocean are even fewer than within it, and as a result the true endemicity of many species has yet to be conclusively proven (Lindsay D *et.al*, 2014). Some reports also suggested the role of climate change in increasing gelatinous zooplankton populations. But only scattered information reported regarding the aspect of climate change as well as molecular characterization and taxonomy from the Indian Ocean. Therefore in order to plug the dearth of information on these, the present proposal would conduct morphological identification along with the molecular systematic evaluation of the gelatinous species from the Arabian sea region around Indian Ocean of which molecular systematic analysis of regional assemblages of gelatinous zooplankton serve as a baseline for recognizing species invasions, faunal shifts, and status of ecosystem health. Additionally the spatio -temporal distribution and abundance of these species with a special perspective on the role of climate change in the proliferations of gelatinous zooplankton species needs to be evaluated. Attempts will also be made to elucidate the phylogenetic relationship of these organisms.

Moreover, biodiversity assessment is not valid, without having a proper knowledge on the species characteristics; its morphology, the pattern of distribution and abundance, succession and related information. It is irony that off late, most of the research is oriented to general ecological, microbiological and molecular aspects of organisms, grossly neglecting the science of taxonomy. Further information on the systematic and molecular characterization of gelatinous zooplankton are usually neglected in most of the studies despite of its role in energy transfer in marine trophic webs. Therefore the present study involving the impact of climate change on proliferations of gelatinous zooplankton combined with its taxonomy, genetic characterization is relevant in this context.

Most of the information on the siphonophores are available from the world oceans including Atlantic, Pacific and Mediterranean sea (Purcell, 2012; Condon et.al, 2012).But only scattered information available on gelatinous zooplankton species including the aspect of climate change as well as molecular taxonomy, from the Indian ocean. Sampathkumar (2012) recorded 115 species of gelatinous zooplankton from the Indian EEZ of which 11 species of Scyphomedusae, 22 species of Hydromedusae, 17 species of Siphonophores, 5 species of Ctenophore, 9 species of Doliolids, 17 species of Salps, 15 species of Appendicularians and 19 species of Chaetognaths were recorded. Hundred and sixteen valid species, one variety and three doubtful species known from the Indian Ocean, of which 89 occur in the Indian seas have been reported by Daniel in 1985. Works and reports of Siphonophores from Indian waters were those by

Sundara Raj (1927), Leloup (1934) and Daniel and Daniel (1963) from the Madras Coast; Daniel (1966, 1974). from the West and East Coasts of India and Rengarajan (1973, 1975 and 1983) from the West Coast of India.

A recent study had been carried out in 3 islands of Lakshadweep - Kavaratti (Iat. 10°33' N and long. 72°38'E), Kalpeni (Iat. 10°05' N and long. 73°39'E)and Minicoy (Iat. 08°17'N and long. 73°04' E) during April 2013-March 2014 whose objectives included the composition, distribution, abundance, community structure of zooplankton, the spatio - temporal variations of hydrographic parameters along with its influence on zooplankton community structure and diversity and to assess the taxonomy and systematics of Siphonophores. Sixteen species of siphonophores were identified by Principal investigator of the project proposed and his group from the samples collected from the Lakshadweep islands in the Arabian Sea-Kavaratti, Kalpeni and Minicoy Islands (Rithin Raj, 2014).The sixteen species which are identified belonged to nine genus coming under three different families of a single suborder under the order Siphonophorae of which 10 species were considered as new reports from Lakshadweep sea.

Studies regarding substantial molecular analysis of gelatinous species were also rather limited from Indian Ocean since the prevalent studies that too limited, were from Atlantic Ocean. Ortmanet.al (2010) reported 231 sequences for a portion of the mitochondrial Cytochrome Oxidase I (mtCOI) gene obtained from 95 species of Medusozoans including; 84 hydrozoans (61 siphonophores, eight anthomedusae, four leptomedusae, seven trachymedusae, and four narcomedusae), 10 scyphozoans (three coronatae, four semaeostomae, two rhizostomae, and one stauromedusae), and one cubozoan from several areas of Atlantic ocean.Erin,2000 did the molecular phylogeny of 5 species of Nacromedusae 18s gene sequence and cloning the ITS1 gene of each individual. However a paucity of information on gelatinous zooplankton in the 9 southern hemisphere outside of the Southern Ocean still persists (Lindsay et.al, 2014).Furthermore, the expected outcome would be pioneering information on general ecology, community structure, taxonomy and genetic characterization of gelatinous zooplankton from the Arabian sea and Bay of Bengal.