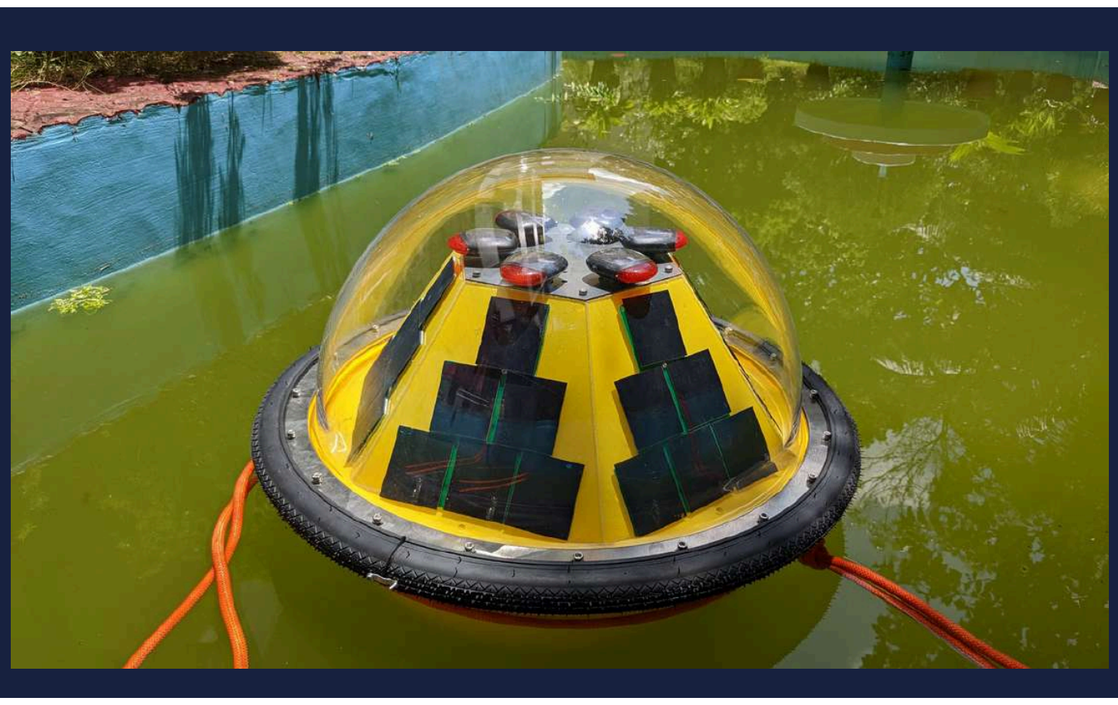
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

SDG 14. Life Below water

14.3 SUPPORTING AQUATIC ECOSYSTEMS THROUGH ACTION

14.3.4. TECHNOLOGIES TOWARDS AQUATIC ECOSYSTEM DAMAGE PREVENTION



14.3.4. TECHNOLOGIES TOWARDS AQUATIC ECOSYSTEM DAMAGE PREVENTION

1. OCEAN BUOY TO PROVIDE REAL-TIME DATA ON MARINE POLLUTION

An ocean data buoy system deployed in the Cochin estuary by researchers at Department of Physical Oceanography, Cochin University of Science and Technology provides real-time data on marine pollution and a variety of other water-quality parameters including temperature and salinity. The system has state-of-the-art water-quality sensors and can be used in a variety of natural environments such as estuaries and near-shore water and transfers real-time data every 10 minutes via GPRS to a receiving station at the department. The buoy offers a wide range of applications, including monitoring marine pollution, conducting bio-geochemical assessments, analyzing the impacts of climate change, and facilitating ecosystem conservation and public health efforts.

The project was funded through the National Higher Education Mission (Rashtriya Uchchatar Shiksha Abhiyan) and the Seed Money for New Research Initiative by Cusat. Deployment was successful in 2019, and the real-time retrieval of the data from the buoy continued for two years. After a break buoy was redeployed in February 2024.

Fig.14.3.39. Honourable Vice Chancellor CUSAT inaugurated the buoy redeployment and research activities

Ocean buoy to provide real-time data on marine pollution

The system developed by Cusat deployed in Cochin estuary

SPECIAL CORRESPONDENT

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Fig.14.3.40.The launched ocean data buoy system by the Department of Physical Oceanography, CUSAT

2. OBS DEPLOYMENT CRUISE ON BOARD ORV SAGAR NIDHI

Seven participants from the Department of Marine Geology and Geophysics took part in the expedition (Cruise No. SN-189), focused on the "Deployment of 18 Ocean Bottom Seismometers (OBSs) in the Central Indian Ocean" from April 6 to May 2, 2024, on board ORV Sagar Nidhi. The group from the department comprised two M.Sc. Marine Geology students, three M.Sc. Marine Geophysics students, a postdoctoral fellow, and a project associate. The cruise was organized by the National Centre for Polar and Ocean Research (NCPOR), Vasco da Gama, Goa, with the vessel provided by the National Institute of Ocean Technology (NIOT), Chennai. Throughout the cruise, they covered 3,750 nautical miles and engaged in various scientific activities, learning about OBS technology and other onboard geophysical instruments. They learnt the preliminary processing of the seismological data obtained from OBSs and actively participated in the deployment of all 18 instruments. Additionally, the team collected sediment and water samples through gravity coring and CTD profiling, respectively. Their collective efforts significantly contributed to the successful execution of the cruise, which aimed to enhance the understanding of the region's geophysical characteristics and support ongoing research into the Indian Ocean geoid low.

Fig.14.3.41. Students and Researchers from CUSAT participated in OBS Deployment Cruise on Board ORV Sagar Nidhi

3. ESTABLISHMENT OF IN SITU INTELLIGENT PASSIVE ACOUSTIC SENSOR NETWORK FOR MONITORING MARINE HABITATS

Underwater is one of the areas which is less explored, even though it is one of the areas of active research because of its vast area to be explored. The highways of water are often very busy throughout the year because of the ships, cargo, mining etc., but little did we have put in the effort to monitor the noise pollution in our oceans as we have done in the land to take into account of the rate of impact it might have caused to the environment, especially the marine habitat. As we are all aware that our ecosystem consists of marine habitats, any sort of impact on that will have a serious impact on the whole ecosystem. The SSUP project aims at taking initial steps to collect, monitor & analyze the noise levels in aquatic marine ecosystems and thus take necessary steps to control & mitigate the same. The primary sensory modality of communication underwater is acoustics. This helps them to navigate, communicate and forage. Besides the naturally occurring noises like seismic activities and earthquakes, the noise levels in the oceans have increased tremendously due to human activities which include but are not limited to mining, shipping, fishing, deep sea exploration etc. Increasing noise activity along the coastal regions would lead to loss of marine habitat or even to the extinction of species. Up until now, we don't have proper tactics or measurement techniques to measure the noise levels on seas. With the advantage of Artificial Intelligence this work aims to develop intelligent passive acoustic monitoring systems for monitoring noise and its effect on marine habitat, thus taking an initial step to monitor, study and analyze the noise levels thus helping in mitigating and controlling noise pollution in underwater. The passive acoustic monitoring system is developed on Sony Spresense, which is a low-power, edge ML supported board that stores and analysis the noise levels in oceans as well as able to monitor the vicinity of marine habitat using the intelligent sensor network and Artificial intelligence, deployed on a buoy to the areas to be monitored for. The buoy is expected to record and analyze the severity of noise levels and should be able to classify the type of marine habitats based on the sounds they produce.

Fig.14.3.42. Buoy developed by CUSAT to monitor marine habitats

4. CUSAT'S SCHOOL OF INDUSTRIAL FISHERIES SIGNS MOU WITH PLAN@EARTH NGO

The School of Industrial Fisheries (SIF) at Cochin University of Science and Technology (CUSAT) has entered into a significant Memorandum of Understanding (MoU) with Plan@earth, a leading non-governmental organization committed to environmental conservation. This collaboration marks a vital step towards achieving the Sustainable Development Goals (SDGs) related to environmental protection and sustainability. The MoU was signed by Dr S Sabu, the director, school of industrial fisheries and the President of Plan@earth Mr Mujeeb Mohammad in a function presided by Dr Sivanandan Achari, The Registrar of CUSAT. Mr Nishin TP, Senior Specialist – CSR, Apollo Tyres Foundation delivered the keynote address.

Under this MoU, SIF-CUSAT will associate in the ongoing projects named Drive for recovery of ocean plastic (DROP) and Mangrove Restoration and Conservation (MARC). This MoU will enable providing technical expertise and support to Plan@earth in executing various environmental projects. The partnership will foster consultancy opportunities for the faculty at SIF, allowing them to contribute their knowledge and skills to the NGO's ongoing initiatives.

Furthermore, the collaboration will offer students of SIF-CUSAT a chance to actively participate in these projects. They will have opportunities to volunteer, gain hands-on experience, and engage in internships that align with their academic and professional aspirations. This involvement will not only enrich their educational journey but also equip them with practical skills in environmental conservation.

Fig.14.3.43. CUSAT Signs MoU with Plan@earth NGO

5. BEACH CLEANING ACTIVITY ON WORLD OCEAN DAY 2023

As part of World Ocean Day, on June 8th 2023 Department of Marine Biology, Microbiology and Biochemistry in association with Ocean Society of India, conducted a beach cleaning activity at: Edavanakkad Beach, Ernakulam, Kerala. Around 120 students from Research Department of Fisheries and Aquaculture, St.Albert's College, Ernakulam; Department of Zoology, Maharajas College, Ernakulam; Sacred Heart College, Thevara; National Centre for Aquatic Animal Health, CUSAT and Association of Fisheries Graduates actively participated in the activity. The inauguration of the cleaning activity was done by the Vypin M.L.A Shri.K.V Unnikrishnan. Around 460 kg of different wastes were collected of which about 240kg was plastic wastes. Discarded rubber foot wears was another major waste forming 103kg. Paper wastes and glass bottles was also present in large quantity. News on the beach cleaning activity was published in the daily regional newspapers such as Mathrubhoomi, Malayala Manorama and Desabhmani.

മാതൃഭൂമി

എടവനക്കാട്, മുനമ്പം ബീച്ചുകളിലെ പ്ലാസ്റ്റിക് മാലിന്യങ്ങൾ നീക്കം ചെയ്തു

11/06/2023 PARAVUR/VYPIN Pg 09

Fig.14.3.44. Newspaper report of beach cleaning activity on World Ocean Day 2023

6. INTERNATIONAL COASTAL CLEANUP DAY CELEBRATION

On International Coastal Cleanup Day, the Department of Marine Biology, Microbiology, and Biochemistry at CUSAT, in collaboration with the National Centre for Coastal Research (NCCR), CIFNET, and UC College, Aluva, organized a coastal cleanup at Fort Kochi Beach. Around 100 students and teachers gathered at Vasco de Gama Square on Saturday, September 16, 2023 Fort Kochi Beach, Kerala, India, ready to contribute to marine conservation.The event commenced with a presidential address by Dr. Sajeevan T P, Professor and Chief Coordinator of the cleanup, followed by Dr. Bijoy Nandan, Senior Professor and Dean, who welcomed the gathering and emphasized the urgent need to address marine litter and microplastic pollution. He highlighted the impact these pollutants have on marine ecosystems and stressed the critical importance of conservation.

Special guests, including MLA Sri. K J Maxi and Councilor Sri. Antony Kureethara, praised the students and faculty for their proactive efforts. They emphasized the value of such programs in raising awareness about plastic pollution and underscoring the urgent need to protect our oceans and biodiversity. Following these opening remarks, the participants moved to the beach and spent over an hour collecting approximately 40 gunny bags of waste, totaling around 480 kg. The majority of the waste consisted of plastic items, which were sorted and handed over to Plan@earth, an organization focused on environmental conservation, for responsible disposal. The initiative also saw participation from LitterLog, an AI-based system that monitors plastic pollution.

After the cleanup, participants took part in an awareness rally with placards and banners advocating for effective waste management and highlighting the pressing need to address marine litter, particularly plastic. The event sent a strong message about the significance of safeguarding our oceans and preserving marine biodiversity. CUSAT plans to expand this initiative, involving all departments to strengthen its impact and promote sustainable practices for a healthier ocean and a more secure future.

Fig.14.3.45. Team from CUSAT participated in Coastal cleanup activity in connection with International Coastal cleanup day

Fig.14.3.46. Volunteers from CUSAT engaging in cleanup activities

7. BEACH CLEANING ACTIVITY ON WORLD OCEAN DAY

As part of World Ocean Day, on June 8th 2024 Department of Marine Biology, Microbiology and Biochemistry in association with Ocean Society of India, conducted a beach cleaning activity at Puthuvypu Beach, Kochi, Kerala. About 100 students from Research Department of Fisheries and Aquaculture, St.Albert's College, Ernakulam; St.Teresa's College, Ernakulam; Sacred Heart College, Thevara; National Centre for Aquatic Animal Health, CUSAT and Association of Fisheries Graduates. also actively participated in the activity. The inauguration of the cleaning activity was done by the Vypin M.L.A Shri.K.V Unnikrishnan. 530 kg of different wastes were collected of which about 126 kg was plastic wastes. Discarded rubber foot wears was another major waste forming 256kg. News on the beach cleaning activity was published in the daily local newspapers such as Mathrubhoomi, Malayala Manorama and Desabhmani

Fig.14.3.47. Brochure of the beach cleaning activity on World Oceans Day


വളപ്പ് ബീച്ച് ശുചീകരിച്ചു

ലോക മഹാസമുദ്രദിനത്തോടനുബന്ധിച്ച് കൊച്ചി ശാസ്ത്രസാങ്കേതിക സർവകലാശാല സ്കൂൾ ഓഫ് മറൈൻ സയൻസസ്, ഓഷ്യൻ സൊസൈറ്റി ഓഫ് ഇന്ത്യയുമായി സഹകരിച്ച് വളപ്പ് ബീച്ച് ശുചീകരിച്ചു. കെ എൻ ഉണ്ണികൃഷ്ണൻ എംഎൽഎ ഉദ്ഘാടനംചെയ്തു.

സൊസൈറ്റി ഓഫ് മറൈൻ ബയോളജിസ്റ്റ്സ്, ഡിപ്പാർട്ട്മെന്റ് ഓഫ് മറൈൻ ബയോളജി, മൈക്രോബയോളജി ആൻഡ് ബയോകെമിസ്ട്രി, സെന്റ് ആൽബർട്സ് കോളേജ്, സെന്റ് തെരേസാസ് കോളേജ്, ഭാരത മാതാ കോളേജ്, സേക്രഡ് ഹാർട്ട് കോളേജ്, അസോസിയേഷൻ ഓഫ് ഫിഷറീസ് ഗ്രാജുവേറ്റ്സ് എന്നിവയും ഹരിതകർമസേനാംഗങ്ങളും ബീച്ച് ശുചീകരണത്തിൽ പങ്കാളികളായി. നൂറിൽപ്പരം വിദ്യാർഥികൾ പങ്കെടുത്തു.

ഓഷ്യൻ സൊസൈറ്റി ഓഫ് ഇന്ത്യ പ്രസിഡന്റ് ഡോ. എൻ വി കുര്യൻ, സ്കൂൾ ഓഫ് മറൈൻ സയൻസസ് ഡയറക്ടർ ഡോ. എ എ മുഹമ്മദ് ഹാത്ത, പ്രോഗ്രാം കോ-ഓർഡിനേറ്റർ ഡോ. പി പ്രിയജ, ഡോ. വിഷ്ണു വേണുഗോപാൽ എന്നിവർ സംസാരിച്ചു. എളങ്കുന്നപ്പുഴ പഞ്ചായത്ത് പ്രസിഡന്റ് രസികല പ്രിയരാജ്, വാർഡ് അംഗം സ്വാതിഷ് സത്യൻ എന്നിവർ പങ്കെടുത്തു.

Fig.14.3.48. Newspaper report of the beach cleaning activity on World Oceans Day

8. MAKE YOUR DEAL TO PROTECT THE OCEAN CAMPAIGN AND BEACH CLEAN UP

BEACH CLEAN UP in celebration of hashtag#worldoceansday was organised by Marine Stewardship Council (MSC) in association with Sustainable Seafood Network of India (SSNI) and Cochin University of Science and Technology (CUSAT) in Puthuvype Beach in Kochi, India. The Panchayath president of Elamkunnapuzha panchayath, MSC India Head Dr.Ranjit Suseelan, with Director School of Industrial Fisheries.

Fig.14.3.49. Brochure of make your deal to protect the ocean campaign and beach clean up

Fig.14.3.50. Volunteers participating on beach clean up activity

Fig.14.3.51. Beach cleaning at Puthuvype beach in Progress

Fig.14.3.52. Volunteers who actively participated in beach cleaning at Puthuvype beach

9. ZERO WATER EXCHANGE SHRIMP CULTURE SYSTEM WITH INTEGRATED DISEASE MANAGEMENT AND BIO-REMEDIATION.

This is a precise technology by which semi - intensive shrimp culture can be carried out without water exchange. Instead, the quality of culture environment is maintained through the application of bioaugmentors for detritus degradation, nitrification and denitrification and hydrogen sulphide removal. To maintain healthy intestinal flora, indigenously developed probiotic preparations are used. They are administered through diet by way of surface coatings. An integrated Disease Management protocol has been developed and extended and continuously provide technological support. Continuing Education programmes are being organized and farmers are trained in this process. The Centre is always opened to the farmers to address their issues having four technical personnels on board. The precise preventive health management products developed and extended to the farmers are:

A. Detrodigest (Detritus degrader)

One of the basic requirements of a successful bio-augmentation is the suitability of the microorganisms concerned in terms of their requirements for establishing in a region and to colonize and perform within a short period. The organism used for the preparation of Detrodigest is Bacillus cereus sensulato MCCB 101 (Genbank Acc. No. EF 062509) isolated from aquaculture fields of Kerala and subjected to rigorous screening procedures. Extensive field level demonstration and validation over a period of five years has been made in Kerala and Tamil Nadu to ascertain its suitability in shrimp culture systems and it has proved to be an appropriate preparation for prolonged and safe detritus management in any aquaculture systems.

Fig.14.3.53. Detrodigest

Fig.14.3.54. PS-1 & PS-4

An extensive study on the salinity preference of the organism in Detrodigest revealed its euryhaline nature by growing and adequately producing hydrolytic enzymes at all salinities tested ranging from fresh water to seawater (0 - 45 ppt). The organism in Detrodigest is highly versatile with the potential to produce a variety of enzymes such as protease, lipase, chitinase etc. Rapid degradation of detritus as soon as formed by Detrodigest makes more dissolved oxygen available at the pond bottom.As a result of the digestion of detritus, mineralization proceeds at faster rate resulting in phytoplanktion bloom, generally three days after the addition of Detrodigest. The bloom may remain for 10 days and for perpetual blooming repeated addition once in 10 days has been found to be fruitful. For effective colonization in a micro-ecosystem, the introduced organism must be in sufficiently large numbers. Economic considerations dictate brewing Detrodigest at farm site by the farmers themselves. Accordingly, 300-ml Detrodigest containing 109 -1012cfu/ml would be required to obtain sufficient cell count for one-hectare pond by brewing overnight in 100 L medium. This is provided in a solid for after immobilizing in a mineral base material to facilitate reaching the pond bottom.

B. PS-1 & PS-4 (Antagonistic probiotic for the control of pathogenic *Vibrio*)

PS – 1(Fresh Water) PS- 2 (Brackish) and PS-4 (Marine)are preparations aimed at fresh, brackish and marine environments. For fresh water application the product will contain Pseudomonas aeruginosa MCCB 102 (Genbank Accession no. EF 062514) for brackish, MCCB 117 (Genbank Accession no.EF 062511) for marine and MCCB 119 (Genbank Accession no. EF 062513) for freshwater systems. All are indigenous isolates from Indian waters. The organism produces a bioactive molecule, Pyocyanin, preventing the growth of pathogenic Vibrio present in aquaculture systems. The product is available in 100 and 300-ml bottles, which consists of 109 to1010Cells/ml, adequate to exclude luminescent bacteria from hatchery and grow out systems. The antagonistic molecule pyocyanin suppresses growth of Vibrio sp both in hatchery and grow outs. Increases survival rate of larvae.Improves overall health of the animal in grow out. PS – seriesis normally pale yellow in colour on storage, attains a green colour on shaking. The preparation has a shelf life of 180 days at room temperature.In hatchery the application of PS - series can be initiated from Nauplius stage onwards at a rate 100-ml/ ton water /day to get 106 cells/ml of culture water. For effective colonization in a micro-ecosystem, the introduced organism must be in sufficiently large numbers.

C. Enterotrophotic (Gut probiotic)

Enterotrophotic is a scientific blend of Bacilluscereussensulato (MCCB 101) (Genbank accession. no. EF 062509 and Arthrobacter nicotianae(Genbank accession no. EU402968). (MCCB 104) isolated from culture environment and characterized for application as gut probiotic. They control Vibrio in shrimp/prawn intestine by way antagonistic activity mediated by an extracellular anti-vibrio molecule and enhances feed acceptance and digestion by way of producing hydrolytic enzymes.The dosage has been calculated to make available each animal 1x103 CFU per animal on daily basis and it would be 20ml per Kg. Dilute the calculated quantity of Enterotrophotic with an appropriate binder gently mix with feed, shade dry for one hour and administer to the animal in such a way that the probiotic will be available to all animals.

Fig.14.3.55 Enterotrophotic (Gut probiotic)

D. NBC -0, NBC -15 and NBC -30 (Nitrifying bacterial consortium) (Nitrification - Removal of toxic ammonia through oxidation.

Overall shrimp health and survival is often hampered by high levels of ammonia and nitrite where unionized ammonia level more than 0.03 mg/L is toxic. Shrimp farmers often find it difficult to manage ammonia in the culture systems thanks to the inadequacy of the naturally occurring nitrification. In such instances beyond bio-stimulation, bioaugmentation has to be adopted. Besides, while nitrifying bioreactors have been designed the requirement of nitrifying bacteria to activate them arose. These two requirements lead to the development of nitrifying bacterial consortia by adopting enrichment technique. Accordingly, three categories of nitrifying bacterial consortia could be generated such as NCB -0, NCB -15 and NCB -30 to be applied in fresh, brackish and marine culture systems. Uniqueness of the consortia is that both nitrification and denitrification could be accomplished through one consortium and aerobic denitrification is a specialized phenomenon in nature. These consortia are generated in nitrifying bacteria production units and are provided for application in hatcheries, Recirculating aquaculture Systems and in aquaria. A specialized preparation ready to apply in grow out systems has also been made available.

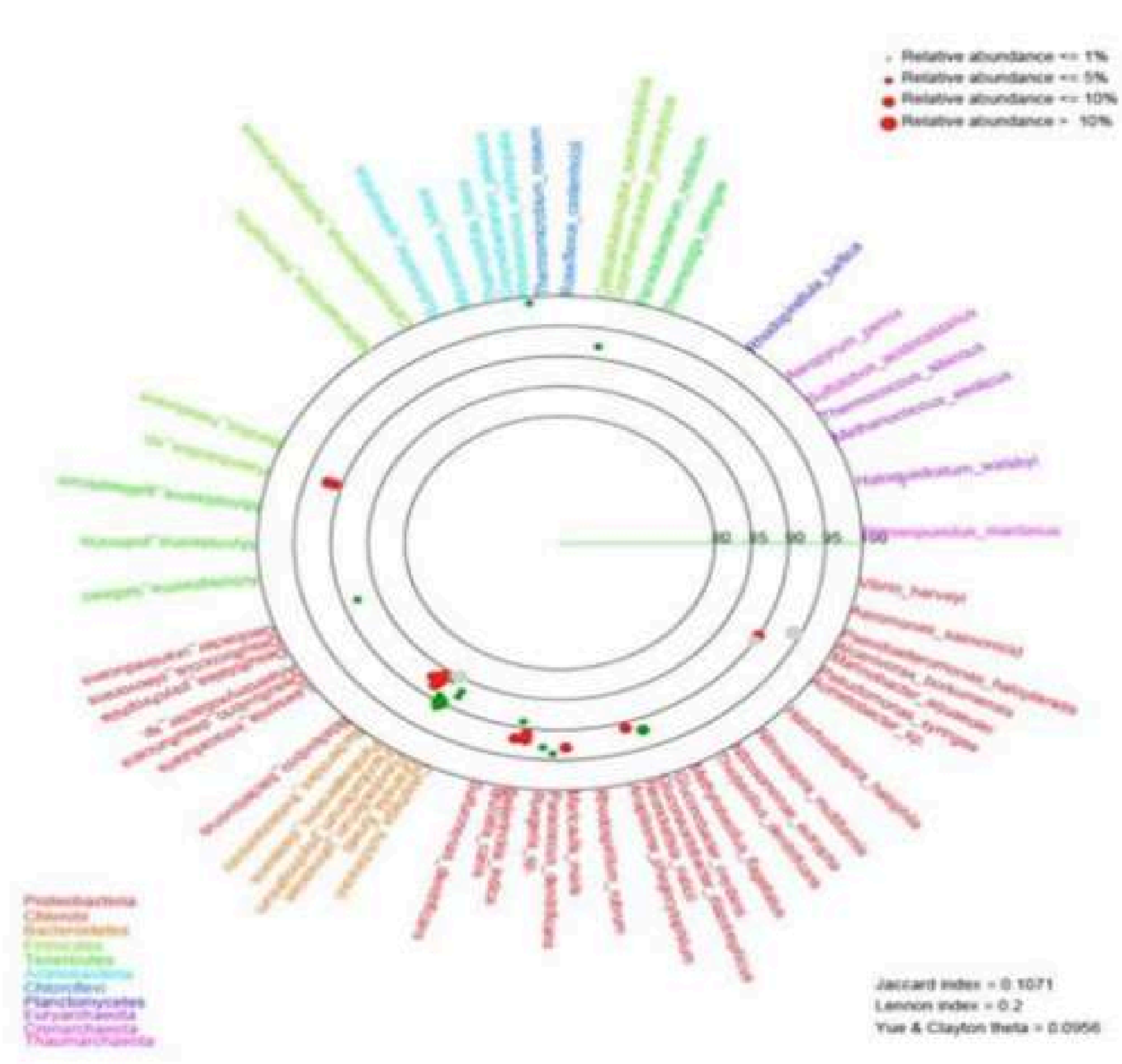

Fig.14.3.56. Phylum compostion and phytogenetic relationship of nitrifying bacterial consortia

E. PSB

Photosynthetic sulphur bacteria (*Rhodospeudomonas julia* MCCB147) (Removal of Hydrogen sulphide (Through oxidation). In aquaculture systems soil Eh has greater importance in the sense that when the Eh drops down below -150 mVolts hydrogen sulphide production takes place and if the hydrogen sulphide is allowed to get dissolved in to water H2S toxicity and consequent death will take place in the animals. Nature has its way of managing this eventuality by having a group of photosynthetic sulphurbacteria, which will grow at the pond bottom and absorb the emanating hydrogen sulphide and to oxidize it to Hydrogen ions and Sulphur. This hydrogen is used as the reducing power for fixation of carbon dioxide. In all aquaculture systems the required quantity and type of photosynthetic sulphur bacteria may not be available. In such cases bioaugmentation happens to be required for establishing H2S oxidation. *Rhodospeudomonas julia* MCCB147 has been identified as bioaugmenor and used as the ingredient of the product 'Hydrogen sulphide oxidizer' to be applied at the pond bottom through an applicator. Photosynthetic sulphur bacteria (*Rhodospeudomonas julia* MCCB147) (Removal of Hydrogen sulphide (Through oxidation).

Fig.14.3.57 Enterotrophotic (Gut probiotic)

In aquaculture systems soil Eh has greater importance in the sense that when the Eh drops down below -150 mVolts hydrogen sulphide production takes place and if the hydrogen sulphide is allowed to get dissolved in to water H2S toxicity and consequent death will take place in the animals. Nature has its way of managing this eventuality by having a group of photosynthetic sulphurbacteria, which will grow at the pond bottom and absorb the emanating hydrogen sulphide and to oxidize it to Hydrogen ions and Sulphur. This hydrogen is used as the reducing power for fixation of carbon dioxide. In all aquaculture systems the required quantity and type of photosynthetic sulphur bacteria may not be available. In such cases bioaugmentation happens to be required for establishing H2S oxidation. *Rhodospeudomonas julia* MCCB147 has been identified as bioaugmenor and used as the ingredient of the product 'Hydrogensulphideoxidizer' to be applied at the pond bottom through an applicator. The marine yeast Candida MCCF101 on administering through diet at the rate 106cfu g-1feed as surface coating enhances growth, feed utilization and disease resistance in finfish and shell fishes. It contained 30% protein, 36.5% carbohydrate, 1.52% lipid, 12.05% nucleic acid, 10.05% dietary fibre, 6.67% ash, and 16.16% total free amino acids with considerable amount of essential amino acids (valine, isoleucine, phenylalanine, histidine, methionine, arginine, threonine, lysine and leucine) and polyunsaturated fatty acid (linoleic acid 22.45%). This is available as 'MY- 1' at100 &300ml aliquots as live and in inactivated form.

G. 'Pm -1 *Picoclorum maculatum*' - Rich in PUFA and carotenoids

Marine picoalga'Pm -1 *Picoclorum maculatem* MACC3 has been identified 'as a rich source of polyunsaturated fatty acids, especially gamma linolenic acid, caroenodis and pigments. An optimized process was developed for the production and harvesting of this nutritionally rich microagal species and the safety of the microalgal biomass harvested through flocculation was evaluated by testing the cell cytotoxicity in human, fish and insect cell lines and was assessed safe. Pm -1 is now available as live feed for application in aquaculture

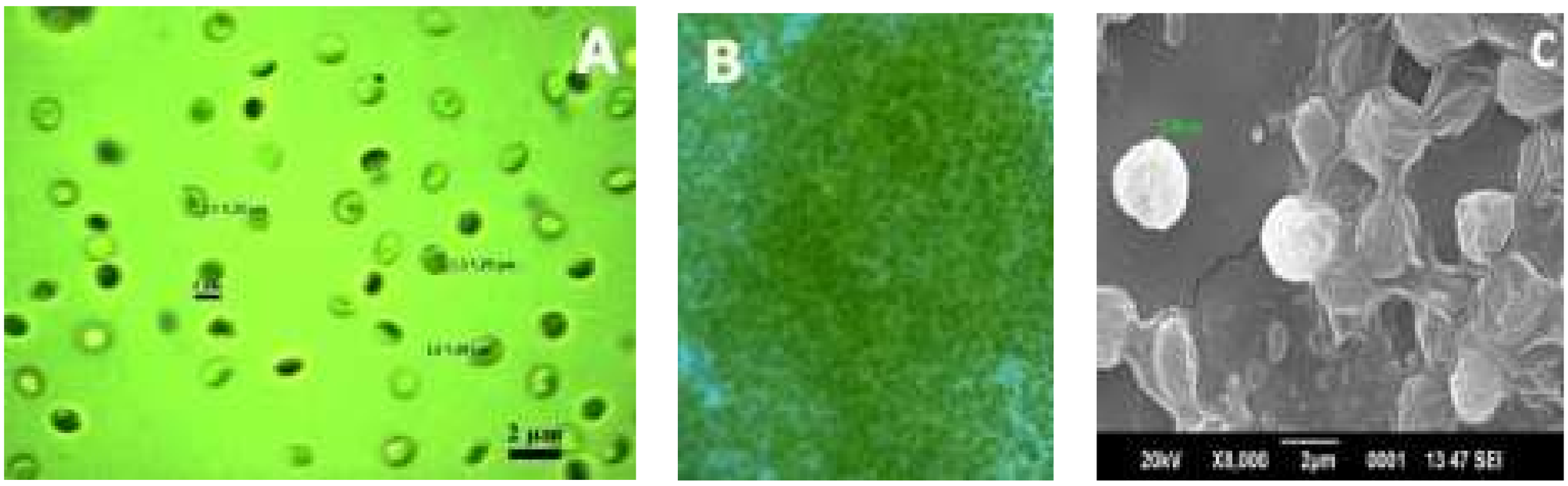

Fig.14.3.58 *Picochlorum macculatum* lightmicroscopic images of cells and concentrated biomass and scanning electron microscopic (SEM) images of cells and chitosan flocculated biomass

H. Garbactum

This is a blend of two strains of Bacillus and a strain of Pseudomonas having high order of hydrolytic potential to rapidly digest protein, lipids, carbohydrates, cellulose, chitin and other compounds of plant and animal origin. The bioaugmentor is provided in 300 ml aliquots which need to be diluted and sprayed over the garbage.

Fig.14.3.59 Garbactum