

**INTERNATIONAL CONFERENCE ON
FRONTIERS IN MARINE SCIENCES**

MARICON-2024
ABSTRACT VOLUME



**SCHOOL OF MARINE SCIENCES
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
8-10 APRIL 2024**



**INTERNATIONAL CONFERENCE ON
FRONTIERS IN MARINE SCIENCE CHALLENGES AND PROSPECTS
MARICON 2024**

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Jointly Organized by

School of Marine Sciences

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Message

Analyses by the Intergovernmental Panel on Climate Change (IPCC) and numerous researchers have highlighted global concerns for marine resources and ecosystems. The primary threats to these vital components of Earth's biosphere stem mainly from industrialization and anthropogenic activities. It is notable that the country boasts over 7500 kilometers of coastline, enriching it with vast marine diversity and opportunities.

Significant advancements in ocean observations and services, such as the Potential Fishing Zone service and Ocean State Forecasts, have been made by Indian institutions including the Indian National Centre for Ocean Information & Services (INCOIS), the National Centre for Coastal Research (NCCR), the Centre for Marine Living Resources & Ecology (CMLRE), and in ocean technology by the National Institute of Ocean Technology (NIOT). Furthermore, the Deep Ocean Mission is progressing in its noble quest to uncover the vast unknowns of the ocean and ensure the sustainable exploration of its resources, both living and non-living.

In addition to these research and development efforts, it is vital to maintain sensitivity towards coastal cleanliness and ecological conservation. It is heartening to see public engagement in these initiatives, particularly evident in the ministry-coordinated clean-up program held on International Coastal Clean-up Day (the third Saturday of September each year), which has emerged as arguably the world's largest coastal clean-up campaign, drawing enormous numbers of volunteers to the cause.

I am extremely delighted to note that the School of Marine Sciences at the Cochin University of Science and Technology (CUSAT) is organizing the International Conference on Frontiers in Marine Sciences (MARICON 2024) from April 8-10, 2024. This event not only celebrates the 86-year legacy of the School of Marine Sciences at CUSAT but also offers an excellent platform for leading marine scientists, research scholars, and students within the country to engage in discussions, share knowledge, and explore the latest scientific developments in the field of marine sciences.

I extend my heartfelt congratulations to CUSAT for organizing this important international conference and wish MARICON 2024 every success.

M. Ravichandran
(M. Ravichandran)



Preface

School of Marine Sciences, Cochin University of Science and Technology (CUSAT) is one of its kinds school in the country offering all branches of marine sciences such as Marine Biology, Marine Geology and Geophysics, Physical Oceanography, Chemical Oceanography and Atmospheric Sciences under the same umbrella. This offers an excellent platform for interdisciplinary learning of marine sciences. No wonder, the alumni of the school of marine sciences are decorating high offices in all the marine science institutions across the country.

The International Conference on Frontiers in Marine Sciences 'MARICON-2024', is the second edition of highly successful MARICON-2019, which was held during December 16-20, 2019 at the Lakeside Campus of School of Marine Sciences. Although we decided to organize this as a biennial event, COVID-19 imposed restrictions did not allow us to go ahead with such a plan. However, we kept the idea alive and planned for this event for the last two years which is culminated into the genesis of MARICON-2024.

As in the case of MARICON-2019 we had an overwhelming response to the call for participation in MARICON-2024. We have received more than 400 abstracts for presentation under various theme areas. In fact, MARICON-2024 provides several cross cutting research areas under various themes in marine sciences. Being a highly interdisciplinary branch of science, we have identified 26 focal themes under marine sciences to provide an opportunity for every marine science researcher to participate and deliberate in the discussions. We are indeed thankful to all those responded to us in a very short time by way of submitting their abstracts for presentation.

The scientific sessions MARICON-2024 are ranging from Marine Biodiversity and Conservation to Air-Sea interactions and Regional Climate Modeling; Tropical Marine Ecosystems to Polar Oceans, Offshore Geomarine Resources to Lithospheric Studies and Geodynamics; Ocean Observation Systems to Monsoon Prediction and Predictability; Coastal Processes and Estuarine Dynamics to Submarine Ground Water Discharge and Mapping; Advancements In Aquaculture to Aquatic Animal Health and Management; Marine Bioprospecting and Drugs From The Sea etc. to mention a few. It was a herculean task to categorize the large number of abstracts spreading across wide ranging areas. Our research scholars and students with guidance from the faculty toiled hard to realize this task in double quick time. We are immensely thankful to each one of them.

Besides the scientific abstracts of poster and oral presentations, this abstract volume also includes the abstracts of plenary, keynote and invited lectures. We hope that this compilation of abstracts in a book form will be of great use to the researchers in the field of marine sciences. We take this opportunity to thank everyone involved in this humble effort of bringing this Compendium of Abstracts of MARICON 2024 a reality.

(Editorial Board)



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PLENARY SESSION



POLAR WARMING AND TROPICAL LINKAGES

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The polar regions are a critical component of the Earth's climate system and have complex, non-linear linkages with low latitudes through the ocean and atmosphere. They are also very sensitive to global changes. While both the Arctic and West Antarctica have experienced dramatic changes during recent decades during a time of increasing global mean temperature, the relative roles of local versus remote forcings on such changes are not well understood. In a rapidly changing world, the two-way linkages between the poles and tropics can play key roles in the climatic evolution of these sensitive regions. Such tropical–polar teleconnections operate on a range of timescales and are found to have a dominant role through Rossby wave dynamics. Recent studies have highlighted that a rapid decline in Arctic sea-ice during recent decade is increasing extreme precipitation events over India. Further, studies have suggested that intensification of cyclones over the Arabian Sea is concurrent with the positive phase of Warm Arctic - Cold Eurasia features. Although recent studies have contributed greatly to our understanding of polar–tropical teleconnections, many aspects of these linkages remain poorly understood and require further study using a combination of observational, model and proxy-based climate records.

Keywords: Polar climate, climatic evolution, Rossby wave dynamics



COLOUR, CARBON AND CLIMATE

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The most common product available from satellite-based ocean-colour data is chlorophyll concentration. It is an important ecological property of aquatic ecosystems and provides the basis for computations of primary production at the global scale. At the same time, in a climate-change context, there is much emphasis on biologically-mediated carbon pools and fluxes. To meet both ecological and climate-related needs, it therefore becomes useful to track the dynamics of both carbon and chlorophyll at large scales. In this presentation, some recent developments in deriving satellite-based estimates of biological pools and fluxes in the oceanic mixed layer will be discussed. The approaches are combined with the time series of ocean-colour data from the Climate Change Initiative of the European Space Agency to examine trends in data over the last two and a half decades. The work was carried out as part of the ESA BICEP project.

Keywords: *Climate change, carbon pool, biological pool, chlorophyll*



EMERGING TRENDS IN MARINE BIODIVERSITY DOCUMENTATION AND CONSERVATION: GLOBAL SCENARIOS AND INDIAN PERSPECTIVES

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The predominant metric for assessing biodiversity, known as species richness, is estimated to be approximately 242,000 within marine ecosystems worldwide, as reported by the World Register of Marine Species (WoRMS). Of this total, India contributes around 20,000 species, as indicated by data aggregated from the Zoological Survey of India (ZSI) and the Ocean Biogeographic Information System – Indian Ocean Node (OBIS-IndOBIS). Globally, the annual rate of discovery for new marine species stands at approximately 2,332, whereas in India, this figure is less than 100. Typically, newly described marine species conform to global trends, with a focus on smaller-sized benthic crustaceans and molluscs, often lacking molecular data support. Given the current pace of discovery and characterization, it's anticipated that several centuries may pass before the remaining unknown marine species are catalogued. The accessibility of literature will be increasingly crucial, with retired professionals and citizen scientists expected to make significant contributions to marine taxonomy. Challenges in describing new marine species encompass various factors, including technological constraints in accessing hard-to-reach habitats, the need for training in molecular barcoding, and institutional barriers such as limited funding for taxonomic research and regulatory complexities. While future marine biodiversity research could target lesser-known species in unexplored environments like deep-sea habitats and seamounts, and organisms engaged in various associations, there's a pressing demand for a robust interactive database. Additionally, national collaboration between organizations is essential to share trained taxonomic manpower and establish a comprehensive repository of marine species. While the primary goal of biodiversity science is to document unknown species, urgent attention is required to conserve species facing multiple threats. Understanding patterns of biodiversity, including measures such as alpha, beta, and gamma diversity, has been a focal point for biologists for centuries, albeit hindered by the typically slow and meticulous nature of traditional taxonomic tools. This paper highlights the intricate links between marine biodiversity and the UN Sustainable Development Goals, emphasizing the need for holistic approaches to ocean conservation and sustainable development. By acknowledging the interplay between conservation endeavours and socio-economic priorities, it offers insights for policymakers and stakeholders to develop integrated strategies that promote both marine well-being and human welfare in a rapidly evolving world. Moreover, it explores how emerging technologies like omics, AI, and ROVs can be leveraged, alongside collaborations with flagship international programs, to better understand the rich biodiversity heritage of the country. Further, there is an urgent need to mainstream biological diversity into natural capital accounts and to provide the required research support to save life below water, to achieve the targets set for the UN SDGs.

Keywords: Marine biodiversity, Conservation, UN SDGs



AEROSOLS OVER THE INDIAN OCEAN: AN ICARB EXPERIENCE

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In the last two decades, extensive field campaigns over the oceanic regions surrounding the Indian subcontinent have been carried out to understand the spatio-temporal heterogeneities of physical, chemical, and optical properties of marine aerosols. The Integrated Campaign for Aerosols, gases and Radiation Budget (ICARB) under ISRO – Geosphere Biosphere Program (ISRO – GBP) was the major field experiment for aerosol characterisation over the South Asian region. The main component of the ICARB was observations onboard research vessel, ORV Sagar Kanya, supported by observations from a network of aerosol observatories over Indian sub-continent and aircraft based measurements from selected locations. The first of the series was conducted during the pre-monsoon season of the year 2006 (ICARB-2006) covering both the Arabian Sea and the Bay-of-Bengal. The second one of the series was conducted during the winter of 2009 (W-ICARB) over the Bay-of-Bengal. The latest of the series was conducted during the winter of 2018 (ICARB-2018), aiming at the microphysical properties of the continental outflow of aerosols over the Arabian Sea and equatorial Indian Ocean associated with the north-eastern winds in winter. ICARB has brought out several unique results on aerosols over oceanic regions around India. The first time observations on (1) the meridional gradient in elevated aerosols over Indian region, (2) significant zonal and meridional gradient in the aerosol induced lower atmospheric heating rate across Indian peninsula, (3) the surprisingly high anthropogenic aerosol fraction in southern Bay of Bengal, (4) role of ocean biogeochemistry and anthropogenic emissions in the secondary aerosol formation over the marine regions, (5) role of new particle formation in the cloud condensation nucleation efficiency, (6) mixing state of the continental outflow to the oceanic regions ...etc are the outcome of ICARB.

Keywords: ICARB, aerosols, Arabian Sea, Bay of Bengal



FISHERIES FOR FOOD SECURITY AND SUSTAINABLE LIVELIHOOD

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Fish is a highly nutritious source of protein and essential nutrients. It is one of the most efficient converters of feed into high-quality food. Fish also provides income and livelihoods for communities across the world. Fish is more nutritious than staple plant foods, providing high levels of animal protein, health-promoting long-chain fatty acids (LC-PUFAs), and micronutrients. It can play a crucial role in improving the nutritional status of individuals, especially those at risk of malnutrition, such as children and pregnant women. Fish is high in essential vitamins and minerals that can help alleviate micronutrient deficiencies, childhood stunting, and health conditions like cardiovascular disease, high blood pressure, gestational diabetes, and anaemia. India's contribution to global fisheries and aquaculture was impressive, with a share of 8%, making it the third-largest contributor in terms of aquatic animals and plants globally. India became the world's top producer of inland capture fisheries, producing 1.8 million metric tons. India is also the second-largest inland aquaculture producer and the fourth-largest producer among global capture fisheries in the world. In marine capture fisheries, India ranked fifth, contributing 5% to the global marine catch. In terms of total volume, India is the third-largest fish consumer after China and Indonesia. Fish production in India surged 115%, reaching 14.164 million metric tons, with a compound annual growth rate (CAGR) of 5.63%. Domestic consumption of fish accounted for 83.65% of total production. Annual per capita fish consumption increased from 4.9 to 8.89 kg, an increase of 3.99 kg (81.43%) with a growth rate of 4.05%. The fisheries sector is a sunrise industry with potential for addressing the demands of domestic consumption and export. However, it faces challenges including depleting fish stocks, lack of access to facilities, and poor management practices. Sustainable and responsible fish farming practices are crucial to address these issues. The demand side also plays a role in promoting responsible consumption practices. Policy support and collectivization of fish farmers and fishers can improve access to investments, infrastructure, technology, inputs, and markets. The fisheries sector has the ability to create livelihood opportunities for millions of people and hence has a significant role to play in the socio-economic development of the nation.

Keywords: *Fisheries, Food Security, Sustainable development*



KEY NOTE



MIGRATING ARCTIC TERNS DO CONNECT ARCTIC AND ANTARCTIC

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Arctic Terns are world champions of bird migration, flying every year from the Arctic (where they breed) to the Antarctic (where they winter). Geolocators with light profile registration have made it possible to track these birds during migration, with daily positions as long as there is a day and night and as long as it is not too close to the equinox. There was a big difference in the route of terns breeding in The Netherlands and terns breeding on Svalbard. The recorded routes have been analysed for the wind support experienced during migration. Using IPCC climate models, this wind support was also predicted in the future.

Keywords: Arctic Tern, Geolocators, Migration



CARBON TO CARBON CREDITS

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The marine environment covering a large expanse of the coastal ecosystem is experiencing accelerated GHG (greenhouse gas) emissions of carbon dioxide (pre-industrial: 260-270 ppm, post-industrial: 415 ppm), methane (pre-industrial: 722 ppb, post-industrial: 1866 ppb), and nitrous oxide (pre-industrial: <280 ppb, post-industrial: 334 ppb) associated with rising temperature and warming scenarios, giving rise to a host of other challenges, including environmental degradation, eutrophication problems, natural disasters, extreme weather events, food and water insecurity, economic disruptions, etc. The larger functionality of marine and coastal wetlands is to perform as repositories of carbon sinks, but is seriously getting hampered by various actions in the Anthropocene. As one-third of the world's population is directly linked to the diverse marine environment for their livelihood, but degradation of these ecosystems may critically alter the socio-economic balance. Furthermore, it heightens the risks of irreversible damage to marine ecosystems in the temperate as well as in the tropics. Addressing these challenges is not only crucial for preserving the intrinsic value of our marine systems but also for developing effective policies and practices to combat climate change. The utilization of marine environments for carbon sequestration presents a promising avenue for mitigating greenhouse gas emissions and addressing climate change. This research work explores the concept of harnessing carbon sequestration mechanisms inherent in marine ecosystems, such as mangroves, seagrasses, and algae, to generate carbon credits. By examining the biological and physical processes involved in carbon storage within marine environments, along with the policy frameworks governing carbon credit systems; this study elucidates the potential for monetizing marine-based carbon sequestration efforts. This is essential for securing the well-being of future generations and maintaining balance in our ever-changing world.

Keywords: Carbon credit, Marine Environment, Climate change



MODELLING OF LAND SURFACE OVER THE INDIAN REGION

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In the first part of the lecture, the study evaluates the uncertainty in soil moisture estimates using the five different forcing precipitation data sets from the: Global Data Assimilation System (GDAS), Tropical Rainfall Measurement Mission (TRMM)-Multi-satellite Precipitation Analysis (TMPA), Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks-Climate Data Record (PERSIANN-CDR), Global Precipitation Mission (GPM), and Indian Meteorological Department (IMD) gridded data, over the Indian domain using the Noah land surface model within the NASA Land Information System (LIS). The simulations are conducted using the five different precipitation data sets over the Indian subcontinent for 3 years from 2012–2014. The simulation results are compared with the weekly soil moisture station data available from the IMD for different depths. Results indicate that the LIS-Noah soil moisture estimates forced with IMD rainfall agreed better among the five simulations with IMD in situ data. In the second part of the lecture, the study evaluates the improvement of soil moisture estimates obtained from Noah LSM by ingesting them with the satellite-derived Advanced Scatterometer (ASCAT) soil moisture retrievals over the Indian domain for the year 2012, using the LIS. The improved soil moisture estimates are validated with the in-situ India Meteorological Department (IMD) soil moisture observations and also with the high-resolution Indian Monsoon Data Assimilation and Analysis (IMDAA) regional reanalysis data. The percentages of grid points over the Indian domain where the improvement parameter shows positive values are 59.14% (winter), 69.17% (pre-monsoon), 43.59% (monsoon), and 77.53% (post-monsoon). Furthermore, the forecast impact parameter also indicates the positive impact of data assimilation. Also, 12 of the 22 stations show reduced RMSE soil moisture error after data assimilation is performed while only 6 of the 22 stations show higher correlation coefficient in soil moisture without data assimilation, when validated with the in situ IMD soil moisture observations. The study has also evaluated the irrigation impact of ASCAT in the assimilated soil moisture using triple collocation (TC) method. For the TC analysis, the model-based Global Land Data Assimilation System (GLDAS), Catchment Land Surface Model (CLSM), and MERRA (Modern-Era Retrospective analysis for Research and Applications) Land data set together with soil moisture model outputs with and without ASCAT assimilation are used to calculate the error and correlation coefficient of each of the two set of triplets. The results of the TC analysis further conclusively show the positive impact of irrigation effects in the ASCAT-assimilated soil moisture model output.

Keywords: Land information system, Advanced scatterometer, Global data assimilation system



DESIGN OF AN AUTOMATED SYSTEM FOR ONLINE/UNDERWATER ANALYSIS OF INTRACELLULAR AND EXTRACELLULAR ANTIMICROBIAL RESISTANCE GENES (IARGS AND EARGS)

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Extra-cellular and intracellular antimicrobial resistance genes (eARGs and iARGs) are among the most complex emerging biological contaminants of interest in freshwater and marine environments. In terrestrial environment, effluent from wastewater treatment plants represents the most important source for these ARGs. Their prevalence in marine environment is of interest to assess its background diversity of ARGs and their spread. At present, monitoring techniques for most of the known ARGs is expensive and require in-lab sample processing leading to limited spatial and temporal measurements. Our team has been developing field-deployable molecular analysis devices and approaches for eDNA for dozens of waterborne pathogens, antimicrobial resistance genes, invasive species, and genes related to specific functions such as nitrogen cycling and harmful algal blooms. Currently, we have validated qPCR and isothermal assays for more than 350 marker genes related to antimicrobial resistance, and dozens of invasive species of interest. We have leveraged direct amplification (without cell lysis) greatly simplifying the measurement approach under field conditions. We are currently engaged in designing and validating an online monitoring device employing microfluidic chips capable of automatically analyzing 96 ARGs (both iARGs and eARGs) simultaneously using isothermal techniques. The chip may also include primers targeting indicators of waterborne pathogens likely to be present in surface waters due to anthropogenic activity and eDNA for dozens of invasive species. The analytical module will also be integrated with an automated water sampling system for continuous monitoring and connected to a network for data sharing and control. When fully developed and field-validated, the platform will allow automated analysis of ARGs in freshwater and marine environments.

Keywords: Antimicrobial resistance, Nitrogen cycling, Harmful algal blooms, ARGs



MARINE ORGANISMS IN VARIOUS ENVIRONMENTS AND MIGRATORY
ECOLOGY OF FISH IN TEMPERATE REGIONS: EXAMPLE OF SADO ISLAND,
SEA OF JAPAN

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Marine environment is various among regions. One of major characteristics of it in temperate regions is seasonal fluctuation. Seasonal changes such as water temperature, wave actions, light condition and winds affect marine organisms and their ecology, life cycle and distribution. Sado Island located in northern Japan have various geographic features like rocky shore, sandy beaches, brackish lake, and many small streams, where have various aquatic organisms in each environment. Seasonal changes of plankton fauna are related to high water temperature and strong warm ocean current in summer, and heavy cold wind and high waves in winter. Coastline is inhabited by benthic animals such as barnacles and oysters as well as their planktonic larvae. Various environments in Sado Island would play a role of high biodiversity there in comparison with those of close area in mainland Japan. Small freshwater streams are habitats of aquatic migratory animals such as fish, shrimps, and snails. Aquatic animals in offshore island streams should be descendant of migratory organism. Many of them have migratory life history, though it is costly. There are many fish in streams on Sado Island even though it is a relatively small offshore island, streams are steep and small, and some streams are ephemeral. Our study showed almost of all stream fish in Sado Island have migratory life cycle and unique sympatric habitat utilization with microhabitat differences. They would have unique ecology in relation to aquatic environmental characteristics in Sado Island. Overall, ecology of aquatic organisms and environments are closely related.

Keywords: Sado Island, Plankton, Seasonal fluctuation, Microhabit



ECOTOXICOLOGY AND MONITORING OF POLLUTANTS IN THE MARINE ENVIRONMENT

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Since the turn of the century, a number of manmade activities have contaminated the marine environment daily, which finally results in a loss of marine biodiversity. One major source of pollution for the maritime environment is land-based activity. Once in the marine ecosystem, contaminants have the potential to change chemically or biologically, to accumulate or even to become larger. Hence, the fate and transport of pollutants significantly influence the ecotoxicological impacts in the marine environment. The ecotoxicology of pollutants mainly depends on the physico-chemical and biological agents in the ecosystem. The marine contamination is mostly caused by heavy metals, plastics, POPs, radioactive materials, and other toxins like contaminants of emerging concern. The entire biota is in danger due to this massive maritime pollution. There are various monitoring techniques for the pollutants in the marine environment such as chemical monitoring, biomonitoring, bioindicators and biomarkers. Various new technologies are also available to monitor marine contamination.

Keywords: Ocean, Toxics, Pollution, Sediment, Biota



NEGATING THE HOAX AROUND THE BLUE ECONOMY FROM THE CHALLENGES IN ECOSYSTEM CONSERVATION TO SUSTAINABLE UTILISATION OF RESOURCES

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The Blue Economy, in its very concept, promises global prosperity through the sustainable utilisation of ocean resources. However, beneath this glittering cover, there lies numerous intricate challenges that can put at risk the ecosystem health and resource sustainability. This paper discusses the complexities surrounding the paradigm of the Blue Economy, addressing issues such as regional cooperation, sectoral coverage, blue economy accounting, and global consensus on ocean conservation. The Blue Economy's reliance on activities such as intensive fishing, shipping, offshore energy production, mining and extraction activities can lead to the overexploitation of marine resources, depleting fish stocks, damaging critical habitats, increasing pollution, and disrupting ecosystems. This can lead to the loss of biodiversity, including the decline or extinction of marine species, disrupting ecosystem functioning and resilience, displacement of coastal communities and traditional fishing practices, and affecting livelihoods and cultural heritage. The multifaceted challenges and considerations inherent in the Blue Economy paradigm can be overcome through the dynamics of regional partnerships in the sustainable development of marine resources. This necessitates collective attempts among neighbouring nations and stakeholders to mitigate conflicts over resource utilisation and promote shared prosperity. Furthermore, sectoral collaborations should develop a viable Blue Economy framework, recognising its borderlines on the sustainable exploitation of diverse marine sectors. The opportunities and challenges of shifting from fishing and shipping to emerging sectors like renewable energy and marine manufacturing may create sectoral nuances, which need to be solved through strategies for maximising economic gains while safeguarding marine ecosystems. Adopting advanced accounting methodologies and accurate valuing practices for marine resources, which suit the unique characteristics of marine ecosystems, has to be developed and provide policymakers and stakeholders for evaluating the economic viability and sustainability of blue economy initiatives. By developing the appropriate international agreements, conventions, and collaborative initiatives, the efficacy of existing mechanisms in addressing transboundary challenges such as marine pollution, overfishing, and habitat degradation can be revamped. Weak regulatory frameworks and inadequate governance mechanisms can exacerbate the negative impacts of the Blue Economy by allowing unsustainable practices, further degrading marine ecosystems and biodiversity. Pivotal opportunities like the declaration of the UN Decade of Sustainable Ocean Development and SDG 14 can leverage the agenda of ocean conservation by involving primary stakeholders. By creating a global framework under the ambit of ocean development, equitable opportunities in blue industries and collective responsibility in the sustainability of marine ecosystems can be maximised thereby drawing a delicate balance between economic growth and environmental preservation. The cornerstone for solving the complexities and judicious implementation of the Blue Economy practices therefore demands regional cooperation, sectoral collaboration, innovative approaches to valuation, international agreements, and leveraging global initiatives.

Keywords: Regional cooperation, Blue industries, sectoral coverage



ECOSYSTEM ECOLOGY OF SOME FASCINATING BIOLOGICAL FEATURES IN THE INDIAN SEAS

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It is generally believed that Earth's mighty oceans are even more mysterious than outer space. The majority of the earth's surface is covered by water, but 95% of our oceans remain still unexplored. Comprehensive research by combining satellite remote sensing, physics, chemistry, and biology of the ocean, has significantly improved our understanding of the marine ecosystem functioning. Advancements in research methodologies have provided a lot of opportunities to understand the biophysical interactions in the ocean on different spatial and temporal scales. This lecture essentially provides a glimpse into the advantage of the ecosystem ecology approach to understand some fascinating biological features in Indian seas especially those associated with the mudbank of Kerala and the Gulf of Mannar Marine Biosphere Reserve.

Keywords: Mudbank of Kerala, Gulf of Mannar biosphere reserve, Marine biodiversity



THE KUNMING-MONTREAL GLOBAL BIODIVERSITY FRAMEWORK (GBF) AND MARINE BIODIVERSITY CONSERVATION IN INDIA

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Around 17% of humanity now live in India of which six percent reside in the coastal zones. The rapid population growth and associated anthropogenic impacts particularly evident in India's coastal and marine regions, has necessitated an urgent need to improve the state of knowledge on biodiversity to develop and implement effective conservation mechanisms. The Kunming-Montreal Global Biodiversity Framework (GBF) has chalked out an ambitious plan to implement broad-based action to transform our societies' relationship with biodiversity by the year 2030 - much of this in line with the 2030 Agenda for Sustainable Development and the Sustainable Development Goals. The GBF has 23 global targets for urgent action for the year 2030, with several of them explicitly concerning marine ecosystems, their biodiversity and conservation. These include among others the restoration of 30% of degraded marine and coastal ecosystems, effective protection of 30% of marine and coastal areas, and ensuring zero extinction of threatened species. The effective adoption and implementation of the GBF will however require a concerted effort from a wide range of stakeholders. This presentation will provide an overview of the GBF with regard to marine biodiversity conservation in India, and assess the preparedness and challenges for its effective implementation.

Keywords: *Global Biodiversity Framework Biodiversity, conservation, Sustainable Development*



RECENT ADVANCES IN MARICULTURE: FOCUS ON SHELLFISH AND FINFISH SEED PRODUCTION

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Mariculture, a vital subset of aquaculture, is gaining prominence in India's coastal regions due to its significant contributions to food security, economic growth, and employment opportunities. Global aquaculture production reached a record of 122.6 million tonnes in 2020, of which aquatic animals contributed 87.5 million (USD 264.8 billion) and 35.1 million tonnes of algae (USD 16.5 billion). Of this, 68.1 million were from marine and coastal aquaculture, and the remaining were from inland waters. Of the 17.54 million tonnes contributed by marine and coastal molluscs, most of which come from the non-fed aquaculture of marine bivalves (16.2 million tonnes) (FAO 2022). Amidst the global surge in aquaculture production, India's coastal aquaculture sector emerges as a crucial player, accounting for a substantial share of marine and coastal molluscs and other aquatic animal products. Employing over 2.8 crore fishers and fish farmers, India ranks among the top three fish-producing nations globally, underscoring the sector's pivotal role in the country's Gross Value Added (GVA) and agricultural GVA. Fish and fish products have currently become one of the leading categories in agricultural exports from India, reaching an all-time high marine export earnings of Rs. 63,969 crores in the year 2022-23, with a significant portion contributed by shrimp farmed in coastal ponds. Despite its potential, current mariculture production in India remains modest. Initiatives led by institutions like the ICAR-Central Marine Fisheries Research Institute (CMFRI), RGCA and ICAR-CIBA, CSIR-CSMCRI have laid foundations for mariculture development, yet substantial room for growth exists. Significant progress has been achieved recently in the seed production of shellfish species like oysters, mussels, and clams, alongside finfish varieties such as snapper, and emperor breams. Additionally, advancements have been made in the seed production of various ornamental fishes, including clownfish, damsels, and anthias species. By leveraging successful practices from inland and brackish water aquaculture, India can strategically enhance mariculture production. Diversification of cultivated species, including finfishes, shellfishes, ornamental fishes, and seaweeds, alongside the adoption of sustainable farming practices, is imperative to maximize productivity. Furthermore, addressing socio-economic disparities and uplifting marginalized fishing communities are critical objectives. India's extensive coastline and inland water resources offer vast potential for expanding and improving coastal aquaculture. To harness this potential sustainably, strategic policy interventions, technological innovations, and capacity-building initiatives are essential. By prioritizing inclusive growth, environmental stewardship, and food security, India can realize the transformative potential of mariculture in its coastal regions.

Keywords: Mariculture, shrimp, gross value added, ornamental fish



GEOSPATIAL TECHNOLOGY FOR EARTH SYSTEM SCIENCES

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Geospatial technology plays a pivotal role in Earth System Science by providing tools and methods to analyze, visualize, and understand the complex interactions between various components of the Earth system. Earth System Science aims to comprehend the interconnectedness of the atmosphere, hydrosphere, biosphere, geosphere, and anthroposphere, and geospatial technology offers a multidimensional perspective crucial for achieving this goal. At its core, geospatial technology involves the collection, analysis, and interpretation of spatial data related to Earth's surface and its features. This technology encompasses a wide range of tools and techniques, including Geographic Information Systems (GIS), remote sensing, and Global Positioning System (GPS). Satellite-based remote sensing platforms provide valuable data on land cover, vegetation health, ocean temperatures, atmospheric composition, and other environmental parameters. These data enable scientists to track changes over time, identify patterns, and assess the impacts of natural processes and human activities on the Earth system. GIS, on the other hand, facilitates the integration and analysis of various geospatial datasets. By overlaying layers of information such as topography, land use, and climate data, GIS allows researchers to identify spatial relationships and patterns that contribute to a deeper understanding of Earth's dynamics. GIS also plays a crucial role in spatial modelling, allowing scientists to simulate and predict future scenarios based on different environmental variables and scenarios. In Earth System Science, geospatial technology is also instrumental in disaster management and mitigation. From monitoring and early warning systems for natural disasters like hurricanes, earthquakes, and wildfires to assessing the vulnerability of communities to climate change-induced events such as sea-level rise and extreme weather events, geospatial technology helps policymakers and emergency responders make informed decisions to protect lives and property. Furthermore, geospatial technology supports research in fields such as ecology, hydrology, climatology, and geology by providing spatially explicit data and analytical tools. For example, in ecology, GIS and remote sensing are used to study habitat fragmentation, species distribution, and biodiversity patterns. In hydrology, these tools aid in watershed modelling, flood mapping, and groundwater management. Geospatial technology also contributes to climate studies by monitoring greenhouse gas emissions, analysing climate patterns, and projecting future climate scenarios. Overall, geospatial technology serves as a powerful toolset for Earth System Science, enabling researchers to explore the interconnectedness of Earth's subsystems, assess environmental changes, and develop strategies for sustainable resource management and resilience-building in the face of global challenges such as climate change and natural hazards. As technology continues to advance, the integration of geospatial data and analysis techniques will play an increasingly vital role in advancing our understanding of the Earth system and informing evidence-based decision-making for a more sustainable future.

Keywords: Geospatial technology, Climate change, Sustainable future



LATE QUATERNARY STRATIGRAPHY AND CHRONOLOGY OF COASTAL SEDIMENTS OF SOUTH INDIA: IMPLICATIONS OF SEA LEVEL AND TECTONICS

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Various late Pleistocene- Holocene beach deposits have been identified in Kerala and Tamil Nadu at the coasts of South India. The remnants of former sealevel high stands at the coasts of south India are generally scarce, usually represents either last interglacial (-120 ka) or mid Holocene eustatic maximum. The outcrops at the coasts of Tamil Nadu are located few meters above sea level and the ones at the coasts of Kerala are found 2-3 m below present day sealevel. The deposits in the east coast of Tamil Nadu represents medium to coarse moderately sorted sand with sub-horizontal or gently sea-ward dipping stratification. The outcrop consists of ~7.0 m thick succession of alternating cross laminated quartzitic conglomerate with intervening sandy lenses, which are capped by aeolian sand deposits. An intermediate layer and a basal layer contain cemented coarse sand, gravel with abundant bivalve shells and other molluscs. Based on stratification and presence of shells, it may be formed in the upper shoreface or foreshore settings. A poorly sorted consolidated unit of medium to coarse grained sand with gravel unit along with cross stratified troughs and hummocky stratification shows that this may have formed in the upper shore face facies where wave reworking occurs. The samples collected at distinct sedimentary units have shown OSL ages of 6 ± 1 ka for the upper aeolian unit, followed by 24 ± 1 ka for the marine sequence and 53 ± 4 ka for the basal gravel layer. The third section had given an age of deposition during 31 ± 1 ka and 102 ± 8 ka. Coastal wetlands occurring at the central part of Kerala between $10^{\circ}15' - 10^{\circ}30' N$; $76^{\circ}05' - 76^{\circ}20' E$, forms the northern end of the South Kerala Sedimentary Basin. The general stratigraphy in the coasts of Kerala comprised of aeolian sediments in the upper part, followed by fluvial/alluvial sand, inter-tidal deposits and marine- marginal marine sediments. The sections display lenticular bedding within the mudflat sediments at 3 m depth and invertibrate shells within the grey sandy clay to clayey stratum at variable depth (between 6- 11m). OSL dating of marine- marginal marine sediments at various depth yielded two sets of ages; 3.2 ± 0.2 and 10.2 ± 1.2 ka and 40.4 ± 4.7 and 44.3 ± 3.2 ka. Radiocarbon dating of shells yielded ^{14}C age of 4800 ± 80 yr (PRL-3382) and >40 ka BP (PRL No.3363). The shell samples collected shows that their deposition has occurred in a shallow marine-marginal marine conditions. The emergence of the coast may be attributed to higher sealevel stand that had occurred in the area during this time or due to late Quaternary tectonic deformation in the area.

Keywords: Pleistocene- holocene beach deposits, sea level, radiocarbon dating



PARADIGM SHIFTS IN DISASTER MANAGEMENT CONCEPTS – AN OVERVIEW

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The traditional approach to disaster management, centred on reactive responses to crises, is facing unprecedented challenges in the wake of the increasing frequency and intensity of disasters worldwide. A paradigm shift is underway, heralding a transition towards proactive resilience strategies. This presentation explores the critical elements of this paradigm shift and its implications for disaster management practices. Central to the paradigm shift is a reorientation towards risk reduction and preparedness, emphasising the importance of preventive measures to mitigate vulnerabilities and enhance community resilience. This proactive approach encompasses a range of activities, including risk assessment, early warning systems, and capacity building, aimed at reducing the likelihood and severity of disasters. Moreover, the new paradigm prioritises inclusivity and participation, recognising the vital role of local communities, marginalised groups, and civil society organisations in decision-making processes. By incorporating diverse perspectives and local knowledge, disaster management efforts become more contextually relevant and sustainable. Interdisciplinary collaboration lies at the heart of the paradigm shift, fostering holistic approaches that acknowledge the complex interplay of social, economic, environmental, and technological factors in shaping disaster risk. By leveraging advancements in technology and innovation, such as remote sensing and data analytics, stakeholders can enhance risk assessment, early warning, and response capabilities. Crucially, the paradigm shift advocates for adaptive management practices that embrace uncertainty and promote continuous learning. By monitoring and evaluating interventions and incorporating lessons from past experiences, stakeholders can iteratively improve disaster management strategies, ensuring their effectiveness and relevance in dynamic contexts. In conclusion, the paradigm shift in disaster management represents a fundamental reimaging of approaches to resilience-building, emphasising proactive, inclusive, and adaptive strategies. Embracing this shift promises more effective and sustainable responses to the multifaceted challenges posed by disasters, ultimately fostering safer and more resilient communities.

Keywords: Disaster management, Sustainability, resilience-building



BIOSURFACTANTS: ECO-FRIENDLY SOLUTIONS FOR POLAR SCIENCE AND SUSTAINABLE DEVELOPMENT

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Biosurfactants, encompassing compounds like rhamnolipids, lipopeptides, sophorolipids, and polysaccharides, are natural surface-active agents produced by diverse microorganisms and marine organisms, lauded for their environmentally friendly attributes and multifunctional properties related to industrial applications. In marine ecosystems, an array of organisms, including algae, bacteria, fungi, yeast, and marine plants, have been identified as potential biosurfactant producers. These biomolecules exhibit versatile surface-active properties, rendering them apt for applications spanning bioremediation to enhanced oil recovery. Other than marine oil pollution scenarios, biosurfactants emerge as important agents in curtailing environmental degradation resulting from oil spills. Their adeptness in emulsifying hydrophobic compounds like crude oil accelerates the biodegradation process by enhancing oil accessibility to hydrocarbon-degrading microorganisms. Beyond their remedial functions, biosurfactants serve diverse industrial sectors encompassing pharmaceuticals, food, cosmetics, and agriculture. Their biodegradable nature, low toxicity, and renewable sourcing position them as appealing substitutes to synthetic surfactants across a wide spectrum of applications. In Polar Science, biosurfactants play a crucial role due to their unique properties and the challenges posed by extreme environments. Polar regions, characterized by low temperatures and harsh conditions, are particularly vulnerable to environmental disturbances, including oil spills. Biosurfactants offer promising solutions for mitigating these challenges in polar ecosystems. Their ability to function effectively under cold temperatures makes them valuable tools for combating oil pollution in polar waters and coastal areas. Moreover, the presence of diverse microorganisms in polar environments, such as psychrophiles and extremophiles, provides a rich source of biosurfactant-producing strains. These organisms have adapted to survive in extreme cold and are capable of producing biosurfactants with specialized properties tailored to polar conditions. Additionally, the biodegradable nature of biosurfactants is advantageous in polar environments where ecosystem resilience is crucial for long-term sustainability. Furthermore, biosurfactants find applications beyond remediation efforts in Polar Science. They can facilitate the dispersion of pollutants, enhance nutrient availability, and promote microbial activity in cold environments, thereby contributing to ecosystem restoration and maintenance. Additionally, their potential use in polar industries such as biotechnology, pharmaceuticals, and bioremediation align with the growing need for sustainable solutions in these regions. Overall, the inclusion of biosurfactants in Polar Science underscores their significance as versatile compounds with the potential to address environmental challenges and support sustainable development in polar regions.

Keywords: Biosurfactant, psychrophiles, extremophile



CLIMATE CHANGE IMPACT ON INDIAN SUMMER MONSOON AND CHARACTERISTICS OF EXTREME RAINFALL EVENTS

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This study investigates the impact of climate change on Indian Summer Monsoon Rainfall (ISMR) and analyses the characteristics of extreme rainfall events (EREs) across India. Utilizing multiforcing ensemble projections from a high-resolution global climate model, we examine various global warming scenarios. Under each scenario, the model is forced with four patterns of future sea surface temperature (SST) change, derived from a combination of mean SST changes projected by approximately 28 coupled ocean-atmosphere models and subgroups identified through cluster analysis of tropical SST changes. Our findings indicate a projected increase in surface air temperature and rainfall across India, with the exception of a reduction in rainfall over the Western Ghats (WG) region. We identify enhanced atmospheric water vapor content and increased low-level moisture transport as primary contributors to the intensification of ISMR. Projected reduction in rainfall over WG is found to be associated with a drastic reduction in the southwesterly winds and moisture transport into the region. This reduction is accompanied by a weakening of the summer mean meridional circulation and diminished vertical velocities. Our analysis indicates that these changes result from larger warming in the upper troposphere relative to the surface and lower levels, leading to a decrease in the lapse rate. Consequently, there is an increase in vertical moist static stability, inhibiting vertical ascent in response to global warming. The increased stability weakens vertical velocities ultimately reducing large-scale precipitation, which is a major contributor to summer mean rainfall over the WG orographic region. This is further corroborated by a significant decrease in the frequency of moderate-to-heavy rainfall days over the WG, indicative of the decrease in large-scale precipitation in this area. Therefore, the drastic reduction in vertical ascent and weakening of circulation due to the ‘upper tropospheric warming effect’, predominates over the ‘moisture build-up effect’ in reducing the rainfall over this narrow orographic region. This analysis illustrates that monsoon rainfall over mountainous regions is strongly controlled by processes and parameterized physics that need to be resolved with adequately high resolution for accurate assessment of local and regional-scale climate change. Analysis of extreme events indicates a rise in both warm days and nights, accompanied by a steady increase in extreme rainfall events from low to high emission scenarios. Furthermore, the utilization of a high-resolution model allows for a detailed examination of projected changes at homogeneous zones across India. Consistent with the overall increase in rainfall, extreme rainfall events also show a uniform rise across these zones. Changes in extreme rainfall intensities can be attributed to the Clausius-Clapeyron relationship, highlighting the influence of warmer atmospheric states. Particularly, very extreme rainfall events (vEREs) exhibit significant sensitivity to enhanced temperatures, suggesting potential implications for future climate scenarios. Additionally, our analysis underscores the complex interplay between altered radiative forcing, atmospheric stability, and moisture content on precipitation intensity. We anticipate a shift towards more convective clouds and alterations in circulation patterns, contributing to future changes in EREs during the Indian summer monsoon season.

Keywords: Indian Monsoon, Climate Change, Rain fall



KAVARATTI: AN INDIA-LED APPROACH TO COUNTER CLIMATE CHANGE

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Accelerating Global Warming demands viable solutions that suit the Global South, with Indian leadership. The Glitter Belt approach is to gradually but directly reduce insolation planetwide using ultralight solar-powered, reflective UAV swarms operating continuously in the mid-stratosphere. This has been shown viable, practical, and uniquely suited to mapping remote ocean atmosphere. Any proactive method must be vetted against criteria set out by the UN and National Academies. The 1st requirement of transparency and stakeholder information is met through over 27 peer-reviewed publications and media presentations since 2017. The second requirement is scientific validation via detailed Climate simulations and predictions, to verify absence of harmful effects. Such simulations need continuous mapping of data planetwide for a few years, including remote oceans that are till now inaccessible except by satellites with low resolution and short transit times. The Kavaratti Project is to demonstrate continuous mapping of atmospheric and ocean surface data over Lakshadweep Sea and Indian coastline, as prelude to mapping from high altitude (30 km) planetwide. Climate data acquisition coincides with vehicle flight testing until and after nations scale up the system. The first test vehicle is nearing flight at ePlane Co. near IIT Madras, preceding progression to autonomous flight of an 8m span “Flying Leaflet” (FLT) with 400km daily range. This FLT is the nucleus for 72m span reflector “Flying Leaf” vehicles that remain airborne indefinitely. This presentation (with video and physical model), summarizes research to-date, and describes design and dynamic flight simulation. It suggests planned sensor suites and measurement strategies. We will discuss a Polar Necklace plan to strengthen sea ice around the Antarctic coastline, as well as expansion path to stop and reverse Global Warming. The presentation is to inform local technical community including Coast Guard and Navy, along with Meteorology academic experts and enthusiastic students, who are cordially invited to participate.

Keywords: Sunlight reflection, Lakshadweep Sea Meteorology, Antarctica, Global Sout



Polar Sciences



LATITUDINAL AND VERTICAL DISTRIBUTION OF PROKARYOTIC COMMUNITIES IN THE WESTERN ARCTIC OCEAN AND ITS POSSIBLE CLIMATE CHANGE LINK

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The Arctic Ocean is experiencing rapid environmental changes due to global warming. This has led to a significant decrease in the extent and thickness of Arctic Sea ice, and this is being accelerated, particularly during the summer season. The Arctic Ocean water column is unique, with distinct water mass layers. The western Arctic Ocean, the oceanic region that has Pacific water within the halocline depth, has experienced the most rapid sea ice retreat driven by heat transport from the Pacific water inflow. The melting and retreat of ice cover led to strong environmental gradients in terms of salinity, temperature, and light penetration with increasing depth. The physico-chemical changes in the water column have implications for vital biological processes, leading to ecosystem-wide impacts from surface to abyssal depth. The environmental alterations in the Arctic Ocean have significant implications not only on the hydrographic and physicochemical conditions of the ocean but also on the structure and functioning of the ecosystem. To understand the impact of sea ice decline and increased Pacific water inflow on the microbial ecosystem of the Arctic Ocean, microbial community structure and distribution have been studied using amplicon and metagenomic based approaches. The results of the latitudinal distribution study revealed that Pacific water, dominated by chemoheterotrophic populations, can alter the microbial community composition of the Arctic Ocean, which has higher oligotrophic and chemoautotrophic populations. Chemoautotrophic populations are being replaced by heterotrophic populations when sea ice melts and Pacific water inflow increases. A total of 23 bacterial phyla were detected in the surface seawater, which is dominated by phylum Proteobacteria. The vertical distribution of microbial communities showed a clear stratification with significant differences among different water depths, and the water masses in the Arctic Ocean appeared as a major factor explaining their distribution in the water column. A total of 34 bacterial phyla were detected across the water column. Oligotrophic heterotrophic bacteria were dominant in the surface waters, whereas chemoautotrophic and mixotrophic bacterial and archaeal communities were abundant in deeper waters.

Keywords: Western Arctic Ocean, Amplicon sequencing, metagenomics, Chemoautotrophs, Mixotrophs



DISTRIBUTION OF DIAZOTROPHS IN THE WESTERN ARCTIC OCEAN

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The Arctic Ocean is critically influenced by the recent environmental perturbations due to climate change. As a consequence, the Arctic Sea ice extent is declining at a rapid pace during the past decades and is anticipated to increase in the coming future. The melting of sea ice exposes the underlying water column to higher light intensities, which in turn enhances the primary production of the ecosystem. Nitrogen generally acts as a limiting nutrient for primary production in the Arctic Ocean and is supported by fixing up of nitrogen by diazotrophs. To assess diazotroph diversity and identify the specific phylotypes that might be unique for the Arctic environment, we chose a targeted analysis of the *nifH* gene, coding for the iron protein of the nitrogenase enzyme. A total of 638 OTUs of diazotrophic communities are detected from 32 samples. Diazotrophs in the coastal water of western Arctic Ocean revealed the presence of diazotrophs (N₂ fixing bacteria) and showed significant spatial and vertical variations in the surface and deep-water water communities. Cluster I cyanobacterial communities includes UCYN-A (*Candidatus Atelocyanobacterium*) were the dominant diazotrophic bacterial communities in the surface and DCM waters in the near coastal waters and cluster III Desulfuromonadaceae and Clostridiaceae and were dominant in deep Arctic waters. Diazotrophic communities in the surface waters are dominated by cyanobacterial diazotrophs and in the deep Arctic waters are dominated by delta-proteobacterial heterotrophic diazotrophs. Diazotrophic communities in the Western Arctic Ocean were controlled dissolved inorganic nitrogen (DIN) and nitrogen to phosphorous (N:P) ratio.

Keywords: N₂ fixation, Arctic, Betaproteobacteria, Western Arctic Ocean



SPATIO-TEMPORAL VARIABILITY IN MASS BALANCE AND DYNAMICS OF HIGH ARCTIC VALLEY GLACIER VESTRE BROGGERBREEN, SVALBARD

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Most of the high Arctic valley glaciers have been experiencing enhanced melting during last two decade in response to ongoing global warming. Vestre Broggerbreen, a valley- glacier of Svalbard covering 4.6 km² areas has been monitored during 2011 to 2018 to understand the changes in glacier behaviors due to ongoing climate change. Mass-balance investigations show that the ice masses have been steadily decreasing during 2011-2019. There was no single positive balance year observed during 2011-2019. The estimated mean specific net balance was -0.70 ± 0.14 m w.e. per year with overall cumulative balance of -5.59 w.e. for studied period. The glacier lost almost 2.57×10^7 metric tons of ice mass during eight years period. The observation shows a potential control of winter accumulation and summer snow events on net mass balance of this glacier however there is no clear sign of climatic warming through increased melting. ELA has significantly increased and reduce the Accumulation Area Ratio (AAR) of the glacier. An inverse - relation has been observed between ELA and annual mass balance. Further there is no trend observed for Snow Water Equivalent (SWE) too during studied period. The trend analysis of eight years data revealed an imbalance condition of glacier with decrease of the winter balance (less accumulation) and slightly increase in summer balance (more ablation). There are no significant changes revealed in surface velocity either in accumulation or ablation zone ranges from 2-9m/y. The lower terminal shows little accelerated loss during last three years of studied period but statistically not significant. Observation indicated a positive correlation between snout retreat and retreat of the boundary between the warm- and cold-based ice. A comparative study with Austre Broggerbreen shows that the net balance is slightly increasing and become more negative than decade ago. Zero net balance would be obtained if the winter precipitation increased about 40% to 50%, it may also get by lowering temperature by 0.8°C -1°C.

Key word: Mass balance, Surface flow, ELA, Arctic, Svalbard



ARCTIC SEA-ICE HARBOURS DISTINCT PROKARYOTIC COMMUNITY STRUCTURE AND ECOLOGICAL FUNCTIONS ACROSS THE CENTRAL ARCTIC OCEAN

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Sea-ice is considered one of the largest biomes on the planet, covering about 13% of Earth's surface. However, over the last two decades, the Arctic summer sea-ice extent and thickness have reduced drastically in the Arctic Ocean. The reduction in Arctic Sea ice cover is shown to have cascading effects on the entire Arctic marine ecosystems with direct implications for the planetary albedo and ocean stratification. In the present study, we have investigated the prokaryotic community structure and functions among the sea ice cores collected from three different geographical locations (North Pole, Amundsen Basin and Nansen Basin) in the Central Arctic Ocean. The full-length 16S rRNA amplicon sequencing through Oxford Nanopore Technologies revealed distinct profiles of prokaryotic community structure among the three sea ice stations. The taxonomic classification revealed that sea-ice core samples were comprised of 10 bacterial phyla, 146 different genera, and 205 species with different relative abundance profiles. Taxa belonging to Proteobacteria were mainly dominant in North Pole ice stations, while cyanobacterial taxa were more predominant in the Nansen and Amundsen ice stations. The genome-resolved metagenomics approach yielded about 28 metagenome-assembled genomes (MAGs) from the three ice stations. The microbial metabolic functions associated with carbon, nitrogen and sulfur cycles were also found to be different among ice stations.

Keywords: Sea-ice, Central Arctic Ocean, Amplicon sequencing, Genome-resolved metagenomics, Oxford nanopore, Biogeochemical cycles



Spatial Distribution, Fate and Possible Sources of Mercury in the Lacustrine System of Schirmacher Hills, East Antarctica

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Mercury (Hg) demonstrates exceptional global persistence due to its extended atmospheric residence time. This prolonged atmospheric lifespan facilitates long-range transport and ubiquitous environmental distribution, raising concerns about potential Hg accumulation and ecological impacts even in pristine environments like Antarctica. Previous Antarctic Hg research has primarily focused on environmental occurrence. Despite recent advancements, significant knowledge gaps persist regarding the environmental fate of Hg in Antarctic terrestrial ecosystems. Existing literature indicates that Antarctic environments and surrounding regions have historically exhibited relatively low mercury contamination compared to other geographical areas worldwide. Hence, comprehending the sources and transformations of mercury in Antarctica is crucial for predicting how environmental changes, such as emissions and climate change, might affect the mercury cycle. The present study examined the total mercury (THg) concentrations in surface sediments of the lacustrine system in Schirmacher Hills to determine their spatial distribution. The results showed that THg concentrations in these lacustrine sediments were less than 5.0 ng/g. These values fall considerably lower than THg levels reported from previous Antarctic sediment studies. Even though the presence of research stations like Maitri (India) and Novolazarevskaya (Russia), anthropogenic Hg inputs appear negligible in the Schirmacher Hills. This is evidenced by the observed THg concentrations in surface sediments falling well within established guidelines set by the World Health Organization (WHO) and the US Environmental Protection Agency (USEPA). However, adhering to the Antarctic Treaty System's and the Indian Antarctic Act's commitment to environmental protection necessitates continued monitoring and impact assessment. This includes tracking potential anthropogenic influences, such as Hg contamination. Such a comprehensive approach is crucial for ensuring the long-term health of this pristine ecosystem, especially considering the evolving threats of Hg contamination under a changing Antarctic environment.

Keywords: Mercury, East Antarctica, Lacustrine Sediments



AN IMPROVED METHOD TO INCREASE SNOW MAPPING ACCURACY IN HIGH-ALTITUDE WETLANDS USING REMOTE SENSING

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Snow being one of the critical components of hydrological cycle in high-altitude terrains, whose massive, rapid flow under the influence of gravity causes severe damage to the natural environments. In India, though occurrence of snow is limited to higher altitudes of the Himalayas, snowmelt water plays a major role in the water supply sector. Further, the snow apron of the region is getting reduced over the years due to global warming and climate change. Although the monitoring/mapping of snow cover was difficult earlier, the advent of remote sensing technology has made the mapping more precise and easier in recent years. The separation of floating ice from water in snow-covered regions has always been challenging due to the close similarity in the spectral characteristics of snow and water. Considering all these, an effort has been made to formulate a modified normalized difference snow index (MNDSI) with improved efficiency in mapping snow and floating ice from water in the lake areas located in higher altitudes using the spectral bands of visible region and near infra-red region. The new index has been tested at high-altitude lakes; a high-altitude lake located in the Leh district of Ladakh. The performance of the new index has been compared with the commonly used snow indices such as the Normalized Difference Snow Index (NDSI), Normalized Difference Snow and Ice Index (NDSII), and Difference Snow Index (DSI) and validated for two other sites located in high altitude region namely Tso Lhamo and Tso Kar wetland. Qualitative and quantitative analyses were adopted to evaluate the performance of the MNDSI. The overall agreement values of above 96% and F1 score of 0.97 are obtained for MNDSI. The comparative analyses of results with other three indices indicate that MNDSI is a promising alternative for snow cover mapping in high altitude lakes.

Keywords: *Snow cover, Polar regions, snow index, high altitude lakes*



TRACE METAL DISTRIBUTION AND METAL TOLERANT BACTERIAL DIVERSITY ASSOCIATED WITH A GLACIO-MARINE SYSTEM IN ARCTIC

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The long-range transport of pollutants especially metals, via atmospheric and oceanic circulation along with localized anthropogenic influence have contributed to their release and accumulation in various Arctic ecosystems. In the present study, we assessed the background trace metal concentrations and the metal tolerant bacterial fraction associated with an Arctic glacier and fjord system by enrichment with metals such as Hg, Pb, Cd, Ni, Co, Zn, and Mn. Higher trace metal concentrations were noted in the sediments as compared to the water samples. The highest values of Hg (90.9 µg/Kg), Pb (7.9 mg/Kg), Cd (0.2 mg/Kg) were observed in the outer fjord sediment KNS1 while the highest concentration of Ni (40.8 mg/Kg) was noted in the glacier sediment VB and Co (13.2 mg/Kg), Zn (223.9 mg/Kg), and Mn (362 mg/Kg) were noted in the glacier foreland sediment BR. It was also evident that the Kongsfjorden samples yielded the highest total retrievable bacterial counts in different metal amendments as compared to the glacier samples. The dominant metal tolerant bacterial fraction belonged to the class γ -proteobacteria (45%), α -proteobacteria (19.8%), and Actinobacteria (15.8%). Species belonging to the genus *Pseudomonas* were noted from all the sampling locations and all the metal amendments suggesting their inherent metal resistance properties. The presence of *merA*, *czcA*, *czcC*, and *czcD* genes in the metal tolerant bacterial fraction from the terrestrial and fjord samples indicated that metal resistant genes (MRGs) are prevalent even in environments with limited anthropogenic influence. Further, the multiple antibiotic resistance noted for metal tolerant isolates, especially towards the β -lactams and penicillin, implied the co-occurrence of genes for antibiotics and metal resistance within their genomes. Thus, the study indicates that the local Polar microbiota could harbor naturally occurring metal resistant genes and antibiotic-resistant genes which could further be potentially transmitted in the ecosystem.

Keywords: Trace metal; metal tolerant bacteria; glacier; fjord; antibiotic



UNPRECEDEDNTED CHANGES IN THE WEDDELL SEA MAXIMUM SEA ICE EXTENT IN 2023: ROLE OF ATMOSPHERIC CIRCULATION ANOMALIES AND POLAR STORMS

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In recent years, Antarctic Sea ice has experienced a notable decline since 2016, contrasting with modest growth over the previous four decades. This study examines the influence of polar storms on the significant reduction of sea ice extent (SIE) in the Weddell Sea during the seasonal ice maximum period in September 2023. The Antarctic SIE maximum on 7 September represented the lowest annual maximum in the satellite era, with substantial contributions from the Ross (37.7%) and Weddell (32.9%) Seas. An exceptionally deep Amundsen Sea Low and its eastward shift led to strong northerly flow with record wind anomalies ($> 12 \text{ ms}^{-1}$) across the Weddell Sea in autumn, resulting in extreme atmospheric temperatures and forcing the ice edge to remain southward of its mean position. Despite climatologically maximum rate of ice growth in May; May 2023 saw a large reduction in growth rate, contributing to the exceptionally low SIE. Moreover, during the ice growth period, episodes of slow ice growth or even ice retreat occurred during the passage of several polar storms. Notably, the largest retreat occurred in June following the development of a poleward moving storm with an extreme atmospheric river. The study suggests that the SIE decline in Weddell Sea was influenced by a combination of storm-induced dynamic processes (poleward propagation of swells, wind waves, and ice drift) and thermodynamic processes (poleward influx of atmospheric heat and moisture from the south Atlantic Ocean, coupled with ocean mixed layer warming). Atmospheric circulation anomalies in September 2023 were associated with El Niño and negative Southern Annular Mode. Overall, the Antarctic SIE has undergone remarkable fluctuations, with frequent record lows.

Keywords: Sea Ice, Climate Change, Weddell Sea, Antarctica



AN ENVIRONMENTAL MAGNETISM APPROACH FOR SOILS AND SEDIMENTS OF SCHIRMACHER OASIS, EAST ANTARCTICA

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Environmental magnetism helps in understanding the properties of iron-bearing minerals present in soils and sediments, which provides information on the environmental processes, governing their transportation, deposition, and alteration. The present study provides insights into the mineral magnetic properties and their relationship to weathering processes occurring under the extreme conditions of Schirmacher Oasis, East Antarctica. Environmental magnetic analysis was carried out for the surface sediments ($n = 50$) and soil samples ($n = 78$) collected from Schirmacher Oasis to identify the mechanisms that control the formation and distribution of the iron oxide minerals. Low-field magnetic susceptibility (X_{lf}), indicative of the concentration of magnetic minerals, shows a mean value of $109.5 \times 10^{-8} \text{ m}^3 \text{ kg}^{-1}$ for the soil samples and $126.376 \times 10^{-8} \text{ m}^3 \text{ kg}^{-1}$ for the sediment samples, suggesting the presence of magnetically strong minerals. The frequency-dependent susceptibility (X_{fd}) and the percentage frequency-dependent susceptibility ($X_{fd}\%$) are indicative of the presence of superparamagnetic (SP) grains, hence they are indicative of the degree of pedogenesis. $X_{fd}\%$ remains $< 2\%$ for most of the samples, indicating the absence of SP grains. The parameter XARM/SIRM, reflective of the magnetic granulometry show mean values of $53.1 \times 10^{-5} \text{ mA}^{-1}$ for soil and $49.66 \times 10^{-5} \text{ mA}^{-1}$ for sediment samples indicating the predominance of coarse-grained magnetic minerals. Statistically significant correlation between X_{lf} and SIRM for the soil ($r=0.786$, $p<0.05$, $n=78$) and sediment samples ($r=0.679$, $p<0.05$, $n=50$) reflects the dominance of ferrimagnetic grains in the samples. The parameter S-ratio represents the proportions of minerals with low and high coercivity. Most samples show S-ratio ranging from 0.97 to 0.99, demonstrating that low coercivity magnetic minerals regulate the magnetic signal. The various interparametric ratios revealed the absence of bacterial magnetite, anthropogenic magnetite, and authigenic greigite, suggesting that the magnetic minerals are formed due to weathering processes in the region.

Keywords: Magnetic properties; Ferrimagnetic minerals; weathering; Schirmacher Oasis; Antarctica



CARBON POTENTIAL AND BLUE CARBON CONTRIBUTION OF MEIOBENTHIC NEMATODES IN THE ARCTIC KONGSFJORD

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Situated on the western shores of Spitsbergen Island within the Svalbard archipelago at 79°N 12°E, Kongsfjord serves as a vital site for monitoring CO₂ levels, given the heightened impact of global warming in the Arctic. With atmospheric carbon levels soaring by 30% over the past century and a half, addressing this trend is paramount to combatting climate change. Benthic carbon storage emerges as a promising avenue for climate mitigation, despite lingering uncertainties regarding its ecological consequences. Within this framework, meiofauna, particularly nematodes, assume a pivotal role in the intricate dynamics of carbon cycling, essential for sustaining ecosystem health. Data and samples for the present study were collected during Arctic expeditions conducted in 2015, 2016, and 2017. The study aimed to assess the carbon potential of individual nematodes and quantify the total carbon sequestered by nematodes within the Arctic Kongsfjord. Among the 72 nematode species identified, *Anticoma eberthi* exhibited the highest carbon potential at $13.96 \pm 3.05 \mu\text{g mg}^{-1}$, followed by *Marylynnia complexa* ($12.94 \pm 1.05 \mu\text{g mg}^{-1}$) and *Prooncholaimus obtusicaudatus* ($11.26 \pm 2.03 \mu\text{g mg}^{-1}$). Conversely, *Desmolorenzia* sp. and *Viscosa glabra* recorded the lowest values at $0.012 \mu\text{g mg}^{-1}$ and $0.04 \mu\text{g mg}^{-1}$, respectively. Upon the death of nematodes, their carbon content contributes to the fjord bed as blue carbon. The cumulative blue carbon contribution over the three years amounted to $16376.04 \mu\text{g}/10\text{cm}^2$, with 2015 exhibiting the highest contribution ($5709.88 \pm 1256.44 \mu\text{g}/10\text{cm}^2$), followed by 2016 ($5383.70 \pm 1124.35 \mu\text{g}/10\text{cm}^2$), and 2017 showing the lowest ($5282.46 \pm 998.5 \mu\text{g}/10\text{cm}^2$). Remarkably, no significant temporal variation in carbon contributions was observed across the three years, suggesting a stable blue carbon sequestration potential of nematodes in Arctic marine ecosystems over time. This study highlights the anticipated contribution of nematode-sequestered carbon to the "Blue Carbon Economy," emphasizing the multifaceted approaches to carbon sequestration and the potential economic benefits therein.

Keywords: Carbon Potential, Blue Carbon, Meiobenthos, Nematodes, Kongsfjord



BIOMASS BURNING CONTRIBUTION TO THE ARCTIC BLACK CARBON

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Black carbon (BC) is emitted from the incomplete combustion of carbonaceous material, fossil fuel and biomass burning (BB). Black carbon absorbs short-wave radiation and is the second largest contributor to global warming after carbon dioxide. Deposition of BC in snow reduces the surface albedo and further contributes to the rise in temperature due to the positive warming feedback effect. The Arctic is warming at an alarming rate, three to four times faster than the global average warming rate, known as Arctic amplification. In the last few years, intensive forest fires in the nearby regions have been a concern of biomass burning contribution to the Arctic black carbon. The source and contributor to the BC mass concentration are still not much understood in the Arctic. In this study, Biomass burning contribution to BC mass (BB%) over the Arctic station Ny-Ålesund (78.9°N , 11.9°E) has been investigated. BC mass concentration and BB% were measured using a seven wavelength Aethalometer (model AE-33). The highest median value of BC was observed in Spring (55 ng m^{-3}), and the lowest was in Autumn (15 ng m^{-3}). Biomass burning contribution to BC mass (BB%) was found to be the maximum in Summer (35%) and the lowest in Autumn (15%). In Spring, elevated concentrations of BC may result from long-range transport from lower latitudes. Additionally, low precipitation during this period contributes to the persistence of these aerosol pollutants, further amplifying the concentration of BC. Reduced long-range transport and wet scavenging are responsible for lower BC mass concentration during Autumn. The intense forest fires in the Siberian region are responsible for high BB% in the summer. Higher BC mass can influence the Arctic amplification, which may lead to faster melting of Arctic ice.

Keywords: Biomass Burning, Black Carbon, Forest Fire, Aethalometer, Arctic



TROPOPAUSE HEIGHT ESTIMATION USING CHANGE POINT DETECTION METHODS ON MARA DATA

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The tropopause, demarcating the boundary between the troposphere and stratosphere, plays a pivotal role in shaping weather patterns and climate dynamics. However, traditional methods for determining tropopause height, such as radiosonde measurements, are hindered by limitations in resolution and coverage. In contrast, atmospheric radars, exemplified by the Moveable Atmospheric Radar for Antarctica (MARA), offer continuous, high-resolution observations that hold promise for enhancing tropopause characterization. This study introduces a novel approach for estimating tropopause height utilizing MARA data spanning the years 2014 to 2023. Operating at 54.5MHz, MARA provides valuable signal-to-noise ratio (SNR) data derived from echo power measurements. Using change point detection (CPD) techniques, the study aims to identify transitions in SNR profiles indicative of tropopause variations. The accuracy of the CPD-derived tropopause height estimations will be comprehensively validated against radiosonde measurements from the nearby Novolazarevskaya Station. Radiosondes, serving as ground truth data sources for tropopause height, facilitate rigorous validation of the proposed methodology. The proximity of Novolazarevskaya Station ensures that the radiosonde measurements closely correspond to the atmospheric conditions observed by MARA, enhancing the reliability of the validation process. This study contributes to advancing tropopause detection techniques by leveraging continuous atmospheric radar data and CPD methodologies. The unique setting of Antarctica underscores the significance of this research, as understanding tropopause dynamics in this polar region is crucial for comprehending global climate systems and addressing the unique challenges posed by polar environments. Integrating advanced signal processing techniques with atmospheric radar data offers a promising avenue for remote sensing-based tropopause height estimation, with potential implications for weather forecasting, climate modeling, and environmental monitoring in polar regions.

Keywords: Tropopause, polar science, Antarctica, Radar, Change point detection, Signal processing



PALAOENVIRONMENTAL STUDY AND EVOLUTION OF LAKE SIERRA AND LH04 IN EAST ANTARCTICA

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Nickel (Ni) and Zinc (Zn) concentrations in oceanic sediments serve as proxies for past climate conditions, offering insights into environmental changes over geological timescales. Analyzing the abundance and distribution of Ni and Zn in sediment cores provides their core distribution and potential environmental processes, providing valuable insights into past climate dynamics. Understanding the relationship between Ni and Zn concentrations in oceanic sediments and past climate helps refine climate models and improves our ability to predict future climate trends and their potential impacts on marine ecosystems. The samples for the analysis were collected from two lakes, Sierra and LH04, situated in the Larsemann Hills of East Antarctica for paleoenvironmental studies. For Sierra, the sediment core depth ranges from 0 cm to 53 cm, while for LH04, it extends from 0 cm to 196 cm. Following acid digestion and sequential extraction of sediment, the results from ICP-OES led us to conclude that the analysis of nickel (Ni) and zinc (Zn) concentrations in Lake LH04 and Lake Sierra provided valuable insights into their downcore distribution and potential environmental processes. These variations in Ni and Zn concentrations in both lakes indicate the influence of different processes and environmental factors. The observed patterns suggest changes in sources, sedimentation dynamics, and potentially climatic conditions over time. Factors such as terrigenous input, organic matter flux, and climate variations may contribute to the observed concentration patterns. Overall, the findings highlight the complex interplay of various factors shaping the downcore distribution of Ni and Zn in Lake LH04 and Lake Sierra.

Keywords: Nickel (Ni) and zinc (Zn), Paleoenvironmental study



AN INORGANIC GEOCHEMICAL PERSPECTIVE OF ENVIRONMENTAL CHANGES FROM AN EAST ANTARCTIC LAKE

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Lacustrine sediments in the ice-free regions of Antarctica are excellent archives for reconstructing the paleoclimate. The present study discusses the paleoenvironmental variations spanning the past 27.64 cal ka BP from Lake L55, a dried, land-locked lake in the Schirmacher oasis, East Antarctica. During the last glacial period (LGP), the low-field magnetic susceptibility (χ_{lf}), which reflects the concentration of magnetic minerals, show high values, indicating enhanced concentrations of strongly magnetic minerals. The ratios K/Al and Rb/Sr, indicative of weathering intensity, show higher values during the LGP, reflecting a higher intensity of physical weathering during this period. The parameter 100Ti/Al, a proxy for aeolian input, shows higher values during the LGP, suggesting enhanced aeolian input. Total organic carbon (TOC %) shows low values during the LGP, suggesting low productivity due to cold and dry conditions. Between ~21.4 and 18.5 cal ka BP, an increasing trend is observed for χ_{lf} , K/Al, Rb/Sr, and 100Ti/Al, indicating colder conditions in the region and an enhanced degree of physical weathering, synonymous with the Last Glacial Maximum (LGM). During the Holocene, the low χ_{lf} values, along with low values of K/Al and Rb/Sr, suggest warmer conditions suitable for a higher degree of chemical weathering. The reduced values of 100Ti/Al reflect decreased aeolian influx. An increase in the TOC values indicates enhanced primary production, leading to more organic matter in the lake under warmer conditions. The biplot of TiO₂ vs Al₂O₃ reflects an intermediate to felsic provenance, consistent with the catchment geology. The magnetic susceptibility data and the geochemical ratios indicate colder conditions in the Schirmacher Oasis between 27.4 and 18.5 cal ka BP, which was followed by warm and wet conditions marking the onset of deglaciation. At ~11.7 cal ka BP, increasingly warmer conditions were recorded, marking a transition to the Holocene.

Keywords: Geochemistry, weathering, glacial-interglacial, East Antarctica, aeolian influx



TREND AND INTERANNUAL VARIABILITY OF HEAT CONTENT IN THE BARENTS SEA

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This study investigates the profound changes occurring in the Arctic, specifically in the Barents Sea, characterized by unprecedented warming known as Arctic Amplification. It scrutinizes two distinct phases, 1958-1979 and 1980-2017, during both summer and winter seasons, to explore long-term and interannual variability in the heat content of the Barents Sea. Notably, a consistent 0.16°C per decade increase in heat content in the Barents Sea is observed in the latter phase. While long-term variability remains unchanged during the phase I, it significantly increases in the phase II, marked by a slope of $0.019 \times 10^9 \text{ J/decade}$ for summer and $0.024 \times 10^9 \text{ J/decade}$ for winter. Interannual variability, assessed through standard deviation and Empirical Orthogonal Function (EOF) analyses, highlights maximum variability in the central part of the Barents Sea region for both summer and winter seasons in both phases. While summer interannual variability patterns remain consistent, winter exhibits significantly higher variability in the second phase, indicating distinct seasonal differences in interannual signals. The Arctic Oscillation plays a dominant role in influencing interannual variability. This study enhances our understanding of the evolving characteristics of the Barents Sea's heat content, both in the long term and on an interannual basis, providing valuable insights into the complex dynamics of this vital Arctic region.

Keywords: Arctic Amplification, Barents Sea, Arctic, long-term Variability, Interannual Variability, Arctic Oscillation



THE ROLE OF FREE-LIVING LARGER NEMATODES (>500 μ M) IN THE CARBON DYNAMICS OF ARCTIC ECOSYSTEM

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The Arctic Ocean forms a unique ecosystem marked by diverse habitats influenced by different gradients. Carbon sequestration in the Arctic ecosystem is crucial as it being a less disturbed area, forms a potential blue carbon sink and also helps in understanding the region's ecological dynamics as well as its role in global climate regulation. Free-living nematode communities, key organisms in the Arctic ecosystem, significantly contribute to carbon flow. They have high carbon potential as they trap carbon from the atmosphere to maintain their biomass and indirectly promote blue carbon sequestration through decomposition in the marine sediments where carbon gets stored for long term. This study assessed the carbon potential and blue carbon sequestration of free-living larger nematodes(>500 μ m) in the Arctic Kongsfjord, estimating the total carbon contribution across three stations within the inner fjord of Kongsfjord in the year 2019. The analysis resulted in the identification of 21 species of Nematodes belonging to 14 genera, 10 families and 4 orders. Among them, Aerolaimida (54%) was the dominant order. The station K1 had high diversity. The species that was found to be most prevalent in the study stations was *Dorylaimopsis* sp, accounting for 29% of the total. Considering the individual carbon potential, *Admirandus belogurovi* ($23.25 \pm 0.26 \mu\text{g}/\text{mg}$) had the highest carbon potential and the lowest carbon potential was recorded for *Terschellingia* sp. ($0.07 \pm 0.004 \mu\text{g}/\text{mg}$). On comparing the station wise contribution of carbon, the total carbon contribution was high in station K1 ($89.70 \pm 1.58 \mu\text{g}/\text{m}^2$) and lowest in station K2 ($61.25 \pm 1.02 \mu\text{g}/\text{m}^2$). Sediment carbon content analysis was also conducted, revealing consistently high levels of inorganic carbon across study stations. As nematodes have been recognised as potent carbon sequester within the benthic fauna, the study can help in understanding blue carbon sequestration in the ecosystem, contributing to the ecological significance and potential in mitigating climate change impacts.

Keywords: Blue carbon, Carbon sequestration, Kongsfjord, Nematodes.



RECORDS OF ENVIRONMENTAL VARIATIONS FROM AN EAST ANTARCTIC OASIS: A PERSPECTIVE GAINED FROM INORGANIC GEOCHEMICAL ANALYSIS

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The present study discusses the mid-late Holocene environmental changes from Stepped Lake, a coastal lake located at distance of 200 meters from the coast of Broknes Peninsula, Larsemann Hills, East Antarctica. A sediment core spanning the past 6.37 cal ka BP was obtained from the lake. Previous studies indicate that the lake existed as a submarine basin during the mid-late Holocene. Therefore, diatom studies were conducted to delineate the marine-lacustrine transitions, and based on the results, core was divided into three zones. In Zone 1 (6.37 – 3.07 cal ka BP) sea-ice associated diatoms are dominant; therefore, the lake was presumed to be submarine during this interval. Weathering ratio K/Al shows higher values till ~4.3 cal ka BP indicating the dominance of physical weathering over chemical weathering during this interval. Chemical weathering indices CIA (Chemical Index of Alteration) and PIA (Plagioclase Index of Alteration) also remain lower during this interval indicating colder conditions. In the ternary plot of Al₂O₃ - (CaO + Na₂O) - K₂O (A-CN-K), most samples from zone 1 show low degree of chemical alteration. Total organic carbon percentages (TOC) show very low values in zone 1 suggesting low productivity. 100Ti/Al ratio, indicative of aeolian input suggests enhanced aeolian input in zone 1. In Zone 2 (3.07 – 1.75 cal ka BP) a mixture of marine and lacustrine diatoms is present. Zone 2 represents a transition zone. CIA and PIA show higher values in zone 2 while K/Al remains lower indicating higher degree of chemical weathering. In Zone 3 (1.75 – 0.25 cal ka BP) lacustrine diatoms are dominant indicating freshwater conditions. Highest values of CIA and PIA are seen in zone 3 indicating warm and wet conditions. ICV (Index of Compositional Variability) values remain >1 for all samples indicating that the sediments of lake are immature sediments with progressive weathering.

Keywords: Weathering, sediment provenance, mid – late Holocene, marine- lacustrine transition, East Antarctica



A STUDY ON GREENLAND SEA ICE VARIABILITY DURING 1979-2017

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The present study is an attempt to understand the relationship between sea-ice concentration (SIC) and Ocean Heat Content. The seasonal variability of the SIC in the Greenland Sea was investigated using the SIC obtained from the NOAA/NSIDC passive microwave satellite data for a period of 1979-2017. Empirical Orthogonal Function (EOF) analysis was performed on the seasonal anomalies of SIC during the 39-year period. It is noticed that, North Western part of Greenland Sea, North West & South East of Svalbard were the regions where the maximum variability was observed. Also, a remarkable negative trend was observed in EOF mode-1, since 2000 with a sharp decline in the year 2003. The Mode-2 time series pattern showed inter-annual variability with a neutral trend. The EOF Mode-1 could be a combination of inter-annual variability as well as the linear trend. To reveal the relation between SIC and Ocean Heat Content, the Heat Content was correlated with the principal components of the leading EOF modes. In EOF Mode 1 during winter, a significant negative correlation over most of the Greenland Sea was noticed, while positive correlation was observed for mode 2. This suggests that as the heat content increases, mode-1 pattern will be in the negative phase, with decline in sea-ice in most of the study region, while the positive correlation for mode-2 need to be studied more carefully. Distinguishing trends in mode-1 & mode-2 are the negative trend in sea-ice and the inter-annual variability respectively.

Keywords: *Greenland Sea, Sea Ice, Variability, Anomalies*





Aquatic Animal Health & Management Studies



FIELD-LEVEL EVALUATION OF MARINE PICOALGA *PICOCHLORUM MACULATUM* MACC3 BIOMASS (PMAC-1) AS A FUNCTIONAL FEED FOR ORNAMENTAL FISHES

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Marine microalgae have emerged as a promising alternative to traditional feeds for preventive healthcare in aquaculture. This study validates the impact of chitosan-flocculated dried biomass of the marine picoalga *Picochlorum maculatum* MACC3 (Pmac-1) as a functional feed for ornamental fishes in large-scale settings. This follows a previous laboratory bioassay that demonstrated significant enhancements in growth, digestive health, immunity, ornamentation, and gut microbiome composition of juvenile Silverado guppies (*Poecilia reticulata*) supplemented with 10% Pmac-1. The experiment was conducted at an ornamental fish farm in Calicut, Kerala, India, focusing on supplementing the diet of cherry red guppies (*P. reticulata*) with 10% Pmac-1 over a period of 60 days. Two experimental groups, each comprising 3500 guppy juveniles, were established, with the control group receiving commercial feed mixed with 1% gelatin and the treatment group receiving commercial feed mixed with 10% Pmac-1. Growth parameters were measured at the beginning and end of the study. The results indicated significant differences in net weight gain (WG), specific growth rate (SGR), and feed conversion ratio (FCR) between the control and treatment groups. Image-based color analysis using the R package colordistance revealed significantly higher pigmentation in the treated fish, with distinct clustering of control and treated fish, highlighting the beneficial effects of introducing *P. maculatum* MACC3 biomass as a feed ingredient. This study confirmed the role of Pmac-1 as a functional feed ingredient for enhancing the growth and pigmentation of ornamental fishes, which can be transferred to the ornamental fish industry.

Keywords: *Picochlorum maculatum* MACC3, Chitosan, Cherry red guppies, *Poecilia reticulata*, Functional feed.



AN INCIDENCE OF THE ASSOCIATION OF *TRICHODERMA* TO ULCERATIONS IN *CHANNA STRIATA*

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An incidence of ulcerations on the body and mass mortality has been reported in an earthen culture pond in a village, Perumbavoor, Kerala India. Initial Investigations started from the site which included assessment of the environmental quality, collection and transportation of moribund fishes to the lab, and further extended to extraction of tissue samples aseptically from kidney, brain, muscle, lesion and spleen and inoculating them onto Tryptic Soy and Sabouraud Dextrose agar plates and subjecting to PCR detection of viral pathogens to identify the causative agent. After 48 hours of incubation fungal growth was observed from the internal organs on SDA and bacterial growth on TSA from the ulcerations. The fungus isolated in pure form was subjected for morphological traits and found septate forming Aplanospores. Sequence analysis of the intergenic spacer (ITS) revealed it belonging *Trichoderma* species having close similarity to *T. harzianum*, *T. citrinoviride* and *T. lixii*. Bacterial isolates obtained from the ulcerations alone were identified belong to *Bacillus* spp. and *Aeromonas* spp. No PCR amplification of the viral pathogens investigated for Rhabdovirus was observed. The results bring to light the association of *Trichoderma* to ulcerations in *Channa striata*, and the probable cause of mortality. This finding is important in the sense that *Trichoderma* is well known biocontrol agent for plant pathogens. There are a few earlier reports on the same phenomenon which warrants further investigations.

Keywords: *Channa striatus*; *Trichoderma*; *Epizootic Ulcerative Syndrome*; *Aplanospores*; *Mortality*



THE EXISTENCE OF ACUTE ANAEROBIC CONDITIONS IN THE SURFACE SEDIMENTS IN THE TRADITIONAL SHRIMP CULTURE SYSTEMS OF KERALA

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Sustainable and profitable aquaculture depends on the conditions of the pond ecosystem, having the sediment–water interface being the primary influencing factor. Redox potential and pH are the significant sediment quality parameters that represent the intensity of anaerobic conditions in the pond sediment, which may affect the dominant microbial transformations of substances, the toxins production, and mineral solubility, as well as the water and sediment quality. The study was mainly focused on shrimp culture systems in the Alappuzha and Ernakulum districts of Kerala, and during the process water and sediment samples from 13 padasekharams and 27 individual farms were subjected for the study to evaluate the prevailing water and sediment quality around the year which would point out the prospects of the culture in the area. The sediment quality parameters measured were pH, Eh, sediment oxygen demand and hydrogen sulphide production potential and the water quality parameters were salinity, pH, alkalinity, hardness, ammonia and nitrite. In all the culture systems as a whole pH of sediment ranged between 6.5 to 8.5, whereas Eh was below -150M Volts lowering to even -400 M Volts in certain locations. In most of the locations, a strong negative correlation was obtained between Eh, sediment oxygen demand and hydrogen sulphide production potential suggesting remedial measures to be undertaken to increase Eh and to lower sediment oxygen demand and hydrogen sulphide production potential. Overall water chemistry was suitable for shrimp culture all over the area. The study suggested that acute oxygen depletion might take place at any point in time with the liberation of hydrogen sulphide leading to mortality and morbidity of shrimp and other associated stocks if appropriate bioremediation protocols are not implemented.

Keywords: Redox potential, pH, Sediment Oxygen Demand, Hydrogen sulphide production potential



IS WHITE SPOT SYNDROME VIRUS A TRUE VERTICALLY TRANSMITTED VIRUS?

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White spot disease, caused by white spot syndrome virus (WSSV), has historically been the most devastating disease in shrimp aquaculture industry across the world, since its first report in 1992. Knowledge on the mode of viral transmission is one of the most important ways to interrupt the spread of the virus and to develop management measures. In India, the annual revenue loss due to WSSV is estimated to be USD 238.3 million. Although many studies have been carried out on the WSSV during the past three decades, this disease is not under control to date at the farm level and therefore, management of this disease continues to be the priority area of scientific research. The modes of pathogen transmission are generally divided into two: vertical (parents to offsprings) and horizontal transmission (between individuals). Although horizontal transmission of WSSV has been demonstrated to a large extent, vertical transmission of WSSV remains limited to few reports, and studied rarely. There are research works supporting WSSV can be vertically transmitted, while mode of transmission is not proven. Vertical transmission occurs from the mother to offspring through viral particles being shed at the time of spawning and then ingested by larvae at first feeding, although it is not clear whether the WSSV virions are present inside the shrimp eggs. By using *in situ* hybridization and TEM, viral particles were only detected in the connective tissue layer surrounding the seminiferous tubules in males, while in females viral particles were observed in the ovary, follicle cells, oogonia, oocytes and connective tissue cells. Furthermore, no virus infection was found in mature eggs, which may imply that infected eggs die by the virus before maturation. Recently, reports are that the gravid females with low WSSV copies showed fully developed ovary without characteristic signs of WSSV infection. Researchers observed this situation in infected wild broodstock based on gene sequencing using real time PCR, while *in situ* hybridization failed to confirm the result and they did not attempt experimentation in the laboratory condition. The confirmation of true vertical transmission of WSSV from mother to offspring is still elusive.

Keywords: WSSV, vertical transmission, wild broodstock, shrimp



GENE SILENCING OF GONAD INHIBITING HORMONE IN POST-LARVA OF *PENAEUS MONODON* MEDIATED THROUGH ORAL ADMINISTRATION OF *INVITRO* SYNTHESIZED dsRNA

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Shrimp maturation is governed by the hormones secreted by neurosecretory structures known as XOSG (X-organ sinus gland complex) in the eyestalk such as crustacean hyperglycemic hormone (CHH), moult inhibiting hormone (MIH), and gonad inhibiting hormone (GIH). Unilateral surgical removal of eye stalk which facilitate the removal of X-organ sinus gland complex to nullify the inhibitory hormones effects is the age-old practice to induce maturation in shrimp. Being unethical and the one which delimit the repeated breeding of valuable broodstock, dsRNA mediated gene silencing has been conceptualized and developed. The RNAi has been used for experimental manipulation of gene expression using long dsRNA to silence cognate gene expression. In the present study, 316 bp gonad inhibiting hormone (GIH) specific dsRNA from cDNA were constructed *in vitro*. Then the GIH dsRNA constructs were orally administered into post-larva (*Penaeus monodon*). The phenotypic parameters and gene expression of crustacean hyperglycemic family hormone were monitored using semi quantitative RT-PCR. The gene silencing of CHH, MIH and GIH genes and a significant increase in size and rate of survival could be attained by oral administration of GIH dsRNA for a period of 7 days. The results clearly showed that the silencing of GIH gene in turn triggered the expression of CHH, MIH and GIH gene, which played a key role in growth and development. These results suggest the possibility of using dsRNAs of CHH family hormone genes as molecular tools for silencing inhibitory genes in turn affecting induced maturation in *P. monodon*

Keywords: crustacean hyperglycemic hormone, gonad-inhibiting hormone, dsRNA, moult-inhibiting hormone, RNAi



ASSESSMENT OF GOLDFISH (CARASSIUS AURATUS) IMMUNE RESPONSES: CYHV-2 INFECTION VS. HEAT-INACTIVATED VACCINE

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CyHV-2 stands as a prominent viral pathogen of significant concern within goldfish populations. CyHV-2, a member of the Cyprinidae family, is known to afflict not only goldfish but also other species such as the crucian carp and Prussian carp with its pathogenic effects. Its spread through global ornamental fish trade spans continents, emphasizing its widespread impact. Vaccination is a well-known preventive measure against this virus. This study aims to evaluate goldfish immune responses to CyHV-2 infection and vaccination with a heat-inactivated vaccine. CyHV-2 was propagated in faintail goldfish fin (FtGF) cell lines to yield a titer of 107.8 TCID50/mL. The heat-inactivated vaccine, prepared by subjecting the virus to 80°C for 1 hour, was confirmed effective through observation of cytopathic effects in FtGF cell lines. Goldfish were divided into infected, vaccinated, and control groups, each in triplicate, and inoculated intraperitoneally. Kidney and spleen tissues were collected at various intervals (6 hours, 2 days, 4 days, 10 days, 16 days, and 30 days), and the expression of IL-12, IL-10, IFN- γ , CD8, and CD4 immune genes was analyzed using qRT-PCR. Our findings revealed significant expression of IL-10 in kidney tissues by the 6th hour in vaccinated fish, while CD8 and IL-12 genes exhibited significant expression in spleen tissues of vaccinated fish. CD4 demonstrated significant expression by the 6th hour, and IFN- γ by the 2nd day in kidney tissues of infected fish. In conclusion, our study demonstrates that the heat-inactivated CyHV-2 vaccine induces a notable immune response in goldfish, with early expression of IL-10, CD8, and IL-12 in kidney and spleen tissues, highlighting its potential as an effective preventive measure against CyHV-2 viral infection. Moreover, field-based investigations are essential to assess the economic viability and practicality of implementing these vaccinations in the market.

Keywords: *CyHV-2, goldfish, heat inactivated CyHV-2 vaccine, immune gene expression*



A SIMPLE RECIRCULATING AQUACULTURE SYSTEM FOR THE EXPERIMENTAL REARING OF BIVALVES AT THE LABORATORY

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Long-term experimental rearing of bivalves in laboratories can be cumbersome when carried out in conventional tanks, which require regular waste removal, water exchange, and water quality maintenance, and result in inevitable stress and/or mortality in animals. In this context, we established a simple recirculating aquaculture system (RAS) suitable for long-term laboratory-scale maintenance of bivalves. This system consisted of culture tanks connected to solid filtration and biofiltration units. The performance of the RAS was compared to that of a conventional water exchange-based rearing system, using the Indian backwater oyster, *Crassostrea madrasensis*, as the experimental animal, and reared for three months. Water quality parameters were analyzed every three days. Animals were monitored daily for signs of stress and/or weakening using standard guidelines, and any mortalities were recorded. Although water quality parameters in the conventional system were maintained in the optimum range through regular water exchange and necessary supplementation of aquaculture-grade buffering agents, oyster mortality at the end of the culture duration was 80% in the conventional system compared to only 10% in RAS. These results demonstrate a significant improvement in the welfare of the animals through the employment of RAS for long-term maintenance in laboratories.

Keywords: Recirculating aquaculture system, bivalve, laboratory-scale, water quality, animal welfare



ENHANCING GROWTH AND DIGESTIVE EFFICIENCY IN GIFT TILAPIA THROUGH PROBIOTIC SUPPLEMENTATION WITH *BACILLUS CEREUS* MCCB

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The aquaculture industry is continuously exploring sustainable methods to optimize the growth and productivity of fish species. Among these methods, the use of probiotics has emerged as a promising strategy to enhance growth performance, health, and overall well-being in aquatic organisms. *Bacillus* species have demonstrated the potential to augment growth parameters and improve nutrient utilization efficiency across various fish species. This study aimed to investigate the effects of *Bacillus cereus* MCCB 101 on the growth parameters of GIFT Tilapia. Over a 30-day feeding trial, GIFT Tilapia fingerlings (average weight of 0.91 ± 0.02 g) were distributed among 18 tanks, with triplicates for each treatment. Fish were fed six different diets: a control diet (without probiotics) and five probiotic-coated diets with varying concentrations (0.2%, 0.4%, 0.6%, 0.8%, 1%). After the feeding experiment, growth parameters (including weight gain, daily weight gain, specific growth rate, feed conversion ratio, viscerosomatic index, hepatosomatic index, and condition factor) were evaluated, along with the activity of digestive enzymes (such as amylase, cellulase, protease, pectinase, xylanase, mannanase, tannase, and chitinase) in the intestine. Our findings revealed significant improvements in growth parameters and digestive enzyme activity compared to the control group, with the most notable results observed in tanks with a 1% probiotic concentration. These results underscore the potential of *Bacillus cereus* MCCB 101 as an effective growth promoter in tilapia culture.

Keywords: Probiotic, *Bacillus cereus*, Tilapia, Growth parameters, Digestive enzymes



IMMUNOSTIMULATORY EFFECTS OF *BIOPHYTUM SENSITIVUM* DIETARY SUPPLEMENTATION ON GROWTH PERFORMANCE, INNATE IMMUNE RESPONSE, ANTIOXIDANT STATUS, IMMUNE GENE EXPRESSIONS, AND DISEASE RESISTANCE AGAINST *STREPTOCOCCUS AGALACTIAE* IN NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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The tilapia aquaculture is confronting major setbacks due to various disease outbreaks. Streptococcosis caused by *Streptococcus agalactiae* is becoming a serious concern. *Biophytum sensitivum* is an auspicious medicinal plant widely distributed in India and included in the “Dashapushpam” which is a group of ten herbs used as a prominent traditional medicine in Kerala. *B. sensitivum* has been reported to have various bioactivities such as antibacterial, antioxidant, and anti-inflammatory properties.

Conventional treatment strategies such as antibiotics, and chemotherapeutics pose inevitable risks to public health, food safety, and the environment. Medicinal plants as natural immunostimulants are a promising alternative to combat antimicrobial resistance (AMR) in aquaculture. This study was conducted to evaluate the growth performance, and disease resistance in Nile tilapia with dietary supplementation with *B. sensitivum*. The preliminary phytochemical analysis was done and the results of GC-MS analysis showed the presence of phenolic compounds, saponins, essential oil, flavanones, polysaccharides, and pectin in the whole-plant methanolic extract. The total antioxidant capacities determined by the phosphomolybdenum assay, and DPPH assay showed a higher activity compared to the standard. The presence of inhibition zones confirmed the antibacterial activity by the disc diffusion method. The experimental design consisted of five groups in triplicate: negative control, treatment groups (T1- 1%, T2- 2%, T3- 4%); and positive control for pathogen infection. The experiment lasted for 56 days and, all groups except the negative control were challenged with *S. agalactiae*. The results revealed that T1 (1%) showed a considerable increase in weight, specific growth rate, and feed conversion rate. The immune parameters evaluated by the activities of lysozyme, myeloperoxidase, and respiratory burst showed a significantly elevated response in the T1 group. The total IgM expression was also elevated in T1. An extended study evaluating the efficiency of cost-effective nano feeds and their effects on gut microbiomes, histomorphometry, and disease resistance against other aquaculture pathogens is required.

Keywords: Natural immunostimulants, antibiotics, medicinal plants, *Biophytum sensitivum*, Nile tilapia



MOLECULAR EPIDEMIOLOGY OF VIRAL DISEASES IN FINFISHES FROM 2019 TO 2024 AND DEMONSTRATION OF PREDICTION MODELLING

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Aquaculture is currently contemplating intensive animal production systems globally. This situation leads to transboundary movements of seeds, which increases the probability of disease transmission. Viruses are the principal pathogens affecting the aquaculture industry. Our study analyzes the viral disease prevalence in Indian aquaculture and looks into the prediction of future disease episodes from a modelling perspective to enhance diagnosis potential. Here we conducted molecular screening of 24 selected fish viruses using specific oligonucleotide primers. Whenever positive amplicons were obtained in agarose gel electrophoresis, they were sequenced and analyzed using NCBI-BLAST. Phylogenetic analysis of the sequence data was obtained using MEGA. For the disease prediction modelling, a list of fish virus diseases reported so far across the world was prepared, and the possibilities of occurrence in India were analyzed using three basic parameters: cultured species, geography, and transboundary movements. In our study, 648 samples of different species were carried out, including edible and ornamental fishes screened for viral pathogens according to the species-wise clinical signs exhibited. Viral etiologies were observed and documented in the samples screened. Among the viral pathogens screened, Cyprinid Herpesvirus 2 (CyHV2), Infectious Spleen and Kidney Necrosis virus (ISKNV), Carp Edema Virus (CEV), Nervous Necrosis Virus (NNV), and Tilapia Parvovirus (TiPV) has been detected during the period. Among them, ISKNV and CyHV2 were detected as the most prevalent. TiPV reported in tilapia alerted the sector for vigilant disease surveillance, and it triggered the study on the predictive modelling of viral disease transmission in Indian aquaculture. The results suggest that Indian aquaculture is more susceptible to an alarming number of finfish viruses than the reported nine viruses to date. The results provide insight into the status and prevalence of viral disease, covering both food and ornamental fish culture. The predictive modelling recommends that an effective quarantine and seed quality assurance have to be attained at all levels of aquaculture to prevent the transmission of viruses.

Keywords: Aquaculture diseases, fish virology, fish disease surveillance, disease prediction modelling



ROLE OF MOLECULAR ADJUVANTS IN ENHANCING THE VACCINE EFFICACY FOR PROTECTION AGAINST *STREPTOCOCCUS AGALACTIAE* INFECTION IN NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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Aquaculture is the fastest-growing animal food production sector globally having a key role in food security. Intensification of tilapia farming has promoted severe disease outbreaks, resulting in high mortalities and economic burden with *Streptococcus agalactiae* being a major pathogen in tilapia culture. *S. agalactiae* is a major bacterial pathogen causing streptococcosis mainly characterized by septicemia and severe meningoencephalitis followed by mass mortalities in tilapia culture resulting in huge economic loss worldwide. Vaccination is a proven method for controlling infectious diseases in aquaculture. It is important to realize that to ensure best profit margins by reducing mortality rates of fishes, vaccination along with good nutrition, sanitary practices and biosecurity maintenance are utmost important as far as aquaculture industry is concerned. The current study aims to investigate the effect of recombinant flagellin protein and tilapia interferon- γ (IFN- γ) as molecular adjuvants in enhancing the immune response in tilapia when used along with *S. agalactiae* formalin killed vaccine (FKV). Flagellin is the most potent pathogen associated molecular patterns (PAMPs) in fish activating host immune response by the production of pro-inflammatory cytokines, chemokines and co-stimulatory molecules. The role of IFN- γ is very prominent in both innate and adaptive immune responses that it plays a very important role in defining Th1 immune response in all vertebrates. Recombinant flagellin protein and tilapia IFN- γ were prepared to use as molecular adjuvants in delivering formalin inactivated *S. agalactiae* to tilapia. The adjuvanted vaccine was injected intraperitoneally (i.p.), followed by a booster dose on Day 22. A virulent strain of *S. agalactiae* was injected into the vaccinated fish and subsequent mortality was measured for 3 weeks. The relative percentage survival of each group was calculated. The fishes were sampled at fixed time intervals to perform ELISA to measure specific IgM antibody levels in Nile tilapia sera against *S. agalactiae*, histopathological examinations and immune gene expression using RT-PCR. The expression of IgM antibodies in presence of both flagellin and IFN- γ indicates the protectivity and efficacy of vaccine and the enhanced activity of molecular adjuvants in increasing the immunity in tilapia. Relative percentage survival (RPS) of 59.37%, 71.87% and 81.25% was observed for bacterin vaccine adjuvanted with flagellin, IFN- γ and both respectively with an RPS of 15.62% for



the unvaccinated control group after challenge with *S. agalactiae*. The highest protection was observed in fish immunized with *S. agalactiae* adjuvanted with both flagellin and IFN- γ . Gene expression analysis by using qRT-PCR found that IgM, IgT, IgD, IFN- γ , TNF- α IL1 β , IL-8, IL-2, were significantly increased in the spleen and head kidney of vaccinated fish. The study emphasizes a safe potential approach for novel vaccination strategies employing molecular adjuvants incorporated into a bacterin vaccine that provide protection to fish against infectious bacterial diseases. This study will facilitate to pursue the commercialization of the recombinant flagellin coupled interferon vaccine and to advance scientific knowledge on bacterial diseases. Follow-up work with this vaccine will elucidate whether the vaccine can provide protection against more virulent challenge, and potentiate commercialization for use in tilapia aquaculture in LMIC.

Keywords: *Streptococcus Agalactiae, Molecular Adjuvant, Flagellin, Interferon- γ , Vaccine Efficacy, Nile Tilapia*



INSIGHTS INTO EARLY IMMUNE DEVELOPMENT: HISTONE H2A-DERIVED AMP EXPRESSION IN *TRACHINOTUS BLOCHII*

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Antimicrobial peptides (AMPs) are ancient innate immune defense molecules that combat various pathogenic microbes. This study identifies and characterizes a Histone H2A-derived antimicrobial peptide (designated as Tb-HIS) from the Silver Pompano, *Trachinotus blochii*, offering insights into its gene expression profile during different developmental stages. Molecular characterization and phylogenetic analysis revealed Tb-HIS as a 111 bp full-length mRNA transcript encoding 37 amino acids, showing high similarity with Histone H2A AMPs from various species. Gene expression profiling of Tb-HIS from the egg stage to the adult stage (3rd, 6th, 9th, 12th, 15th, 20th, 30th, and 40th-day post-hatching (DPH)) demonstrated consistent expression patterns in the egg and adult stages, with diverse patterns in other stages. This study highlights the importance of histone-derived AMPs in reducing larval disease incidence and severity, thereby enhancing overall fish health and survival. It contributes to our understanding of innate immunity in early fish development and provides valuable insights for future research on immune system dynamics in *T. blochii* and the therapeutic potential of AMPs.

Keywords: Antimicrobial peptides, Aquaculture, Gene expression, Silver pompano, Histone derived, *Trachinotus blochii*.



TRANSCRIPTOMIC AND *IN SILICO* ANALYSIS OF β - 3 THYMOGIN FROM *PENAEUS MONODON*

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Beta thymosins represent unique classes of peptides found in both vertebrates and invertebrates, exhibiting diverse functions that play a pivotal role in the innate immune systems of organisms. This study encompasses transcriptomic analysis of the beta thymosin gene, particularly focusing on β -3 thymosin from *Penaeus monodon*. The β -3 thymosin isoform isolated from *P. monodon* comprised 128 amino acids, translated from a 387 bp nucleotide sequence. Tissue-level expression profiling revealed the highest transcript levels of the peptide in the haemolymph, suggesting its crucial role as an immune modulator, given that the haemolymph serves as the primary organ of production for the majority of immune molecules. Additionally, ontogenetic transcriptomic analysis of the peptide was conducted to elucidate its role throughout various developmental stages. Understanding the basal production of thymosin genes across different stages aids in further investigations into how this peptide contributes to immune regulation, particularly concerning infections associated with each developmental stage. Furthermore, the peptide underwent *in silico* analysis to elucidate its molecular and functional properties. The predicted alpha-helical peptide showed potential as an antimicrobial and anticancer agent, as well as exhibiting potential antibiofilm activity.

Keywords: Antimicrobial Peptides, Aquaculture, Shrimp, Thymosin



ASSESSING THE ANTIMICROBIAL EFFICACY OF SYNTHETIC B-THYMOSIN AGAINST *VIBRIO VULNIFICUS* IN TILAPIA

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Antimicrobial peptides (AMPs) play a crucial role in the innate immune response of fish and are gaining attention as potential alternatives to conventional antibiotics due to their broad-spectrum antimicrobial activity and low likelihood of inducing bacterial resistance. In the present study, the antimicrobial efficacy of β -Thymosin, a synthetic AMP derived from *Oreochromis niloticus* (Tilapia), was investigated against *Vibrio vulnificus* in Tilapia juveniles. Tilapia juveniles were acclimated and injected with varying doses of the synthetic peptide before being challenged with *V. vulnificus*. The experimental groups consisted of six sets of 20 fishes each, with peptides administered at four different concentrations ranging from 50 to 400 microg. Tissue samples were collected at six time intervals up to 48 hours post-infection to assess immune gene expression in response to synthetic peptide administration and challenge employing real-time PCR. The results revealed significant up-regulation of immune genes in fish administered with the synthetic peptide compared to the control groups, indicating enhanced protection against *V. vulnificus* infection. This study underscores the potential of β -Thymosin as a promising antimicrobial agent for combating *V. vulnificus* in aquaculture settings, offering insights into novel strategies for disease management in aquatic environments.

Keywords: Synthetic antimicrobial peptide, Thymosin, In vivo, *Oreochromis niloticus*, *Vibrio vulnificus*.



MARINE ACTINOMYCETES CONFERRING PROTECTION AGAINST WHITE SPOT VIRUS INFECTION IN PENAEUS MONODON CULTURE SYSTEM

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Aquaculture is one of the fastest-growing industry in the food supply sector supporting food security and nutrition worldwide. Being delicious and nutritious, Penaeus monodon has high consumer demand in the global market. However, the industry is facing severe challenges due to various infectious diseases out of which the white spot virus disease is the most important. Actinomycetes are gram-positive bacteria that have a high GC content compared to their counterparts and are capable of producing a broad range of secondary metabolites and many of these act as anti-bacterial and antiviral agents. Marine actinomycetes isolated from mangrove sediments were used for the present study. Three isolates with high hydrolytic enzyme production property and granulation ability were selected (A 56, A44, R32) to test their potential for application as a bioremediator in the shrimp culture system. The selected actinomycetes were identified by 16S rRNA sequencing. These actinomycetes were applied in P. monodon culture system and after a period of one month, the animals were challenged with white spot syndrome virus. Survival of the animals were monitored throughout the culture period. The immune gene expression was noted before and after the challenge with WSSV. Bacterial diversity of the shrimp larval rearing water was analysed based on the amplification of hypervariable region (V3-V4) of the 16S rRNA gene in the metagenome. The administration of actinomycetes enhanced the expression of immune genes in P. monodon. The results showed that the application of actinomycetes could confer better survival in P. monodon larval-rearing system challenged with WSSV.

Key words: Marine Actinomycetes, White Spot Syndrome Virus, Antimicrobial Peptides, Metagenomics



ASSESSING THE IMMUNOMODULATORY POTENTIAL OF ASHWAGANDHA ROOT POWDER ON PENAEUS VANNAMEI BOONE, 1931 AGAINST VIBRIO PARAHAEMOLYTICUS

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In this research study, the Ashwagandha (*Withania somnifera*) root powder (ARP) was incorporated in the formulated feed diet at the level of 0% (control), 2.5%, 5% and 7.5% to understand its effect on growth, innate immune responses and survival against *Vibrio parahaemolyticus* in *Penaeus vannamei*. A 60-day feeding trial was conducted to evaluate the effect of Ashwagandha root powder in a plastic tank system. The selected shrimp PLs were randomly distributed in 4 groups of quadruplicate tanks (16 tanks) using completely randomized design. Compare to control diet, immune response parameters (phenoloxidase activity, superoxide anion level and total haemocyte count) were significantly enhanced ($p<0.05$) in *P. vannamei* fed with Ashwagandha (*Withania somnifera*) root powder incorporated diet. A significant higher weight gain (WG), specific growth rate (SGR), protein efficiency rate (PER), survival rate (SR) and lower feed conversion ratio (FCR) were observed in 7.5% ARP treatment as compared to controlled diet ($p<0.05$). This study showed that 7.5% inclusion of ARP in feed diet enhanced the growth performance, immune response and resistance against *Vibrio parahaemolyticus*.

Keywords: *Ashwagandha root powder, Penaeus vannamei, immune response, Vibrio parahaemolyticus*



TRANSCRIPTOMIC AND *IN SILICO* ANALYSIS OF β - 3 THYMOSIN FROM *PENAEUS MONODON*

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Polysaccharides derived from microalgae are biopolymers composed of long chains of sugar molecules and have gained significant attention due to their potential applications in various industries, including food, pharmaceuticals, cosmetics, and biotechnology. Red microalgae are enveloped within polysaccharides forming a gel matrix and in the exponential growth phase, they release exopolysaccharides into the surrounding medium, which are reported to have antiviral, antioxidant, anti-cancerous, and anti-inflammatory properties. In the present study, a red unicellular microalga *Dixonella grisea* MACC1 (GenBank Accession No. JF428838), isolated from the west coast of India, was used for the production of sulphated polysaccharides, which were characterized using FT-IR, SEM and ICP-OES and tested for antiviral activity against White Spot Virus in shrimp larvae. The production of polysaccharides was optimized in f/2 medium and the Plackett-Burman design revealed that temperature and pH were the critical factors influencing growth, while temperature had a significant role in the polysaccharide production. The large scale production in a 50L indigenous photobioreactor yielded a higher growth rate (0.245hr⁻¹) than in the laboratory scale (0.094hr⁻¹). The characterization of polysaccharides by FT-IR analyses confirmed the presence of sulphate, c-o group, OH group and uronic acid in the polysaccharide. The major trace elements in the lyophilized polysaccharides identified by ICP-OES analyses were zinc, iron and magnesium. The in-vivo challenge experiments with white spot syndrome virus in shrimp post larvae fed with algal biomass, polysaccharides, and the culture as such in triplicate showed increased survival rates in the test groups indicating the suitability of the microalgae as a feed supplement. The survival rates of the larvae were notably higher when fed with algal biomass coated shrimp feed. Therefore, the present study points marine unicellular red microalga *Dixonella grisea* MACC1 as a potential producer of sulphated polysaccharides and the microalgal biomass as a potential feed supplement with protective effect against viral pathogens in aquaculture.

Keywords: *Dixonella Grisea, Sulphated Polysaccharides, Feed Supplement, White Spot Syndrome Virus*



STRESS AND IMMUNE RESPONSES OF *ETROPLUS SURATENSIS* ON CHRONIC AMMONIA EXPOSURE

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Ammonia is one of the deleterious water quality parameters that must be managed for successful aquaculture production. The present study evaluated the impact of chronic ammonia exposure on the physio-biochemical and immunological responses of *Etroplus suratensis*. Fish were exposed to four different ammonia concentrations (0, 1, 2, and 4 mg L⁻¹ of Total ammonia nitrogen (TAN)) at 28.6°C for 30 days. The lowest haemoglobin (Hb) level was observed in fish exposed to the highest level of TAN (4 mg L⁻¹). The serum glucose and cortisol levels were higher in the 4 mg L⁻¹ TAN exposed group than in the control group. The serum total protein and albumin levels were substantially decreased with TAN exposure, and the lowest was at 4 mg L⁻¹ of TAN. The liver superoxidase dismutase (SOD) and catalase (CAT) activities in fish exposed to 4 mg L⁻¹ of TAN were significantly higher than in control. Enzymes such as alkaline phosphatase, Serum Glutamic- Oxaloacetic Transaminase (SGOT), and Serum Glutamic- Pyruvic Transaminase (SGPT) were higher in fish exposed to 4 mg L⁻¹ TAN. Immune parameters like IgM and TNF-α were lower in higher ammonia concentrations. The HSP (heat shock protein) 70 gene expression was significantly higher at 1mg L⁻¹ TAN, and the IGF (Insulin-like growth factor)-1 gene expression was lower at 4mg L⁻¹ TAN. In short, chronic exposure to ammonia at or above 1 ppm induced stress responses and immune suppression in *E.suratensis*. Hence, it's important to manage TAN levels below1 ppm in the culture system of *Etroplus* to ensure good health.

Keywords: Ammonia toxicity, TAN, IGF, IgM



INCIDENCE OF HIGH-LEVEL PREVALENCE OF IHHNV IN *PENAEUS MONODON* IN BOTH TRADITIONAL AND SCIENTIFIC CULTURE SYSTEMS OF

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IHHNV (Infectious Hypodermal and Hematopoietic Necrosis Virus/ *Penaeus stylirostris* densovirus (PstDNV)) is one of the potential crustacean pathogens classified by the World Organization for Animal Health (WOAH/OIE). IHHNV is a non-enveloped single-stranded DNA virus, icosahedron structure with a 22nm diameter. This disease is characterized by reduced growth and deformities of the cuticle and rostrum, and it affects the tissues of mesodermal origin and ectodermal origin. All life stages of penaeid species, including eggs, larvae, post larvae (PL), juveniles, and adults, are susceptible to IHHNV. In adults, Females afflicted with IHHNV are unable to produce embryos or hatch their eggs. Most of the penaeid species can be infected with IHHNV, including the principal cultured species, *P. monodon*, *P. vannamei*, and *P. stylirostris* and have multiple non-crustaceans identified with incomplete evidence of susceptibility. Some members of a culture population act as carriers of IHHNV sub clinically, which may cause transmission both in horizontal and vertical ways. Although in some populations, this infection results in subtle and chronic runt-deformity syndrome (RDS), and does not cause huge mortality in stocks. Infected species exhibit a greater degree of cannibalism, which enhances the degree of disease transmission. This study is focused on developing specific pathogen-free brooders by collecting samples from various traditional and scientific systems in Kerala. The samples underwent OIE-listed pathogen screening by using Multiplex PCR. DNA samples were amplified using primers IHHNV1095F/R with 55°C annealing temperature. Amplicons of 392 bp were sequenced to confirm the presence of IHHNV infection. Out of 40 samples, 65% were found to be infected, among them 38.4% of shrimps were asymptomatic. 61.53 % showed signs such as antennae cut, uropod necrosis and tail erosion. This indicates that the traditional and scientific culture systems of Kerala are with IHHNV. A package of practices developed to protect the culture environment from viral pathogens has been described.

Keywords: Infectious Hypodermal and Hematopoietic Necrosis Virus IHHNV, *Penaeus monodon*, Runt-deformity syndrome RDS, Multiplex PCR, cannibalism, broodstock.



ISOLATION AND IDENTIFICATION OF ANTIBIOTIC-RESISTANT MICROBES FROM THE POST-LARVAE OF BLACK TIGER SHRIMP, *PENAEUS MONODON*

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Aquaculture plays a pivotal role in India's economy by generating employment, enhancing food security, and contributing to GDP growth. The detrimental impacts of antibiotic resistance (AMR) in aquaculture call for holistic efforts to reduce its burden on the environment. In the above context, our study aimed to assess the prevalence of antibiotic-resistant strains and the extent of drug resistance among the native bacterial population of black tiger shrimp *Penaeus monodon*, post larvae (PL). A total of 22 antibiotic-resistant microbial colonies could be isolated from the shrimp PL by plating serially diluted samples on agar plates containing specific antibiotics. Further characterization of the resistance of these isolates was done by streaking pure cultures onto nutrient agar medium containing variable concentrations of antibiotics (Ampicillin 100-1000 µg/mL, Tetracycline 10-100 µg/mL, Gentamycin 10-100 µg/mL and Chloramphenicol 50-500 µg/mL). MAR index and resistance pattern were worked for the isolates from which 5 representative samples exhibiting higher MAR indices were identified using 16s rDNA markers. Out of the five, two samples were identified as *Vibrio* sp, two as *Pseudomonas* sp, and one as *Exiguobacterium* sp. Antibiotic resistance profiling of *Exiguobacterium* sp was done with the Kirby–Bauer test method against 20 different antibiotic strains as the report on antibiotic resistance pattern of *Exiguobacterium* strain from the Indian region is lacking. Of the tested antibiotics, the isolate showed resistance to 3 antibiotics only (Ampicillin, Chloramphenicol, and Nitrofurantoin) with a MAR Index of far less than 0.25. *Exiguobacterium* is a common bacterium in aquaculture ponds, especially in shrimp culture ponds, and it has the potential to develop as a probiotic. Therefore, antibiotic sensitivity screening of a native shrimp/shrimp culture system bacterium with future prospects to be a part of a probiotic consortium is highly desirable. Furthermore, the emergence of resistance to Chloramphenicol and Nitrofurans is a clear indication that despite being prohibited in aquaculture use, these drugs are still being utilised in aquaculture practices.

Keywords: Antimicrobial resistance, antibiotics, aquaculture, *Penaeus monodon*, *Exiguobacterium* species



IDENTIFICATION AND CHARACTERIZATION OF INFECTIOUS VIBRIO STRAINS ISOLATED FROM PENAEUS VANNAMEI IN BIOFLOC CULTURE SYSTEM: A CASE STUDY

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Biofloc Technology (BFT) is a sustainable aquaculture method that impacts Pacific white shrimp's gut microbiota, affecting their physiological processes, well-being, and growth. The main bacterial infections that threaten global shrimp farming is vibriosis which led to mortalities and significant economic loss. Acute hepatopancreatic necrosis disease (AHPND), brought in by *Vibrio* sp., is a well-known bacterial infection listed by World Organization of Animal Health (WOAH/OIE) in farmed penaeid shrimp also referred to as Early Mortality Syndrome (EMS). Shrimp with AHPND exhibit signs like lethargy, anorexia, retarded growth, empty gastrointestinal tract, and pale hepatopancreas, which are common in other diseases as well. This study evaluates *Vibrio parahaemolyticus* and *Vibrio alginolyticus* bacterial infections in Pacific white shrimp in BFT, focusing on isolation, characterization, diagnosis, and establishment of treatment and preventive strategies. The gross colony morphological observation revealed swarming on ZoBell's marine agar. They were motile, glucosefermenting, Gram-negative short rods, susceptible to 6,7 diisopropylamino pteridine (O/129) sensitive and arginine dihydrolase positive. Accordingly the organisms were identified as *V. parahaemolyticus* and *V. alginolyticus*. This finding highlights the alarming situation prevailing in shrimp biofloc systems with seasonal variations which can be made sustainable based on probiotics and immunostimulants.

Keywords- Vibriosis, Biofloc technology, *Vibrio parahaemolyticus*, *Vibrio alginolyticus*, AHPND, Early Mortality Syndrome, *P. vannamei*.



ISOLATION AND IDENTIFICATION OF FUNGAL INFECTIONS IN PENAEUS VANNAMEI FROM THE SHRIMP CULTURE SYSTEMS OF KERALA, INDIA

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Shrimp farming has emerged as a significant contributor to the Indian aquaculture industry. With its vast coastline and favourable environmental conditions, India has become one of the leading global shrimp producers. Despite its growth, shrimp farming faces various challenges such as disease outbreaks, environmental concerns, fluctuating market prices and regulatory issues. *Penaeus vannamei*, commonly known as white-leg shrimp is widely cultured for commercial purposes in aquaculture. Its adaptability, fast growth rate, high market demand and relatively large size make it a preferred choice for shrimp operations worldwide. Despite its relatively higher resistance to certain diseases compared to other shrimp species, *P. vannamei* remains vulnerable to bacterial, fungal, viral infections and parasitic infestations. This study was aimed to isolate and identify pathogenic fungi detected in *P. vannamei* collected from shrimp farms in Kerala. The shrimp showed noticeable clinical indications, such as antennae cut and twisted abdomen, along with degeneration of hepatopancreas. PCR amplification of the ITS region using the primers ITS1 and ITS4, followed by sequencing confirmed the presence of *Aspergillus unguis* and *Penicillium citrinum* with a molecular identity cut-off of 99%. This study also explored factors influencing fungal colonisation, including water quality and environmental conditions. Understanding the dynamics of the presence of fungi in *P. vannamei* is critical for implementing effective management strategies to mitigate the risks associated with mycosis in shrimp.

Keywords: Shrimp Farming, *P. Vannamei*, Fungal Infection, Water Quality, Environmental Conditions



STREPTOCOCCUS spp. ASSOCIATED WITH SEPTICAEMIA IN ETROPLUS SURATENSIS AND LIZA PARSIA GROWN IN OPEN CAGES IN BRACKISH WATER ENVIRONMENT: A CASE STUDY

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Beta thymosins represent unique classes of peptides found in both vertebrates and invertebrates, exhibiting diverse functions that play a pivotal role in the innate immune systems of organisms. This study encompasses transcriptomic analysis of the beta thymosin gene, particularly focusing on β -3 thymosin from *Penaeus monodon*. The β -3 thymosin isoform isolated from *P. monodon* comprised 128 amino acids, translated from a 387 bp nucleotide sequence. Tissue-level expression profiling revealed the highest transcript levels of the peptide in the haemolymph, suggesting its crucial role as an immune modulator, given that the haemolymph serves as the primary organ of production for the majority of immune molecules. Additionally, ontogenetic transcriptomic analysis of the peptide was conducted to elucidate its role throughout various developmental stages. Understanding the basal production of thymosin genes across different stages aids in further investigations into how this peptide contributes to immune regulation, particularly concerning infections associated with each developmental stage. Furthermore, the peptide underwent *in silico* analysis to elucidate its molecular and functional properties. The predicted alpha-helical peptide showed potential as an antimicrobial and anticancer agent, as well as exhibiting potential antibiofilm activity.

Keywords: *Etroplus suratensis, Liza parsia, Streptococcus, water quality deterioration, bacterial infection*



ISOLATION, CHARACTERIZATION, AND IDENTIFICATION OF VIBRIOS FROM PENAEUS VANNAMEI AND PENAEUS MONODON IN ZERO WATER EXCHANGE SHRIMP CULTURE SYSTEMS OF KERALA AND THEIR MANAGEMENT OPTIONS: A CASE STUDY

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Vibriosis is one of the most widespread diseases which play a leading role constraining sustainable growth of shrimp culture sector worldwide. It is also rampant in the Indian subcontinent, manifesting through clinical signs such as oral and intestinal necrosis, appendage and cuticular lesions, shell-related ailments, systemic infections, and septic hepatopancreatitis. Acute hepatopancreatic necrosis disease (AHPND), also referred as Early Mortality Syndrome (EMS). The present study was focussed on isolation, characterization, and identification of two *Vibrio* species, *Vibrio parahaemolyticus* and *Vibrio vulnificus*, associated with mortalities in *P. vannamei* and *P. monodon* grown in Zero water exchange culture systems. Samples were gathered from different culture ponds characterized by diverse salinity ranges. The phenotypic characterization of the isolates revealed them as Gram-negative short rods, motile, fermented glucose without gas, and produced cytochrome oxidase, arginine hydrolase negative, sensitive to 6,7 diisopropyle pteridine (O/129) and did not ferment sucrose (Green colonies on TCBS). By way of the sequence analysis of 16S rRNA gene they were found to belong to *Vibrio parahaemolyticus* and *Vibrio vulnificus*. Being opportunistic pathogens, they pose significant risk in intensive shrimp aquaculture systems with zero water exchange. However, through strict bioremediation to stabilize culture environment quality, administration of probiotics and immunostimulants vibriosis could be managed successfully.

Keywords: Key words: Aquaculture, Vibriosis, *Vibrio parahaemolyticus*, *Vibrio vulnificus*, *Peneus vannamei*, *Penaeus monodon*, 16S rRNA



IMMUNE RESPONSE AND EFFICACY OF A FEED-BASED CHITOSAN/β-GLUCAN INCORPORATED VACCINE AGAINST *STREPTOCOCCUS AGALACTIAE* DISEASE

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Aquaculture is the fastest emerging sector supporting livelihood and economy of low to middle-income countries. Nile tilapia (*Oreochromis niloticus*) is one of the major cultivable fish economies with great potential contribution to economy. The intensification of aquaculture is threatened by several pathogenic exposure leading to mass mortality. *Streptococcus agalactiae* is one of the significant pathogens resulting in massive mortalities in tilapia farms in recent decades. As an alternative to antibiotics, the development of a safe and effective vaccine is a great strategy to control fish diseases. Oral immunization is considered an ideal route for drug delivery in aquaculture, due to easiness, time-saving, and non-stressful management. Chitosan/ β-glucan incorporated nanoparticle is used due to its, biocompatibility, biodegradability, muco-adhesiveness, nontoxic nature and high thermostability.

The current study emphasizes the efficacy of the fused nanoparticle to enhance immune response in *O. niloticus* against *S. agalactiae*. The synthesized nanoparticles were combined and biophysical characterization including SEM, FTIR, and surface charge via zeta potential were done to confirm the synthesized nano-vaccines stability. Fishes were separated into four different groups Group (A)- Control(C), Group (B)- Formalin inactivated *S. agalactiae* (FKV), Group (C)- Chitosan / β-glucan (Cs/β-g), Group (D)- Chitosan/ β-glucan + Vaccine (Cs/β-gV). Fishes were fed for 7 days intervals with vaccine feed and afterward fed with control diet. At specific time intervals (0th, 7th, 14th, 21st, 28th, and 35th) days post-vaccination samples were taken for serological examination of lysozyme, blood respiratory burst, and myeloperoxidase activity. Antibody titer study for IgM and gene expression study was done using ELISA and qRT-PCR, respectively. A significant increase in IgM titer value was observed in serum samples. Specific genes like IL- 1β, TNF- α, TCR- β, MHC- II, IgM, IgD, and IFN- γ also had significant fold changes in head kidney and spleen of Chitosan/ β-glucan+ Vaccine group. The relative percentage of survival (RPS) of vaccine group is fundamentally greater than control group denoting the effectiveness of Chitosan/β-glucan as a promising vaccine carrier. Concerning the results the chitosan/β-glucan nano-fusion can be considered as a potentially safe and efficient oral vaccine carrier for sustainable aquaculture.

Keywords: Oral vaccine, Chitosan/β-glucan incorporated nanoparticles, *S. agalactiae*, Nile tilapia.



CHITOSAN ENCAPSULATED NOVEL IMMERSION VACCINE ENHANCED WITH B- GLUCAN AS ADJUVANT AGAINST AQUATIC PATHOGEN *EDWARDSIELLA*

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Nile tilapia (*Oreochromis niloticus*) holds great economic value in fish farming in low to middle-income countries. Edwardsiellosis, a pathogenic disease caused by *Edwardsiella tarda* in intensively farmed Nile tilapia, causes a huge loss of fish species. Immersion vaccine is a non-invasive vaccination method for fishes where the mucoadhesive property of chitosan-based (CS nano vaccine with β-glucan) nano has been greatly recognized as an effective mucosal vaccine delivery system in large-scale fish farming.

The current study is designed to investigate the effectiveness of immersion delivery with chitosan nano-vaccine with β-glucan as an adjuvant to elicit the mucoadhesive property of the vaccine. Chitosan/ β-glucan (Cs/ β-G) vaccine was formulated and characterized by Fourier transform infrared (FTIR), Scanning Electron Microscope (SEM), and particle charge analysis by Zeta potential. Biophysical characterization confirms the stability of synthesized nano-vaccine. The mucoadhesive property was carried out by fluorescent imaging (DAPI stained) of vaccine-exposed fish. *Oreochromis niloticus* (12 ± 2g) was randomly distributed into four different groups, Control (C), Chitosan/β-glucan alone (Cs/β-G), Formalin Killed vaccine (FKV) and Chitosan/β-glucan Vaccine (Cs/β-g V). Fish was given an immersion bath on the 1st and 21st-day booster dose in formulated vaccines for 30 minutes. At different time intervals (0th day, 14th, 21st, 36th Day Post Vaccination) serum, spleen, and head kidney samples were collected and innate immune responses were evaluated by qRT-PCR, lysozyme, myeloperoxidase, and antiprotease activity. IgM antibody titre was measured by ELISA where IgM titre reached the peak at the 14th DPV and 36th DPV of Cs/β-g V compared to the control group. Gene expression analysis by using qRT-PCR found that IgM, IgD, IFN-γ, TNF-α IL1β, IL-8, and IL-2, were significantly increased in the spleen and head kidney of CS/β-g V fishes compared to other groups. The efficacy of the vaccine was examined by immersion challenge (1x10⁷ CFU/mL) with virulent *E. tarda* after 36th DPV in tilapia. A high relative percentage survival (RPS) was noted with Chitosan/ β-glucan Vaccine (CS/ β-g V) compared to the control group. The study reveals a plausible approach for immersion vaccination for tilapia farms to maintain sustainable aquaculture. Where same delivery technology can

Keywords: *Edwardsiella tarda*, chitosan alginate polymer nano-vaccine



IMMUNE RESPONSE AND PROTECTIVE EFFICACY OF β -GLUCAN AND ALKOXYGLYCEROL AS ADJUVANT IN *STREPTOCOCCUS AGALACTIAE*

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Aquaculture is a major source of commercial commodities and a promising food livelihood source in low to middle-income countries. The aquaculture sector in India is confronted with difficulties due to the emergence of many fish diseases, which are caused due to poor water quality and inappropriate safety precautions. Nile Tilapia (*Oreochromis niloticus*) farms are facing *Streptococcus agalactiae* infections causing mass mortality following economic losses. Vaccines can safely treat multidrug-resistant streptococcosis replacing antibiotics. Multiple studies justify that immunomodulators like β - glucan and Alkoxy glycerol (AKG) have improved immunity in fish. β - glucan and AKG are natural homopolymers and lipids respectively which have proven immunostimulant capabilities in fishes and can be effectively used as a prominent adjuvant to improve vaccine efficacy. The present study aims to demonstrate the improved adjuvant efficacy of β - glucan and AKG in the formalin-inactivated *S. agalactiae* vaccine. The virulent strain of *S. agalactiae* was cultured in TSB broth and a 0.5% formalin treatment was given to formulate a vaccine of 3×10^7 CFU.fish⁻¹. The β -glucan at a concentration of 0.5 mg.fish⁻¹ was sonicated at 60% of maximum output at 20 kHz frequency and power of 240 W to break down its particle size and further mixed with formalin-inactivated bacterin and 60% AKG of the total vaccine formulation per fish. Juvenile Nile tilapia of a body weight of 10 ± 2 g was intraperitoneally injected with 0.1 ml formulated vaccine. The fish were fed with a commercially available diet twice daily and the water quality parameters were maintained at the optimum level. Fish blood and mucus were sampled weekly to measure immunochemical parameters like SOD, CAT, MPO, and Lysozyme activity following bactericidal activity. On the 14th and 28th day post-vaccination fish serum IgM titre value and plate agglutination were observed where the presence of antibodies in the immunostimulant-incorporated vaccine groups was enhanced compared to the control group.



Innate and adaptive immune genes TNF- α , MHC I α , MHC II β , CD4-L2, CD8 α , and IFN- γ expressions were significantly increased in formulated vaccine groups with β -glucan and AKG as adjuvants. The study highlights the enhanced activity of β -glucan and AKG incorporated vaccine has the potency towards commercialization for sustainable aquaculture.

Keywords: β -glucan, Alkoxy glycerol, *Streptococcus agalactiae*, vaccine, immune response



THE EFFECTS OF MICROPLASTIC ON PEARL SPOT (*ETROPLUS SURATENSIS*): TISSUE ACCUMULATION, HAEMATO-IMMUNOLOGICAL RESPONSES, AND RELATED GENE EXPRESSION

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Microplastic pollution is a pervasive and damaging stressor in aquatic environments that poses potential risks to organisms and ecosystems. In this study, microplastics accumulation in the intestine, gills, liver, spleen, muscle, and brain and changes in the haematological and innate immune parameters as well as gene expression were investigated in pearl spot (*Etroplus suratensis*) juveniles, which were semi-statically exposed to environmentally relevant concentrations of polystyrene microplastics (PS MPs) (1 μm). The fish were exposed to 0.2, 2 and 4 mg/L concentrations of PS MPs for 14 days. Microscopic counting, fluorescence detection using fluorescence conjugated MPs, and confocal microscopy were utilized to quantify MP accumulation in different tissues. The MPs were detected and quantified in all the tested tissues of the exposed fish, with the highest concentrations found in the intestine and the lowest in the brain. The concentration of MP accumulation in fish tissues found to increase proportionally with ambient concentration. Fish treated with MPs showed a significant decrease in haematological parameters such as white blood cells (WBC), red blood cells (RBC), hemoglobin (Hb), hematocrit (HCT), and platelets (PLT). MPs exposure found to decrease respiratory burst activity, MPO activity, ceruloplasmin activity, serum IgM levels and serum bactericidal activity whereas an increase in serum lysozyme activity was observed. In addition, the exposure to PS-MPs found to down-regulate the expression of *IL1 β* and *TNF α* in the spleen in a concentration-dependent manner. Overall, the results of the study confirmed that environmentally relevant concentrations of PS MPs caused the accumulation of these particles in pearl spot and affected haematological and immune parameters adversely.

Keywords: Polystyrene microplastic, accumulation, haematology, immunology, *Etroplus suratensis*



THE EARLY IMMUNE FOUNDATION: TRACKING THE EXPRESSION PATTERNS
OF CRUSTIN AND PENAEIDIN ANTIMICROBIAL PEPTIDE GENES IN THE
GIANT TIGER SHRIMP, *PENAEUS MONODON*

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Shrimp aquaculture is a rapidly growing vital industry prone to disease outbreaks impacting both shrimp health and industry sustainability. Antimicrobial peptides (AMPs), which are small but mighty proteins play a crucial role as part of the innate immune defence system in shrimps. This study investigates the expression dynamics of two important Antimicrobial Peptide (AMP) families, Crustin and Penaeidin, in *Penaeus monodon*, during its developmental stages, coupled with insights into tissue-specific expressions. Two isoforms from each family were subjected to semi-quantitative RT-PCR analysis spanning from early larval stages (Nauplius V, Zoa II, Mysis I) to post-larval stages (3, 10, 13, 19, and 25) and in adult shrimps across gill, haemolymph, and muscle tissues. The analysis of the results revealed that the Penaeidin gene exhibits a consistent upsurge in expression from early larval stages to adulthood, whereas the Crustin gene displays an initial increase during early larval stages followed by diverse expression patterns in later stages. Notably, both genes exhibit high expression in gill tissue, emphasizing its significance as an immune hub. The critical role of AMPs in safeguarding these invertebrates against diseases underscores their potential as a cornerstone of shrimp health management. A better understanding of immunophysiological mechanisms at play along life stages can contribute to the sustainability and growth of the global shrimp aquaculture industry.

Keywords: *Antimicrobial peptides, Crustin, Penaeidin, Penaeus monodon, Gene expression, Life stages, Innate immunity*



UNRAVELING GENOMIC INSIGHTS INTO CANNIBALISM IN TELEOST FISH

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While cannibalism leads to significant economic losses in aquaculture, understanding the underlying genetic factors is crucial. This study aimed to identify the differences in gene expression between shooter and non-shooter fish larvae and juvenile populations in *Anabas testudineus*, the Climbing perch. The methodology included animal feeding and maintenance, induced breeding, larval rearing, separation of shooter and non-shooter populations and relative gene expression studies using qPCR. A total of 10 genes associated with aggression, feeding habits, memory and growth regulation were selected as per previous reports on fish cannibalism. The study revealed notable variations in gene expressions between the shooter and non-shooter populations of *A. testudineus*. qPCR results indicated up-regulation in genes bmp4, agmo, asns, TH, mical2, hnmt, and slc6a4, suggesting elevated levels of aggression, skeletal development, increased growth rate, and antisocial behavior. Conversely, genes bdnf and kif20a showed downregulation, suggesting a loss of cognitive functions such as learning and memory in predators. These findings remained consistent in both larval and juvenile stages. The expression of genes involved in cannibalism in fish, including both upregulation and downregulation, can be significantly influenced by environmental cues. Factors such as hunger, food availability, population density, water quality, and temperature can interact with a fish's genetic predisposition, thereby either increasing or decreasing the rate of cannibalism. Cannibalism is a complex trait, and a single gene may not solely determine it, but rather influenced by a combination of genetic, environmental, and social factors.

Keywords: Cannibalism, teleost, *Anabas testudineus*, Climbing perch, gene expression, shooter, non-shooter



INVESTIGATION OF BACTERIAL PATHOGEN KLEBSIELLA SPS. IN AQUACULTURE FARMS IN ERNAKULAM DISTRICT, KERALA, INDIA

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Global aquaculture production has increased rapidly in recent years and the sector has become one of the fastest-growing food production industries in the world. Aquaculture is a promising food sector to meet the nutritional requirements of the burgeoning human population. Kerala is one of the major aquaculture-producing states in India. The present work was carried out to study the presence of bacterial pathogen, Klebsiella sps. in the aquaculture farms in Ernakulam District, Kerala. Fish samples were collected from the farm in March 2024. Hydrographical parameters such as water temperature, salinity, and pH were measured on the field. The dissolved oxygen level was between 3-6mg/L in all the farms. The nutrient parameters such as dissolved organic nitrogen (NH_3 , NO_3^- , and NO_2^-) were below the detection level. Alkalinity Hardness, Carbonate, and Bicarbonate levels were acceptable. Further, the microbial quality of the farm was also studied. Specific chromogenic media were used for the isolation of bacterial pathogen Klebsiella. The identified Klebsiella isolates were exposed to 18 antibiotics of 11 classes. The isolates showed More than 50% resistance to Piperacillin, Azithromycin Tetracycline and Nitrofuran. The majority of the Klebsiella isolates from fish showed multiple antibiotic resistance with a MAR index greater than 0.2 and it indicates a high-risk source of contamination, where antibiotics are frequently used. The presence of bacterial pathogens makes the situation worse. In conclusion, higher levels of fecal contamination along with the presence of human pathogens may pose potential health hazards to consumers.

Keywords: Aquaculture, Bacterial pathogens, Klebsiella, Antibiotic Resistance



CHITOSAN ENCAPSULATED NOVEL IMMERSION VACCINE ENHANCED WITH B- GLUCAN AS ADJUVANT AGAINST AQUATIC PATHOGEN *EDWARDIELLA*

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Nile tilapia (*Oreochromis niloticus*) holds great economic value in fish farming in low to middle-income countries. Edwardsiellosis, a pathogenic disease caused by *Edwardsiella tarda* in intensively farmed Nile tilapia, causes a huge loss of fish species. Immersion vaccine is a non-invasive vaccination method for fishes where the mucoadhesive property of chitosan-based (CS nano vaccine with β -glucan) nano has been greatly recognized as an effective mucosal vaccine delivery system in large-scale fish farming. The current study is designed to investigate the effectiveness of immersion delivery with chitosan nano-vaccine with β -glucan as an adjuvant to elicit the mucoadhesive property of the vaccine. Chitosan/ β -glucan (Cs/ β -G) vaccine was formulated and characterized by Fourier transform infrared (FTIR), Scanning Electron Microscope (SEM), and particle charge analysis by Zeta potential. Biophysical characterization confirms the stability of synthesized nano-vaccine. The mucoadhesive property was carried out by fluorescent imaging (DAPI stained) of vaccine-exposed fish. *Oreochromis niloticus* (12 ± 2g) was randomly distributed into four different groups, Control (C), Chitosan/ β -glucan alone (Cs/ β -G), Formalin Killed vaccine (FKV) and Chitosan/ β -glucan Vaccine (Cs/ β -g V). Fish was given an immersion bath on the 1st and 21st-day booster dose in formulated vaccines for 30 minutes. At different time intervals (0th day, 14th, 21st, 36th Day Post Vaccination) serum, spleen, and head kidney samples were collected and innate immune responses were evaluated by qRT-PCR, lysozyme, myeloperoxidase, and antiprotease activity. IgM antibody titre was measured by ELISA where IgM titre reached the peak at the 14th DPV and 36th DPV of Cs/ β -g V compared to the control group. Gene expression analysis by using qRT-PCR found that IgM, IgD, IFN- γ , TNF- α IL1 β , IL-8, and IL-2, were significantly increased in the spleen and head kidney of CS/ β -g V fishes compared to other groups. The efficacy of the vaccine was examined by immersion challenge (1×10^7 CFU/mL) with virulent *E. tarda* after 36th DPV in tilapia. A high relative percentage survival (RPS) was noted with Chitosan/ β -glucan Vaccine (Cs/ β -g V) compared to the control group. The study reveals a plausible approach for immersion vaccination for tilapia farms to maintain sustainable aquaculture. Where same delivery technology can be implemented with other pathogens in the global aquaculture system.

Keywords: *Edwardsiella Tarda*, Chitosan Alginate Polymer Nano-Vaccine, Mucoadhesive Property, Immersion Vaccine



PREVALENCE OF ANTIMICROBIAL RESISTANCE IN ESCHERICHIA COLI COLLECTED FROM CAGE CULTURE AND POND CULTURE OF CENTRAL KERALA, PIZHALA ISLAND COCHIN BRACKISHWATER.

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The rising trend of Antimicrobial resistance (AMR) has become a major health concern for both humans and aquatic animals. AMR is increasingly being found in aquatic animal systems, as well as in human and terrestrial animal health systems. Aquaculture systems such as cage and traditional pond farm situated in Pizhala Island, central Kerala, Cochin brackish water were studied to understand the water quality and bacteriological parameters. Water quality parameters such as pH, salinity and conductivity and bacteriological parameters such as total plate count (PC) of heterotrophic bacteria, Total coliforms (TC), Faecal Coliforms (FC) were analyzed from the study area. The prevalence of antimicrobial resistance among Escherichia coli isolated from water samples were also analyzed. In the present study, all the water samples revealed high TPC, TC and FC. The Most Probable Number (MPN) test, E. coli were high and detected from all the samples at considerable level and it indicates fecal contamination in the sampling sites. The isolates were subjected antibiotic sensitivity testing using Kirby Bauer disk diffusion method. The isolates were highly resistant to Penicillin G (100%), Methicillin (100%), Oxytetracycline (100%), Erythromycin (100%), Ampicillin (66.66%) and intermediate sensitive to Amikacin (33.33%) and Tetracycline (33.33%). None of the E. coli isolates were resistant to Cefpodoxime, Nalidixic Acid, Kanamycin, Streptomycin, Chloramphenicol and Gentamycin. Probiotics, vaccines, bacteriophages are some of the alternatives to reduce antibiotic usage in aquaculture farms.

Keywords: Antibiotics, Antimicrobial resistance, Escherichia coli, traditional pond, Cage culture



Marine Genomics



COMPARATIVE GENOMIC ANALYSIS OF VIBRIO SPECIES ISOLATED FROM FRESHWATER AND MARINE ECOSYSTEMS TO DECODE VIRULENCE AND ANTIMICROBIAL RESISTANCE PATTERNS

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Vibrios, a diverse group of Gram-negative bacteria, are prevalent in aquatic environments and are known for their pathogenicity and sensitivity to climate change indicators. Notable species such as *Vibrio cholerae*, *Vibrio vulnificus*, and *Vibrio alginolyticus* are particularly infamous for their public health implications. Their ability to thrive in aquatic habitats, coupled with their virulence and resistance to antibiotics, highlights the critical need to investigate their ecological roles and the health hazards they present. This study focuses on the genomic analysis of *V. cholerae* from both freshwater and marine sources, as well as *V. vulnificus*, and *V. alginolyticus* from marine environments, to better understand their pathogenic potentials. Our findings reveal distinct virulence gene profiles among the studied *Vibrio* sp. with *V. alginolyticus* harbouring genes encoding the Type III Secretion System 1 (T3SS1), while *V. vulnificus* carrying genes encoding presumptive cytotoxin (rtxA) and outer membrane protein U (ompU). Environmental *V. cholerae* isolates exhibited an array of virulence factors including the Type VI Secretion System (T6SS) and virulence factors typical of *V. parahaemolyticus*, whereas clinical isolates exhibited different virulence factors such as zonula occludens toxin, cholera toxin, and accessory colonization factor. Furthermore, *in silico* biotyping and serotyping revealed that environmental *V. cholerae* isolates were non-O1/non-O139 strains, while clinical isolates were of the O1 El Tor Variant (7th pandemic strain). Antimicrobial resistance profiling demonstrated differing resistance patterns between environmental and clinical isolates, with environmental *V. cholerae* showing resistance to carbapenems and fluoroquinolones, while clinical isolates exhibited resistance to aminoglycosides and sulphonamides. Notably, environmental isolates displayed resistance to antibiotics classified under the Watch group of the WHO AWaRe antibiotics classification, highlighting the urgent need for surveillance and control measures to combat antimicrobial resistance in marine environments. These findings highlights the critical need for surveillance of *Vibrio* pathogens in marine ecosystems, adopting a One Health approach that encompasses human, animal and environmental health. A comprehensive understanding of the genomic diversity, virulence factors, and antimicrobial resistance of *Vibrio* sp. is vital to formulating robust strategies that can lessen the public health risks and preserve the ecological balance of marine habitats.

Keywords: *Vibrio, climate change, virulence, antimicrobial resistance, cholera*



MOLECULAR AND FUNCTIONAL CHARACTERIZATION OF A NOVEL HEPcidin ISOFORM, EA-HEP FROM YELLOW SPOTTED ROCKCOD, *EPINEPHELUS AREOLATUS* (FORSSKAL, 1775)

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Hepcidin, an antimicrobial peptide (AMP) rich in cysteine, is a crucial element of the innate immune system in fish. It plays a significant role in preventing the dissemination of microbial infections by diminishing iron availability and triggering intracellular cascades. Teleost fishes, owing to its exposure to diverse environmental conditions such as pathogens, oxygen levels, and iron concentrations, showcase a broad spectrum of hepcidins. A novel hepcidin isoform (*Ea*-Hep) was identified from the yellow spotted rockcod, *Epinephelus areolatus*. The cDNA sequences of *Ea*- Hep had a 270 bp open reading frame (ORF) with a coding capacity of 90 amino acids. Nucleotide and Protein blast analysis confirmed that both the peptides belonged to the HAMP1 group of hepcidin superfamily. Similarity searches using homology analysis tool BLAST indicated that Ea-Hep showed 96% similarity to hepcidin from *Alphestes immaculatus*. The Mature peptide showed a predicted molecular weight of 2.99 kDa with a therotical PI of 8.75. The *Ea*-Hep was recombinantly produced in *E. coli* Rosettagami B(DE3)PLysS cells. The recombinant peptide, r*Ea*-Hep was purified by Fast Protein Liquid Chromatography (FPLC). The peptide exhibited significant antibacterial activity towards human/fish pathogens such as *Bacillus cereus*, *Escherichia coli*, *Aeromonas hydrophila*, *Edwardsiella tarda*, *Pseudomonas aeruginosa*, *Vibrio parahaemolyticus*, *Vibrio proteolyticus* and *Vibrio harveyi*. The peptide's ability to inhibit bacterial pathogens holds promise for its application in medicine/aquaculture.

Keywords: Antimicrobial peptide, Hepcidin, HAMP 1, *Epinephelus areolatus*, Antibacterial activity



COMPARATIVE ANALYSIS OF VIRAL PARTICLE PURIFICATION METHODS FOR MARINE VIROME STUDIES

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Viral metagenomics, essential for exploring the virome of an ecosystem, relies on robust purification and concentration of viral particles from samples. Marine sediment samples present unique challenges, demanding precise viral particle isolation techniques. This study investigates the efficiency of two crucial methods in viral metagenomics, namely PEG precipitation and flocculation, for purifying viral particles from estuarine sediment. Approximately 1kg of sediment samples underwent PEG precipitation and flocculation methods, combined with filtration and centrifugation, to purify viral particles. The purity was subsequently validated using various methods. Viral particles purified by these methods were examined via epifluorescence microscopy with SYBR Gold, revealing higher purity in PEG precipitated samples despite increased co-sedimentation with the flocculation method. Metagenomic nucleic acid extraction using QIAamp kit (Qiagen) exhibited a prominent band with PEG but produced a smear with flocculate, indicating superior DNA quality with viral particles purified using PEG precipitation. Spectrophotometry analysis corroborated these findings, highlighting enhanced purity. Subsequent 16S rRNA PCR revealed bacterial contamination solely in flocculate, affirming the superiority of the PEG precipitation method for viral particle purification over flocculation. These results validate the efficiency of PEG precipitation for purifying and concentrating viral particles for marine viral metagenomics, underlining the critical role of method selection in maintaining sample integrity and downstream accuracy. Future investigations, including NGS and viral community characterization, could further evaluate the efficacy of PEG precipitation protocols in downstream viral metagenomics analyses. In conclusion, this study emphasizes the importance of methodological considerations in viral metagenomics, guiding researchers towards more effective viral particle purification strategies in challenging environmental samples.

Keywords: *Viral metagenomics, PEG precipitation, Flocculation, Marine sediment, Virome*



UNRAVELLING THE VIROME ASSOCIATED WITH THE SEDIMENTS OF THE COASTAL WATERS.

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Viruses are incredibly abundant and diverse organisms found in aquatic environments. There is still a shadow of an awareness of their great diversity and the importance of the roles they have played. Next-generation sequencing is an effective and appropriate technique for deciphering the details of the different aspects, and viral metagenomics paves the way for this. In the present study, we followed this path to get a snapshot of the metavirome composition of the sediments from the coastal waters. Centrifugation, filtration, and flocculation were used to separate the virus particles from the sediment and concentrate and purify them. The metavirome was produced by subjecting the nucleic acid extracted from the flocculate to Illumina whole genome amplification. The next-generation sequencing revealed the presence of several viral families and their functional diversity. As a result, the findings demonstrate that metagenomics is an essential technique for investigating and comprehending the viral population connected to the coastal environment. Hence, the information produced by this work may be crucial in advancing future research to completely comprehend the functions and significance of the viral species found in coastal and other aquatic systems.

Keywords: Metagenomics, Phages, Sediment, Virome, Next generation sequencing



TURBULENCE IN THE ARCHAEO TAXONOMY: INTRODUCING TWO NOVEL MAGS INTO CLASS JANJXX01 FOR BETTER RESOLUTION

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The investigation of primordial evolution, particularly through the prism of archaea, furnishes invaluable insights into the nascent phases of terrestrial existence. Archaea, delineating one of the triumvirate domains of life, have been pivotal in sculpting our comprehension of evolutionary paradigms. Among the riveting offshoots of archaea lies the phylum Thermoproteota, renowned for the prowess of its constituents to thrive in extreme thermal conditions typified by high-temperature environments such as hydrothermal vents and thermal springs with near-neutral pH levels. Within the variegated taxa encompassed by Thermoproteota, an exceptionally remarkable but underexplored class, denoted as c_JANJXX01, beckons investigation at the genetic stratum. This class epitomizes a distinct lineage of archaea characterized by extraordinary thermotolerance and metabolic adaptability. Our investigation endeavors to bridge this lacuna in knowledge by harnessing sophisticated genomic and bioinformatics methodologies to delineate the genomic attributes, metabolic capacities, and ecological roles of class JANJXX01 archaea in their indigenous habitats. Specifically, we have unveiled two unprecedented archaeal genomes procured from abyssal sediments of the Gulf of Kutch, attributable to the same class within the Thermoproteota phylum, thereby shedding luminosity upon their evolutionary import and ecological functionalities within this unique marine milieu. Through meticulous scrutiny of pan genomics, pathway module profiling, functional characterization of identified genes, their engagement in sundry metabolic pathways, and rudimentary statistical scrutiny of genome attributes, this inquiry heralds a pioneering contribution within the JANJXX01 class of Thermoproteota. It furnishes a profounder understanding of the molecular machinations underpinning both nascent unearthed genomes within the same clade.

Keywords: Thermoproteota, Pangenomics, Marine microbiome, Deep sediments



WESTERN COAST OF INDIA: INSIGHTS FROM SEASONAL MONSOONAL VARIATIONS IN BACTERIAL DIVERSITY

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Upwelling, a pivotal process in marine ecosystems, serves as a vital conduit for essential nutrient transport. Despite its significance, the intricate bacterial community dynamics within upwelling zones along the Western coast of India remain largely uncharted. This study embarks on a comprehensive exploration of bacterial diversity, employing cutting-edge metagenomic analyses, to decipher the intricate responses to seasonal monsoonal fluctuations—Premonsoon (PR), Monsoon (MN), and Post-monsoon (PM). Our investigation unveils a rich diversity of bacterial communities, revealing distinct spatial distribution patterns during upwelling events compared to PR and PM seasons. Moreover, compelling evidence emerges of phylogenetic taxonomy intricately shaped by ecological nuances within these dynamic marine environments. Assessment of physiochemical parameters—including temperature, salinity, dissolved oxygen, and nutrient concentrations (nitrite, phosphate, silicate, nitrate, and ammonium)—indicates the pronounced upwelling conditions during MN. Notably, the bacterial community exhibits remarkable diversity within upwelling systems, surpassing that of both PR and PM periods. Dominant bacterial orders during MN include *Pelagibacterales*, *Sphingomonadales*, *Rhodobacterales*, *Flavobacteriales*, *Alteromonadales*, *Hyphomicrobiales*, and *Burkholderiales*. During PR, *Synechococcales*, *Pelagibacterales*, *Moraxellales*, *Sphingomonadales*, and *Rhodobacterales* were dominant, while PM showed dominance of *Synechococcales*, *Pelagibacterales*, *Flavobacteriales*, *Bacillales*, and *Eubacteriales*. Metric MDS cluster analysis showed 80% similarity between PR and PM, while the MN upwelling system emerges as a season of distinct diversity—a testament to the intricate interplay of environmental dynamics and microbial communities in the Arabian sea.

Keywords: Premonsoon, Post monsoon, Metagenomics, Metric MDS



TISSUE-WISE GENE EXPRESSION PROFILING OF ANTIMICROBIAL PEPTIDES IN THE GENETICALLY IMPROVED FARMED TILAPIA (GIFT), *OREOCHROMIS NILOTICUS*

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Antimicrobial peptides (AMPs) are molecules of innate immune defense mechanism, which play a significant role in maintaining the healthy state of organisms thriving in varied and diverse habitats. The present study investigated the expression profile of ten AMP genes, such as β -defensin, hepcidin, histone H2A-derived AMP, piscidin-1 to -5, thymosin β 1, and thymosin β 4, in tissues like gill, blood, skin, muscle, stomach, intestine, pancreas, ovary, brain, heart, and liver of healthy adult *Oreochromis niloticus*. Semi-quantitative analysis revealed constitutive expression of all AMP genes, albeit at varying levels across tissues. Hepcidin exhibited distinct variations, with the highest expression observed in the pancreas, brain, and liver. Differential expression patterns were observed for the piscidin isoforms, with piscidin 1 showing the lowest expression and limited distribution in gill and blood tissues. Thymosin β 1 and β 4 displayed distinct transcriptomic profiles, with thymosin β 4 showing higher expression in the gill, blood, stomach, and brain. The findings suggest tissue-specific roles for AMPs in the innate immune defense system of *Oreochromis niloticus*. The presence of thymosin β in non-immune related tissues highlights its involvement in broader physiological processes. These results contribute to the understanding of AMP expression patterns and their potential functions in fish tissues. Further research is needed to explore the functional significance of tissue-specific AMP expression and its implications in fish health and disease resistance.

Keywords: Antimicrobial peptide, Expression profile, Innate immune defense, *Oreochromis niloticus*, Tissue-specific



DEVELOPMENT OF A FISH-SPECIFIC CRISPR/CAS9 PLATFORM WITH *NEOR*-MEDIATED TARGETED G418 SELECTION TO ENHANCE SCREENING EFFICIENCY OF GENOME-ENGINEERED CELLS *IN VITRO*

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CRISPR technology provides a simple and efficient method for editing the genomes of cells, providing powerful tools for fundamental research. While using Cas9 to target a genomic site is very efficient, making a specific mutation at the site. CRISPR-edited cells usually represent only a small portion of the overall cell population, identifying, enriching, and isolating this subset poses a significant challenge. Besides, when mutated cells do not exhibit phenotypic differences from unedited ones, the task becomes more challenging. The process of isolating and characterizing properly edited cells can be arduous and time-consuming. Since, screening numerous individual colonies is necessary to pinpoint precisely edited cells. Moreover, the limited availability of an effective gene-editing platform for fish cell lines stems from the absence of fish-specific vectors that utilize active promoters to control the expression of both single guide RNA (sgRNA) and the Cas9 protein within a single expression platform. In this study, we have developed a plasmid-based CRISPR/Cas9 delivery system specifically tailored for fish cells, incorporating a selectable marker to enhance the screening efficiency of edited cells. We have amplified RNA polymerase type III promoters such as U6 (ZU6) and an endogenous promoter like elongation factor 1 alpha (ZEF1 α) from the fish genome, then integrated them into a mammalian-specific CRISPR/Cas9 delivery system to enhance genome editing efficiency. This involved replacing the human U6 promoter (hU6), responsible for directing the expression of sgRNA, and the chicken beta actin (CBh) promoter, directing the expression of spCas9 protein, in a single vector expression system. Additionally, NeoR was incorporated into the vector system to improve the screening efficiency of genetically engineered cells, enabling fast and easy selection of edited cells *in vitro*. This development signifies a substantial progress in the potential application of the CRISPR/Cas9 system in other teleost, both *in vitro* and *in vivo*.

Keywords: CRISPR/Cas9, genome editing, sgRNA, Cas9, fish cells, Neo^R



SYSTEMS APPROACH TO INVESTIGATE THE MOLECULAR INTERACTIONS IN THE BIOSYNTHETIC PATHWAY OF PYOCYANIN PRODUCED BY *PSEUDOMONAS AERUGINOSA*

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Pyocyanin, a nitrogen-containing heterocyclic secondary metabolite produced by *Pseudomonas aeruginosa* is a potent aquaculture drug proved to be effective against vibriosis and other bacterial infections. It exhibits antibiotic action through the production of reactive oxygen species such as superoxide(O_2^-) and peroxide (H_2O_2) that cause oxidative cell injury or cell death. Concentration of pyocyanin ranging from 5 to 10 mg⁻¹ does not show any pathological effect in eukaryotic systems and this makes pyocyanin suitable in sustainable aquaculture. The concentration of Pyocyanin obtained in the culture medium was below 6 mg/L and the cost of commercially available Pyocyanin vary from around €56.40 (5113.27INR) to more than €202.10 (18322.55INR) per 5 mg of Pyocyanin. Hence improved and cost-effective production of Pyocyanin has significance in aquaculture systems. Exact biochemical mechanisms and the gene clusters involved in the production of Pyocyanin in *Pseudomonas aeruginosa* is well studied. However, the genetic modification of Pyocyanin biosynthetic pathways in *P. aeruginosa* still needs to be experimented for improving the yield of pyocyanin. In this study an attempt has been made to reconstruct the Pyocyanin biosynthetic pathway in *Pseudomonas aeruginosa* by implementing the systems approach of incorporating the key components and interactions using computational tools. The resultant pathway is a network of possible metabolic, signaling and regulatory interactions that contribute to the synthesis of pyocyanin. This enables us to visualize the entire molecular interactions in a single frame that would reveal the possible sites for gene level manipulations to enhance the production of pyocyanin.

Keywords: Pyocyanin, Systems approach, *Pseudomonas aeruginosa*, Sustainable aquaculture



SEASONAL ALTERATION OF MICROBIAL COMMUNITIES ASSOCIATED WITH THE SEA URCHIN *STOMOPNEUSTES VARIOLARIS*

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An island mass influences the biogeochemistry and biological production of the surrounding waters. The coastal waters surrounding Grande Island, Goa, offer a unique microenvironment for the organisms thriving therein as it experiences variations in biogeochemical parameters both seasonally and due to the presence of the island mass. The organism-associated microbiome has an important role in shaping its response towards the environment. In this study, we aimed to understand the native microbial community associated with sea urchins dwelling around Grande Island and changes in community structure seasonally. Sea urchins were collected seasonally, and DNA extraction was performed. Amplicon sequencing of the V3-V4 region of 16S rRNA gene was carried out, followed by data analysis using QIIME2. The gut-associated microbial community altered seasonally, with higher alpha and beta diversity during the northeast and spring-inter monsoons (NEM and SIM). Higher abundances of phylum Bacteroidota (40-50%) and Proteobacteria (25%) were found during southwest and fall-inter monsoons (SWM and FIM), while Firmicutes had increased abundance (33-35%) during NEM and SIM. Microbes adapted to anoxia and sulphidic conditions were found in higher numbers in the gut during SWM and FIM, represented by the family Desulfocapsaceae, Fusibacter genera with Fusibacteraceae family, and order Rhodospirillales, although smaller in number. In contrast, there was a higher abundance of anammox bacteria in the gut, as represented by Anaerolineaceae belonging to phylum Chloroflexi during NEM and SIM. Additionally, the exclusive representation of archaeal taxa Methanobrevibacter within phylum Euryarchaeota correlates to the high methane levels reported in this region during the NEM and SIM. Our study describes a unique microbial community associated with the urchins found in the coastal region of Goa. It indicates that the microbiome associated with the sea urchins can adapt to seasonal changes by altering the associated microbial community, the relevance of which is yet to be demonstrated.

Keywords: *Stomopneustes variolaris; Sea urchin; Arabian Sea; Microbiome; 16S rRNA*



COMPREHENSIVE GENE EXPRESSION PROFILING AND FUNCTIONAL ANNOTATION OF GILL TISSUE IN THE ASIAN GREEN MUSSEL, *PERNA VIRIDIS* (*Linnaeus, 1758*)

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Mussels play a pivotal role in environmental health and toxicity monitoring and as a valuable nutritional resource for fisheries. De novo transcriptome assembly stands as a crucial tool for unravelling gene expression patterns and uncovering novel genetic information, particularly in organisms lacking reference genomes. Within this framework, we present the de novo assembly of the gill transcriptome of *Perna viridis* using next-generation sequencing. Our sequencing efforts unveiled a substantial dataset comprising over 434,810 transcripts with an average length of 887 base pairs. To elucidate the functional aspects, we employed BLAST and EggNOG for functional annotation, while the resulting assembly underwent functional classification using the GO, Reactome, and KEGG databases. Additionally, we gauged the assembly's completeness through BUSCO analysis, revealing that 95% of conserved genes were successfully captured, underscoring the high quality of our assembly. Our dataset stands as a comprehensive sequence resource, significantly advancing molecular studies on *Perna viridis*. This work highlights the efficacy of Illumina sequencing and de novo transcriptome assembly, especially in species lacking genomic information. The outcomes of our research not only underscore the potential for further molecular investigations but also point towards diverse applications across various scientific disciplines.

Keywords: *De Novo Transcriptome Assembly, Functional Annotation, Perna viridis, Gill Tissues*



COMPARATIVE MITOGENOMICS, PHYLOGENY AND EVOLUTION OF THE UNDEREXPLOITED OCEANIC PURPLEBACK FLYING SQUID, *STHENOTEUTHIS OUALANIENSIS* (LESSON, 1830) FROM THE INDO-PACIFIC

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Sthenoteuthis oualaniensis is an underexploited and promising oceanic squid distributed throughout the Indo-Pacific (40°N to 40°S of the equator) with huge latent stock in the Arabian Sea. It has a unique and complicated population structure reported to date in Ommastrephid squids. The species has three major morphotypes (giant, middle-sized/medium, dwarf), out of five forms of distinguishable sizes and different spawning groups. It has a unique phylogeographical structuring with four novel lineages from the Indian Ocean viz. the giant form endemic to the Northwestern Indian Ocean, a dwarf form from the Lakshadweep waters, and two middle-sized forms. The dwarf form is restricted to the equatorial oligotrophic waters (10–15°N & S). According to the latest research, there exist two highly cryptic dwarf lineages residing in the Indian and Pacific Oceans respectively. Mitogenomics is very useful in illuminating phylogenetic relationships more effectively than analyses based on single genes or subsets of genes. For a complete understanding of the evolution of this species, information about all lineages from the Indian Ocean is necessary. The mitogenomes of the giant and dwarf forms were characterized recently and this study aimed to generate reference mitogenomes of the missing two lineages in the middle-sized form of the species from the Indian Ocean. This will serve as a baseline for the global genetic comparison of the species concerning its morphological variation. We assembled the whole mitogenome using the NOVOPlasty algorithm utilizing low-coverage Illumina sequencing. The AT-rich mtgenomes had eighteen PCGs, twenty-three tRNAs, two rRNAs, and two non-coding areas. Six genes and one non-coding region were duplicated in the mitogenome. Of the 43 genes, 22 were encoded by its Heavy strand, and the remaining genes were encoded by its Light strand. Three major AT-rich codon families were found by a codon usage analysis. Various morphotypes of *Sthenoteuthis* shared a compositional symmetry, based on the skew statistics of the PCGs. Purifying selection operating on PCGs was revealed by Ka/Ks studies of different lineages. Notwithstanding their clear physical differences, phylogenetic analysis identified the giant and dwarf forms of the Arabian Sea as sister taxa. The lineages of the middle-sized forms from the Indian Ocean clustered with other middle-sized forms from the Pacific. Intense adaptive radiation and active speciation events expedited by fast generational turnover as well as sympatric and allopatric speciation can be considered as possible causes for the multiple forms of this species.

Keywords: Squid, *Sthenoteuthis*, Morphotypes, Mitogenome, Phylogeny, Evolution



EFFECT OF TRACE METALS ON THE BACTERIAL COMMUNITY STRUCTURE IN COASTAL AND OPEN OCEAN WATERS OF THE INDIAN OCEAN

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Input of essential nutrients and trace metals through aerosol deposition is crucial to the oceans. The bacterial abundance and community structure determine their ecological functions, and any change in environmental conditions, such as elevated metal concentrations arising from aerosol dust deposition and trace metal leaching, could significantly affect the bacterial diversity, their biological activities and subsequently the ecological functions. Traditionally studies have focused on the effect of iron fertilization on phytoplankton communities, and only limited research is available on the effect of trace metals on marine heterotrophic communities. This is the first study wherein onboard microcosm experiments were conducted at different locations in the Bay of Bengal (NM1) and the Indian Ocean (NM5), coupled with high-throughput Illumina sequencing of the 16S rRNA amplicon, to observe the shifts in marine heterotrophic communities in response to trace metal amendments. The onboard microcosm experiments were carried out using 24 litres of seawater collected from the chlorophyll maxima region and amended with 100 nM each of four bioactive trace metals (Fe, Zn, Cu, Mn) individually and as a mixture. Following the incubation period (5 days), the water was filtered through 0.22µm cartridge filters and the filter paper was processed for metagenomic DNA extraction and sequencing. The results depict a significant difference in the bacterial community between the two locations sampled (PERMANOVA, p= 0.0019), wherein the alpha diversity indices (Shannon and Chao-1) at location NM5 are higher than that at NM1. The dominant phyla at NM1 include Proteobacteria, Bacteroidata and Planctomycetota; and at NM5 Proteobacteria, Cyanobacteria and Actinobacteriota dominated. The location NM1, being a coastal site is more influenced by an increased influx of pollutants from the Indo-Gangetic Plain. As such, the bacterial communities at this location were dominated by hydrocarbonoclastic bacteria belonging to the family Cellovibrionaceae and Oleiphilaceae. The addition of trace metals negatively impacted these bacterial taxa that are otherwise beneficial to the environment. Furthermore, the abundance of Vibrio species increased on metal addition, which is a considerable public health concern since many species are potential human pathogens. At location, NM5, the cyanobacterial communities were drastically inhibited by the addition of trace metals, which could imply the negative impacts of aerosol deposition of cyanobacterial communities in the open ocean waters. Hydrocarbonoclastic bacteria (Alcanivorax and Marinobacter) were stimulated on metal addition suggesting a plausible role of hydrocarbonoclastic bacteria in the biogeochemical cycling of metals in oceans.

Keywords: Bacterial Diversity; High-throughput Sequencing; Indian Ocean; Microcosm; Trace Metals.



HYDROCARBON DEGRADING ENZYME MACHINERY FROM AN ARCTIC FJORD MICROBIOME

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Studies on hydrocarbon-degrading enzyme machinery in the Arctic are crucial due to the region's susceptibility to contamination from increasing anthropogenic activities. Understanding the mechanisms and effectiveness of microbial enzymes in Arctic soils and marine environments is essential for developing efficient bioremediation strategies. Hydrocarbon pollution in the Arctic primarily stems from oil exploration, extraction, and transportation activities, as well as local ship emissions and summertime boreal forest fires. Plastics, including microplastics, are another major pollutant in the Arctic, originating from various sources such as wastewater, land-based waste storage, shipping, fisheries, tourism, and lost fishing gear, posing a severe threat to Arctic ecosystems and wildlife. Biosurfactants, enhance the bioavailability of hydrophobic pollutants, and play a vital role in hydrocarbon degradation in the Arctic. Exploring the diversity and functionality of enzymes in Arctic ecosystems provides insights into how microbes adapt to cold environments and metabolize different hydrocarbons. In the current study total ORFs from a shotgun metagenome sequence of a near glacier surface sediment metagenome from Kongsfjorden, Arctic, was extracted using 'Metaprodigal' and screened for genes involved in hydrocarbon metabolism using curated hydrocarbon aerobic degradation enzymes and genes (HADEG) database. This brought out the presence of 84 genes involved in 31 different degradation pathways of alkanes, alkenes, aromatic hydrocarbons, plastics and biosurfactants. The genes and pathways involved in aromatic hydrocarbon was found to be more diverse and abundant with prominence of benzoate degradation, phenylacetate degradation and protocatechuate degradation pathways. The abundance of genes involved in the degradation of polybutylene adipate terephthalate (PBAT), polyhydroxyalkanoates (PHA), polyhydroxy butyrate (PHB), polybutylene succinate adipate (PBSA), polylactic acid (PLA), and polyether sulfone (PES) in Arctic sediment metagenomes signifies the potential for bioremediation of plastic waste in Arctic environments. The presence of biosurfactants like emulsan and rhamnolipids increases the bioavailability of the hydrocarbons. The array of genes identified comprises, Esterase (*est*) which are crucial for breaking down ester-containing polymers in plastic degradation, *PcaG* involved in the degradation of protocatechuate, an intermediate in the breakdown of aromatic compounds, *PaaK* which activates phenylacetic acid in the phenylacetic acid



degradation pathway, *XylL* which catalyses the meta-cleavage of catechol, a common intermediate in aromatic compound degradation and *Blc* a component of alkane monooxygenase, which initiates alkane degradation converting alkanes into primary alcohols were found to be the abundant. Therefore, research on genes encoding hydrocarbon-degrading enzymes in the Arctic underscores the significance of microbial communities in aiding the remediation of hydrocarbon-contaminated sites in cold environments, showcasing their potential in bioremediation.

Keywords: Arctic, Hydrocarbon degradation, Bioremediation, Microbial genetics



COMPARATIVE STUDY ON THE RESISTANCE CAPACITIES OF *Halomonas* sp. FROM THE INDIAN OCEAN USING WHOLE GENOME SEQUENCE ANALYSIS

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Whole genome-based studies of bacterial species serve as an important tool to understand the genetic elements underlying resistance to various pollutants like metals, antibiotics and other stressors so as to identify their capacity to help them survive in different stressful environmental conditions. In this study, a whole genome-based analysis was carried out to understand the resistant signatures of two *Halomonas* sp., belonging to Gammaproteobacteria, isolated from Indian Ocean samples. *Halomonas* sp SS10-MC5 and *Halomonas maris* QX-1 are two halophilic bacteria identified from the hydrothermal vents and deep-sea sediments of the Indian Ocean respectively. The whole genome of these species was retrieved from NCBI and annotated using Prokka to identify the metal resistance genes (MRGs) and antibiotic resistance genes (ARGs) along with a detailed phylogenomic study on both species. The circular genome map of *H. maris* QX-1 showed the presence of resistant genes against metals such as arsenic, copper, manganese, cobalt, zinc, cadmium, mercury, nickel, chromium, cobalt and zinc and the presence of ampicillin resistant genes. *H. sp* SS10-MC5 do not possess MRGs for mercury and chromium while it exhibited ARGs for ampicillin and tetracycline. Both these bacterial genomes showed the presence of efflux-pump genes, *mdt* and *acr*. The phylogenomic study of *H. maris* QX-1 showed they are close to *H. glaciei* DD-39, and it is confirmed by *in silico* DDH-analysis (55.8%), G+C difference (0.01%) and OrthoANI-analysis (91.75%). *H. sp* SS10-MC5 was found to be closer to *H. sulfidoxydans* MCCC-1A11059 with a DDH value of 92.5%, G+C difference of 0.13% and OrthoANI value of 99.4%. The study therefore highlights that these species could be useful for bioremediation to remove harmful metal and antibiotics from their surroundings in a more cost-effective way.

Keywords: *Halomonas* sp, Whole Genome Sequence Analysis, Resistance genes, Phylogenomic



METABOLOMIC PROFILING OF MARINE SPONGES FROM GULF OF MANNAR REGION, TAMIL NADU

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Due to incredible biodiversity, the marine environment produces a wide range of biologically active compounds, including PUFAs, proteins, pigments, vitamins, and minerals, among others, that are to some extent used as ingredients in functional foods. For this study we have used marine sponges namely, *Bubaris vermiculata*, *Callyspongia clathrate*, *Callyspongia spinosissima*. The species were collected from a trash at kunthukal, Ramanathapuram Dist, South East coast of India. The fraction was extracted using silica gel column chromatography. Profiling of metabolites present in the sponges were performed using Gas Chromatography-Mass spectrometry Technique. GC-MS analysis of three marine sponges profiled 183 unique compounds. It is profiled 41, 45, 87 bioactive compounds in the marine sponges includes *callyspongia clathrate*, *Bubaris vermiculata*, and *Callyspongia spinosissima* respectively. Several of the identified compounds have known bioactivities 1,2,3,4-tetrathiane has been reported to have antimicrobial and antitumor activities, while eicosane has been shown to have antibacterial properties. Hexatriacontane has also been reported to have antimicrobial and antioxidant activities. These findings suggest that marine sponges are a potential source of bioactive compounds that could be useful for the development of new drugs and other applications. Overall, our results demonstrate that marine sponges are a rich source of diverse chemical compounds with potential applications in various fields.

Keywords: Bioactive compounds, *Bubaris vermiculata*, *Callyspongia clathrate*, *Callyspongia spinosissima*, Antimicrobial and antitumor activities.



Coastal Processes & Estuarine Dynamics



SPATIO-TEMPORAL VARIABILITY IN SEDIMENTARY VARIABLES AND ELEMENTAL RATIOS OF A RAMSAR WETLAND, SOUTHWEST INDIA

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Ashtamudi wetland located along the southwest coast of India, is under the threat of organic and inorganic contaminants which negatively impact the ecological health. The study area is ecologically significant as a Ramsar Site and information on geochemical characteristics is limited. Hence the present study aims to evaluate the geochemical status of Ashtamudi wetland using sediment quality variables and nutrient elemental ratios. Sediment pH was controlled by the fresh water discharge from Kallada River and tidal ingressions from Arabian Sea. Anoxic condition of the sedimentary environment was due to mineralization of organic matter (OM), substantiated by declined values of redox potential. Texture of the sediment was controlled by river influx, with dominance of fine-grain size during post monsoon. However, during the monsoon, there was a gradual increase in sand content due to terrestrial runoff. Total organic carbon (TOC) varied from 0.14 to 15.51% (Post Monsoon) and 0.11 to 10.72% (Monsoon). Enhanced TOC levels in the riverine zone was sourced to run-off and in industrial zone due to effluent discharge. Average C/S ratio in sediments was between 1.5 - 5 category, inferred sediment deposition under periodic anoxia. Intermediate values of C/N indicated mixed origin of OM from in situ primary production and also inputs from terrestrial sources. The C/P and N/P ratios in sediments indicated phosphorus build up, while lower N/P values suggested increased denitrification and benthic nitrogen recycling, fostering primary productivity in the wetland ecosystem.

Keywords: Wetland, Ramsar site, Elemental ratios, Organic matter



MICROPLANKTON DYNAMICS IN POLLETHAI MUDBANK REGION OF ALAPPUZHA, KERALA, SOUTH WEST COAST OF INDIA

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The presence of a mudbank serves as a notable manifestation of the periodic variations resulting from the environmental circumstances encountered by the coastal waters of the southwestern region of India during the southwest monsoon. This current investigation delves into the dynamics of microplankton in the Pollethai Mudbank area of Alappuzha, Kerala, located on the southwest coast of India, spanning from May to August 2023. Microplankton, comprising microphytoplankton and microzooplankton, emerge as the predominant plankton groups in the mudbank vicinity. Over the course of the research, a total of 81 microplankton species were recorded, with two episodes of bloom events taking place along the Pollethai Coast. Particularly, *Asterionellopsis glacialis* and a *Thalassiosira* sp. underwent blooming phenomena in May (pre-monsoon) and June (monsoon), respectively. The occurrence of an *Asterionellopsis glacialis* bloom marks the first report from the west coast of India. The month of May (pre-monsoon) showcases a notable proliferation of microphytoplankton species. A total of 70 microphytoplankton species were identified along the Pollethai coast. Notably, diatoms, represented by 56 species, emerged as the prevalent group, followed by dinoflagellates comprising 11 species. Also, 11 microzooplankton species were documented during the study period. Within this category, tintinnids, copepod nauplii, radiozoa, foraminifera, and polychaete larvae were identified as the primary groups. The physical and chemical parameters, specifically temperature, salinity, pH, dissolved oxygen and inorganic nutrients, were gauged and recorded. The southwest monsoon period witnessed a decline in dissolved oxygen, salinity, temperature, and pH levels, whereas inorganic nutrients and chlorophyll a exhibited an upsurge during this time. Additionally, an initial occurrence of the mudbank phenomenon was noted during the study period. Nonetheless, the mudbank did not consolidate, and the initial characteristics of the mudbank shifted towards Omanapuzha, situated south of Pollethai.

Keywords: Mudbank, microplankton, microphytoplankton, microzooplankton, southwest monsoon



SEASONAL DYNAMICS AND ENVIRONMENTAL DRIVERS OF PRODUCTIVITY IN THE KOCHI ESTUARINE SYSTEM: INSIGHTS FROM ESTUARINE TURBIDITY MAXIMA AND NUTRIENT ABUNDANCE

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Estuaries, as vital transitional zones between freshwater and marine environments, exhibit dynamic physical and biogeochemical processes. Estuarine turbidity maxima (ETM) significantly influence sediment transport, nutrient cycling, and primary productivity. The Kochi Estuarine system, situated on the southwest coast of India, offers an excellent opportunity for studying seasonal ETM variations due to its intricate river network, robust tidal regime, diverse geomorphology, and rich marine biodiversity. Analysis of monthly in-situ CTD data collected from June 2008 to May 2009 along the Kochi estuary highlights ETM presence near the mouth during June-September, attributed to heightened river efflux. Conversely, ETM shifts towards the inlet's farthest point during March-May due to saline incursion. Notably, a comprehensive study of production in the Cochin estuary across all seasons reveals a consistent abundance of NO₃, indicating eutrophic conditions throughout the year. Principal component analysis underscores the non-limiting role of NO₃ in production dynamics within the Cochin estuary. During the pre-monsoon period, the Cochin estuary exhibited high productivity, contrasting with reduced production levels during the monsoon due to elevated turbidity in the water column. Post-monsoon conditions saw surface production, facilitated by water column stratification resulting from decreased river discharge and tidal influence. Unlike pre-monsoon conditions where production extended to the bottom in many regions due to increased light availability, post-monsoon production remained predominantly surface-oriented. However, despite conducive ambient conditions, not all stations displayed enriched chlorophyll (chl) production. Principal Component Analysis was conducted to explore the relationship between chl and major production contributors, revealing a consistent positive correlation between temperature and chl levels. The standardized chlorophyll (chl) values across ten stations in the tropical estuarine system exhibit pronounced spatial variability, with some stations showing significantly higher chl concentrations compared to others, suggesting localized hotspots of productivity within the estuary. Additionally, temporal fluctuations in chl concentrations indicate dynamic seasonal changes in productivity influenced by environmental factors such as nutrient availability and water column characteristics.

Keywords: Tidal regime, Estuarine turbidity maxima (ETM), Principal Component Analysis (PCA)



MONITORING NEARSHORE DYNAMICS THROUGH LOW-COST SMART VIDEO TECHNOLOGY

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Nearshore dynamics play a crucial role in societal, commercial, cultural, and tourism activities and contribute significantly to our economy. Monitoring such processes is always challenging due to lack of data, poor understanding of the complexity, difficulties in installing equipment in the sea and the danger pose to the personnel. As an alternative method, remote sensing, specifically shore based video monitoring, has emerged. Satellite based remote sensing is often difficult to adapt due to limited availability of high-resolution data, costs associated with it and repeatability issues. On the other hand, Video based monitoring is often expensive due to various reasons like proprietary technology, costs of operations, maintenance etc. Under SAMUDRA programme by Space Applications Centre (SAC ISRO) in collaboration with NCESS (MoES) and Andhra University, we established a Low-cost Video-Based Monitoring System (VBMS) containing a high-resolution camera at the top of the tower 35-meter at Rushikonda Beach, a Blue-flag certified beach. Continuous video data are collected in a local computer throughout the day (from dawn to dusk) and processed in the form of every 20-minute time scale using an open-source Quantitative Coastal Imaging Toolbox (QCIT). The video data is meticulously transformed into a scientifically meaningful data by correcting the camera distortions, rectifying the video imagery using Differential Global Positioning System (DGPS). Subsequently, standard image products such as Timex, Bright, and Dark images are generated. The rectified Timex images have proven invaluable in identifying nearshore oceanographic features such as rip currents, sandbars, beach cusps, and shorelines, along with their temporal and spatial dynamics. Furthermore, we extract wave parameters such as significant wave height, wave period, and nearshore bathymetry information with good accuracy from the pixel information. We have also classified the beach into different categories adapting standard methods and identified the probable periods of rip currents existence. This information is invaluable for ensuring beach safety and provides immense support to the beach managers.

Keywords: Nearshore dynamics, VBMS, QCIT, standard image products



ABUNDANCE, SEASONAL PATTERNS AND PREDATORY EFFECT OF THE EXOTIC JELLYFISH *BLACKFORDIA VIRGINICA* IN A TROPICAL MONSOONAL ESTUARY

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The hydromedusae *Blackfordia virginica* has been documented across a broad geographical range, albeit primarily confined to sporadic sightings within estuarine environments of both temperate and tropical regions. The medusa stage of this species has the potential to alter planktonic food webs through predation on zooplankton; however, the extent of its impacts have not been well determined. This study aimed to elucidate the spatial and temporal dynamics of an established *B. virginica* population within a temperate estuarine ecosystem and its influence on the mesozooplankton community. Seasonal field sampling from March to December 2021 in the Cochin Estuary confirmed a seasonal abundance pattern, with peak numbers during the post-monsoon period compared to the monsoon and pre-monsoon seasons. Analysis of *B. virginica* gut contents, using indices like Occurrence, Numerical, Vacuity, and Selectivity, revealed a high predation rate (71.18%) on copepods, the dominant zooplankton group. However, the Selectivity index showed a negative preference for copepods and a higher preference for mysids, cladocerans, and fish larvae. Prey consumption peaked during the pre-monsoon season, with fewer empty guts compared to the monsoon. Large individuals (>10 mm polar diameter) were most abundant in the pre-monsoon season. Utilizing size-clearance rate equations, it was estimated that the population could remove an average of 15% of integrated mesozooplankton stocks, increasing to 40% during the pre-monsoon season. The ongoing replacement of meso- and microplanktonic species by gelatinous species is altering the structure of marine food webs. Hence, this study underscores the importance of species identification and the documentation of physical and ecological data to comprehend their responses to changing climatic conditions.

Keywords: Gelatinous Zooplankton, Invasive, predation, Cochin estuary



ATMOSPHERIC METHANE CONTRIBUTION FROM URBANISED MANGROVES AND THEIR ROLE IN GLOBAL METHANE BUDGET

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The heightened impact of methane (CH_4) on global warming, coupled with increasing human-driven activities in mangroves, raises concerns about the role of tropical urbanized mangroves in climate mitigation. This research unveils findings indicating that mangrove stands within the highly urbanized Cochin city emit 139 to 1089 $\mu\text{mol m}^{-2} \text{ d}^{-1}$ of CH_4 into the atmosphere, with higher CH_4 water-to-air fluxes observed during the pre-monsoon season. The CH_4 water-to-air fluxes from mangroves experiencing anthropogenic degradation were found to be several times higher than those from less disturbed mangrove ecosystems. The study identifies key factors that influence CH_4 dynamics across various human-impacted mangrove ecosystems. Moreover, the study suggests that while mangroves are the primary source of organic matter for CH_4 production, the contributions of marine algae and phytoplankton cannot be disregarded. This research underscores the potentially significant role of tropical mangroves in sequestering carbon from diverse sources to mitigate climate change. However, it also emphasizes the concerning impact of wetland degradation, which can lead to increased CH_4 emissions, exacerbating climate change.

Keywords: Organic carbon, greenhouse gas, Kerala, climate



LARGE-SCALE ENVIRONMENTAL INFLUENCE ON TROPICAL PHYTOPLANKTON COMMUNITY COMPOSITIONS IN THE NEARSHORE (OFF KASARAGOD)/ESTUARINE (CHANDRAGIRI ESTUARY) REGIMES OF SOUTHWEST COAST OF INDIA-HPLC/CHEMTAX APPROACH

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The present study, the comprehensive characterization of phytoplankton community compositions and their seasonal trends in the Chandragiri Estuary (CGE) and adjacent nearshore waters (<20m, off Kasaragod), located on the southwest coast of India, was based on HPLC-derived biomarkers and CHEMTAX analysis. The seasonal data (2018 to 2019) showed substantial variations, mainly in the hydrographic properties, of the CGE which was reflected in phytoplankton characteristics as well. The CGE was warmer (>29°C), high saline (28-35) and well mixed during the spring-inter monsoon (SIM) and winter monsoon (WM) periods along with sufficient inorganic nutrients. By contrast, the CGE was evident with cool (<26 °C), turbid, and nutrient-rich freshwaters during summer monsoon (SM). The mean phytoplankton chlorophyll α (chl α) in the surface waters of CGE was relatively higher during WM, SIM and FIM (<5 mg/m³) periods, whereas in SM, it was exceptionally low (<0.2 mg/m³). The nearshore waters remained invariably low chl α concentrations, irrespective of seasons. The phytoplankton community in the CGE, evaluated based on biomarkers and CHEMTAX calculations, revealed the occurrence of 5 major functional groups, i.e. diatoms, dinoflagellates, cryptophytes, green algae, and cyanobacteria. However, diatoms and cyanobacteria were the most abundant taxa in the estuary, irrespective of seasons. During fall-inter monsoon (FIM), the CGE showed more or less similar quantities of zeaxanthin, alloxanthin and fucoxanthin which signified the co-occurrences of cyanobacteria, cryptophytes and diatoms, respectively. The nearshore waters, on the other hand, sustained consistent dominance of fucoxanthin during most of the seasons (except SIM) which revealed the governance of diatoms. Even though the CGE in general sustain low phytoplankton chl α compared to other major estuaries on the west coast of India, the prevailing discrepancies in hydrographical properties, inorganic nutrients in particular, were sufficient enough to elicit significant phytoplankton compositional variability, unlike the adjacent nearshore waters.

Keywords: Chandragiri Estuary, phytoplankton, diatoms, pigments, HPLC-CHEMTAX



GEOCHEMICAL RESPONSES TO ANTHROPOGENIC INPUTS IN THE DOWNSTREAM SEDIMENTS OF A TROPICAL RIVER, SOUTH WEST COAST OF INDIA

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River sediments frequently serve as a sink and indicator of changes in the water column as well as measure of the degree of anthropogenic influences through air and watersheds. The downstream reaches of Periyar is being threatened by the discharge of untreated industrial effluents and sewage wastes which eventually affects the sustainability of living resources and public health. The study focused on the heavy metal concentrations, grain size and total organic carbon in the surface sediment samples along the lower reaches (industrialized stretch) of Periyar River to evaluate their spatial distribution and degrees of pollution status. The heavy metals contamination in sediments is assessed using sequential and integrated different pollution indices. It is confirmed that the sediments are polluted by V, Cr, Ni, Cu, Zn and Pb due to anthropogenic activities (disposal of untreated /partially treated effluents from industries, municipal wastewater and domestic sewage discharge). The principal component analysis and correlation matrix analysis revealed a substantial positive loading for V, Cr, Ni, Cu, Zn and Pb due to its increased level of contamination in the study area. Further, the local hydrodynamic conditions that prevailing in the area is controlling the sediment distribution and their metal enrichment. Our investigation notably demonstrated the anthropogenic control on sediment quality deterioration and immediate sediment quality management approaches are needed to remediate and control river bed contamination. Moreover, present study can be represented as a reference for the large-scale industrialization and a trudge in pollution due to various industries which discharges high dose of heavy metal effluents into the riverine areas.

Keywords: Sediments, Heavy metals, Anthropogenic, Sources



30-60 DAY OSCILLATIONS OF SALINITY IN A MONSOONAL ESTUARY

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Estuaries on the Indian subcontinent show strong seasonality in salinity, influenced by the Asian Summer Monsoon and are often referred to as monsoonal estuaries (Vijith et al., 2009). Though seasonality is the significant mode of monsoon variability, Intra-Seasonal Oscillations (ISO) with periods between 10 and 90 days are superposed over the seasonal cycle. A dominant component of ISO is the Monsoon Intraseasonal Oscillation (MISO), a large-scale atmospheric phenomenon where the rain-bearing cloud bands formed at the equator propagate northwards in a 30-60 days cycle. Although the seasonal cycle of variability in monsoonal estuaries is relatively known, the intra-seasonal variability is yet to be investigated. In this study, we use high-resolution salinity and temperature measurements from the Cochin estuary, located on the southwestern coastal plain of India. The spectral analysis of the sub-tidal signals of salinity, temperature and sea level exhibits ISO year-round (December 2019 to May 2021). During the dry season (December to April), the salinity was on an average of 30 PSU, and the amplitude of ISO was from 3 to 5 PSU. In the wet monsoon season, the amplitude of ISO varies around 5 to 10 PSU. The wavelet spectrum analysis of salinity shows a prominent 30-60 day variability during July, August, and September. The temperature, sea level, and precipitation spectrum also exhibited similar patterns in the wet season. A 30-60 day band-pass filtered Outgoing Longwave Radiation (OLR) over the Indian Ocean shows the northward propagating cloud band due to MISO. We show that the salinity and temperature variability in the shallowest waters of the Cochin estuary is coherent with the large-scale MISO phenomena. This study shows for the first time that large-scale processes occurring over the Indian Ocean at an intraseasonal time scale influence the salinity and temperature variation in monsoonal estuaries.

Keywords: Estuary, Monsoon Intra-Seasonal Oscillations, wavelet spectrum analysis



STUDIES ON LONG-TERM GEOMORPHOLOGICAL CHANGES ALONG THE THANE ESTUARY ON THE WEST COAST OF INDIA USING GEOSPATIAL TECHNIQUE

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Coastal cities represent critical and fragile ecosystems, constantly influenced by dynamic oceanic and coastal phenomena. This study employs Digital Shoreline Analysis System (DSAS) tools and remote sensing techniques, utilising Sentinel-2A satellite images, to assess coastal changes in Thane Creek and Mumbai, India, focusing from 2018 to 2022. The selection of images based on high and low tide values enables a comprehensive examination of erosion and accretion rates. Statistical indexes, including NSM, SCE, EPR, and LRR, are employed to calculate these rates. The study revealed a maximum erosion rate of -171 m/year during high tide, as per EPR (End Point Rate), indicating an 8% overall coastline erosion in the study region. Notably, the low accretion class experienced a significant rise, occupying 40% of the total shoreline, while that of the high accretion class was 13.05% of the high tide shoreline. Accordingly, in low tide, the maximum erosion rate in the shoreline was 946 m/year, and the low tide shoreline shows erosion of 7% of the overall coastline of the study region. The Low Accretion class is showing an increase compared to other classes, occupying 63% of the total shoreline among the other classes in Low Tide, while the High Accretion class accounts for 2.18%. The study identifies coastline erosion or accretion as manageable but requires special attention for sustainable development. The study shortcomings include reducing uncertainties for higher accuracy in evaluating shoreline changes. Field verifications can be conducted in future phases to build long-term databases. This study will contribute to developing policy guidelines for protecting valuable resources from further deterioration after climate catastrophes.

Keywords: DSAS, LRR, EPR, NSM, SCE



GRANULOMETRIC SHIFTS AND TEXTURAL MATURITY OF REEF ASSOCIATED SEDIMENTS WITH RESPECT TO THE MONSOONAL CHANGES FROM THE CORAL ISLANDS OF THE GULF OF MANNAR

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Being an essential pathway for coastal currents of the Indian Monsoon system, the Gulf of Mannar (GoM) plays a significant role in the Indian ocean dynamics. Here, we investigate how monsoon seasons impacts on the granulometric characteristics and textural maturity to the basic physical oceanographic parameters of the coral islands of the Mandapam group of islands, GoM. Our findings reveals that significant temperature, salinity, and pH fluctuations with distinct patterns emerging across different monsoonal seasons. The post monsoon has the region's coolest waters, while pre-monsoon carries comparatively warm waters. The pre-monsoon has comparatively higher salinity, which reduces to the lowest during monsoon time. The pH shows a broader spectrum of values during post-monsoon while a narrower spectrum during monsoon time. Textural analysis shows that most stations' are having silt as the dominant sediment texture, which implies on the moderate energy condition of deposition. After silt, sand is the dominant grain in majority of the samples. Clay is scarce in most samples and limited to specific ecosystems like mangroves. The frequency of sand and silt occurrence is higher during post-monsoon and comparatively less during pre-monsoon and monsoon. The variation in the abundance of seasonal sediment fraction and other physical oceanographic parameters shows the significance of coastal currents associated with the Indian monsoon system. Negligible anthropogenic impact may also influence the physical parameters like sewage runoff and agricultural land runoff. The microfaunal biodiversity of each station needs to be assessed to decipher the oxygenation characteristics and trace metal analysis of the samples needs to be carried out to finalize the sediment provenance, and ecological health of the region.

Keywords: Granulometry, Gulf of Mannar, Monsoon, Indian ocean, Physical oceanographic parameters



SEASONAL AND SPATIAL VARIATION IN SALINITY: A CASE STUDY OF THE VETTAR RIVER ESTUARY

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The Vettar River Estuary (VRE) is one of the active distributaries of the Cauvery River System among of the 36 others along the east coast of India, characterized by the semi diurnal tide. This bar-built estuary is influenced by the monsoon, exhibiting characteristic variations in freshwater runoff and tidal dynamics. The study reports measurements of salinity during consecutive low, and high tides within a tidal period of 12.41 hours during the post-monsoon, pre-monsoon, and monsoon seasons. The mid-channel is surveyed at roughly 500 m interval up to a maximum of 8.5 km from the mouth. Along with this, three transects, comprising a total of nine stations, were observed, spanning from the mouth to 3.5 km upstream. Vertical profiles at 0.2D, 0.6D, and 0.8D depths were recorded at all the stations, totaling 250 measurements. The work investigates the influence of the monsoon on the steady state of the estuary and the seasonal migration and regression of isohalines are depicted. The annual salt budget is estimated.

Keywords: *Estuary, Vettar River, Cauvery River, Salinity, Seasonal*





Isotope Geochemistry



SR-ND ISOTOPE GEOCHEMISTRY OF BASALTS FROM VEMA FRACTURE ZONE, CENTRAL INDIAN RIDGE: PLUME-RIDGE INTERACTION SITE

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The Vema Fracture Zone (VMFZ) along the Central Indian Ridge (CIR) exhibits a distinctive interplay with the Reunion plume, resulting in a significant CIR offset of approximately 300 km between latitudes 8°S and 10°S. The VMFZ harbors the deepest point in the Indian Ocean, the Vema Trench (VT), which reaches depths exceeding 6500 m, spanning 5 km in width and extending 12 km in a NE-SW direction. Analyses of petrography, mineralogy, and significant trace and rare earth elements reveal predominantly evolved basaltic rocks within the VMFZ, characterized by tholeiitic to calc-alkaline features. The REE signatures ($[{\text{Sm}}/{\text{Yb}} \text{ vs. } {\text{Sm}}]$ and $[{\text{Ce}}/{\text{Sm}}]_{\text{N}}$ vs. $[{\text{Yb}}/{\text{Sm}}]_{\text{N}}$) point to a source derived from a spinel lherzolite mantle with additional input from EM-1 plume melt.

Whole-rock Sr-Nd isotope data from VMFZ basalt samples show a wide range of $^{87}\text{Sr}/^{86}\text{Sr}$ ratios (0.70324-0.70367) and $^{143}\text{Nd}/^{144}\text{Nd}$ values (5.512388-0.512755). Combining these results with previous major and trace element data suggests that VMFZ mid-ocean ridge basalts (MORBs) likely originated from a heterogeneous mantle source comprising both depleted mantle (DM) and HIMU-FOZO components. The geological context of the VMFZ and CIR intersection implies a paleo Plume Ridge Interaction (PRI) scenario, where EM-1 melt from the Reunion Plume may have under-plated a substantial portion of the Indo-African Plate.

This study proposes the existence of a shallow, chambered, incubated melt body, dating back approximately 42-45 million years. The emergence of the CIR around 40-38 million years ago likely perturbed this melt body, introducing depleted MORB melt. Trace element ratios (Hf/3-Th-Ta and Thn vs. Nbn) suggest that the VMFZ basalt retains the signature of a mixing event involving ridges and plume melt.

Keywords: Sr-Nd isotope, VMFZ, mid-ocean ridge basalts



HIGH AMOUNT OF OCEANIC MOISTURE SUPPLY MASK THE AMOUNT EFFECT IN MONSOON FLOODS

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Stable isotopologues of water are useful tools for interpreting paleoclimate proxies such as tree rings, glacial ice, speleothems etc. This requires a robust understanding of how climate and weather controls the isotopic signatures of precipitation and vapor in present day and in the past. The amount effect, or anticorrelation between precipitation amount and the proportion of heavier isotopes in the precipitation, is a key characteristic of the isotopic composition of precipitation in the tropics. The physical processes behind this effect are complex and not fully understood yet. Our study reports the δD of rain and vapor collected from Kochi (station situated in South Western coast of India) which include 4 cyclones and 2 floods during 2018-19 period. We report that the monsoon floods did not exhibit the anticipated δD depletion despite the higher rain amounts, contrary to expectations. To probe into the reason for this, we analyzed the various meteorological parameters during these events and found low-level moisture flux during these events was significantly higher during flood events compared to other events. We also compared this monsoon flood events with the monsoon climatology and the large-scale organized convective events of monsoon-2012. Moisture flux was significantly very high during the flood events. Further analysis also showed that low level moisture convergence (up to 850 hPa) was also higher during the flood events. This high moisture flux and low-level convergence possibly reduced the relative contribution of isotopically-depleted recycled moisture. Our results suggests that these factors should also be considered while interpreting paleoclimate proxies in tropics.

Keywords: Stable isotopes, Floods, amount effect





Geo-Marine Resources and Exploration



GEOLOGICAL SETTING OF MID-OCEAN RIDGE HYDROTHERMAL SULFIDE: CASE STUDIES FROM THE CENTRAL INDIAN AND SOUTH WEST INDIAN RIDGES

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Hydrothermal sulfide mineralization along mid-oceanic ridges holds enormous significance on account of their high base and noble metal content. These are formed over geological time as a result of high-temperature venting. Initially, it was considered that only fast-spreading ridges (eg. East Pacific Rise) host ideal geological conditions for the formation of hydrothermal sulfides. Subsequently, this view was modified after a series of discoveries of hydrothermal sulfides from slow spreading (eg. Mid Atlantic Ridge, Central Indian Ridge - CIR) and ultraslow spreading (eg. South West Indian Ridge - SWIR, Gakkel Ridge) ridges.

This study presents a review of the broad geological features along the slow-spreading CIR and ultraslow-spreading SWIR near the Rodrigues triple junction area, which are prone to hosting sulfide mineralization. The SWIR, having a wide and deep axial valley, devoid of any major transform fault and shows an extensive volume of exposed ultramafic rocks in the flanks at higher structural levels. The emplacement of ultramafic is driven by detachment faults commonly termed as Oceanic Core Complexes (OCCs). Microstructural studies of ultramafic rocks from these OCCs reveal prominent shearing features ranging from ductile to brittle regimes, indicating that the detachment faults associated with OCCs may have a deeper root. The CIR, on the other hand, has a relatively narrow axial valley, segmented by major transform faults, and behaves more symmetric across the ridge suggesting a fair amount of magmatic supply. However, in places exposed, ultramafics are also found along with gabbro in the form of OCCs. These OCCs and associated detachment fault systems set ideal geological conditions for hydrothermal circulation and sulfide mineralization. These OCCs were identified using a high-resolution bathymetry map within our study area and were given special attention while planning exploration strategies. This resulted in the recovery of massive sulfide, hydrothermal chimney fragments, and secondary sulfide mineralogical altered products from multiple locations of CIR and SWIR.

Keywords: Nearshore dynamics, VBMS, QCIT, standard image products



SIGNIFICANCE OF WATER COLUMN STUDIES FOR THE EXPLORATION OF POLYMETALLIC SULPHIDES IN THE INDIAN OCEAN

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Hydrothermal circulation at the global mid-oceanic ridge system is one of the key processes for the transport of heat and mass from the earth's interior to the oceans. Such circulation leads to the formation of sulphide deposits of both scientific and economic interest. Finding these deposits is very challenging because their ariel extent is confined to a small size (a few hundred meters) and quite different from other deep-sea minerals (manganese nodules and cobalt-rich ferromanganese crusts). The exploration strategy involves a multi-disciplinary team that focuses on geophysical, geological and water column studies. Among these, water column studies use both physical and chemical tracers to (1) identify the hydrothermal plume signatures, (2) nature of plumes, (3) inferences on possible host-rock contribution and (4) biogeochemical processes associated with hydrothermal plumes. Sensor-based studies of physical tracers (turbidity, oxidation-reduction potential, and temperature) were carried out by the Conductivity-Temperature-Depth (CTD) profiling system and Miniature Autonomous Plume Recorders (MAPR). Chemical tracers (dissolved gases: helium and methane and dissolved trace metals: manganese and iron) are studied at selected depths where hydrothermal plume layers are observed. Systematic water column studies have been conducted between 2017 and 2020 in CIR & SWIR to identify hydrothermal plumes and associated potential zones of sulphide mineralisation. To date, 13 plumes have been identified along CIR&SWIR. Based on geochemical characteristics, they have been classified as basalt and ultramafic-hosted hydrothermal systems. High-resolution near-seabed surveys using Autonomous Underwater Vehicle (AUV) are underway in some locations. Ground truthing (video imaging) and hydrothermal fluid and sulphide sampling are planned in the coming years using the Remotely Operated Vehicle (ROV).

Keywords: Hydrothermal sulphides, physical tracers, chemical tracers, Indian Ocean



AN OVERVIEW ON THE GEOCHEMISTRY AND GENESIS HETEROGENEITY OF FERROMANGANESE OXIDE DEPOSITS IN THE INDIAN OCEAN

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Ferromanganese (Fe-Mn) crusts and nodules are known as treasure house of rare, trace and ultra trace elements that were adsorbed and scavenged by iron and manganese oxides. Ferromanganese nodules and crusts occur in various parts of the Indian Ocean, including the Central Indian Ocean Basin, Arabian Sea and Andaman Sea. The world-wide explorations of Fe-Mn oxide deposits, especially in the Pacific Ocean, gave a comprehensive idea about the formation mechanisms of ferromanganese oxides linked with the hydrogenetic, hydrothermal and diagenetic processes. However, a comparative examination of Fe-Mn deposits across diverse geomorphic terrains in the Indian Ocean (Afanasiy-Nikitin Seamounts (ANS), Laxmi Basin, Laccadive Ridge, West Sewell Rise and Sewell Rise) demonstrates region-specific differences in their trace, REE, and PGE compositions. The Fe-Mn crusts from the ANS are purely hydrogenetic in origin similar to most seamount crusts from the global ocean. The existence of Co-Ce-Pt as a separate oxide phase in the ANS crusts has been supported by the sympathetic correlation of these elements with the major oxide phases. ANS crusts are also enriched in several other trace elements such as Sb, Tl, As, W, Cd etc. Conversely, the Fe-Mn crusts and nodules from Andaman Sea were formed by rapid precipitation of Fe and Mn oxides in a metal saturated environment facilitated by the hydrothermal and volcanic sources. They are enriched in Ni, Zn, Pb, Li and As etc emanated mainly from hydrothermal sources. In case of Arabian Sea, the compositional variations are mainly dependent on the terrigenous input and phosphatization due to OMZ fluctuations. Overall, the genesis and geochemical variations of the Fe-Mn crusts and nodules in the Indian Ocean are influenced by the factors such as fluctuations in the OMZ, deep water masses propagating through the region, proximity to the continents and water column chemistry altered by complex tectonic activities. The composition of Fe-Mn crusts and nodules is dependent on these specific factors within a particular domain, rather than being predetermined by precipitation processes.

Keywords: Fe-Mn crusts, ANS, Indian Ocean



UNVEILING THE SECRETS OF THE DEEP: HIGH-RESOLUTION AUV DATA FROM CENTRAL INDIAN OCEAN BASIN AND KRISHNA GODAVARI BASIN

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The Ocean Mineral Explorer (OMe-6000) represents India's state of the art 6000-meter depth-rated Autonomous Underwater Vehicle (AUV) to explore the deep-sea world of Indian Ocean. AUV was realized by National Institute of Ocean Technology (NIOT-MoES), Chennai from M/s Kongsberg Maritime, Norway (Hugin 6000). The OMe-6000 is a fully augmented hydrographic and geophysical exploratory tool, equipped with various scientific and survey payloads tailored for deep ocean research. The vehicle was deployed at the first-generation mining site in the Central Indian Ocean Basin (CIOB), to explore the poly-metallic nodules (PMN) at 5300 meters depth. Subsequently AUV was deployed at the Krishna Godavari Basin in Bay of Bengal to explore gas hydrates at a water depth of 1750 meters. High-resolution geophysical data obtained through AUV based exploration have been utilized to scrutinize these areas in detail, aiming to comprehend the distribution of deep ocean resources and associated features. The PMN site has been extensively studied since the 1980s, primarily through ship-based surveys. However, from a mining perspective, high-resolution bathymetric data and comprehensive resource distribution coverage are imperative. This is essential for designing surveys to ensure the safe maneuvering of mining equipment and viable resource recovery. Gas hydrates, a promising energy resource, have garnered considerable attention in recent years. For the first time AUV was deployed at gas hydrate site in India to understand the high resolution signature at the sea floor for gas hydrate distribution pattern.

This study presents the outcomes of a comprehensive exploration at the PMN site and Krishna Godavari Basin, leveraging cutting-edge Autonomous Underwater Vehicle (AUV) technology. The mission focused on acquiring high-resolution data, synthetic aperture sonar (SAS) bathymetry, sub-bottom profiles, including photographs and environmental parameters in the region. Equipped with advanced sensors and imaging systems, the AUV successfully captured detailed imagery of the seafloor, providing unprecedented insights into the geological features of the Indian Basin. Synthetic aperture sonar bathymetry facilitated precise mapping of the underwater terrain, revealing intricate structures and potential resource accumulations.

Furthermore, analysis of the CIOB sub-bottom profile reveals the significant influence of the subsea floor on the formation of seamounts, providing valuable insights into the geological processes that shape the underwater landscape. This observation enhances our understanding of the dynamic geological forces at play in the Central Indian Ocean Basin. The examination of the KG basin sub-bottom profile unveils the presence of high-resolution gas conduits, which create favorable conditions for the formation of hydrates on the sea floor. This discovery offers a deeper understanding of the intricate mechanisms involved in gas hydrate formation within deep-sea environments, contributing to our knowledge of the basin's geological and geophysical characteristics.



In summary, the high-resolution data obtained through AUV technology at the Indian Basin provide a valuable resource for advancing our knowledge of deep ocean resources. This abstract outline the methodology, data quality, and initial findings, setting the stage for in-depth analysis and future exploration endeavors. Detailed explanations of the high-resolution geophysical data collected with AUV from the area will be presented in the conference.

Keywords: AUV, PMN, Central Indian Ocean Basin, Krishna Godavari Basin



Submarine Groundwater Discharge and Mapping



OCCURRENCE OF SUBMARINE GROUNDWATER DISCHARGE ALONG THE COAST OF NORTH GOA: A PRELIMINARY STUDY

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Submarine Groundwater Discharge (SGD) is the transfer of fresh groundwater and recirculated seawater into the ocean. This occurs due to the hydraulic gradient between coastal aquifers and the sea. SGD transfers relatively higher amounts of nutrients to the ocean when compared to the surface flow. Preliminary studies were conducted in Goa's northern coast, where, overexploitation of groundwater due to tourism and recreational activities were observed, which is the probable cause of Seawater Intrusion (SWI) observed in these areas. Literature review and reconnaissance fieldwork were carried out during November 2023 in Vagator, Anjuna, Baga and Calangute. Sampling was carried out at Baga in December during the lowest expected tide (13th December 2024). Porewater samples were collected using a 1 m long pushpoint sampler developed in-house and seepage samples were calculated using seepage-meters developed in-house. Physicochemical parameters, namely pH, Electrical Conductivity (EC) and Dissolved Oxygen (DO) were measured using a portable multiparameter kit. EC variation between the high-tide line and low-tide line were found to be between 54 mS/cm to 13 mS/cm and pH variation was found to be between 7 and 8 respectively. The EC of seawater was recorded at 56 mS/cm whereas the adjacent groundwater showed much lesser conductivity at 490 μ s/cm. Seepage readings were taken and flow rate was calculated to be 11 cm/day. Groundwater overexploitation in the coastal regions has resulted in seawater intrusion into coastal aquifers. Despite this, certain areas, including the study area show no signs of SWI. More SGD studies need to be conducted in this areas not only to identify more SGD zones, but also to identify potential SWI zones and prevent future salt-water intrusions. Further studies identifying probable SGD zones are required along with the quantification of the SGD associated nutrient flux to the sea along the Goan coast-line.

Keywords: SGD, Goa, Groundwater, Porewater, Coastal Aquifers



URBAN HYDROGEOLOGICAL STUDY OF KOCHI URBAN AREA UNDER COASTAL PLAIN, CENTRAL KERALA, SOUTH INDIA

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The urban hydrogeological study of Kochi Urban area in Central Kerala, India has been carried out. The Kochi (*Cochin*) Corporation with an area of 97.88 km² bordering Arabian Sea is noticed for its scenic beauty and tourism potential. The surface water sources of the Kochi Corporation area is contaminated with salinity-brackishness and also polluted by various anthropogenic activities. The water requirements of over 6 lakh city population are catered through abstracting the Tertiary confined aquifers of Vaikom and Warkali Formations. Against the present need of 500 MLD the Kerala Water Authority is supplying 400MLD water to Kochi. For the sustainability of water resources of the Kochi Corporation various supply side management interventions and demand side management measures is proposed in the study.

Keywords: *Tertiary Aquifer, Hydrogeology, Hydrochemistry, Supply side management, Demand side management*



A PRELIMINARY STUDY OF THE SUBMARINE GROUNDWATER DISCHARGE AND ITS GEOCHEMICAL PROPERTIES, ALONG THE KARNATAKA COASTLINE

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Submarine groundwater discharge (SGD) is the flow of groundwater and recirculated seawater into the ocean, often containing more nutrients and minerals than surface water. Samples were collected during the pre-monsoon (March 2023) and post-monsoon (December 2023) periods from four locations (Yermal, Kota, Kumbashi, and Bhatkal) along a 109 km stretch of the southwest coast of Karnataka. Groundwater pH along the coastline ranged from 7.49 to 8.02, slightly higher than inland groundwater pH. Seepage data obtained during the pre-monsoon using a seepage meter showed a low SGD flux of 14.3 cm/day, attributed to the lower input of fresh SGD due to seasonal variability. Electrical conductivity (EC) data in post-monsoon seawater (54.1 ms/cm) and seepage water (43.3 ms/cm) at Kota suggested a high input of mineralized fresh SGD along with recirculated SGD. During post-monsoon, porewater EC ranged from 40.3 ms/cm to about 41.3 ms/cm, indicating a large flux of fresh SGD. The groundwater EC ranged from 0.455 ms/cm to 0.378 ms/cm in both seasons, indicating non-contaminated groundwater. The upper saline plume region showed high salinity during pre-monsoon. Porewater showed high concentrations of metals such as Na (953.6 mg/l), Mg (119.6 mg/l), K (74.44 mg/l), Li (2.12 mg/l) and Ca (41.54 mg/l), suggesting evaporation of recirculated seawater due to meteorological conditions and low input of fresh SGD. Total organic carbon in groundwater ranged from 4-6 ppm. High inland hydraulic head primarily controls fresh SGD in the study area, whereas tides control recirculated SGD. These findings suggest a high flux of metals and carbon to the sea through SGD. Long-term monitoring is required to estimate these numbers more accurately.

Keywords: SGD, conductivity, porewater, groundwater, seawater, carbon, seepage, metals



Societal Applications of Marine Geosciences



STUDENT-SCIENTISTS': A STUDENT-CENTRIC INITIATIVE TO MONITOR CLIMATE CHANGE IMPACT AND COMMUNICATE DISASTER RISK ON THE WESTERN COAST OF INDIA

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Continuously monitoring changes happening in the environment and every single stratum of society at the local level scientifically is essential to come out with evidence-based interventions and policies for preparing coastal communities to cope with climate change. However, considering the length of the coastline to be covered and the financial and human resources required to establish and maintain such a monitoring system, a public-involved, student-centric approach would be suitable and sustainable for a geographically large nation such as India. The project 'Student-Scientist' is working towards developing a network of students from both schools and colleges in the selected coastal regions of Kerala and Karnataka and equipping them with the tools and techniques for scientifically examining, recording, and communicating the changes happening in their immediate environment and community. In the last many years, the coastlines of India have faced an increase in the frequency and intensity of natural calamities such as cyclones, flood etc. The members of the student-scientist network will be communicating the risk of natural disasters using modern and conventional tools of science communication and work towards eliminating misinformation related to climate change, and natural disasters prevalent in their communities. Being part of the local community, armed with the methodologies of science and science communication, and having opportunities to interact with professional researchers, student-scientists will work as a catalyst to build resilience in their community by reaching scientifically validated knowledge essential to adapt with climate change. The agencies of local governance could use the micro-level data generated by the student-scientists to develop evidence-based sustainable development plans. Hence, along with working as a low-cost system to generate and update grass-root level information on the coastal environment and society, the student-scientist will be also instrumental in familiarizing various tools and methodologies of science, communication, and social science with both students and teachers from schools and colleges of the coastal regions as well to enhance scientific temper in the coastal communities.

Keywords: Climate change, Resilience, Student centric approach, Science communication, Disaster risk communication, Coastal communities, Kerala, Karnataka



Oceans & Climate Change



UNVEILING TROPICAL CYCLONES INFLUENCE OVER NORTH INDIAN OCEAN'S UPPER LAYER

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Cyclones are a prominent weather phenomenon over tropical waters. Tropical cyclones over the North Indian Ocean have a significant influence on upper ocean, affecting ocean temperature, ocean stratification and heat content. This study's primary focus lies in examining the impact of various tropical cyclones on the upper ocean, employing a combination of observations and a one-dimensional ocean model. Cyclone Viyaru (May 2013), Cyclone Nanauk (June 2014), Cyclone Hudhud (October 2014), Cyclone Nada (November - December 2016), Cyclone Ockhi (November - December 2017) and Cyclone Amphan (May 2020) are chosen for the study. The study also investigates the sensitivity of the upper ocean to surface fluxes, including heat, wind, and freshwater fluxes, using the Price-Weller-Pinkel (PWP) onedimensional upper ocean mixed layer model. The study begins by establishing a foundational understanding of the upper ocean response to cyclones in the North Indian Ocean, using a combination of observational data and model simulations. Datasets for model forcing and initialization are taken from various buoys such as RAMA and OMNI and Satellite observations for precipitation data. The PWP model is simulated during the period of cyclone and outputs are compared with observations. Sensitivity test are conducted during cyclone Amphan using PWP model. The findings indicate the cyclone induced cooling and salinity variations, as well as the deepening of mixed layer and isothermal layer to these changes. The objective of the sensitivity test is to gain a comprehensive understanding of how different fluxes affect ocean properties and to quantify the extent of their impact. This research offers valuable insights into the transformation of the upper ocean in the North Indian region by cyclones. It underscores the importance of considering various fluxes in order to improve cyclone predictability and our comprehension of their behaviour.

Keywords: North Indian Ocean, PWP model, Tropical cyclone



ROLE OF TROPICAL - EXTRA TROPICAL INTERACTION ON HEAVY RAINFALL EVENTS IN UPPER GANGA AND SHARDA RIVER BASINS IN THE WESTERN HIMALAYAS

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Upper Ganga (UG) and Sharda river basins are situated in the western Himalayas that are prone to high seasonal rainfall and substantial interannual variations during the southwest monsoon season. The study examines the synoptic systems causing heavy rainfall events in the basins using ERA5 reanalysis, rainfall data, and daily weather inferences from IMD (India Meteorological Department). Though the heavy rainfall events in both basins are associated with the interaction of extratropical systems with the tropical monsoon system, the mechanism that leads to heavy rainfall is different. Heavy rainfall events in UG are due to the movement of extratropical systems (trough in westerlies) over the northern parts of India and their interaction with the monsoon trough when it is north of its normal position. The extratropical systems provide convergence at middle and upper tropospheric levels that intensify when they interact with the monsoon trough (especially the western end of the monsoon trough). Further, it is found that cyclonic circulations extending up to the mid-troposphere/low-pressure system that forms in the northwest Bay of Bengal also have a profound effect on the heavy rainfall events in UG. The mid-tropospheric divergence over the cyclonic circulation system feeds moisture to the convergence due to the southward extended trough in the extratropical westerlies and caters to the formation of heavy rainfall events over the basin. In Sharda, the heavy rainfall events are associated with the movement of low-pressure systems from the Bay of Bengal towards the Indo-Gangetic plains and their interaction with troughs in the extratropical westerlies. The low-pressure systems provide anomalous convergence in the lower tropospheric levels and the trough in the mid and upper tropospheric westerlies increases the convergence in the middle tropospheric levels; this mechanism causes heavy rainfall events in the Sharda basin. The study gives insights into the tropical extratropical interaction and its role in the heavy rainfall events over the western Himalayan region.

Keywords: Heavy rainfall, Southwest monsoon, Tropical-extra tropical interaction, western Himalayas



EXPLORING BIOMINERALIZATION POTENTIAL: ISOLATION OF BACTERIAL STRAINS FROM DIFFERENT ENVIRONMENTAL SAMPLES AND EXTRACTION OF BACTERIAL CRUDE CARBONIC ANHYDRASE(CA) ENZYME FOR CARBON SEQUESTRATION ANALYSIS.

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In recent years, the levels of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere have increased significantly due to human activities, creating a significant challenge for the environment in the form of climate change. Microbial enzyme-based CO_2 sequestration offers an efficient and eco-friendly solution to address this issue. The metalloenzyme Carbonic anhydrase (CA) catalyses reversible hydration of CO_2 and displays a strong CO_2 affinity that can be harnessed for its capture from the atmosphere. The main focus of this study is to utilize the bacterial crude CA enzyme to sequester CO_2 through biomimicry. Microorganisms capable of producing CA were isolated from various environmental sources and CA-positive isolates were screened from microbes based on the development of yellow colonies on para-nitrophenyl acetate (p-NPA) containing agar plates. Crude CA enzymes from 4 isolates (S7, S16, S21, and S22) exhibited increased CA activity and were used for further studies. Molecular identification of these bacterial isolates was performed using 16s rRNA sequencing. The optimum growth and enzyme production of CA-producing microbes was determined by studying the effects at various pH, temperature, salt, and metal concentrations. Biomimicry of CO_2 into Calcium carbonate (CaCO_3) was performed using microbial crude CA and the precipitated product was analyzed by various techniques. Among the four isolates, S21 exhibited the highest CA activity (esterase activity = 619 U/ml and hydratase activity=897 WA units) under optimized conditions. SEM-coupled EDX indicated that the formed product displayed a rhombohedral morphology and the elemental makeup of the particles was confirmed as CaCO_3 crystals. FTIR spectroscopy revealed characteristic absorption bands of CaCO_3 , while XRD analysis corroborated that the CaCO_3 polymorph was calcite. This study demonstrated that microbial CA can be effectively used in the capture of carbon from the atmosphere via biomimicry of CO_2 into a valuable product (CaCO_3) thereby reducing the overall carbon footprint.

Keywords: *Carbon Anhydrase, Bacterial, CO_2 sequestration, Biomimicry*



POTENTIAL REASONS FOR ARABIAN SEA RAPID WARMING

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We have analyzed the monthly Sea Surface Temperature (SST) and Ocean Heat Content (OHC) data of the Indian ocean and its sub-regions for the period from 1960 to 2020. We found that SST and OHC had shown an increase in the Indian Ocean and at all the sub-regions with a rapid increase in Arabian Sea as compared to other regions. The Arabian Sea area was further divided into four subdomains (South East Arabian Sea (SEAS- 64:78,8:16), South West Arabian Sea (SWAS-50:64,8:25), North East Arabian Sea (NEAS-64:78,16:25) and North West Arabian Sea (NWAS-50:64,16:25)) to study the regional differences within the AS. The study used subsurface temperature and salinity data from Met Office Hadley Center for the study from 1960 to 2020. We have also used heat flux, Outward Longwave radiation (OLR) and wind datasets from NOAA. A linear regression analysis was conducted to assess the long-term trends in OHC for each oceanic region and to obtain the spatial distribution of the warming trend. There has been a decrease in the magnitude of the long-term trend in OHC with depth for the whole Arabian Sea but upon reaching 400-600m depth range there is a subsurface warming trend. This subsurface warming trend is visible in all the four subdomains for this particular depth range. The trend of subsurface temperature also showed increased subsurface warming. There is a strong correlation between the OHC anomaly across different depth ranges with the surface layer. The trend of heat flux is showing a decreasing trend. The OLR is showing a decreasing trend. The wind speed is showing a decreasing trend since the year 2000 onwards. The influence of heat flux in the Arabian Sea is found to be till the depth of 50m in ocean heat content.

Keywords: Ocean heat content, Indian ocean, Arabian Sea, Heat flux, Subsurface warming



INTERACTION BETWEEN PROMINENT MODE OF INDIAN OCEAN WITH AND WITHOUT EL NINO

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Variability of the Indian (IO) significantly modulate the climate and weather of India. IO contains a huge variability manifests through Indian Ocean Basin wide (IOBW) mode , Indian Ocean Dipole (IOD), Ningaloo Nino/Nina (NNI) and Sub-tropical Indian Ocean Dipole (SIOD). Each mode is seasonally locked. The evolution and decay of each mode linked to others may enhance or subdue the effect the ones. Present study evaluates the spatial and temporal behavior of each mode and analyze their relation in and absence of El Nino during 1940-2023. Spatial characteristics (mean and standard deviation) of IO sea surface temperature has been evaluated monthly to identify the variable zone of IO. Mankendall Trend analysis has been evaluated to identify the IO zone with faster change. IOD, NNI and SIOD indices has been evaluated to understand its progression. Based on threshold of each index, each year has been classified as positive and negative along with EL Nino, LA Nina and Neutral year. It has been observed to be a rare case where four modes are equally active expect for 1997 and 2011. A composite analysis has been done for El Nino years with non-El Nino year, neutral mode using wind at 850 hPa, SST, Vertical Velocity and sub-surface temperature to understand the interaction among different modes. During El Nino, positive IOD events are more whereas during La Nina, SIOD events either neutral or positive only. During 1950- 1990, NNI events are negative while after 1993, NNI events are positive only. A significant modification under warming has been modulating the modes of IO.

Keywords: El Nino, IOD, SIOD, Ningaloo Nina, Indian Ocean



INDIAN OCEAN WAVE CLIMATE PROJECTION USING CMIP6 MODELS: A COMPREHENSIVE ANALYSIS

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This study provides a thorough evaluation of the capability of seven CMIP6 models in replicating the Indian Ocean (IO) wave climate using observational and reanalysis datasets. The historical dataset spanning 35 years (1980-2014) generated using the WAVEWATCHIII model serves as the foundation for this investigation. Employing a range of statistical methodologies such as Taylor diagrams, probability density functions (PDF), and empirical orthogonal functions (EOF), we conduct a comprehensive comparative analysis. Additionally, we utilize extreme wave analysis with ETCCDI indices to assess model performances. Results highlight significant disparities in model performance, with three models—BCC, EC, and MPI—emerging as the top performers in accurately representing wave characteristics in the North Indian Ocean (NIO). These models demonstrate strong correlations and minimal root-mean-square differences compared to buoy observations across various sea states. Further analysis through EOF against ERA5 data confirms the superior performance of BCC, EC, and MPI models in capturing wind and wave patterns. Evaluation of extreme wave events against ERA5 data consistently demonstrates the robustness of these models. In conclusion, rigorous statistical analysis underscores the reliability of BCC, EC, and MPI models in simulating both mean and extreme wave heights in the IO region. Subsequently, a wave climate projection experiment is conducted using these top-performing models. The results reveal substantial changes, particularly over the Eastern Tropical South Indian Ocean (ETSIQ) region, with alterations ranging from 2 to 5% in both mean and extreme wind speeds and wave heights. In summary, our study provides valuable insights into the performance of CMIP6 models in simulating IO wave climate, emphasizing the critical role of accurate representation of wave dynamics in climate projections and adaptation strategies.

Keywords: CMIP6, Waves, Climate projection, Indian Ocean



UNRAVELING THE OCEANIC SECRETS: INSIGHTS FROM RADIOLARIAN ABUNDANCE AND GEOCHEMICAL PROXIES IN THE SOUTHERN BAY OF BENGAL DURING THE LAST 44 kyr BP

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The Southern Bay of Bengal represents a crucial yet under explored region for understanding past oceanographic conditions and their implications for global climate dynamics. In the present investigation is a comprehensive analysis of radiolarian abundance and geochemical proxies to interpret palaeoceanographic conditions during the past 44 Kyr BP. A multiproxy approach is employed in this study by integrating radiolarian distributions pattern, stable isotope and Total Organic Carbon data from a sediment core retrieved from the northern tip of the Ninety east Ridge. Radiolarian abundance distribution and associated geochemical signatures are good indicators of past oceanographic variability. Radiolarian groups, comprising Spumellarians and Nassellarans, exhibit distinct patterns across climatic events, such as Heinrich events and the Last Glacial Maximum (LGM), reflecting responses to temperature changes and nutrient availability. In the study area, during Heinrich Event 4 (H4) Spumellarians show an abundance and the Nassellarans decline drastically, while Heinrich Event 3 (H3) exhibits the opposite trend. The transition from the Holocene to the LGM witnesses a decline in Spumellarians abundance, followed by a resurgence thereafter, whereas Nassellarans become more abundant during the LGM period, which attributes to the transport of cool deep water. 19 radiolarian species were identified from the present study, comprising 12 Spumellarians and 7 Nassellarans. The appearance of certain species like *Dictyocoryne truncatum*, *Dictyocoryne euclidis*, and *Spongaster tetras tetras* after 23 kyr BP suggests environmental changes affecting their habitat suitability. Meanwhile, *Acanthosphaera actinota* and *Acrosphaera spinosa*, also exhibit fluctuations in abundance, indicating possible responses to shifting environmental conditions. Stable isotopic studies reveal fluctuations in sea surface temperature and paleoproductivity, with higher $\delta^{18}\text{O}$ values during cold events and lower $\delta^{13}\text{C}$ values indicative of reduced productivity. Furthermore, the study discusses the climatic fluctuations in the Southern Bay of Bengal, highlighting the interplay between monsoonal variations and paleoenvironmental conditions. This multi proxy investigation, throw light into the oceanic response of the southern Bay of Bengal to the climatic fluctuations during the last 44 kyr BP. This research contributes to our understanding of long-term climate dynamics in the region and their implications for future climate scenarios.

Keywords: Bay of Bengal, Carbon Isotope, Oxygen Isotope, Radiolarians, Total Organic Carbon



CLIMATE CHANGE AND ITS IMPENDING IMPACT ON FISHERIES: A GLOBAL AND INDIAN PERSPECTIVE

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Climate change significantly impacts fisheries, sectors crucial for food security and livelihoods, particularly in coastal regions. These sectors are vulnerable to environmental changes, threatening their socio-economic sustainability. In India, with its extensive coastline and inland water bodies, these sectors are at risk due to climate change impacts such as altered rainfall patterns, rising temperatures, and increased extreme weather events. These changes can reduce farming, fishing, and aquaculture opportunities and disrupt livelihood planning. A study predicts a 25% reduction in ecosystem services on India's east coast over 25 years, resulting in a \$17 billion loss, indicating the potential economic impact of climate change. Globally, climate change negatively impacts fisheries sector, causing stock displacement and shellfish mortality due to changes in water temperature, pH levels, ocean circulation patterns, sea levels, and weather patterns. It is projected that climate change decreases the modelled global fish community biomass by as much as 30% by 2100. Furthermore, Research indicates a projected 25% decrease in ecosystem services on India's east coast over the next quarter-century, equating to a financial loss of approximately \$17 billion. Concurrently, a decline in rainfall is anticipated to reduce the gross per capita availability of freshwater fish in India from 1,820 m³/year in 2010 to 1,140 m³/year by 2050. Globally, the fish catch is projected to decline by 6% by 2100, with an 11% decrease in tropical zones. By 2050, the total global fish catch potential may fluctuate by less than 10%, contingent on the trajectory of greenhouse gas emissions. Since 1930, there has been a 4% decrease in the numbers of fish in critical fisheries worldwide, with fisheries in the Sea of Japan and the North Sea experiencing up to a 35% drop in their numbers. Over the past three decades, marine heatwaves have reportedly increased by more than 50%, and ocean temperatures are predicted to rise by 1- 4°C by 2100. Tropical regions are expected to see up to a 40% decline in potential seafood catch by 2050. If average global temperatures rise by five degrees Celsius, climate change could eliminate 60% of all fish species. Addressing these impacts requires robust adaptation and mitigation strategies, tailored to regional vulnerabilities and capacities, and collaborative efforts from stakeholders, including governments, research institutions, NGOs, and fishing communities. Continuous monitoring and research are needed to assess the effectiveness of these measures. The issue extends beyond environmental concerns, affecting food security, livelihoods, and sustainable development, emphasizing the need for a comprehensive approach in fisheries science and aquaculture.

Keywords: Climate change, Fisheries, Aquaculture



A RECENT INCREASE IN WAVE ENERGY AND SHORELINE SHIFTING DUE TO SEA SURFACE TEMPERATURE ALONG THE KANNIYAKUMARI COAST, INDIA

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Ocean wave energy is one of the cleanest renewable energies and recently wave energy conversion technology has been globally used to replace fossil fuels with renewable energy resources. But the ocean wave energy can also be destructive to coastal areas due to increases in ocean warming. The present study investigates the increases in wave energy due to sea surface temperature along the Kanniyakumari. In this case, wind-generated ocean waves play an important role in coastal processing and determine coastal flooding and erosion. The long-term changes of wave energy at five different locations (Kanniyakumari, Muttom, Colachel, Enayam and Kollenkode) in the Kanniyakumari coast from 2000 to 2024 are described. Copernicus ERA5 SST reanalysis hourly data used. Following that, multi-temporal Landsat images were used to demarcate the rate of shoreline shifting with the help of GIS-based Digital Shoreline Analysis System. Increasing sea surface temperature is one of the main factors affecting waves globally. The spatial difference between shoreline and sea surface temperature variations has been mapped using geospatial technology. We estimated that wave energy along this study region ranges from 6.5 to 8.5 kJ/km. The shoreline changes were calculated along the study region and some coastal villages were highly vulnerable due to ocean waves. The results show the sea surface temperature is a consequence of anthropogenic global warming, which changes the global wave pattern and makes waves stronger. This study reveals that the wave power is a potentially valuable climate change indicator.

Keywords: Global warming, Waves, Shorelines, Climate Change, Kanniyakumari



CARBON DYNAMICS AND HYPEROXIC CONDITIONS IN THE INTERTIDAL ROCKPOOLS ALONG THE CENTRAL WEST COAST OF INDIA

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Shallow inter-tidal ecosystems such as rockpools provide important insights in understanding the ongoing climatic change and their consequences. We studied the diurnal and seasonal variations in carbon chemistry and associated physicochemical parameters of intertidal rockpools along the central west coast of India during 2019-2022. The diurnal sampling revealed that daytime pH_T variability in the rockpools at higher tidal zones showed a greater fluctuation of 0.98 pH_T unit (8.23 to 9.22) than that in the lower tidal zone 0.58 pH_T unit (7.81 to 8.39). This increase in pH_T is attributed to the net ecosystem productivity, as reflected in the decrease in alkalinity and Dissolved inorganic carbon (DIC), coupled with the increase in total organic carbon (TOC). Consequently, the dissolved oxygen concentrations in the system increase to a hyperoxic (up to 13.2 ml/l) condition, while during nighttime there occurs a sharp fall and the ecosystem experiences low dissolved oxygen (2.4 ml/l) conditions due to respiration. Higher net ecosystem productivity in the day counters the carbonate dissolution by respiration at night as indicated by the aragonite and calcite saturation constants above 1. However, the rock pools are more vulnerable to changes in carbonate chemistry during the southwest monsoon season (SWM) due to the freshwater influence, along with reduced productivity due to the cloud cover. This poses a concern for the calcareous organisms inhabiting these rockpools, as they endure a prolonged duration of carbonate undersaturation state during the SWM. This study provides insight into understanding the fluctuating carbon chemistry in a dynamic ecosystem like intertidal rockpools and will contribute in policy making to mitigate the impacts of future climatic changes.

Keywords: Rockpools, Carbonate, pH_T, Ecosystem, Hyperoxia



IDENTIFYING EXTERNAL FACTORS DRIVING SEA SURFACE TEMPERATURE VARIATIONS IN THE INDIAN OCEAN

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Sea surface temperature (SST) serves as a crucial indicator of the state of the Earth's oceans, reflecting factors such as productivity, pollution, and global climate change. Variations in SST have profound effects on marine ecosystems. Recent research has highlighted how the warming of the oceans, resulting in a reduced temperature contrast between land and sea, can weaken the Indian Summer monsoon and potentially exacerbate droughts in South Asia. Understanding the causes behind changes in SST is essential for crafting effective adaptation and mitigation strategies. To explore changes in SST across the Indian Ocean, we analyzed multiple observational datasets, including HadISST (v1.1) and ERSST (v3b), to account for uncertainties. Our study focused on four specific regions within the Indian Ocean: the Bay of Bengal (BOB), Arabian Sea (AS), Southwest Indian Ocean (SWIO), and Southeast Indian Ocean (SEIO). These regions were selected based on differences in SST trends between two distinct time periods (1979-2009 and 1948-1978). Using a regression-based Regularised Optimal Fingerprinting (ROF) method, we examined SST patterns across these regions, leveraging data from seven climate models in the Coupled Model Intercomparison Project Phase-5 (CMIP5) and Phase-6 (CMIP6) databases. Our analysis revealed that while greenhouse gas (GHG) forcing could be attributed to SST changes in the Bay of Bengal during the period 1906-1955, the results were sensitive to the choice of observational dataset. However, over the full 100-year period (1906-2005) and the subsequent 50-year period (1956-2005), clearer attributions to GHG forcings were found, with some influence from other anthropogenic factors, primarily anthropogenic aerosols, observed over the Arabian Sea and Southeast Indian Ocean. We observed a better alignment between observations and CMIP6 models, possibly due to improved forcing datasets and model enhancements. Extending our analysis to include simulations beyond 2005 and 2015 using RCP/SSP scenarios in CMIP5 and CMIP6, respectively, we examined the differences in warming patterns and their impacts across the four subregions of the Indian Ocean.

Keywords: SST, Detection, Attribution, Fingerprint



PRELIMINARY ASSESSMENT OF THE SEDIMENTARY ENVIRONMENT IN THE SOUTHEASTERN ARABIAN SEA USING ORGANIC COMPONENTS IN THE SEDIMENT CORE

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This study presents a comprehensive analysis of sediment core samples collected from the southeastern Arabian Sea, focusing on their textural properties and organic content. The sediment analysis revealed significant variations in sand, silt, and clay percentages along the depth profile, indicating changes in sediment sources, transport processes, and depositional environments. The predominance of silt and clay particles suggests the influence of fluvial inputs and suspended sediment transport from nearby rivers, while ocean currents play a role in the transportation and deposition of fine-grained sediments. Particle size distribution analysis indicated a relatively uniform sediment composition, with varying degrees of sediment sorting. Skewness analysis revealed an asymmetrical distribution towards finer particles, suggesting specific transport mechanisms or depositional conditions favouring the accumulation of finer sediments. Kurtosis analysis indicated higher concentrations of particles around the mean size, reflecting different sediment transport regimes. The analysis of organic content revealed distinct variations in total organic carbon (TOC) percentages along the sediment core, with higher values in the upper layers and decreasing trends with depth. Fluctuations in TOC content were observed, suggesting episodic depositional events or changes in organic matter preservation. These variations may be linked to changes in monsoonal activity, oceanic circulation, or regional climate patterns. The nitrogen, hydrogen, and sulphur content also demonstrated variability, providing insights into the composition of organic matter and diagenetic processes. The C/N ratio indicated a shift from terrestrial to marine sources down the sediment core. Overall, this study contributes valuable insights into the sedimentary environment and environmental dynamics of the southeastern Arabian Sea.

Keywords: Sediment core, Arabian Sea, Total Organic Carbon, Particle size Analysis



CHEMICAL WEATHERING AND ASSOCIATED CO₂ CONSUMPTION RATES OF KARAMANA RIVER DRAINING SOUTHERN GRANULITE TERRAIN, INDIA.

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The dissolved solute chemistry of a river is the resultant of several hydrogeochemical processes, which link the geosphere-hydrosphere-atmospheric systems within the basin. The main goal of this study is to discerning the dissolved solute sources, controlling mechanisms of a small tropical west-flowing coastal mountainous river, the Karamana river basin (KRB), flowing through the Southern Granulite Terrain (SGT), India. A total of 39 water samples are collected for three different seasons covering the full hydrological cycle followed by standard physio-chemical analysis and the hydrochemical data that produced is within the reproducible limits. Additionally, a chemical mass balance (CMB) model is used for source-wise solute load quantification, along with estimates of Silicate weathering rates and CO₂ consumption rates. The geochemical data of rock, soil, and weathered profile specific to the KRB are employed to procure the objectives along with the hydrochemical data. The CMB model confirms that the silicate weathering (52.80%) is the dominant process controlling the dissolved load chemistry followed by the anthropogenic (38.35%) and atmospheric input (8.84%) at the outlet. The estimated SWR and CCR for KRB at the outlet region are 53.58 t km⁻² yr⁻¹ and 16×10⁶ mole km⁻² yr⁻¹ respectively, signifying the intense chemical weathering of silicate rocks in the region. This is further confirmed by the Arrhenius plot (SWR versus 1/T) which reveals that activation energy (AE) for silicate weathering to occur in KRB is only 24.7 kJ mol⁻¹. The SWR of KRB are comparable with other west-flowing Western Ghats (WGs) rivers, but are higher than the east-flowing WGs, Peninsular and Himalayan rivers. This must be attributed to lower silicate weathering activation energy of KRB due to the granulite terrain of steep slopes combined with tropical humid climate (high rainfall and high temperatures) and topographical undulation in the region.

Keywords: CO₂ drawdown, Climate change, Chemical weathering



IMPACTS OF CLIMATE CHANGE ON FISHERIES

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The consequences of human-caused climate change on aquatic ecosystems are becoming more evident, but this evidence needs to be weighed against the "normal" cycles and unpredictability of the climate that have impacted fisheries throughout human history. All life phases of an organism are predicted to be impacted by climate change, which will also have an impact on ecosystem function, species diversity, and community sizes. Although the scientific research on how climate change affects fisheries has advanced quickly, it is not fairly distributed both geographically and methodologically. Fish have evolved to live in certain ecological niches and hydrologic regimes, and their physiology and environment are closely related to each other. Therefore, changes brought about by climate change will have an impact on their physiology and life cycles. Range shifts will probably happen at the species level rather than the community level, which means that fish communities may alter. This will put new biotic stresses on aquatic populations. The sole biological alternative available to fish who are unable to migrate or adjust is genetic modification. Affected fisheries might make it harder for underdeveloped nations to satisfy their food needs and cause financial losses for wealthier nations. Fish that live in natural or manmade systems will be more stressed by the effects of global climate change as they intensify with time. Furthermore, the negative consequences of climate change will be made worse by human actions (such as increasing water diversion).

Keywords: Climate change, Aquatic ecosystems, Fisheries



GENE EXPRESSION ANALYSIS OF SALT ADAPTATION IN THE SPOTTED EURYHALINE CICHLID, *Pseudetroplus maculatus* (BLOCH, 1790)

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Euryhaline cichlids, such as *Pseudetroplus maculatus*, exhibit remarkable adaptability to a wide range of salinity levels. To elucidate the molecular mechanisms underlying this adaptation, we performed gene expression analysis on gill tissues of *P. maculatus* exposed to varying salinity conditions. RNA sequencing yielded a comprehensive transcriptome assembly, revealing significant changes in gene expression profiles in response to salinity stress. Gene ontology and pathway enrichment analyses highlighted key biological processes and molecular pathways involved in salt adaptation, including ion transport, osmoregulation, and stress response. Notably, several candidate genes encoding transporters, ion channels, and stress-related proteins were identified as potential regulators of salinity tolerance. This study provides valuable insights into the molecular basis of salt adaptation in euryhaline cichlids and lays the foundation for future functional studies on specific genes involved in this process.

Keywords: Euryhaline, Transcriptomics, Salinity, RNA sequencing



CLIMATE CHANGE IMPACTS ON THE BIOPHYSICS AND ECONOMICS OF WORLD FISHERIES

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Overfishing is the primary cause of the underperformance of the world's marine fisheries, but pollution and other human-caused factors also play a role. Global fisheries are already suffering difficulties, but climate change will make them more difficult to manage since it is starting to modify ocean conditions, especially water temperature and biogeochemistry. The productivity of marine fisheries is anticipated to be impacted by these changes. The primary productivity, distribution, and prospective yield of exploited marine species will all alter as a result of climate change, which would have an effect on the global fisheries economy. Fishing will be influenced by climate change in terms of distribution within and across nations' exclusive economic zones, as well as the amount and quality of marine fish caught. According to preliminary findings from recent research, many places would see losses in household incomes, fishing company earnings, and revenue due to climate change, while others regions and/or nations may see gains in the benefits of fisheries. Our current decisions will determine a major portion of the economic effects of climate change on fisheries. There is enough scientific data to support the implementation of climate change mitigation and adaptation measures in order to minimize the effects on fisheries, even in the face of knowledge gaps about the effects of climate change on fisheries. With severe economic ramifications, governments have often responded to diminishing fishing possibilities in a reactive rather than an anticipating manner.

Keywords: Climate change, Fisheries, Biogeochemistry, Mitigation, Adaptation, Economics



CLIMATE CHANGE AND FISHERIES: AN AWARENESS STUDY AMONG FISHERIES GRADUATES

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Climate change stands as one of the primary challenges as it is widely acknowledged and faced by India today. The impacts are already evident and could become catastrophic if an immediate action is not taken. The 17 Sustainable Development Goals (SDGs) established by the United Nations aim to address various social, economic, and environmental challenges faced by the world. SDG 13 aims to take urgent action to combat climate change and its impacts. Building knowledge and capacity to meet climate change through education and awareness raising is one of the targets that comes under SDG 13. In this context, an awareness study was conducted among fisheries graduates to know their basic knowledge about climate change and its impact on fisheries. Data were collected from around 46 fisheries graduates with the help of a structured questionnaire. Most of the respondents were in the age group of 21-25 years. All respondents were introduced to the term climate change during their schooling years, but the majority gained further knowledge from their course curriculum (63%), followed by social media (17.4%) and newspaper (15.2%). Degree programs offered by fisheries universities are giving importance to the climate change aspects. 39.1% of respondents indicated that climate change refers to a rise in sea level, followed by an increase in CO₂ levels or acidification of water (34.8%), and an increase in water temperature (15.2%). Concerning the knowledge level of fisheries graduates, the major impact of climate change in marine fisheries is attributed to changes in migration patterns, changes in species distribution, and changes in spawning time. Correspondingly, the inland fisheries were affected by changes in water quality parameters, retardation of fish growth rate, and increase in disease outbreaks. The upcoming research works of fisheries students should focus on mitigation strategies, causes, and impact of climate change.

Keywords: Climate change, Fisheries, Sustainable Development Goals, Knowledge level



Marine Bio-Geochemical Dynamics



IMPACT OF THE VARIABILITY OF BIO-OPTICAL PROPERTIES, NUTRIENT LOADING ON PHYTOPLANKTON SIZE CLASS AND ITS REMOTE ESTIMATION IN A MONSOON ESTUARY-A CASE STUDY FROM THE SOUTH-WEST COAST OF INDIA

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The Cochin estuary is the largest monsoonal estuarine system along the southwest coast of India. The freshwater influx from 6 rivers and discharge from the city through canals, tide-induced circulations, and mixing in the estuary make this system highly dynamic and diverse. The effect of nutrient loading on the changes in the phytoplankton size class was studied and had a significant determinant of the biogeochemistry and carbon flux of the estuary. During monsoon, Chlorophyll-a (Chl-a) concentration was highly varied spatially ranging from 0.0914 to 4.06 mg m⁻³, with an average value of 1.15 ± 1.13 mg m⁻³. The CDOM spectral slope (SCDOM) value was comparatively high during SWM, ranging from 0.0002 to 0.24 nm⁻¹ with an average value of 0.014 ± 0.044 nm⁻¹). Macro and Micro fractions of phytoplankton showed a good correlation with total Chl-a concentration ($R^2=0.790, 0.757, N=12$). During the monsoon period, nutrients enter the estuary triggering macro and micro phytoplankton size class dominance along with physical mixing in the surface layers preventing the sinking causes the dominance of large phytoplankton especially during the fag end of the monsoon. The picophytoplankton abundance was low during the period (0.004 ± 0.013 mg/m³). The CDOM and TSM concentration significantly affected spectral remote-sensing reflectance (Rrs), and the bigger plankton showed an influence in the blue region of the reflectance. The impact of size fraction on reflectance needs to be further studied to improve the retrieval technique for PSCs in the Cochin estuary.

Keywords: Phytoplankton Size Class, Chlorophyll, Remote Sensing Reflectance



SEASONAL VARIATION OF PHOSPHORUS CYCLING IN ASHTAMUDI ESTUARINE SYSTEM: INSIGHTS FROM FRACTIONATION ANALYSIS

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Phosphorus fractionation was used to find the seasonal cycling of phosphorus (P) in Ashtamudi in 2022 during monsoon and non-monsoon seasons. The sub-surface water and surface sediment were collected from 11 sites were sequentially leached to determine five fractions of P and their average percentage contribution to total P. Phosphate in the water column showed seasonal variations in both study area, with high values during the non-monsoon season in Ashtamudi. Geochemical parameter in the study site is influenced by the sediment texture. Total phosphorus (TP) in the surface sediments of Ashtamudi during monsoon ranged between 37.4 and 536.8 µg/g and during non-monsoon is in between 227.7 to 1842.5 µg/g. The phosphorus fractionation follows the trend Iron bound phosphorous [(Fe (IP) ≈ P] > Calcium bound phosphorous [Ca (IP) ≈ P] > Acid soluble organic phosphorous [ASOP] >Alkali soluble organic phosphorous [Alk- OP] >Residual organic phosphorous [Res-OP]. The Fe-IP values in Ashtamudi during monsoon ranges between 0 to 30.3 % of TP and during non-monsoon the range in between 0.03 to 70.3 % of TP. The Ca-IP ranges between 0.5 to 74.8% of TP and during non-monsoon ranges between 0.26 to 91.8% of TP. The ASOP ranges between 1.9 to 50.8 % of TP during monsoon and during non-monsoon the ranges between 3.9 to 91.8% of TP. The Alk-OP ranges between 17.3 to 68.7% of TP during monsoon and during non-monsoon season 6.7 to 16.9 % of TP. ROP ranges from 0.009 to 0.6% of TP during monsoon and during non-monsoon values ranges from 0.0008 to 0.03% of TP. ROP is the minimum fraction due to diagenesis. Bioavailable phosphorus (BAP) accounted for more than 58% of TP during monsoon and 86.4% during non-monsoon. The high content of bioavailable P can generate the release of P to the overlying water column and may alter the primary productivity, trophic status of the estuarine system.

Keywords: Phosphorus fractionation, Geochemical parameter, Bioavailable fraction, Primary productivity



EFFECT OF TROPICAL CYCLONE ON OXYGEN MINIMUM ZONE OVER THE ARABIAN SEA

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The study examines the effect of tropical cyclones (TCs) over oxygen minimum zone (OMZ) in Arabian Sea (AS) and reveals change in the OMZ depth and its thickness using satellite and ARGO data. The ARGO profiles during very severe cyclonic storm Vayu and severe cyclonic storm Kyarr demonstrates the decrease in dissolved oxygen (DO) concentration in the subsurface during storms attributing to intense storm-induced upwelling and negative Ekman pumping velocity. During TC Vayu, the maximum pressure drop at the centre was 32 hPa and sustained wind speed of 14.1 m/s near the ARGO location on 12 June 2019. The upwelling resulted in the increase of near surface chlorophyll from oligotrophic condition at the time of pre-storm to 2.5 mg/m³ after the passage of the storm. As a result, it is observed that the DO decreased in 40 to 180m water depth on 14 June at the observation location. The OMZ depth shifted to shallower depth of 129 m from 169 m and as a result its thickness increases from 1021 m to 1110 m. During TC Kyarr, the maximum pressure drop at the centre was 6 hPa and sustained wind speed of 10.28 m/s on 24 October 2019 near the ARGO location. The response of the DO was similar to that observed for the cyclone Vayu with Ekman pumping velocity equal to -0.1×10^{-4} m/s. The chlorophyll concentration increased by 0.5 mg/m³ on 3 November. The DO decreased in the subsurface water column as compared to the pre-storm levels. The temperature also dropped from greater than 29.5 °C to approximately 28.5 °C due to the entrainment of cold water. The upwelling brings oxygen poor water and increase the OMZ thickness from 1131 m to 1179 m. Thus, upwelling during TCs shifts the upper boundary of OMZ to shallower depth which decrease OMZ depth and increase its thickness. Also, the difference in the response of DO observed in AS depends on the TC intensity, wind speed, chlorophyll concentration, air-sea flux, intensity of the storm induced upwelling and mixing in the subsurface.

Keywords: Dissolved oxygen, Oxygen minimum zone, Tropical cyclone



AN OVERVIEW OF THE WADGE BANK HYDROGRAPHY, DYNAMICS AND THE ENVIRONMENT

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The Wadge Bank (WB), situated in the North Indian Ocean, emerges as a region of extreme ecological significance, characterized by diverse oceanographic features and high fish productivity. Research spanning several decades has illuminated various aspects of this dynamic ecosystem, revealing intricate relationships between oceanographic phenomena, fishery dynamics, and environmental variables. Studies have delineated the seasonal variations in sea surface temperature (SST), salinity, and dissolved oxygen levels, helping us understand the interaction between physical and biological processes. During the pre-monsoon and monsoon season, temperature differentials between offshore and coastal areas indicate the presence of thermocline movements, while upwelling events during the southwest monsoon enrich surface waters with nutrients, fostering elevated fish biomass. The Arabian Sea High-Salinity Water, Persian Gulf Water, and Red Sea Water contribute to the region's distinct water masses, each with its unique salinity and temperature variations. The interaction of these water masses influences the distribution of fish species, with nemipterids dominating the catches in the WB. The local demersal fishery, which includes both resident and migratory stocks, experiences changes in catch rates throughout the year, matching the patterns of monsoonal cycles and ocean conditions. Upwelling, a key process driving productivity, lifts nutrient-rich subsurface waters to the surface, supporting thriving ecosystems and attracting diverse fish communities. Researchers have documented the spatial and temporal dynamics of upwelling, elucidating its role in shaping the distribution and abundance of marine species. The WB faces environmental challenges despite its ecological richness, including dissolved oxygen level fluctuations and fishing yield variations during different monsoonal forcings. Fishery yields in the WB are primarily influenced by water temperature rather than salinity, with an apparent correlation between dissolved oxygen levels and productivity. In conclusion, the WB emerges as a dynamic and productive marine environment characterized by complex interactions between oceanographic processes, fishery dynamics, and environmental variables. Continued research and conservation efforts are essential to safeguarding this significant region's resilience and economic viability.

Keywords: Hydrography, Water masses, Oxygen Minimum Zone, Biological productivity





Marine Policies & Regulations



LIVE BAIT POLE AND LINE TUNA FISHERY: A REVIEW ON THE TRADITIONAL ECOLOGICAL KNOWLEDGE OF THE LAKSHADWEEP FISHERMEN

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The global capture fisheries production was 90.3 million tonnes in 2020, among which 78.8 million tonnes were from marine waters. Tuna and tuna-like species catches were estimated at about 7.8 million tonnes from global waters in 2020. Skipjack tuna and Yellowfin tuna account for 4 percent and 2 percent of the catch, respectively. In 2020, India witnessed a marine fish production of 3.727 million tonnes. Lakshadweep, being India's only coral atoll system with an archipelago of 36 islands, has an ecologically diverse ecosystem that nurtures rich and unique marine life and contributes over 0.12 lakh tonnes of marine fish production. There exists a healthy coexistence between people and the environment due to the pole and line fishery, which is not only socio-economically viable but also environmentally sustainable. The live-bait pole and line tuna fishery is a unique fishery that targets the resilient, oceanic Skipjack tuna using small planktivorous baitfish. The pole and line fishery of Lakshadweep has been practiced in Minicoy, the southernmost island of Lakshadweep, for centuries. They have developed and preserved a diverse set of customary practices and associated knowledge systems termed Traditional Ecological Knowledge (TEK) to manage and sustainably use the limited resources. The customary practices include a customary institution, practices associated with the TEK of Minicoy like a seasonal ban on baitfish collection, quantification and conversion of baitfish, and a traditional calendar. A Community-Based Fisheries Monitoring Programme and Fisheries co-management in the island led to the establishment of a fishery monitoring programme, which exhibits participatory knowledge generation through fishers' contribution to resource monitoring efforts and documentation of the customary systems of resource management in Minicoy. This stands as a unique instance of a functional TEK-based management regime in India. These findings offer valuable insights and lessons, setting a precedent for future efforts in fisheries governance across other coastal regions of India.

Keywords: Climate change, Fisheries, Biogeochemistry, Mitigation, Adaptation, Economics



EMPOWERING SUSTAINABILITY: REIMAGINING FUEL SUBSIDIES FOR TAMIL NADU'S FISHERIES SECTOR

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The marine fisheries industry in Tamil Nadu is a vital source of livelihood for coastal communities, yet it faces persistent challenges such as fluctuating fish stocks and economic pressures. Governmental support, especially through fuel subsidies, plays a crucial role in ensuring the sustainability and growth of this sector. Recent governmental proposals, such as increasing subsidized kerosene to 3,700 liters per year (up from the previous allocation of 3,400 liters), signify a proactive approach to addressing fishermen's needs. Similarly, for diesel, the government of Tamil Nadu provides tax-exempted diesel of 18,000 liters per craft per year for mechanized fishing boats and 4,000 liters per craft per year for motorized crafts registered in the fisheries department. Initiatives aimed at promoting fuel-efficient engines and hybrid technologies show promise in optimizing resource utilization within the fisheries sector. Embracing such innovations can help alleviate strain on resources while simultaneously enhancing the economic viability of fishing operations. Furthermore, fostering collaboration among governmental bodies, non-governmental organizations (NGOs), and stakeholders is essential for crafting comprehensive strategies for sustainable fisheries management. Through concerted efforts, Tamil Nadu can lead the way towards the continued prosperity of its fisheries sector while also preserving marine ecosystems for future generations. This collaborative approach not only ensures the resilience of coastal communities but also underscores the state's dedication to fostering sustainable development.

Keywords: Subsidy, Stakeholder, Fuel





Marine Pollutions & Ecotoxicology



SEASONAL DYNAMICS OF MICROPLASTIC POLLUTION IN THE WATER AND SEDIMENT OF SAMBRANIKODI MANGROVE ISLAND, KERALA

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Microplastic (MP) pollution has emerged as a critical global environmental concern, posing significant threats to ecosystems worldwide. Among these ecosystems, mangroves characterized by their intricate root systems, unique biodiversity and ecological functions, are particularly susceptible to MP contamination. In this study, we conducted an analysis of microplastics (MPs) in the water and sediment of Sambranikodi mangrove island in Kerala ($8^{\circ} 92' 90$ N, $76^{\circ} 56' 78$ E) during pre-monsoon (PRM), monsoon (MON) and post-monsoon (POM) periods of 2022 and 2023. Our results revealed a higher abundance of MPs in water during POM (2.45 particles/L) and in sediment during MON (3030 particles/kg) in 2022. Fibre was the dominant morphotypes in both water and sediment throughout all seasons during 2022 and 2023. Mesh-size analysis indicated variable retention of MPs, with 180μ retaining higher numbers in water and sediment during the POM of both 2022 and 2023. Specifically, in sediment, 180μ retained high number of MPs during 2022 (PRM-195 particles/Kg, POM-520 particles/kg) and during 2023 (PRM-141 particles/kg, POM-198 particles/kg). MPs exhibiting transparent and blue colour were prevalent in both water and sediment samples during all seasons of both years. In the water and sediment, polymer composition analysis identified HDPE and LDPE as the most abundant polymers during 2022, while HDPE, PP and PE dominated during 2023. Variations in tidal levels and sediment dynamics exert a significant influence on MP retention within mangrove ecosystem, emphasizing the pivotal role of monsoon patterns in modulating the spatial distribution of MP pollution.

Keywords: Microplastics, Mangrove, Pollution, Polymer



IMPORTANCE OF PUBLIC BEHAVIOUR AND AWARENESS ON MITIGATING WATER ASSOCIATED DISEASES AND FAECAL CONTAMINATION IN LAKSHADWEEP ISLAND

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Controlling water-associated diseases in coastal regions presents a multifaceted challenge due to the intricate nature of disease transmission. The diverse behaviour of local populations, influence by their occupations, cultural norms, religious practices, recreational activities, and practice of sanitation and hygiene, contribute to the risk of contracting water associated diseases. Promoting compliances with Water, Sanitation and Hygiene (WASH) standards and ensuring universal access to safe drinking water critical in mitigating disease spread. Nonetheless, comprehensive strategies are essential to eliminate pathogen transmission by addressing microbial contamination in water bodies and reducing public exposure. The World Health Organization (WHO) reports that unsafe WASH practices contribute to approximately 70 % of diarrheal diseases, suggesting that the remaining 30 % may stem from contact with faecally contaminated aquatic environments. Our study involved interviews with over 400 households on Kavaratti Island, Lakshadweep, and the analysis of 45 water samples from public wells and ponds. Despite all homes having access to desalinated water, only 25 % rely solely on it for drinking. The majority blend desalinated with well water, while half of the residents boil their water, a mere 2 % use filtration systems. Notably, there is minimal understanding of the scientific rationale behind boiling among the populace, who often combine boiled well water with desalinated water for consumption. An analysis of the disease data provided by the health department revealed the prevalence of acute diarrhoeal disease on the island. We isolated 72 coliform bacteria and 51 Vibrio-like organisms from these samples for molecular taxonomy and antibiotic sensitivity testing. The 16S rRNA gene analysis showed that the faecal indicator bacteria isolated belonged to *Enterobacter* sp. (38. 5 %), *Klebsiella* sp. (35.4 %), *Shigella* sp. (113.9 %) and *Escherichia* sp. (9.2 %). Antibiotic resistance pattern indicated that over 70 % of the coliforms and Vibrio-like organisms exhibited resistance to ampicillin. Additionally, 30-50 % of these bacteria showed multiple antibiotic resistance, with some being resistant to as many as 8 out of 16 antibiotics tested. Our findings highlight the critical need for public education on WASH protocol and environmental surveillance for pathogen prevalence. Such measures are essential to curb the transmission of water-associated diseases particularly in coastal regions where there is frequent interaction with aquatic systems.

Keywords: Water associated disease, Faecal contamination, Antibiotic resistance, Public awareness, WASH



INTER-ANNUAL VARIATIONS OF TRACE METALS IN EDIBLE SEA URCHIN *TRIPNEUSTES GRATILLA*, FROM A TOURIST BEACH ALONG THE SOUTHWEST COAST OF INDIA

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Sea urchins are marine invertebrates belonging to phylum Echinodermata and are recognized as valuable bioindicators of environmental health. In the present study, inter-annual variation of trace metals such as Zn, Mn, Ni, Cu, As, Pb, Cr, Cd, Se, and Co was assessed in water, sediment, and various body parts of an edible sea urchin, *Tripneustes gratilla*. The samples were collected from the coastal waters of Kovalam, a popular tourist destination located along the southwest coast of India, for three years (January 2020, 2021, and 2022). Trace metal analysis was conducted using ICP-OES. Significant annual variations were observed in the concentration of metals such as Pb, Cr, Mn, Cu, Zn, and Ni in water, sediment, and sea urchin soft tissues. Water and sediment samples showed maximum concentration during 2022. In water, Zn was the most abundant metal (25.19–39.15 µg/l), followed by Mn (9.15 to 15.24 µg/l) and Pb (5.21–9.91 µg/l). Sediment exhibited higher metal concentrations than in water. In sediment, essential metals such as Zn (35.26–55.12 µg/g) and Mn (39.58–45.12 µg/g) showed highest concentration, whereas Pb (12.35–18.2 µg/g) and Cr (7.69–14.8 µg/g) were the dominating non-essential metals. In Sea urchins, the soft tissues showed comparatively high concentrations of metals, with significant annual variations compared to the hard parts. Zn was the predominant metal in all body parts, with a maximum value of 96.27 µg/g in the gonad tissue during 2022. Among non-essential metals, Pb (3.61 µg/g) and Cr exhibited high values (4.82 µg/g) in the gut tissue during 2022. In general, there was an increasing trend in the concentration of most of the metals, with a maximum during 2022.

Keywords: Heavy metal pollution, Intertidal, Biomonitoring, Sea urchin



INVESTIGATIONS OF BACTERIOLOGICAL QUALITY OF FLOOD-AFFECTED WATER BODIES WITH SPECIAL REFERENCE TO MULTIDRUG-RESISTANT WATERBORNE PATHOGENS

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Climate change significantly influences the composition of contaminants and pathogens found in water sources. Rising global temperatures contribute to an increased frequency and intensity of extreme weather events, such as torrential rainstorms and coastal flooding. These events are expected to become even more prevalent, raising concerns about waterborne disease outbreaks. However, there has been few investigations of microbial contamination in association with multidrug resistance resulting from frequent natural hazards have been reported. This study assessed the risk of multidrug-resistant pathogens (MDRPs) in different water sources within the coastal belts of Cochin; faces a growing threat from climate change-induced phenomena like **coastal flooding** and merging of waterbodies. Bacterial strains were isolated using selective and chromogenic media, followed by molecular identification. *Escherichia coli* and *Vibrio* species were the most common waterborne MDRPs, along with other opportunistic pathogens. All bacterial isolates except *Klebsiella pneumoniae* and *Acinetobacter seifertii* were beta-hemolytic. All strains exhibited resistance to at least one antibiotic and significantly higher resistance was observed for carbapenem, macrolides, and colistin antibiotics. A high multiple antibiotic resistance index (MAR) was found in 83% of MDRPs. Of all the evaluated isolates 56% were strong biofilm producers. Moreover, a concerning number of isolates harboured antibiotic resistance and virulence genes including *blaTEM*, *blaSHV*, *blaOXA*, *hlyA*, *aer*, and *act* indicating the potential to produce toxins and disease-causing factors. This study concludes that frequent flooding and inundation significantly increase MDRPs prevalence, posing a serious public health threat. Our findings emphasize the urgent need for enhanced water quality monitoring and management in coastal areas prone to natural disasters.

Keywords: Antibiotic resistance, Biofilm, Coastal flooding, Multidrug-resistant pathogens, Virulence genes.



ASSESSMENT OF HEAVY METAL POLLUTION IN BEYPORE ESTUARY SEDIMENTS: IMPLICATIONS FOR ENVIRONMENT MANAGEMENT

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The Beypore Estuary, located in Kozhikode, Kerala, serves as a critical ecological and economic resource facing the impacts of rapid industrialization and urban expansion. This study aims to comprehensively assess the distribution and contamination levels of heavy metals in Beypore Estuary Sediments. Sampling was conducted at multiple sites along the estuary during October 2023 and the concentrations of heavy metals (Pb, Cd, Cr, Fe, Zn, and Ni) were analysed using atomic absorption spectrometry (AAS). The concentration of metals exhibited the following trend: Fe>Cr>Ni>Zn>Pb>Cd. From the result, the concentration of Fe along the study area was high and ranged from 8712.87 mg/kg to 22609.12 mg/kg. The observations from the study indicate elevated concentrations of certain heavy metals in sediments at specific sites, potentially attributed to anthropogenic activities such as industrial and port activities. These elevated levels of heavy metals pose significant risks to both aquatic life and human populations relying on the estuary for sustenance. The findings underscore the urgent need for environmental management and remediation strategies to mitigate heavy metal pollution in Beypore Estuary. By implementing effective strategies, we can ensure the preservation of this vital ecosystem and safeguard the well-being of both aquatic life and human communities in the region.

Keywords: Heavy metal, Beypore Estuary, Pollution



SEASONAL DISTRIBUTION AND METAL - LIGAND INTERACTION IN THE SURFACE SEDIMENTS OF RIVER - ESTUARY CONTINUUM SOUTH WEST COAST OF INDIA

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This study describes the geochemical distribution of heavy metals (Ni, Zn, and Cd) and identifies the critical factors that significantly control these heavy metals distribution and speciation in estuarine and river sediments from south west coast of India (Muvattupuzha River and Cochin Estuary). Fifteen samples were collected from river-estuary continuum during wet and dry season were subjected to total metal concentrations and speciation studies in accordance with BCR protocol. The study has also taken a notice on total metal concentration in river-estuary continuum which indicates estuaries are the major sink for heavy metals to reside. Their order of abundance in both river and estuary founds to be Zn > Ni > Cd during both seasons. Their average concentration founds to be 153.47mg/kg, 38.45mg/kg, and 1.35mg/kg during dry season and 122.46mg/kg, 33.41 mg/kg and 0.97 mg/kg during wet season respectively for Zn, Ni, and Cd. Crustal sources influence the abundance of heavy metals in river sediments of south-west coast of India, but estuarine parts (Cochin Estuary) were polluted indicating its bioavailability in estuary. Zn and Cd found to be more bioavailable in estuarine segment than River segment. Distributions of Ni in sediments from river- estuary continuum was controlled by organic carbon present in the sediments. However, Fe-Mn oxide minerals seemed to be a dominant factor in controlling the distribution of studied heavy metals in the studied sediments of south west coast of India. The outcome of this study may help in decision-making to predict the levels of these heavy metals from natural and anthropogenic sources and to control heavy metal pollution.

Keywords: Heavy metal, River-estuary Continuum, BCR fractionation



ACUTE TOXICITY OF ETHION 50% EC ON *OREOCHROMIS NILOTICUS*

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The present study aimed to evaluate the acute toxicity effect of Ethion50 % EC by using Juvenile Nile tilapia as a test model. The study was conducted three times using a control group and three test experiments, each of which had 10 animals. The results were evaluated using the renewal test method. The lethal concentrations at 50 % (LC_{50} for 96 h) were determined using the probit analysis. The physical and chemical parameters such as pH, Temperature, dissolved oxygen, nitrate level, and nitrite level of the water in the tank in which they were kept were continuously monitored. Behavioral and Morphological changes were observed in fish exposed to Ethion at 96 h LC_{50} . The value of 96 h LC_{50} were estimated at 1.36 mg/L. The affected fish exhibited a loss of equilibrium with erratic and darting swimming movements, hyperactivity, frequent visits to the water surface, avoidance behavior, loss of balance, frequent head standing, secretion of mucus, and increasing rate of opercula activity. The results in the present study suggest that low levels of Ethion in the aquatic environment may alter adverse effects on growth and development in Nile tilapia.

Keywords: *Oreochromis niloticus*, Ethion50%EC, LC_{50} , Behavioural and Morphological.



A STUDY ON ABUNDANCE OF MICROPLASTICS INGESTION IN COMMERCIALLY IMPORTANT FISHES ALONG KARNATAKA SOUTHWEST COAST OF INDIA

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In the field of packaging, plastics have grown in importance ever since the 1950s when the first commercially viable plastic was developed. Unfortunately, there is growing scrutiny from the environment regarding these materials. Because the environment changes, larger plastic waste gradually breaks down into tiny fragments that range in size from metres to micrometres. Several marine organisms can easily consume microplastics due to their small size (<5 mm) irrespective of their feeding habit. Based on their eating habits *Sphyraena obtusata*, *Lactarius lactarius*, *Escualosa thoracata*, and *Odonus niger* were the species chosen for the study. The study region comprised the main landing centres of the Karnataka coast, namely Mangalore, Malpe, and Karwar. Fish digestive tracts were processed utilising an alkali digestion procedure. Fourier Transformed Infrared (FTIR) spectroscopy with attenuated total reflectance and stereoscopic microscopy were applied to the processed samples. Particles of plastic were categorised into three main categories: fibres, fragments, and miscellaneous materials. 33.06% of microplastics had a size less than 100 µm. The microplastics that were seen were red, green, blue, and black in colour. It was discovered that 82% of the fish samples had at least one microplastic in their stomach. The amount of microplastics varied significantly throughout the stations, however there was no discernible variation amongst the species that were gathered according to feeding habits. The polymers found in the fish stomach from every location were polyethylene, polystyrene, polyacrylonitrile, high density polyethylene, and SEBS. The greatest amounts of microplastics were found in the records of Malpe (Station 2) and Mangalore (Station 1). The fish species condition factor was more than 1, indicating that the growth conditions were favorable. The study found that fish captured along the Karnataka coast have been contaminated with microplastics, and that the level of plastic pollution in fishing areas is at or above what would lead to inadvertent ingestion.

Keywords: Microplastics, FTIR, Pollution, Debris, Polyethylene, Fibres



ASSESSMENT OF MICROPLASTIC CONTAMINATION IN JELLYFISH *CRAMBIONELLA ORSINI* ALONG THE SOUTH KERALA COAST

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Microplastics, a subset of plastics that are <5 mm in length, are increasingly found in nearshore systems and have been discovered in many marine species. While microplastic ingestion is extensively documented in aquatic organisms, there is limited research focusing on cnidarians, despite their substantial role in marine trophic interactions. This preliminary study investigates the occurrence and ingestion of microplastics by jellyfish (*Crambionella orsini*) along the Coasts of South Kerala, where data on this phenomenon are lacking. Samples were collected from three stations; Vizhinjam, Sanghumugham, and Perumathura, over a month-long post-monsoon period using tow nets. After collection, the samples underwent digestion with 10% KOH at 60°C for 24 hours and subsequent filtration through a 38 µm sieve. Further filtration through a 0.8 µm Whatman filter targeted particles smaller than 38 µm. The obtained microplastics were dried, examined under a stereomicroscope, and confirmed using a hot needle test. Particles were assigned to four particle type categories: fragment, pellet, film, and microfibers. The study revealed microplastics primarily as colorless fibers, with additional hues predominantly in black, blue, and red. µFTIR examination confirmed that synthetic microfibers were the prevailing microplastic identified at all three locations. Across all sites and total samples, (57%) contained microplastics. Spatial differences in microplastics were detected, with the number of plastics detected per individual differing between locations. *Crambionella* collected from Vizhinjam and Sanghumugham had significantly higher plastic densities per individual than from Perumathura. Plastic size did not significantly differ between locations. The findings contribute to a deeper understanding of the interaction between microplastics and marine fauna along the South Kerala coast, particularly focusing on zooplankton feeders like jellyfish, which inadvertently consume microplastics in the water column. Given the limited global research on the presence of microplastics in jellyfish and the potential for trophic transfer, this study plays a crucial role in expanding our knowledge in this area.

Keywords: Microplastic, *Crambionella orsini*, South Kerala Coast



COMBATTING MARINE PLASTIC POLLUTION: COMMUNITY-LED EFFORTS TOWARDS SUSTAINABLE OCEAN CONSERVATION

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The world's oceans, essential ecosystems supporting diverse marine life and providing sustenance for billions of people, face escalating threats from human-induced activities, notably the pervasive presence of plastic pollution. Studies underscore the concerning trajectory of plastic waste in the ocean, with forecasts indicating an imbalance where plastic may outweigh fish by 2050. Despite only 1% of marine litter being visible on the surface, a substantial portion descends to the seabed, detrimentally impacting fishing operations through net entanglement and reduced catch yields. In response to this pressing environmental challenge, Plan@Earth, a Kerala-based NGO, launched the 'Drive to Recover Ocean Plastics' (DROP) initiative. This study elucidates the plastic recovery efforts facilitated by community engagement and awareness campaigns spearheaded by the NGO. It details the strategies employed to incentivize fishermen to retrieve and return ocean plastics encountered during fishing expeditions. Furthermore, the study quantifies the volume of ocean plastics recovered through the DROP program and forecasts the potential amount of plastic waste discarded by fishing vessels. Plan@Earth's proactive approach in addressing marine pollution through community participation exemplifies a promising model for advancing Sustainable Development Goal 14: Life Below Water. By emphasizing collective action and environmental stewardship, the NGO's efforts underscore the imperative of integrating sustainable practices to safeguard marine ecosystems for present and future generations.

Keywords: Marine pollution, Marine Plastic recovery, Fishing vessels, Sustainable Development Goals.



DISTRIBUTION OF MICROPLASTICS IN THE SURFACE WATER OF ASHTAMUDI LAKE, A RAMSAR SITE IN KOLLAM, KERALA

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The increasing prevalence and accumulation of microplastics represent a significant environmental concern, as they are ubiquitous in air, water, sediments, and various aquatic species. The presence of anthropogenic microplastic waste in aquatic habitats has garnered global attention. This study represents the first report detailing the types, abundance, and characteristics of microplastics found in the surface water of Ashtamudi Lake. As a brackish water estuary and a RAMSAR site located in Kollam, Kerala, this research sheds light on the presence of microplastics in this unique ecological setting. A total of 844 microplastic items were obtained from six different sites of the lake in the study during the pre-monsoon, monsoon and post-monsoon seasons of 2022. The total microplastic abundance is 281.47 ± 6.6 items/L indicating their extensive dispersion in the water. Among the stations, Asramam (urban) showed the highest number of microplastics (114.7 ± 12.5 items/L) and the lowest number of microplastics are in Munroe Island (rural) (17 ± 2.8 items/L). Fibers and fragments were the most dominant microplastic shapes found. Polymer types were characterized by using Fourier Transform Infra-Red spectroscopy (FT-IR) and Raman spectroscopy. Polyethylene, Polyvinylchloride and Polypropylene were the most abundant and Nitrile and Nylon 6,6 were the least abundant polymers found. Sampling sites near to the busiest city locations having higher anthropogenic activities showed significantly high levels of microplastic pollution. This study offers valuable insights that contribute to a deeper comprehension of microplastic pollution within estuarine ecosystems. It suggests that the higher population density and increased waste generation in urban areas serve as primary sources of microplastic pollution in estuarine environments. By emphasizing the importance of microplastic monitoring in estuarine ecosystems, this research underscores the need for proactive measures to address this pressing environmental issue.

Keywords: Microplastics, FT-IR, Raman spectroscopy, Surface water, Ashtamudi Lake.



MARINE APPLICATIONS OF CARBONNANODOTS IN HEAVY METAL SENSING

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Nanotechnology in the 21st century often originates from human creativity and ambitions, exemplified by carbon nanodots (CDs) possessing an sp² -hybridized nanocrystalline core and an amorphous core-shell abundant in surface functional groups, resembling other carbon nanomaterials. Initially discovered in arc-discharge carbon soot in 2004, CDs enable the manipulation of matter at dimensions ranging from 1 to 100 nm, unlocking novel applications like sensing various heavy metal ions, prioritizing sensitivity and specificity, and garnering significant attention due to their phantasmagoric characteristics like fluorescence behavior, high photoluminescence quantum yield, and compatibility with biological systems. Conversely, carbon dots offer a lucrative and versatile alternative to existing heavy metal detection methods such as inductively coupled plasma mass spectrometry (ICP-MS), Atomic absorption spectrometry (AAS), Atomic fluorescence spectrometry (AFS) and other molecular biology approaches. The rise in human-induced heavy metal contamination has resulted in the pollution of water bodies, including oceans, rivers, lakes, and drinking water sources, raising concerns about health and safety. In this context, the primary focus of this review revolves around the need for the development of an optical nanoprobe for heavy metal detection in environmental samples. Different heavy metal sensing resilient probes can be derived from various sources and are generally recognized for their low chemical and cytotoxic profiles. These economical carbon probes can be seamlessly integrated into on-site environmental assessments, potentially revolutionizing environmental monitoring efforts. Also, the review sets itself apart from previous literature by emphasizing the utilization of carbon nanodots as a method for detecting harmful heavy metal ions in the ocean with describing an insight into the mechanism in nanoparticle synthesis with classification of top-down and bottom up approaches, its smashing properties and their applications in marine monitoring. Furthermore, it examines the detection capabilities of carbon nanodots in marine environments and explores potential challenges and solutions to enhance sensing of hazardous heavy metals.

Keywords: Nanomaterial, Marine sources, Metal pollution, Heavy metals



ECOTOXICOLOGICAL EVALUATION OF ANTIFOULING BIOCIDES ON THE *VILLORITA CYPRINOIDES VAR COCHINENSIS* AS POLLUTION INDICATOR IN THE COCHIN ESTUARY-SOUTHWEST COAST OF INDIA

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Antifouling biocides are one of the major threats to non-target marine organisms worldwide even though new formulations are introduced. Cochin estuary, one of the major estuarine systems along the south-west coast of India was surveyed during the present study for two years. Phenyltins, Irgarol 1051, and Chlorothalonil are the biocides considered. Phenyltin derivative concentrations varied spatially and the organotin degradation index was used to understand the degradation of phenyltins. Their toxicological effect was determined with the help of the Sentinel organism *Villorita Cyprinoides var Cochinenensis*, a commonly found bivalve. The acetylcholine esterase enzyme inhibition rate in the nervous system of the bivalve was used as an indicator of pollution monitoring in the Cochin estuary. The LC₅₀ value of triphenyltin is low compared to its derivatives, Chlorothalonil and Irgarol 1051. This leads to the high toxicity of triphenyltin to organisms. The sublethal concentration showed the inhibition trend of biocides against acetylcholine esterase enzyme.

Keywords: Cochin estuary, Sediments, Antifouling biocides, Acetyl cholinesterase



ASSESSMENT OF SEASONAL VARIATION AND TOXICITY POTENTIAL OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN SURFACE SEDIMENT OF ASHTAMUDI WETLAND, SOUTH-WEST COAST OF INDIA

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PAHs are of concern due to their persistence, bioaccumulation potential, and toxicity to aquatic organisms. They can adhere to sediments, accumulate in organisms, and disrupt biological processes, posing risks to both aquatic ecosystems and human health. PAHs are a group of endocrine-disrupting chemicals listed as priority pollutants by the United States Environmental Protection Agency (USEPA). In this study, we report the seasonal variation of PAHs in Ashtamudi Lake to assess the sources and toxicity of these potential endocrine disruptors in the lake. Surface sediments were collected from 11 stations across different parts of Ashtamudi Lake during monsoon and non-monsoon seasons in 2022 and analyzed for sixteen PAH congeners. Concentrations ranged from 142.3 to 2621.38 ng/g and 202.64 to 3225.62 ng/g in the monsoon and non-monsoon respectively. A profound seasonal difference was observed ($p < 0.05$) in the distribution of Σ_{16} PAHs with maximum average concentration during the non-monsoon (981.01 ng/g) than monsoon (645.59 ng/g). According to diagnostic ratios, the major sources of PAHs in Ashtamudi Lake are from petroleum and petroleum combustion. Calculated carcinogenic toxicity equivalents (TEQ) values ranged from 9.17 to 633.41 ng g⁻¹ in the surface sediments. When classified according to the pollution levels, sediments from Ashtamudi Lake could be classified as moderately to highly polluted with PAHs. This study serves as a valuable baseline for upcoming studies on organic pollutants in Indian wetlands and underscores the urgency of implementing robust measures to control micropollutants effectively.

Keywords: PAHs, Endocrine Disruptors, Seasonal Variation, Surface Sediments, Diagnostic Ratios, Toxicity



FRACTIONAL DISTRIBUTION AND MOBILITY OF HEAVY METALS IN ASHTAMUDI ESTUARY SEDIMENTS: IMPLICATIONS OF ECOLOGICAL RISK ASSESSMENT

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Estimating the fractional distribution of sediment-bound heavy metals holds great significance for the ecological risk assessment of contaminated aquatic systems. Environmental factors contribute to the mobility of heavy metals and their accumulation in various ecological matrices. In this study, the fractional distribution of Fe, Ni, Mn, Pb, Cr, Zn, Cu, Ni, and Co in the sediments of the Ashtamudi estuary, located along the southwest coast of India, was assessed. Eleven sediment samples were collected from different parts of the Ashtamudi wetland during both the monsoon and non-monsoon seasons. The results indicated that the residual fraction was the predominant phase for all metals except Mn during both seasons. Among the non-residual fractions, Zn, Ni, and Co were predominantly associated with the Fe–Mn oxide fraction, while Cu and Cr were linked with the organic fraction throughout both seasons. Mn exhibited the highest mobility in the first fraction, while Fe showed the lowest mobility, suggesting that Mn is the most mobile element among those studied. In the Ashtamudi estuary, high exchangeable fractions of Mn and Cd were observed, indicating their high bioavailability. Although the exchangeable fraction of Pb was negligible, it still poses a risk of bioaccumulation due to the presence of oxidisable and reducible fractions. The results revealed that the extractable amounts of heavy metals, particularly in mobile fractions (such as acid-soluble, reducible, and oxidizable), were higher compared to the immobile fraction (residual), possibly due to anthropogenic sources. The findings could indicate the anthropogenic introduction of heavy metals into the sediments, stemming from the recent rapid industrial development and urbanization in the vicinity of Ashtamudi Lake.

Keywords: Ashtamudi Lake, fractional distribution, bioavailability, heavy metals.



SPATIAL DISTRIBUTION OF MICROPLASTICS IN THE SURFACE SEDIMENTS OF BHITARKANIKA WILDLIFE SANCTUARY, EASTERN INDIA

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Microplastics (MPs) are recognized as an emerging contaminant globally, with their presence now extending to even previously untouched regions. In the present study, we investigated the prevalence of microplastics present in surface sediments ($n = 20$) collected from the Bhitarkanika Wildlife Sanctuary situated in the northeastern Kendrapara district of Odisha, Eastern India. This sanctuary is renowned as one of India's largest mangrove ecosystems, which provides habitat to diverse fauna, including saltwater crocodiles, snakes, and numerous migratory bird species. The mean microplastic abundance in surface sediments was 12.373 (± 13.554) MPs/kg. The 0.3-1 mm size range had the highest recorded size range (40.74%), then 1-5 mm (29.63%) and 0.1-0.3 mm (29.63%). With 88.89% of the total, fibers led all other microplastic categories, followed by fragments (9.25%) and film (1.85%). No foam or pellets were detected. The predominant colour is transparent(50%), followed by black(29.62%), blue(12.96%), red(3.70%), yellow(1.85%) and green(1.85%). The polymer composition and surface features of MPs will be presented during the conference as the studies are being carried out. Anthropogenic activities such as tourism and aquaculture significantly impact the Bhitarkanika ecosystem, leading to the accumulation of microplastics (MPs) in the region. Overexploitation and human activities diminish economically important mangrove habitats and their resident species. This study provides baseline information on the extent of MP contamination along the Bhramani River coast in the Bhitarkanika region of Odisha, India.

Keywords: Microplastics, Mangrove, Sanctuary, Sediment, Bhramani, Odisha



SPATIOTEMPORAL DYNAMICS AND ECOLOGICAL RISK ASSESSMENT OF MICROPLASTICS IN THE INDUSTRIALLY POLLUTED CUDDALORE COAST, SOUTHEAST INDIA

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Microplastic (MP) pollution poses a significant threat to coastal ecosystems, necessitating a thorough examination of its seasonal fluctuations and ecological impacts. This study investigates MPs in Cuddalore's coastal waters and sediments across four seasons (Oct 2020 – Sep 2021), revealing varying concentrations that peak during the monsoon and pre-monsoon periods, influenced by increased rainfall. The research emphasizes spatiotemporal variations in microplastic levels along the Cuddalore coast, with higher concentrations found in sediments (59.7–325.4 particles/kg) compared to water (6.1–31.4 particles/kg), particularly during the monsoon and pre-monsoon seasons. Fibrous microplastics dominate (water: 69–100%, sediments: 66–92%), with prevalent polymers such as polyethylene, polyethylene terephthalate, and polypropylene identified. While the Pollution Load Index indicates relatively low pollution (1.0–1.4), concerns arise from the higher values of Polymer Hazard Index and Potential Ecological Risk Index, especially due to the presence of polymers like polyurethane and polyamide. Additionally, spatiotemporal correlations reveal strong positive relationships between rainfall and MP concentrations in coastal waters ($r = 0.881$) and low-tide sediments ($r = 0.954$), indicating a dynamic exchange of MPs between these compartments. However, the weak correlation ($r = 0.391$) between rainfall and MP concentrations in high-tide sediments suggests that other factors such as tidal dynamics and longshore currents significantly influence MP distribution in this zone. These findings underscore the critical need for effective management strategies to safeguard coastal ecosystems from microplastic pollution, considering the complex interplay between seasonal dynamics, polymer types, pollution levels, and associated risks.

Keywords: Plastic pollution, ecotoxicology, seasonal variation, microplastics



UNTARGETED METABOLOMICS-BASED RISK ASSESSMENT OF EXPOSURE TO ENVIRONMENTALLY RELEVANT CONCENTRATIONS OF ENDOCRINE DISRUPTOR COMPOUND EXPOSOME AS AGAINST EXPOSURE TO A SINGLE COMPOUND

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Endocrine-disrupting Chemicals (EDCs) are prevalent in marine environments, posing substantial risks to human health through chronic exposure via aquatic foods, potentially leading to metabolomic disorders. Existing risk assessments typically employ a chemical-by-chemical approach, evaluating toxicity individually for each compound at higher doses, without elucidating the cocktail effects of EDC exposome exposure. Untargeted metabolomics, a novel approach provides insights into the impacts of exposure to EDC mixtures at environmentally relevant concentrations (ERC) and identifies potential biomarkers of adverse health effects. This study assessed the risk of exposure to an EDC exposome at ERC through ingestion of contaminated organisms from Vembanad Lake (VL) using untargeted metabolomics. Our Previous findings reveal Metalaxyl (25 ng/g, 82%), 2-phenyl phenol (12 ng/g, 29%), and Polycyclic Aromatic Hydrocarbons (PAH, 15 ng/g, 27%) as major contaminants in aquatic samples (n=600) from the VL. *In-vivo* risk assessment involved exposing animals to these levels individually and as a mixture for 60 days, followed by untargeted metabolomics analysis with UHPLC-Q-Orbitrap MS. Amino acids, fatty acids, and lysophosphatidylcholines were identified as key biomarkers either up/down regulated. Pathway analysis highlighted changes in purine metabolism, the Citric Acid Cycle, and more. Exposure to the EDC mixture resulted in distinct alterations in Tyrosine and Thyroid hormone metabolism compared to individual Metalaxyl and 2-phenylphenol treatments, while alterations in Glycerolipid metabolism and Mitochondrial electron transport mechanisms were noted compared to the PAH treatment group. These findings emphasize the heightened need to consider mixture effects and long-term exposure dynamics in risk assessment strategies.

Keywords: Endocrine Disrupting Compounds, Untargeted metabolomics, Biomarkers, UHPLC-Q-Orbitrap MS, Vembanad Lake



DISTRIBUTION, SOURCES, AND ECOLOGICAL RISKS OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE CORAL REEF ECOSYSTEMS OF THE LAKSHADWEEP ARCHIPELAGO

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Coral reefs, one of the world's diverse ecosystems, are now vulnerable to local and global stresses. The presence and effect of local stressors like organic pollutants in coral reef ecosystems remain unknown, especially in areas like Lakshadweep. This study aims to fill the research gaps on the distribution, sources and ecological risks of polycyclic aromatic hydrocarbons (PAHs) in the multiple coral islands (Perumal Par, Bangaram, Kavaratti, and Agatti) of Lakshadweep Archipelago. Water and particulate matter were analyzed for 15 PAH priority pollutants and concentrations ranged from 2.77 to 250.47 ng/L in the water and 0.44 to 6469.86 ng/g in the particulate matter. In comparison with other coral reef ecosystems worldwide, the present study showed relatively lower PAH levels. Source apportionment studies and principal component analysis (PCA) indicated mixed sources of PAHs. Petrogenic, low-temperature combustion and pyrogenic are the main PAH contributors to reef waters. Ecological risk assessment showed that dissolved and particulate matter-bound PAHs can have moderate to severe effects on the aquatic organisms of Lakshadweep.

Keywords: Polycyclic aromatic hydrocarbons, Lakshadweep Archipelago, Coral reef, Source apportionment, Ecological risk.



A CASE STUDY ON THE SEASONAL DISTRIBUTION OF MICROPLASTICS IN THE WATER COLUMN OF TWO TROPICAL ESTUARIES IN SOUTHERN INDIA

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Studies on microplastic (MP) accumulation in estuaries can give insights into the transport pathways from fluvial systems to the marine environment. In this study, we present the preliminary results of the work done on two tropical estuaries belonging to rivers Netravathi and Gurupura in southwest Karnataka. Water column samples from 11 stations were collected during the wet (October 2022) and dry (March 2023) seasons. Microplastics were found in all the stations and at all depths. The average (\pm standard deviation) abundance of MPs was higher in the wet season (8.15 ± 3.81 particles/l) and lower in the dry season (1.14 ± 0.78 particles/l). No significant variation was observed in the abundance of MPs across the depth of water column for both seasons, however, they varied significantly across location. During the dry season, higher abundance was observed near the estuarine mouth compared to the upstream location; however, the distribution was reversed during the wet season. In terms of the shape of the plastics, fibre was the most dominant shape in both the wet season (92%) and the dry season (76%), respectively, followed by films and fragments. The 0.1–0.3 mm-sized MPs were dominant during the wet season (63%) and dry season (39%). Polyethylene terephthalate, polyethylene, polyurethane, high-density polyethylene were the most prominent polymers identified. Physicochemical parameters like salinity and turbidity had a strong positive correlation with MPs abundance for the dry season which has resulted in a higher suspension of microplastics in the water column due to the reduced water current and high salinity. Precipitation pattern, vented dam construction across the river system, and proximity to the Bajal Sewage Treatment Plant have contributed to the distribution pattern of microplastics in the estuary.

Keywords: Water column, Pollution hazard, Estuary, Anthropogenic, Hydrodynamic, southern India.



MULTIPLE STRESSORS HAVE THE POTENTIAL TO INFLUENCE SPECIES SURVIVAL: A FUNCTIONAL TRAIT PERSPECTIVE ON EPHIPPIA OF PLANKTONIC MICROCRUSTACEAN *DAPHNIA MAGNA*

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Ecotoxicological investigations often subject test organisms to optimal environmental conditions. However, these organisms rarely encounter such ideal circumstances in their natural habitats. Instead, they typically contend with sub-optimal conditions and periodic exposure to environmental stressors. The interaction between natural stressors and toxicants can result in synergistic effects, wherein the combined impact exceeds the sum of individual stressors. We investigated the responses of *Daphnia magna*, specifically focusing on the dormant egg stage, ephippia, to multiple stressors including cold snaps, dehydration, and selected contaminants of emerging concern (CECs). Our study aimed to understand the short-term implications of these stressors on species survival, emphasizing the importance of functional trait perspectives in ecological research and making them useful in determining the ecological consequences of environmental stressors. Through experimental testing, we assessed various physiological and reproductive parameters including hatching efficiency, maturation, fecundity, ephippia formation, and mortality rates under different environmental conditions. Surprisingly, we found that stressors had both positive and negative impacts on species survival. Sudden dehydration events led to a significant increase in hatching efficiency compared to ambient conditions, suggesting a potential adaptive response to sporadic stressors. Conversely, gradual decreases in temperature had detrimental effects on ephippia, resulting in failed hatching or significantly reduced hatching rates over the course of a one-month experiment. Furthermore, our results indicate that contaminants of emerging concern such as Bifenthrin (insecticide), 4-Octylphenol (pesticide), Atrazine (herbicide), Bisphenol A (raw material used for the manufacturing of plastic), and Sertraline (pharmaceutical) exhibited varying degrees of negative effects on species survival. Significantly, these effects were observed within the relatively short timeframe of our study, highlighting the potential for even greater impacts over the long term. Extrapolating our findings to a broader ecological context, it becomes evident that the cumulative effects of these stressors could lead to significant declines in biodiversity and ecosystem health. Therefore, understanding the functional traits and responses of organisms to multiple stressors is crucial for predicting and mitigating the long-term consequences of environmental changes. In conclusion, our study underscores the complex interplay between environmental stressors and species survival, emphasizing the need for integrated approaches to ecosystem management and conservation.

Keywords: *Daphnia magna*, Environmental stressors, Ephippia, Toxicity



MICROPLASTIC POLLUTION IN THE SEDIMENTS OF BEACHES IN DAPOLI CITY OF MAHARASHTRA, THE WESTERN PENINSULAR REGION OF INDIA

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In marine ecosystem, microplastics are a common occurrence and have raised global concerns due to the rising amount of plastic waste entering the marine environment from various sources. This research investigates the abundance and characteristics of microplastics at six beaches along the western coast of Dapoli City, addressing the global concern of these small plastic particles (<5 mm) entering the marine environment due to increasing plastic waste. The sediment samples revealed an average of $1,234.5 \pm 88.46$ items kg^{-1} dw. Among the beaches surveyed, Murud Beach had the highest abundance with 153 ± 8.47 items kg^{-1} dw, while the lowest abundance of 91.1 ± 5.31 items kg^{-1} dw was observed in Kelshi Beach. The observed sizes of the microplastics were within the range of 200-400 μm , 400-700 μm , 700-900 μm , 900-1000 μm and 1000-3000 μm . The majority of the samples exhibited spectra resembling High-Density Polyethylene (HDPE), Polypropylene (PP), Polystyrene, and Polyvinyl Chloride (PVC). The pollution load index (PLI) risk assessment showed that all sampling sites were at Hazard Level I. This baseline study urges awareness for reducing plastic waste and protecting coastal environments from microplastic pollution. Further research is needed to identify specific sources and understand the toxic effects on marine life, contributing to our knowledge of environmental threats posed by microplastics.

Keywords: Microplastics, Sediments, Risks, Nile Red, Raman spectroscopy



STUDIES ON MICROPLASTIC COMPOSITION AND ITS ABUNDANCE IN THE MANGROVE ECOSYSTEM OF KUMBALANGI, KOCHI

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Mangrove ecosystems, vital for biodiversity and ecological services, face increasing threats from microplastic (MP) pollution. This study examined the presence of microplastics in water, sediment and gastrointestinal tract (GI) of finfishes, Pearl sport (*Etroplus suratensis*) and Tilapia (*Oreochromis niloticus*) from the mangrove ecosystem of Kumbalangi, Kochi, Kerala, and focused on the identification and composition of MPs from the study area during winter monsoon period. MPs isolated by density separation, and analysed using stereomicroscope and confirmation were made with FTIR spectroscopy. MPs were detected in the GI tract of fish samples, with fibers being abundant and widespread in all fish samples. Sediment samples exhibited significantly higher MP concentration compared to water and fish gut. The composition of microplastics obtained consisting of fragments (52%) and fibers (47%) as major particles. Fragments were the most common morphotype followed by fibers and sheets in sediments samples. The dominant microplastics in sediments were polyethylene and polypropylene fragments, while water and fish contained primarily polyamide and polystyrene fibers. Furthermore, a positive correlation between fish size/age and microplastic content suggest feeding habit influences. These findings showed the omnipresence of microplastics in Kumbalangi mangrove ecosystem highlighting their vulnerability to rising MP pollution levels and the possibility of human intake of microplastics by the consumption of fishes. This showed the need for urgent intervention of the protection of mangrove ecosystems from the urban pollution and the need for further research on ecological impacts and human health.

Keywords: Microplastic, FTIR spectroscopy, *Etroplus suratensis*, *Oreochromis niloticus*, mangrove ecosystem, Kumbalangi.



A COMPARISON OF DISSOLVED OXYGEN SIMULATIONS USING REGIONAL PHYSICAL-BIOGEOCHEMICAL MODELS AND COPERNICUS MARINE SERVICE DATA PRODUCTS

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In the present study, we used the skills of three regional coupled physical-biogeochemical models: a one-dimensional model, General Ocean Turbulence Model - European Regional Seas Ecosystem Model (GOTM-ERSEM), another one-dimensional model, General Ocean Turbulence Model - ECOSystem Model (GOTM-ECOSMO), and a three-dimensional model, HYbrid Coordinate Ocean Model-ECOSystem Model (HYCOM-ECOSMO) to study the dissolved oxygen variability in the Arabian Sea. The model simulations were compared with Copernicus Marine Service quality-checked dissolved oxygen data products, including Argo profiling floats and other model products. The variability of the oxygen minimum zone ($OMZ < 20 \mu\text{mol L}^{-1}$) simulated by the models were in comparable range with that of Copernicus data. We evaluated the error metrics between our models and Copernicus products and found them to be minimal. The GOTM-ERSEM, GOTM-ECOSMO and HYCOM-ECOSMO models proved to be well performing models to study the interannual variability of the dissolved oxygen in the Arabian Sea. This signifies that the Copernicus data are found to be highly reliable and can be used for validation of these models in the Northern Indian Ocean waters with as little bias as possible. Moreover, our model's insights into deoxygenation might have the potential to elucidate the fishery dynamics, underscoring the ecological and socioeconomic consequences of oxygen depletion in marine ecosystems. In conclusion, our study confirms the reliability of Copernicus marine data products for evaluating the models in the Northern Indian Ocean while highlighting the potential of our models to elucidate the ecological and socioeconomic implications of oxygen depletion on marine ecosystems, particularly concerning fishery dynamics.

Keywords: Ocean Modelling, Oxygen minimum zone, Northern Indian Ocean, Argo profiling floats



A STUDY ON THE RESISTIVITY SHOWN BY THE BACTERIA ISOLATED FROM THE SEDIMENT SAMPLES COLLECTED FROM COCHIN ESTUARY AGAINST DIFFERENT CLASSES OF ANTIBIOTICS

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The sediments samples were collected from cochin estuary and were tested for the presence of antibiotic resistant bacteria. A total of 27 heterotrophic bacteria which showed antibiotic resistance were isolated from the sediment samples. Ampicillin (100 μ g/ml), Gentamycin (10 μ g/ml), Tetracycline (10 μ g/ml) and Chloramphenicol (25 μ g/ml) were the antibiotics used for screening. Bacteria which showed resistance against tested antibiotics were assessed to detect the range of resistance against these antibiotics in five different concentrations Ampicillin (200, 400, 600, 800, 1000 μ g/ml), Gentamycin (20, 40, 60, 80, 1000 μ g/ml) Tetracycline (20, 40, 60, 80, 1000 μ g/ml) and Chloramphenicol (50, 100, 150, 200, 250 μ g/ml) Bacterial isolates showed maximum resistance towards Ampicillin (49%) Followed by Gentamicin (24%), Chloramphenicol (18%) and Tetracycline (9%) and the percentage resistance of isolates were in the order Ampicillin-Gentamicin-Chloramphenicol> Tetracycline Multiple Antibiotic Resistant (MAR) index was calculated based on the ratio between the number of antibiotics tested to the number of resistant antibiotics. A total of 4 resistant patterns were detected from the heterotrophic bacteria from sediment samples. The most frequently observed MAR Index was 0.25. The study showed the existence of multiple antibiotic resistance among these bacteria. Among 20 isolates tested 10 isolates had been shown multiple antibiotic resistance. Based on the MAR index 5 representative isolates were selected (SBI, SB 21, Sb14, Sb18 and S819) and sent for sequencing Sequence alignment of the obtained sequence using the BLAST algorithm of NCBI revealed the identity of the three isolates as *Vibrio* sp, and one as *Bacillus* sp. Sequencing failed for one isolated. Trimmed and edited sequence obtained from isolate SB I showed 99.65% similarity with *Bacillus thuringensis* strain DMS.B02 165 ribosomal RNA gene, partial sequence, *Bacillus* sp. (in: firmicutes) strain D1-27 TSBA 165 ribosomal RNA gene, partial sequence and *Bacillus bombysepticus* strain Wang 165 ribosomal RNA gene, partial sequence. For all three sequences query coverage is 100% and E value is 0.0. Both isolates SB 14 and 58 18 showed 99.49% similarity to *V parahaemolyticus* strain DSILV14 16S ribosomal RNA gene, the partial sequence with 100% query coverage and an E value of 0.0. The isolate SB 14 showed 99.86% similarity to *Vibrio parahaemolyticus* strain DSILV14 165 ribosomal RNA gene, partial sequence and *Vibrio neocaledonicus* strain M-08 105 ribosomal RNA gene, partial sequence. The isolate SB 18 showed 99.69 % similarity to *Vibrio* sp. strain AGT109 165 ribosomal RNA gene, partial sequence and *Vibrio parahaemolyticus* strain DSILV14 165 ribosomal RNA gene, partial sequence with 100% query coverage and an E value of 0.0. The isolate 5819 showed 100% similarity with *Vibrio parahaemolyticus* strain GRSPKGRMB-L1 165 ribosomal RNA gene, partial sequence, *Vibrio* sp. strain 06N15 165 ribosomal RNA gene, partial sequence and *Vibrio alginolyticus* strain V208 chromosome 1, complete sequence, with query coverage of 100% and an E value of 0.0

Keywords: Sediment Bacteria, Antibiotic resistance, Environmental microbiology,



SEASONAL VARIATION IN ANTIBIOTIC RESISTANCE PATTERNS OF BACTERIAL ISOLATES FROM THE CENTRAL REGION OF COCHIN ESTUARY

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Microbial resistance to conventional antibiotics has emerged as a rapidly evolving global public health concern in recent years. The Cochin estuary, a part of the Vembanad Kole wetland ecosystem, is a highly dynamic ecosystem significantly influenced by anthropogenic activities, receiving substantial amounts of pollutants from various sources. Consequently, it serves as a potential reservoir of antibiotic resistance genes (ARGs). Seasonal sampling was conducted over a year to assess the antibiotic sensitivity profile of resident sediment bacterial isolates from the selected site, the oil tanker jetty in Kochi (9.9648° N and 76.2825° E). Twenty isolates were randomly selected from nutrient agar plates for each season and subjected to antibiotic sensitivity assays against 15 selected antibiotics using the disc diffusion method. The antibiotics included Meropenem, Ceftriaxone, Ampicillin, Oxytetracycline, Erythromycin, Nalidixic Acid, Norfloxacin, Enrofloxacin, Imipenem, Gentamicin, Nitrofurantoin, Cefixime, Furazolidone, Tetracycline, and Trimethoprim. Out of sixty isolates tested, twenty-five exhibited multidrug resistance, with a MAR Index (Multiple Antibiotic Resistance Index) ranging from 0.23 to 0.78. The highest number of multidrug-resistant strains was observed during the post-monsoon season (16), followed by the monsoon season (8). Antibiotic resistance was negligible in the pre-monsoon isolates (1). Tested isolates displayed higher resistance towards Furazolidone (14 isolates), followed by Imipenem (13), Oxytetracycline (13), Tetracycline (11), and Cefixime (10). Further characterization of each isolate regarding genetic makeup for antibiotic resistance and minimum inhibitory concentration for each antibiotic is imperative due to the alarmingly high incidence of resistance.

Keywords: AMR, MAR Index, Antibiotic resistance, ARGs, Cochin estuary.



ANTIBIOTIC RESISTANCE PROFILING OF CENTRAL COCHIN ESTUARY: A CULTURE DEPENDENT APPROACH

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Antimicrobial Resistance (AMR) is increasing globally at an alarming pace with the abuse of medications for human health and advancements in veterinary, agriculture and allied sectors. Tropical estuaries receive a wide range of pollutants, including antibiotics, and this makes them potential hotspots for the evolution of Antibiotic-Resistance Genes(ARGS). The goal of the current study was to identify Multi-Drug Resistant bacteria in the bottom sediments of a domestic sewage discharge point near Marine Drive, Kochi (Latitude: 9.9658° N Longitude: 76.2433° E). Samples were collected for a year seasonally and cultured on nutrient agar plates of specific salinity. Twenty representative colonies were selected from each seasonal sampling and subjected to antibiotic sensitivity against 15 selected antibiotics using the Disc Diffusion method. Meropenem, Ceftriaxone, Ampicillin, Oxytetracycline, Erythromycin, Nalidixic Acid, Norfloxacin, Enrofloxacin, Imipenem, Gentamicin, Nitrofurantoin, Cefixime, Furazolidone, Tetracycline, Trimethoprim were the antibiotics used. Eleven of the sixty isolates tested exhibited multidrug resistance, with a MAR Index (Multiple Antibiotic Resistance Index) ranging from 0.26 to 0.78. The highest number of multidrug-resistant strains was seen during the monsoon season (5), followed by the post-monsoon (4) and pre-monsoon (2) seasons. The current study's findings reveal that the isolates from the monsoon season were resistant to nearly every antibiotic tested, with increased resistance to Cefixime, Furazolidone, Nalidixic acid, and Oxytetracycline. The same antibiotics, including Trimethoprim, were also ineffective against isolates from the post-monsoon season. Along with Tetracycline resistance, the pre-monsoon isolates had greater levels of resistance to Furazolidone and Oxytetracycline. Almost all organisms were susceptible to Gentamicin, Nitrofurantoin, Meropenem, Imipenem and Ampicillin. The current study reports baseline data on antibiotic resistance patterns of culturable microbes. It is necessary to characterize the MDR isolates further to ascertain their taxonomic position and genetic predisposition of resistance.

Keywords: AMR, MAR Index, Antibiotic resistance, ARGS, Disc Diffusion, MDR strains



ASSESSMENT OF HUMAN HEALTH RISK DUE TO MERCURY BIOACCUMULATION IN FINFISH OF COCHIN ESTUARINE SYSTEM, INDIA

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Because of its biological toxicity, mercury (Hg) is globally regarded as one of the most hazardous heavy metals. Both human activity and natural climatic processes show a notable increase in mercury pollution in aquatic ecosystems including estuaries. There is a significant possibility of bioaccumulating the metal in fish and other marine organisms. Seafood is a vital source of protein for humans and the use of fish meat has increased dramatically as people become more conscious of its health and nutritional advantages. This study investigates the bioaccumulation of mercury in the selected fishes of the Cochin estuarine and the possible human health risks associated with it. The fish species used for the study were *Johnius coitor*, *Etroplus suratensis*, *Scatophagus argus*, *Arius subrostratus*, *Mugil cephalus*, *Sillago sihama*, *Caranx ignobilis* based on their abundance and distribution across the estuary. Hg concentration in the fishes ranged from 0.05 (*Mugil cephalus*) to 1.18 mg kg⁻¹ (*Arius subrostratus*) with a mean concentration of 0.36 ± 0.33 mg kg⁻¹. Estimated daily intake (EDI) values were below the oral reference dose (Rfd) provided by the World Health Organization and the United Nations United States Environmental Protection Agency (USEPA). Also, the Total hazard quotient (THQ) values of fish samples were below 1, which indicates no health risk to humans due to mercury.

Keywords: Mercury contamination, Human health risk, Bioaccumulation



TOXICITY EFFECTS OF MANGANESE (Mn) ON BIOMARKER RESPONSES IN POST-LARVAE OF *PENAEUS MONODON* (FABRICIUS, 1798)

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The present investigation focused on the acute and chronic toxicity of manganese (Mn) by examining the effects of biomarker enzymes in the post-larvae of *Penaeus monodon* (Giant Tiger prawn). The study measured the levels of several antioxidant enzymes like catalase (CAT), superoxide dismutase (SOD), esterase (EST), glutathione S-transferase (GST), glutathione peroxidase (GPx), and glutathione reductase (GR) in *Penaeus monodon* exposed to sublethal concentrations of manganese (Mn). It was determined that the 96-hour LC₅₀ value was 6.89 mg L⁻¹, with 95% confidence intervals of 5.28-9.35. The results of the chronic toxicity test showed a No Observed Effect Concentration (NOEC) of 0.37 mg L⁻¹, a Lowest Observed Effect Concentration (LOEC) of 1.86 mg L⁻¹, and a chronic value of 1.12 mg L⁻¹. Four isozymes of esterase were expressed at Rf 0.04, 0.09, 0.43, and 0.60 on chronic exposure to Mn. At Rf 0.04 and 0.09 activity was decreased with the increased exposure concentration. SOD showed the highest activity at the lowest exposure concentration (0.25 mg L⁻¹). The lowest activity was observed at 2.79 mg L⁻¹. Lipid peroxidation, catalase, and GPx activity of the whole body tissues were also increased with increasing concentration of metal. Glutathione S Transferase and glutathione reductase showed a gradual increase in activity with increasing Mn exposure concentration. Acetylcholine esterase activity increased along with the exposure concentrations of Mn in *P. monodon*. This study demonstrated that exposure to Mn had an impact on antioxidant enzyme activity, and these enzymes have a significant potential to serve as markers of metal contamination. Also, these can be used as warning systems for pollution monitoring studies and in the prediction of sublethal metal toxicity.

Keywords: *Penaeus monodon*, Manganese, Biomarker, Antioxidant enzymes, Bioassay



TOXICOLOGICAL EFFECTS OF CADMIUM ON THE GREEN MUSSEL *PERNA VIRIDIS* (LINNAEUS, 1758): INSIGHTS FOR DRAFTING SEAWATER QUALITY CRITERIA

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This study assessed the toxicity of cadmium (Cd) on *Perna viridis* (green mussel), examining its effects on various physiological and biochemical parameters. The 96-hour LC₅₀ for Cd in *P. viridis* was 3.03 ± 0.12 mg L⁻¹, with a confidence range of 2.35 to 3.9. Chronic toxicity tests revealed No Observable Effect Concentration (NOEC) and Lowest Observable Effect Concentration (LOEC) at 0.20 and 0.37 mg L⁻¹ respectively, with a chronic toxicity value of 0.29 mg L⁻¹. Cd accumulation in mussels increased significantly compared to the control group. Enzyme activities such as superoxide dismutase, catalase and glutathione peroxidase increased significantly with Cd exposure. Acetylcholine esterase activity and lysosomal membrane stability decreased in exposed groups. Glutathione reductase, lipid peroxidation, and metallothionein-like protein levels increased in exposed mussels. Clearance rate, respiration rate, and excretion rate decreased dose-dependently. Protein, carbohydrate, and lipid levels decreased with exposure concentration. Mitochondrial electron transport system activity increased, while cellular energy allocation (CEA) and scope for growth (SFG) decreased dose-dependently. This comprehensive toxicological investigation provides valuable data for establishing water quality criteria for Cd contamination.

Keywords: Acute toxicity, Chronic toxicity, Biomarkers



SEASONAL ASSESSMENT OF MICROPLASTIC POLLUTION IN WATER AND SEDIMENT OF COASTAL BEACHES ALONG NORTH KERALA

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Microplastics are plastic pieces with a size of less than 5mm. Coastal beaches act as both source and sink for microplastics, accumulating debris from both land and sea. In the present study assessment of microplastics was conducted in water and sediment of three coastal beaches along North Kerala such as Thalayi, Neerkadavu and Thikkodi during Pre and Post monsoon period. The study revealed significant seasonal variations in the abundance of microplastics in water and sediment. Microplastics showed highest abundance during monsoon season compared to pre-monsoon in both water and sediment. During monsoon season Thalayi beach showed higher microplastics abundance (4.3 particles/L) in water and Neerkadavu beach (690particles/L) showed higher abundance in sediment. During pre-monsoon, higher abundance of microplastics in water was seen at Thikkodi (0.88particles/L) and in sediment at Thalayi (1220particles/ L). Fibres were the dominant morphotype observed, followed by fragments, films and flakes in both in water and sediment during both the seasons. There was a significant increase in the abundance of fibres during monsoon compared to pre-monsoon. The colours of microplastics in the samples included red, black, blue, green and white/transparent. Black fibres were dominant during pre-monsoon in water (48%) and sediment (75%). But red fibres dominated during monsoon period in both water (48%) and sediment (47%). Over all the microplastics pollution in the three beaches were very high which reminds the necessity of proper disposal and management practices.

Keywords: Pollution, Microplastics, Kerala Coast, Beach



HEAVY METAL DISTRIBUTION IN THE SUSPENDED PARTICULATE MATTER ALONG COASTAL WATERS OF CALICUT, SOUTH EASTERN ARABIAN SEA

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Heavy metal discharge from diverse anthropogenic sources are major concern in coastal waters. The accumulation of metals in water and suspended sediments affects various organisms in the environment, influencing their functions in several different ways. Heavy metal distribution in the suspended matter was carried out in the coastal waters of Calicut, South Eastern Arabian Sea to delineate the possible sources. 5 metals were selected for the study, viz Lead, Copper, Manganese, Nickel, and Cadmium. Total suspended matter concentration ranged from 0.172 mg L⁻¹ to 0.885 mg L⁻¹. and are directly linked to the concentration of heavy metals. Potential ecological risk index (RI) analysis was also carried out. The study showed anthropogenic influence of heavy metals distribution in these waters, mainly from nearby sewage effluents. The study will provide insights into the influence of physicochemical factors controlling heavy metal concentration.

Keywords: Heavy metal, Pollution, Risk index, Suspended matter, Arabian Sea



MICROPLASTICS ASSOCIATED BIOFILM ALONG THE MANGROVE STRETCHES OF VEMBANAD LAKE

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MPs provide a surface for colonization and a source of sustenance, and thereby helped bacteria to occupy a new ecological niche. The term "plastisphere" refers to bacterial colonies found in biofilms on microplastics. Interactions between plastic and plastic biofilm may alter the chemical and physical properties of the polymer, potentially leading to its degradation. Both micro- and macro-organisms colonize plastic debris in classical ecological succession and form biofilms composed of microorganisms, to complex biofouling communities consisting of aquatic plants and macro fauna also. The microorganisms of the Plastisphere are also phenotypically diverse, represent a broad range of preferred environmental conditions including aerobes, anaerobes, motile and non-motile organisms, as well as extremophiles. As an alternative, microbes might cling passively to microplastics and use them mainly for surface colonization. Microorganisms, microplastics and their breakdown, and metabolic products are transported, transmitted through food webs for bioavailability, and made accessible for biotic or abiotic reactions within aquatic biogeochemical cycles through active or passive interactions. For the study purpose, water samples were taken from the mangroves that border the KUFOS campus in various places. Collected samples were filtered using nylon mesh, and the microplastics associated biofilm were picked and transferred to the prepared culture media and given a day to colonize. The resulting colonies were further cultured in a non-selective medium, and kept for 24hrs of incubation. Further biochemical tests were conducted to identify the bacterial type. The role of identified bacterial species and its impact on aquatic ecosystem and other organisms were further analysed for exposure assessment and risk characterization as well as suggestions of adequate regulatory measures for plastic litter.

Keywords: *Plastisphere, Microplastics, Micro-organisms, Biofouling communities, Bioavailability*



MICROPLASTICS CHARACTERISATION FROM THE WATER COLUMN AND SEDIMENTS OF SOUTH EASTERN ARABIAN SEA

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Plastic production is increasing day by day along with the increase in plastic pollution, especially in the marine environment. Microplastics (MPs) are recognised as a ubiquitous and serious threat to the biota in coastal, estuarine and marine environment. A report on the abundance of microplastics in the coastal waters in the depth zone of 10 to 40 m in the water column and sediment samples from off Kochi, India is presented. Water samples were collected from the surfaces of four stations (10m, 20m, 30m and 40m) and column of two stations (20m and 40m). Sediment samples were collected from all four stations. Samples collected from four stations were categorised based on colour, shape, size and polymer types using Stereoscope microscope and FTIR spectroscopy, respectively. Based on the FTIR result carbonyl index is calculated to find the extend of microplastics degradation in this area. The major types of microplastics found were fibres of blue colour in water and sediment samples, respectively. The concentration of MPs contamination in surface water, water column and sediment is 13.2 items/m³, 8 items/m³ and 486.5 items/kg dry weight, respectively. This quantitative study will help in further research on the distribution of microplastics particles in the system and the adsorption of organic pollutants and their leaching effects on fauna.

Keywords: Plastic pollution, Microplastics, Water column, Sediments, Arabian Sea



IDENTIFICATION AND CHARACTERIZATION OF MICROPLASTICS FROM KOLE WETLANDS, KERALA

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Microplastics have been identified as emerging environmental pollutants, and is of increasing concern due to the ecotoxicological risks they pose to aquatic and soil organisms as well as humans. When the plastic particles of size less than 5 mm in diameter are formed, they are defined as "Microplastics (MPs)" by the National Oceanic and Atmospheric Administration (NOAA). Microplastic ingestion by a range of species can result in bioaccumulation and biomagnification through the food chain. Recent studies have highlighted that freshwater sources are becoming an important route that transports microplastics to nearby oceans. In this context, to examine the occurrence of microplastic particles in the Kole wetlands, water and sediment samples were collected from five sites and processed for microplastic extraction through density separation (NOAA). Kole wetlands, spread over Thrissur and Malappuram districts in Kerala state and comes under the Ramsar sites of Kerala since 2002. Microplastics were recovered from all sediment and water samples, indicating their extensive distribution. Identification of the polymer components of microplastics was done using FTIR. The optical analysis of collected MPs was done through a digital microscope. Microplastic pollution has been observed with an abundance of 98 particles per m³ and 796 particles per Kg in the water and sediment samples respectively. These detected microplastics were characterized by different colors (white, black, brown, green, red, and blue) and shapes (fragment, fiber, and film). Blue was the dominant colour of MP found in the water and sediment samples. The majority of detected microplastics were fibres. This study, being the first report on microplastics in Kole wetlands, provide impetus for further research on the distribution and impact of this emerging pollutant on the biota of many aquatic organisms.

Keywords : Microplastic, Kole wetlands , Bio availabilitiy , FTIR



ABUNDANCE, DISTRIBUTION AND CHARACTERIZATION OF MICROPLASTICS IN COASTAL SURFACE WATERS OF GOA, INDIA

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Microplastic distribution in marine environment is increasing at an alarming rate. As over 250 million people live along the coast of India who are connected to the coast, immediate attention is required to address and understand coastal pollution. In the present study, the abundance, polymer type and the surface morphology of the microplastics along the coastal waters of North Goa and South Goa beaches were analyzed with a spatial coverage of over 40 km of coastline between the months of August and September 2023. The size range of micoplastics from beach surface waters was studied for 5 to 1 mm and 1 to 0.3mm size ranges. In North Goa, the following five beaches were studied viz., Vagator, Anjuna, Baga, Calangute and Candolim. Surface waters from 25 stations were collected for the study. The concentration of MPs ranged from 0.07 particles/L to 1.12 particles/L with an average of 0.31particles/L. Microplastics were classified based on the shapes and the abundance is as follows, fibers (82 %), foams (9%), films (5%), fragments (4%) and pellets (0.39%). The most commonly occurring color for the fibres was transparent (53%) followed by white (25%), yellow (13%), red (2%), black (2%) and green (1%). The polymers that were identified using FTIR were fragment-polyolefin, fibres – HDPE, Foam-Polystyrene. For South Goa study five beaches namely Velsao, Canca, Utoorda, Bogmalo and Colva were studied. Surface waters from 21 stations were sampled along beaches. The MP values range from 0.170 particles/L to 2.51 particles/L. With an average of 1.20 particles/L. Fibres were the most dominant (94 %), foams (1%), films (1%), fragments (0.4%). White was the most dominant colour (31%) observed for the MPs followed by blue (4%), red (2%), pink (2%), black (1%) and green (1%). The dominant polymers type identified was HDPE. Goa being a coastal state with over 160 km of coastline and coastal tourism being the main source of tourism attraction, makes it vulnerable to plastic pollution from tourism activity. Also the fishing activity along the coasts contribute to the microplastic pollution. Colva was the most polluted beach identified by this study. The pollution indices will further suggest the contamination level along these areas.

Keywords: Microplastic, pollution, Coastal, Goa, India



MICROPLASTIC POLLUTION IN THE SURFACE WATERS OF A TROPICAL MICROTIDAL ESTUARY ON THE SOUTH-WEST COAST OF KERALA, INDIA ACROSS A GRADIENT OF HUMAN IMPACT

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Microplastics (MPs) have been recognized as an emerging contaminant worldwide having adverse impacts owing to the persistence and possible risks to aquatic ecosystems and human well-being. Tropical estuaries, one of the highly productive coastal wetland ecosystems performing immense ecosystem services are under severe threat of microplastic pollution as millions of tons of riverine plastic wastes enter the ocean via estuaries annually affecting the aquatic life. However, knowledge on microplastics contamination from estuaries of tropical coastal region is limited. The present study aimed to characterize the abundance and spatial distribution of microplastics in the surface waters of Kodungallur - Azhikode Estuary forming part of Vembanad-Kol wetland system-a Ramsar site of international significance along the south-west coast of India. The water samples taken from six (with triplicates from each site) sampling sites showed various shapes, colors, sizes, abundance and strong spatial heterogeneity. Among the five types of microplastics identified, fibers and fragments dominated in the water samples. The Raman spectroscopy revealed a polymer composition of polypropylene and polyethylene in the water samples. The abundance of microplastics showed a substantial variation among the sampling sites, ranging from 11 to 71 items per litres of surface waters (in a size range of 10.30 to 4864.56 µm). Understanding the extent of microplastic pollution in the surface waters of Kodungallur - Azhikode Estuary is essential to propose effective management strategies to manage microplastic pollution in the estuary and other similar habitats.

Keywords: *Estuary, Microplastics, Surface water, Characterization*



DISTRIBUTION AND CHARACTERIZATION OF MICROPLASTICS IN THE SEDIMENTS OF A HIGHLY DISTURBED TROPICAL ESTUARY ON THE SOUTH-WEST COAST OF KERALA, INDIA

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Tropical estuaries are unique and one among the highly productive coastal wetland ecosystems on the globe with immense ecological functions. Microplastic pollution have been identified as an emerging threat to tropical estuaries. The abundance and spatial distribution of microplastics in the estuarine sediments however are still poorly understood. The present study aimed to illustrate the characteristics, abundance and spatial distribution of microplastics in the sediments of Kodungallur - Azhikode Estuary forming part of Vembanad-Kol wetland system-a Ramsar site of international significance along the south-west coast of India. The sediment samples taken from six (with triplicates from each site) sampling sites showed various shapes, colors, sizes, abundance and strong spatial heterogeneity. Four different shapes of microplastics with a variety of colors were detected in the estuarine sediments, among which fragments and fibers were the dominant types. The polymer composition of the microplastics identified based on the Raman spectroscopy covered polypropylene and polyethylene. The abundance of microplastics showed a substantial variation among the sampling sites, ranging from 85 to 584 items per kg of dry sediment (in a size range of 10.162 to 4938.76 μm). A difference in spatial distribution of microplastics was observed with highest occurrence in the lower estuary. Understanding the extent of microplastic pollution in the Kodungallur - Azhikode Estuary is crucial for implementing effective management strategies to mitigate its impacts on aquatic ecosystems and human health.

Keywords: Microplastics, Estuarine sediments, Distribution, Risk



IMPACTS OF BIOACCUMULATION AND EXCRETION OF MICROPLASTICS IN CORAL HEALTH

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Corals have been challenged with disastrous events of climatic and anthropogenic etiologies. Microplastics are one among the anthropogenic substances that carry several toxicants that end up entering into marine life leading to bio-accumulation as well as biomagnification. Though there are various reports on the presence of microplastics in coral ecosystems, only very few studies were discussed about the accumulation and excretion of microplastics in corals. However, the impacts of microplastics on symbiotic association and disease severity were not well described. As corals are sensitive to minute changes in the environment there is a need to study their response on the adverse effects of microplastics. Hence, the present study aims to understand the type and quantity of microplastics accumulation, and excretion from the corals, together with their impacts on health of the coral.

Keywords : Microplastics, Corals, Bioaccumulation, Biomagnification



Concentration of various metals in the sediment and water of Thondi coast, Palk Bay, India

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The present study was carried out to analyse the concentration of various metals such as cadmium (Cd), copper (Cu), zinc (Zn), and lead (Pb) from water and sediment samples using atomic absorption spectroscopy (AAS). It was found that, in water sample the metal such as Cd and Cu was absent in all the sites but the concentration of Pb was high 1.4416 ± 0.00 ppm in station 4. In case of sediment samples, Pb concentration was found in higher 11.6239 ± 0.00 ppm at station 1 whereas Cd, Cu and Zn were low. Zn concentration was high 4.5531 ± 0.00 ppm in station 4. The metals level in Thondi coast are found within the maximum permissible limit as suggested by National and International agencies. Continuous monitoring of bioaccumulation of metals in sea foods is necessary for the consumer safety since seafood is considered as pure means of protein diet.

Keywords : Metals, Water, Sediment, Thondi coast.



ACEPHATE PESTICIDE'S SUBLETHAL EFFECTS ON *CYPRINUS CARPIO* (LINNAEUS, 1758) AND OTHER MODIFICATIONS

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Acephate (O, S-dimethyl acetyl phosphoramidothioate), a common organophosphorus insecticide, is used extensively in the agriculture sector worldwide. With its toxicity ascribed to bioactivation on metabolic conversion to methamidophos (or an oxidized metabolite thereof), which functions as an acetylcholinesterase (AChE) inhibitor, acephate is a significant systemic organophosphorus insecticide. Serious concerns regarding the environment and human and animal health have been highlighted by their indiscriminate and unrestrained application. The morphological and physiological alterations brought about by acephate exposure were used to investigate both the acute and long-term toxicity of the substance. For tested fingerlings of *Cyprinus carpio*, the 96-hour LC₅₀ value of acephate exposure was found to be 850.41 ppm. For 28 days, the experimental fish were exposed to two different concentrations, such as 1/5th of the LC₅₀, or 170.082 ppm, and 1/10th of the LC₅₀, or 85.041 ppm, to conduct a sub-lethal study. Changes were noted in the oxygen consumption rate, oxygen:nitrogen ratio, accumulation, and other physiological parameters in *C. carpio* fingerlings. After the experimental period, the fish exposed to sublethal doses of acephate showed significant alterations indicative of accumulation, and vice versa after depuration. After the experimental period, the fish exposed to sublethal quantities of acephate showed significant alterations indicative of accumulation, and vice versa after depuration. After exposure to 1/10th and 1/5th concentrations of acephate, hepatocytes were shown to have degenerative anomalies in the central vein, extensive vacuoles, evident necrotic alterations and piknotic nuclei (PC) of cells. In accordance with the research, *C. carpio* exhibits notable physiological and histological alterations at steady sublethal acephate concentrations in ecosystems, making it more susceptible to organ failure. Our findings indicate that more research is required to evaluate the possibility of reducing the harmful effects of acephate exposure in fish in a sustainable manner and to suggest a tolerable residue concentration of acephate in aquatic environments.

Keywords: Acephate, Bioaccumulation, *Cyprinus carpio*, Depuration, Lethal toxicity, Physiology and Histology.



ASSESSING THE IMPACT OF MICROPLASTIC POLLUTION ON THE COASTAL ECOSYSTEMS OF KERALA

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Kerala has one of the most densely populated and biodiverse shorelines and coastal waters. The threat of microplastics, plastic particles smaller than 5mm poses a significant threat to the already fragile ecosystem. The present article is a comprehensive review of on the sources, types, distributions, accumulation patterns of microplastics in habitats, and potential ecological impacts of microplastics on the marine ecosystems of Kerala and have identified critical knowledge gaps that require urgent attention. A number of land-based sources, such as urban effluents, seasonal monsoons, floods and maritime activities, contribute to a significant microplastic load, which is subject to seasonal fluctuations and circulation variability. Although preliminary studies have shown that microplastics are present ubiquitously in intertidal and shallow water sediments. The extent of contamination across habitats and taxa remains uncertain, especially in terms of trophic transfer and bioaccumulation. The presence of microplastics in many locally harvested fishes, invertebrates, bivalves, shrimps and shellfish species has also been confirmed in field sampling and laboratory tests. Possible mitigation methods include targeted biomonitoring, address deficiencies in waste management. It is also proposed have community engagements at grassroot levels and possible material innovation. The threat posed by microplastics to the coastal biodiversity of Kerala is overlooked and magnified unplanned urban expansion and inadequate waste management practices. Necessitating urgent evidence based conservation initiatives that includes a collaborative effort among scientists, policy makers and the public to address the issue effectively.

Keywords: Microplastic, Biomonitoring, Kerala



EVALUATING THE POTENTIAL OF AQUATIC MACROPHYTES (*PISTIA STRATIOTES L* AND *EICHHORNIA CRASSIPES*) FOR PHYTOREMEDIATION OF METAL POLLUTION (CADMIUM AND LEAD)

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The pollution of surface and subsurface water is a severe unhealthy because of increased urbanisation and rapid population rise. Phytoremediation is the process of reducing pollutant concentrations in polluted soils, water, or air by using plants that can hold, eliminate metals, pesticides, solvents, explosives, crude oil and its derivatives, and other contaminants from the media in which they are present. A trial of 28 days was conducted on aquatic macrophytes such as *Pistia stratiotes* L and *Eichhornia crassipes* that offer significant potential for heavy metal clean up, such as Cadmium (Cd) and Lead (Pb). The experimental setup was done with 2, 4, 10 and 15 mg L⁻¹ CdCl₂ and Pb (NO₃)₂, which were separately harvested at 0, 7, 14, 21 and 28 days and the Cd and Pb concentration in the roots and shoot tissues were estimated by atomic absorption spectroscopy (AAS). The Cd metal accumulation in *E. crassipes* and *P. stratiotes* treated in 15 mg L⁻¹ metal solution observed to be highest in roots and shoots at 21st day and 28th day as 52.02 mg kg⁻¹ and 34.61 mg kg⁻¹; 53.82 mg kg⁻¹ and 46.83 mg kg⁻¹ respectively. The Pb metal accumulation in *E. crassipes* and *P. stratiotes* treated in 15 mg L⁻¹ metal solution observed to be highest in roots and shoots at 21st day and 28th day as 26.18 mg kg⁻¹ and 34.61 mg kg⁻¹; 73.02 mg kg⁻¹ and 51.44 mg kg⁻¹ respectively. The bioaccumulation factor of *E. crassipes*, *A. pinnata*, *P. stratiotes*, and *L. minor* of Cd and Pb metal were 78.95, 84.09, 178.53, 45.79 and 89.91, 77.36, 365.10, 242.67 respectively. The translocation factor of *E. crassipes* and *P. stratiotes* of Cd and Pb metal were 1.15 and 1.15; 1.04 and 0.94 respectively.

Keywords: Bioaccumulation factor, Heavy metal, Phytoremediation, Pollution, Translocation factor



HEAVY METAL POLLUTION ABATEMENT USING BIOFILM: NEW TRENDS AND APPROACHES BIOREMEDIALATION

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The prevalence of heavy metal (HM) contamination in aquatic ecosystems grows alarmingly as it possesses significant threats to environmental integrity and aquatic health. The bioaccumulation properties of the HMs can adversely affect the ecosystem dynamics. Sequestering the HM from the aquatic environment through bioremediation is one of the best methods to deal with abatement of metals. Interestingly, certain strains of environmental bacteria show resilience to contaminants, utilizing HM in their metabolic processes. Biofilm-forming bacteria, in particular, are gaining attention for its capacity to remove HMs from their surroundings due to their ability to absorption/adsorption. In the present study we identified biofilm-forming bacterial strains which are resistant to HM and assess their efficacy in metal removal. An *in vitro* experiment was carried out in a microtitre plate to assess maximum tolerable concentration of heavy metal, followed by batch sorption assay to find out the maximum tolerable concentration of HMs and HM removal ability of the isolate respectively. In our study, *Aeromonas hydrophila*, *Enterobacter* sp. and *Staphylococcus cohnii* were identified as proficient biofilm formers which can remove nickel, cadmium and zinc respectively from the experimental exposure. The bacterial isolates showed \approx 50% sorption ability towards HMs. The findings can be extended to explore the application potential of biofilm forming bacteria in bioremediating HMs in the aquatic environment and can be scaled up to an industrial application level by more standardization and field application experiments, which results in bioprospecting of biofilm. Bioremediation of HMs mediated by biofilm forming bacteria could be an efficient and cost-effective alternative.

Key words: Bioprospecting, Heavy metal resistance, Environmental remediation



A CASE STUDY ON ASSESSMENT OF MARINE LITTER IN SOME SELECTED BEACHES OF UTTARA KANNADA DISTRICT KARNATAKA

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Coastal pollution in Karwar Coast presents a alarming environmental challenge, with thousands of tons of waste, predominantly plastics, entering the oceans annually. Statistical analysis from cleanup activities at Aligadda beach and Rabindranath Tagore beach during 2018, 2019, 2021, and 2023 reveals threatening trends. In 2018, the cleanup yielded 4 tons of trash from Aligadda beach, with plastics comprising 41.1% of the collected debris. Subsequent years saw consistent patterns of plastic dominance, with percentages ranging from 20.3% to 80% across different types of waste materials. The 2019 cleanup at Rabindranath Tagore beach collected 451 Kg of debris, showcasing a significant presence of plastic waste at 20.3%, alongside notable portions of beverage bottles (20.32%) and food wrappers (19.5%). In 2021, a total of 1043 Kg of waste was collected, with plastics accounting for 36% of the litter, followed by glass (11%), fishing materials (7%), and other materials such as foam paper (2%). The 2023 cleanup efforts at Tagore and Aligadda beaches further underscored the plastic pollution crisis. Tagore beach witnessed 70.3% plastics in the recovered litter, with glass (7.9%), footwear (6.5%), paper items (6.2%), cloth (5.2%), and other wastes making up the rest. In comparison, Aligadda beach displayed an alarming 80% of plastic and fishing materials, underscoring the urgent need for targeted interventions. These statistics emphasize the critical need for immediate action to address the tourism-driven waste and the impact of online food delivery services on coastal pollution. Sustainable waste management practices, community engagement, and policy interventions are crucial to safeguarding the ecological integrity of the Karwar Coast and mitigating the escalating plastic pollution crisis.

Keywords: Tagore beach, Aligadda, Plastic, Debris, Karwar



MICROPLASTIC DISTRIBUTION IN COASTAL ENVIRONMENT: A CASE STUDY OF BEACH AND MANGROVE SEDIMENTS IN KOLLAM DISTRICT, KERALA

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Microplastics (MPs) are a prevalent type of pollution, posing risks to human health via multiple exposure pathways. The extent of contamination by MPs in the mangrove ecosystem and beach sediments of the Kollam area in Kerala remains largely unexplored. The presence of MPs in the marine environment is alarming due to their considerable environmental threat. The present study determined the presence of MPs in sediments of the intertidal region of the beach and mangrove ecosystem of the Azheekal region of Kollam District, Kerala. A total of five sediment samples were collected from each ecosystem and subjected to analysis for MPs. Density separation method is utilized for sample extraction, Optical Fluorescence Microscopy and Raman Spectroscopy were used to characterize MPs from sediment matrices. The study identified the presence of 10 -75 MP particles in mangrove sediments and 75-200 particles in beach sediments. The highest concentration of MPs was detected at location B4 on Azheekal Beach and location M5 within the mangrove region. Fibers constituted the primary type of MPs found in beach sediments, while fragments were the significant type in mangrove sediment. This observation could be attributed to their slower decomposition rate than ecosystems with higher microbial diversity. Polypropylene, Polyethylene terephthalate, Polyethylene, Polystyrene, and Nylon are the MP particles isolated from the beach and mangrove ecosystem sediments. As there are limited microplastic studies on the Azheekal beach and adjacent mangrove ecosystems, the current study may provide valuable insights into the extent of contamination and its potential impact on the coastal region of the study area. Understanding the distribution and properties of MPs in beach sediment is essential for devising effective mitigation and management strategies.

Keywords: Microplastic, Mangroves, Beach sediment, Azheekal beach, Pollution.

AMINO ACID-BASED CARBON DOTS FOR FLUOROMETRIC Cu^{2+} ION SENSING IN WATER BODIES

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The development of optical sensors for sensitive detection of copper in water and living system has been an active research area in the past few years because of widespread applications and importance of copper. Higher amounts of copper in water bodies can adversely affect the living organisms including humans. Copper toxicity can result in various health problems in humans including neurological disorders like Alzheimer's disease and prion diseases. Main sources for copper toxicity are from the industrial effluents and leaching. Herein, we have synthesized highly fluorescent hydrothermally derived Carbon dots (C-dots) from L-cysteine which has been efficiently used for the detection and quantification of Cu^{2+} ions in water. After filtration as-prepared C-dots has been characterized properly using dynamic light Scattering (DLS), Raman spectroscopy, Fourier Transform Infra-Red spectroscopy, UV-Visible absorption spectroscopy and Photoluminescence measurements spectrophotometer. Fluorescence studies indicate that the synthesized C-dots display exceptional fluorescence, peaking at 500 nm when excited at 440 nm, exhibiting a Stokes shift of 60 nm. This fluorescence capability of C-dots has been harnessed to develop a fluorometric Cu^{2+} ion sensing probe using a fluorescent-turn-on strategy, with a detection limit of 10 μM . The development of such sensitive optical sensors shows great promise across diverse applications, from environmental monitoring to biomedical diagnostics. By capitalizing on the distinctive properties of hydrothermally derived C-dots, this research contributes to advancing Cu^{2+} ion detection methodologies, meeting crucial needs in both scientific exploration and practical water quality applications.

Keywords: Amino acid-based carbon dots, Uv-visible absorption spectroscopy, photoluminescence

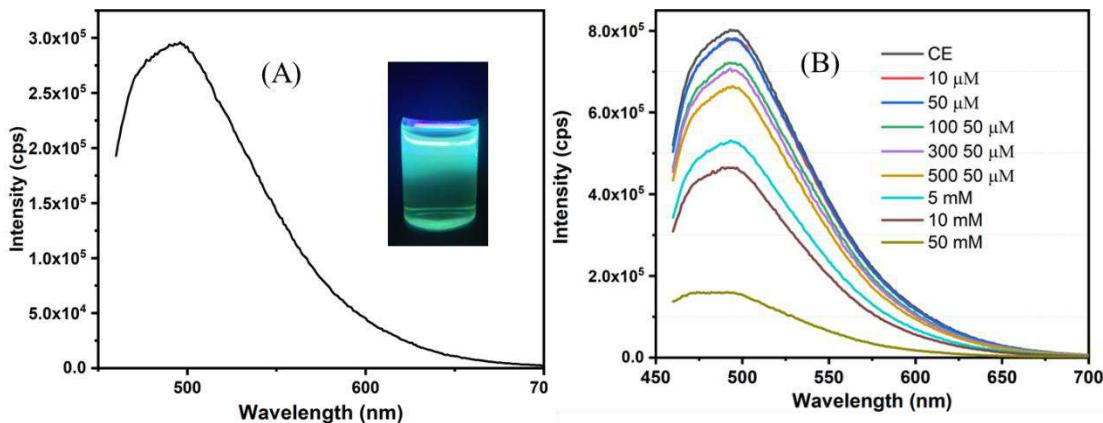


Figure 1 Emission spectrum of C-dots with an inset of real time photograph of C-dots under UV-light (A), Cu^{2+} ion sensing curve using C-dots (B)



POLLUTION ASSESSMENT AND SOURCE IDENTIFICATION OF VANADIUM IN THE SURFACE SEDIMENTS OF OFF KOCHI USING GEOCHEMICAL AND PMF APPROACH

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The occurrence of Vanadium (V) in aquatic sediments is emerging as a significant topic of discussion among scientists, attributed to its potential toxicity and growing utilization in the society. The present study aimed to determine the spatial distribution, source apportionment and pollution status of V in the surface sediments of Off Kochi waters up to 100 meter depth zone. Fifty-four sediment samples representing pre and post-monsoon seasons were collected along a transect from Off Kochi, lying between the latitudes $9^{\circ}57' 59.5''$ - $9^{\circ}54' 30.4''$ and longitudes $76^{\circ}11' 7.04''$ - $75^{\circ}38' 50.3''$ of the South Eastern Arabian Sea. The positive matrix factorization (PMF) modelling approach was employed in the present study to understand the source of V. The source apportionment confirmed that both crustal emissions and oil combustion sources account for the existing V concentrations in the Off Kochi waters. The elemental composition, grain size analysis, and carbon contents were also investigated. Vanadium concentrations were significantly higher in sediment samples collected from nearshore locations where the land-based anthropogenic contribution was found to be maximum.

Keywords: Off Kochi, South Eastern Arabian Sea, Vanadium, Positive matrix factorization



HYDROPHYTES AS POTENTIAL VECTORS OF MULTI-DRUG RESISTANT WATER ASSOCIATED PATHOGENS: AN EXAMPLE FROM VEMBANAD LAKE

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The overgrowth of invasive hydrophytes presents significant socioeconomic and environmental challenges to aquatic ecosystems. Vembanad lake located along India's southwest coast experience a surge in hydrophyte proliferation during the monsoon season, which adversely affects the water quality, fisheries, navigable waterways, agriculture and contribute to the spread of disease vectors. The current study investigates the role of these hydrophytes in transporting pathogens of water associated diseases from inland to estuarine waters during monsoon season. Samples of hydrophytes were collected from 13 stations in Vembanad lake, and the abundance of *Vibrio cholerae* and *Escherichia coli* were enumerated using the quantitative realtime PCR (qPCR) technique. Additionally, we analyzed the antibiotic resistant profiles of representative isolates of these bacteria. The qPCR analysis revealed the prevalence of *E. coli* and *Vibrio* sp. across all samples, suggesting their potential role in pathogen transport. Antibiotic resistance was prevalent, with approximately 80 % of *Vibrio* sp. and 66 % of *E. coli* isolates showing resistance to cefalexin. Moreover 61 % of *Vibrio* isolates were resistant to tetracycline and 50 % of *E. coli* isolates were resistant to erythromycin. The multiple antibiotic resistance (MAR) index indicates that 60 % of isolates had an index between 0.25 – 0.5, while only 4 % exhibited an index above 0.5. Notably, there were significant regional variations in the antibiotic resistance profile of the isolates. Our findings suggest that hydrophytes may act as vectors for the spread of antibiotic resistant bacteria from inland waters to coastal regions, with the extent of this transport influenced by water currents.

Key words: *Hydrophytes, cholera, water associated disease, antibiotic resistance*



POSSIBILITIES OF SHEWANELLA SP. DERIVED PYOMELANIN IN REMEDIATING TEXTILE WASTE WATERS.

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There is an emerging demand for developing promising technologies for the bioremediation of textile effluents, which retains approximately 10 -15 % of the chemicals used for the dyeing process. Apart from the aesthetic problems, these effluents are also toxic and cause to mutagenicity and even carcinogenicity. Other than the direct toxic effects, textile dyes are potent to cause reduction in the reoxygenation capacity of water and blocks the sunlight penetration thereby disrupting the normal living conditions of aquatic inhabitance. The current study reports the potential of pyomelanin secreted by marine bacterium, Shewanella sp., in chelating the dyes, malachite green, crystal violet, trypan blue and cotton blue, from the solution. The extracellular pyomelanin were purified by alkali-acid treatment and the powder were mixed with 100mg/litre textile dye in separate tube for 3 hours. The spectral analysis showed that more than 50 % of the dyes were successfully chelated with pyomelanin powder in 3 hour. Consequently, the current study advocates for the application of pyomelanin derived from Shewanella sp as an effective agent for dye chelation in industrial wastewater treatment.

Keywords: *Shewanella, Melanin, Mutagenicity, Carcinogenicity, Biopolymer*



VERTICAL DISTRIBUTION AND SEASONAL VARIATION OF MICROPLASTICS IN WATER COLUMN ALONG THE SOUTH-WEST COAST OF INDIA

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Microplastics represent a significant threat to marine ecosystems and have garnered extensive global attention. There is a paucity of information on our understanding of sub-surface microplastic concentrations, their movement, and temporal variability especially along Indian coasts. The south west coast is one of the prominent upwelling zones of India. Each year large quantity of microplastic enter the pelagic realm through upwelling making its bioavailability throughout the coastal column water. Present study aims to assess the spatial and temporal distribution of microplastics across various depth profiles of the water column along the southwest coast of India. Subsurface water samples were collected from different depths (5, 10 and 20m) from six locations. Microplastic concentrations ranged from 1.6 to 32.82 items/L. The average microplastic concentrations during pre- and post-monsoon seasons were more (8.36 ± 5.72 and 8.54 ± 6.26 items/L respectively), compared to monsoon period (6.58 ± 3.31 items/L). Microplastic concentrations showed a temporal variation, with the highest average concentrations recorded from Calicut (15.9 ± 9.5 items/L), followed by Kochi (12.7 ± 10.3 items/L), and Ponnani (9.3 ± 3.5 items/L). Notably, a decreasing trend in microplastic concentration was observed from the surface to the bottom layer. Fibres emerged as the predominant microplastic type in most compartments studied. Chemical analysis of selected microplastic particles identified Polyethylene, Polypropylene, Polystyrene, Alkyd resins, and Polyvinyl chloride as the primary polymers present in various compartments of the study area. This study emphasises the accumulation of microplastics within the water column along the Kerala coast, particularly originating from the fragmentation of synthetic items such as fishing nets and clothing materials, highlighting the pervasive nature of microfiber pollution. Monitoring of subsurface microplastics offers a promising avenue for enhancing our comprehension of upwelling zones and their implications for microplastic distribution in column water. Upwelling processes have the potential to transport microplastic particles from deeper layers to the surface, where they can accumulate due to surface currents and convergence zones. By examining the correspondence between upwelling events and variations in microplastic abundance, it is possible to elucidate the role of vertical transport mechanisms in shaping microplastic distribution patterns in coastal waters.

Keywords: Microplastics, Water column, Vertical distribution, Micro fibre.



ASSESSMENT OF HEAVY METAL (Cu, Cd, Pb, Zn, Cr) ACCUMULATION AND ITS RISK DUE TO THE DIETARY INTAKE OF MARINE SEAFOOD (SHELLFISH) FROM THE SOUTHEAST COAST OF TAMIL NADU, INDIA

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Marine ecosystem inhabits crucially important life sources on Earth but there are major emerging contaminants of which heavy metals are the most prominent ones in recent decades. Marine seafood (Shellfish) is one of the most common food sources consumed in a large amount. Accumulation of these heavy metals (Cu, Cd, Pb, Zn, Cr) at more than their permissible level can disintegrate the food chain. Due to their nonbiodegradable property, they get accumulated and get bio-magnified which when consumed by higher organisms can cause even increased lethal effects than their initial toxicity causing harmful effects such as psycho-social dysfunctions, malnutrition, weakening of immunological defense barriers, intrauterine growth retardation, and gastrointestinal cancer &, etc. Triplicates of 5 different species each shellfish samples were collected and analyzed for heavy metal using AAS (atomic absorption spectroscopy) from three major sites of Tuticorin where most fishes are consumed by the local population. It was observed that these metals were present more than their permissible limits in the following order Cr > Pb > Cd > Cu > Zn which could cause various health risks to humans consuming marine seafood. Most, of the animals monitored and analyzed had higher human health risk assessment factors such as BAF, EDI, THQ, CR, and HI which is an alarm to the community. It is concluded with our study that continuous monitoring of the ecosystem and its maintenance should be prioritized and comprehensive care of the marine environment should be devoted.

Keywords: Ocean, Marine pollution, Heavy metal, Shellfish, Seafood & Health risk.



INVESTIGATION ON CONTAMINATION AND SPATIAL DISTRIBUTION OF HEAVY METALS IN SEDIMENTS FROM BEYPORE ESTUARY

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Beypore estuary near Calicut is the third largest estuarine system in the State of Kerala. The Chaliyar River converges into this estuary at Beypore, traversing through diverse physiographic units, and exhibiting stream-like characteristics. Major contributors to the pollution in the Beypore estuary include tile factories, petroleum units, Uru building companies, wood industries, and fishing harbour. In 2001, an investigation addressed concerns about heavy metal contamination from a previously operational pulp factory's waste deposits. The study found the presence of most of the heavy metals (Cr,Zn,Ni,Pb,Co&Mn) exceeding the geochemical background values. No further studies have been reported in this regard so far. Therefore, this study mainly focused on the concentration of metals (Zn,Pb,Cd,Mg, and Fe) and their spatial distribution from 23 surficial sediment samples collected from Chaliyar River and Beypore estuary. Concentrations of metals ranged from 13 to 72mg/kg for Zn, 0 to 132mg/kg for Pb, 0 to 0.8mg/kg for Cd, 750 to 16250mg/kg for Mg, and 6.3 to 26.8mg/kg for Fe. Concentration of heavy metals for Pd and Cd was significantly higher than geochemical background concentration limits given by average shale value(ASV-20mg/kg&0.3mg/kg) and upper continental crust value(UCC-20mg/kg&0.098 mg/kg), whereas concentration for other metals was within limits. The total organic carbon concentration in the sediments ranged from 0.3 to 7.6%, possibly influenced by vegetation or wastewater discharge. Sediment pH ranged from 4.49 to 7.08, indicating slight acidity to neutrality. Electrical conductivity (0.077 to 15.5 mS/cm) reflected high salinity in riverine sediments. An estimation of pollution indices such as contamination factor(CF), modified degree of contamination(mCd), pollution load index (PLI) and modified degree of contamination(mCd) revealed metals Pb and Cd exhibiting moderate to high contamination. The Potential ecological risk index (PERI) represented low to considerable ecological risk for all sites. These geochemical findings offer insights into potential risks and for formulating mitigation measures.

Keywords: Heavy metals, River sediments, Pollution indices, Spatial distribution.



**Marine Biodiversity
&
Conservation**

VERTICAL DISTRIBUTION AND MIGRATION OF PTEROPODS IN THE EASTERN ARABIAN SEA

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Pteropods are planktonic gastropods, also known as "sea butterflies" or "sea angels" due to their stunning look and elegant swimming strategy. Thecosomates, or shelled pteropods, are used as bioindicators of ocean acidification. Vertical migration is a fascinating phenomenon in which practically all zooplankton exhibit synchronised vertical movement both upwards and downwards in the water column over a set period. The current study focuses on the composition and migration of the pteropod community in the eastern Arabian Sea. In September 2019, pteropod samples were collected from six sites in the upper euphotic column (5m, 10m, 20m, and 30m) using a plankton pump, both day and night. Pteropod abundance varied significantly by day and night, with *Heliconoides inflata*, *Limacina bullimoides*, and *Creseis conica* being the most common. The overall abundance of pteropods in the upper depths increased at night. We identified 19 taxa, including 16 genera and 7 species. They are *Creseis conica*, *Heliconoides inflata*, *Limacina bullimoides*, *Clio pyramidata*, *Clio convexa*, *Peracle reticulata*, *Pneumoderma heronensis*, *Cavolinia* sp., *Diacavolinia* sp., *Styliola* sp., *Hyaloclis* sp., *Cuvierina* sp., *Telodiacia* sp., and *Diacria* sp., *Creseis* sp., *Limacina* sp. All of them can be grouped into any one of the following categories such as (a) living in the subsurface with minimal vertical migration, (b) dwelling in the subsurface during the day and on the surface at night with active migration, and (c) non-migrants with little to no diel movement and always residing in subsurface strata. This serves as the baseline data for vertical migration of pteropods in Indian waters.

Keywords: Pteropods, vertical migration, diel vertical migration, biological carbon pump, Arabian sea

CONSERVATION IMPLICATIONS OF THE SCALLOPED HAMMERHEAD SHARK (*S. LEWINI*) FISHERY ALONG THE SOUTH WEST COAST OF INDIA

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India is one of the world's leading exploiters of sharks, with species being targeted for commerce, as well as incidentally trapped as bycatch. As a result, majority of India's shark species are assessed as threatened on the IUCN Red List, and many are strictly protected under the Indian Wildlife (Protection) Act. We focus on one such species of threatened shark, the scalloped hammerhead, *Sphyrna lewini* which is assessed as 'Critically Endangered' on the IUCN Red List. Despite this conservation significance, *S. lewini* is one of the most commercially exploited shark species in India, with its meat being considered to be both a culinary delicacy and believed to have medicinal properties. In this study, we aim to assess the status of the exploitation of *S. lewini* along the Southwest coast of India, through samples obtained from fortnightly sampling carried out in three landing centers along the south west coast of India from December 2022 to December 2023. The exploited length range of *S. lewini* was 51 to 319 cm, with a sex ratio (M: F) of 1: 0.65. The dominant length group that formed part of the landings was 151 to 200 cm, which likely comprise a large share of immature individuals, as the reported length at first maturity in *S. lewini* is 210.5 cm. There is also a significant exploitation of mature and spawning females, with an average number of 36 pups observed in the exploited individuals. We discuss the conservation implications of this indiscriminate exploitation and suggest management measures to secure the future of this species.

Keywords: Bycatch, fishery, critically endangered species

NEW DISCOVERIES OF BRITTLE STARS (ECHINODERMATA: OPHIUROIDEA) FROM THE CENTRAL AND SOUTHWEST INDIAN RIDGES

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Mid-ocean ridges are being prospected for seabed mining, as they harbour massive sulphide deposits associated with hydrothermal venting activity. There is a need for developing sound environmental management plans to protect the resident biological communities from potential impacts of seabed mining. A pre-requisite for such measures is the generation of comprehensive data on seafloor biodiversity in these areas – encompassing vents as well as non-vent ecosystems. To this end, biodiversity surveys are being conducted in the Indian exploration contract area along the Central Indian Ridge (CIR) and South West Indian Ridge (SWIR). These surveys have yielded a good collection of echinoderms, among which the brittle stars (Class Ophiuroidea) are overwhelmingly dominant, represented by 11 species in eight genera and five families (Astrophiuridae, Euryalidae, Ophiacanthidae, Ophiopyrgidae, and Ophiosphalmidae). Many of the species are potentially new to science, including three species of the widely-distributed deep-sea genus *Ophioplinthaca* and one species of the very rare genus *Ophiophycis*. These discoveries are filling gaps in knowledge about the biogeography and connectivity of deep-sea fauna, and highlight the value of deep-sea biodiversity exploration.

Key words: Ridges, seafloor, biodiversity

CALCIUM PRECIPITATION BY CORAL ASSOCIATED BACTERIA AND THEIR IMPLICATIONS FOR REEF FORMATION

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Diverse group of microorganisms maintain a symbiotic relationship with corals, playing pivotal roles in their survival. The coral-Zooxanthellae interactions are extensively reported owing to the shedding of the latter in response to the oxidative stress from anthropogenic sources and climate change indicators, which leads to coral bleaching. On the other side, diverse groups of other coral-associated bacteria were less studied for their importance in the formation and maintenance of reef ecosystems. Recent studies indicated that several other bacteria contribute to the formation of corals through participation in the calcium carbonate precipitation. The current study investigates the role of coral-associated bacteria in reef formation, focusing on their ability to participate in microbially induced calcium carbonate precipitation (MICP). One hundred isolates of coral associated bacteria were analysed in the current study for their abilities to secrete urease and carbonic anhydrase which are the key enzymes mediating the urea hydrolysis and calcium carbonate precipitation. The morphology and composition of these precipitates were also studied using microscopy and XRD techniques. The results indicated that 20 % of the bacterial isolates could precipitate crystals of 1.46 to 0.1mm in calcium precipitating medium in 25 days. Microscopic analysis showed the formation of white-coloured crystals around the colonies indicating the extracellular precipitation. The presence of esterase and urease enzymes were also confirmed in those isolates which showed the formation of visible precipitates. The 16SrRNA gene analysis revealed the identity of positive isolates as *Microbacterium sp.*, *Staphylococcus arlettae*, *Brevundimonas sp.*, *Staphylococcus nepalensis*, *Brachybacterium paraconglomeratum*, *Psychrobacter celer*, *Halomonas sp.*, *Kushneria sp.*, *Pseudomonas sp.*, *Micrococcus sp.*. The study underscores the significant yet less studied role of coral-associated bacteria in reef formation, highlighting their potential as key players in the calcification process that shapes reef ecosystems.

Key words: *Coral reef, bacteria, urease, carbonate precipitation, bleaching*

SEASONAL ASSESSMENT OF CRUSTACEAN DIVERSITY ALONG SANDKHL SANDY SHORE, RATNAGIRI, MAHARASHTRA

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The present study revealed the seasonal variation among the intertidal macrofaunal abundance of Sandkhol sandy shore, Ratnagiri, west coast of India from February 2020 to January 2021. A total of 12 crustacean species were recorded from the shore. Seasonal fluctuation in environmental parameters such as atmospheric temperature (26.91 to 29.58 °C), interstitial water temperature (27.33 to 29.25 °C), sediment temperature (26 to 28.66 °C), interstitial dissolved oxygen (4.71 to 6.23 mg l⁻¹), interstitial water salinity (33.68 to 40.12 psu), and interstitial water pH (8.22 to 8.34) were recorded. The crustaceans, *Ocypode ceratophthalmus*, *Eurobowmaniella simulans*, *Eurydice caudata*, *E. indicus*, *Gammariid* sp., *Onisimus* sp. were dominant throughout the study period. The interstitial water temperature showed a highly positive correlation with sediment temperature while negatively correlated with the abundance of *Clibanarius infraspinatus*. The sediment temperature was negatively correlated with the abundance of *C. infraspinatus*. The macrofaunal diversity indices expressed that the faunal diversity was moderate and showed high evenness throughout the study period. The present study revealed that crustacean's abundance was highest during post-monsoon season, while lowest during monsoon season which may be attributed to the variations in environmental parameters.

Keywords: Crustacean, Seasonal assessment, Sandy shore, Environmental parameters, India

BIOPROSPECTING AND CHARACTERIZATION OF UREASE AND CARBONIC ANHYDRASE BACTERIA, AND THEIR PRECIPITATION STRUCTURAL DYNAMICS DURING MICROBIAL-INDUCED CALCIUM CARBONATE PRECIPITATION.

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Microbially Induced Calcium Carbonate Precipitation (MICP) stands as a ground-breaking and sustainable approach in civil engineering, marking a move towards environmentally friendly techniques for soil improvement, biocementation, and the repair of structural cracks. This study delves into the isolation and characterization of urease and carbonic anhydrase bacteria, alongside evaluations of urease and carbonic anhydrase (CA) activity pertinent to MICP processes. A total of 53 yellow bacterial colonies of pNPA-supplemented media were selected as CA-positive. Among them, 19 were urease positive. Three high-potential CA and urease producing isolates (MS1 and LS1 and SED) were selected for optimization. During optimization, all cultures grew well at alkaline conditions of pH 8-9, temperature of 35- 40°C, and alkalinity of 2-5%. All the isolates were gram-positive with endospore formation. Our findings indicate that a concentration of 3mM para-nitrophenol acetate facilitates bacterial growth, whereas concentrations exceeding this threshold (5mM, 7mM, and 10mM) inhibited microbial proliferation. The successful formation of calcium carbonate by the bacterial cultures was substantiated through Energy-Dispersive Spectroscopy (EDS) analysis, with the calcite polymorphs being further confirmed via Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD) techniques. Preliminary biocementation trials on the sea sand were hindered by elevated salt concentrations, preventing biocementation block formation. However, SEM analyses demonstrated calcite generation and the gradual transition from vaterite to calcite over extended curing periods. DNA isolation and sequencing were conducted for two bacterial strains (MS1 and LS1) and identified them as *Lysinibacillus macrolides* and *Lysinibacillus fusiformis*, respectively. It emphasizes how certain bacterial strains show considerable potential when subjected to ideal conditions of pH, temperature, and nutrient environments. This study highlights the effectiveness of MICP methods for biocementation processes using river and construction sand.

Key words: Biocementation, carbonic anhydrase, urease, Microbial-induced calcium carbonate precipitation (MICP), soil stabilization.

RHIZOSPHERE AND ROOT-ENDOPHYTIC BACTERIOMES OF A TROPICAL TRUE MANGROVE *RHIZOPHORA* SP. AS REVEALED BY METAGENOMIC PROFILING

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Mangrove ecosystems are nutrient limited coastal areas that encounter an array of fluctuating environmental conditions being positioned in the transition zone. Mangrove plants dominate these ecosystems and are responsible for the subsistence of all the organisms in the mangrove food web. Bacteria associated with the intricate root system and the rhizosphere would hitherto be having a significant role in the growth and health of the mangroves in addition to tolerance towards adverse effects of environmental stresses. Thus, there is a need to comprehend the abundance, composition and functional capabilities of root-endophytic bacteriome (EB) and rhizosphere bacteriome (RB) in mangroves. In the present study, high-throughput sequencing technology was used to study bacterial composition in both RB and EB in true mangrove, *Rhizophora* sp., from Puthuvypin, Ernakulam, Kerala. Bacterial community in both the compartments composed of 58 bacterial phyla, 163 classes, 419 orders, 672 families, 1187 genera, and 2559 species. Five dominant phyla were common in both samples which included Proteobacteria, Acideobacterita, Bacteroidota, Patescibacteria, and Desulfobacteriota. The keystone taxa of RB were Dadabacteriales, Pajaroellobacter, Gemmatimonas, Gaiella, and Aquisphaera whereas in EB, the keystone taxa comprised Paludibacter, Gynuella, Hypnocyclicus, Desulfobacter, and Roseimarinus. Bacteriomes were significantly different in EB and RB with variations at the genus level greater than phylum level. However, 3% of the bacterial phyla were common which consisted of Sulfurifustis, Spirochaeta, Novosphingobium, Moranbacteria, Lacunisphaera, Kaiserbacteria, Ignavibacterium, Dongia, Cytophaga, and Candidatus. The metabolic versatility were higher in root endophytic bacteriome with major functional genes such as amino acid metabolism, carbohydrate metabolism, metabolism of cofactors and vitamins, signal transduction, xenobiotics metabolism and membrane transport. This study emphasizes significant role played by rhizosphere and root-endophytic bacteriomes in the sustenance of mangroves.

Keywords: *Rhizophora* mangrove, Rhizosphere, Endophyte, Bacterial diversity

MICROBIOME ANALYSIS OF BLACK CLAM (*Villorita cyprinoides*) FROM VEMBANAD LAKE: A COMPARATIVE STUDY BETWEEN ITS HARVESTING LOCATIONS.

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The black clam (*Villorita cyprinoides*), is one of the major contributors to the molluscan fisheries in India. The estuarine system of Vembanad Lake ranks first in the production of black clams. Bivalves are of particular interest because of their crucial ecological and economic roles. Research on marine invertebrates is still developing, but the mechanisms that determine interactions between the host and their associated microbes are largely unknown. The microbiome of commercially important bivalve species, such as *V. cyprinoides* plays a crucial role in their health and ecological interactions. This study investigates the bacterial diversity within the black clam populations from two distinct locations in Vembanad Lake, namely Perumbalam and Kumarakom, during May 2023. The taxonomic distribution of prokaryotic communities associated with *V. cyprinoides* were revealed using Illumina MiSeq platform. A detailed diversity analysis, phylogenetic reconstruction and data visualization were done using QIIME2. Total raw reads were 1,04,582 for Perumbalam station and 1,25,223 for Kumarakom station. The absolute abundance of bacterial domain for Perumbalam station was 2539 with Shannon index of 3.84 and Simpson index of 0.97. For station 2 Kumarakom, the absolute abundance of bacterial domain was 3552 with Shannon index of 4.05 and Simpson index of 0.97 indicating richness of prokaryotic communities. The clam-associated microbiome consisted primarily of Phylum Cyanobacteria (31.22%), Proteobacteria (30.26%), Spirochaetota (26.80%), Firmicutes (14.6%), Bacteroidota (8.4%), Verrucomicrobiota, (6.83%), and Planctomycetota (4.49%). However, the relative abundances of these phyla exhibited significant variations, wherein the factors such as water quality parameters, sediment composition, and anthropogenic influences were considered as potential drivers shaping the observed microbial diversity patterns in both stations. For instance, phylum Cyanobacteria were highly abundant in the Perumbalam (31.22%) than Kumarakom (6.5%). Phylum Spirochaetota were highly abundant in Kumarakom (26.80%) than in Perumbalam (2.95%). This study provides a baseline information for understanding the microbial diversity associated with *V. cyprinoides*, particularly in specialised ecological niches such as Vembanad Lake. Such insights are crucial for sustainable management practices, conservation efforts, and the development of targeted interventions to enhance the health and productivity of black clam populations in this vital ecosystem.

Keywords: *Villorita cyprinoides*, Microbiome, Vembanad Lake, Perumbalam, Kumarakom

DIVERSITY AND DISTRIBUTION OF GOBIOID FAUNA (TELEOSTEI: GOBIIFORMES) FROM DIFFERENT ECOLOGICAL NICHES OF TAMIL NADU COAST, INDIA

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Order Gobiiformes is one of the most speciose fish groups known, the extent of which is still uncertain, as species are still being discovered and described. Gobioid fishes are taxonomically challenging due to their small size and difficult in identification. And hence, they are among some of the most commonly misidentified fishes. The present study was aimed to access the current status of gobioid fauna along Tamil Nadu coastal waters. Regular surveys were conducted in the various estuaries and major fish landing centres of Tamil Nadu, India, during January 2020 to December 2023. Gobioid were collected by visual search method, handpicking and by scoop net in estuaries during low tides in the intertidal region. They were also procured from trawl (mesh size range, 20–40 mm) bycatch, trawling carried out at inshore and off shore water depth ranging from 10–15 m. In this study, a total of 75 species of order Gobifromes consists of three families viz., Gobiidae, Eleotridae, Microdesmidae were recorded. Among the above families Gobiidae was found as most dominant group (68 species), whereas Eleotridae (6 species) and Microdesmidae (1 species). Six species, *Acentrogobius vanderloosi*, *Mangarinus waterousi*, *Oxymetopon compressus*, *Periophthalmus walailakae*, *Pseudogobius fulvicaudus*, and *Valenciennea wardii* were recorded for the first time from Indian waters. Similarly, five species *A. viganensis*, *Hemigobius hoevenii*, *Eugnathogobius mas*, *E. mandora*, *Mugilogobius tigrinus* were recorded for the first time in estuaries of Tamil Nadu. Revaluation of identity of a few gobioid were also undertaken and resolved. Due to the favourable environment conditions in estuaries (40 species) maximum number of gobioid fishes were recorded than the coastal waters (35 species). Thorough knowledge about the occurrence and distribution of gobioid fishes is still lacking and therefore meticulous field research combined with scientific studies will extend the knowledge on gobioid fishes in India.

Keywords: Gobioid, distribution, estuaries, bycatch, Tamil Nadu



THE FAUNAL DIVERSITY OF WATER HYACINTH (*EICCHORNIA CRASSIPES*) ROOTS FROM DIFFERENT STATIONS OF ERNAKULAM AND ALAPPUZHA DISTRICT

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This study was designed to identify the faunal composition from the fibrous root of water hyacinth and its diversity of species along different sites. This root mats forms a wide habitat, better survival of larva, breeding site for some organism etc. These macrophytes provide food, shelter and refugia for organism. Waterhyacinth spreading may have both positive and negative impact on aquatic system. The main objective of the study is to determine the species diversity associated with the root of water hyacinth. This study is based on 5 locations in Ernakulam (Ekm) and Alappuzha (Alpy) district mainly in ponds, fields, rivers etc. Total of 18 organisms were collected from the 5 sampling sites. The study depicts the importance of water hyacinth as habitat for numerous invertebrates which in turn contribute to the biodiversity of the respective aquatic habitat.

Keywords: Water hyacinth, *Eicchornia*, Insects, Ernakulam, Fibrous roots.



HEALTH ASSESSMENT CRITERIA FOR THE INDIAN MANGROVES

– A CASE STUDY FROM KADALUNDI MANGROVES, KERALA

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Mangroves are the salt tolerant forest ecosystems found mainly in tropical and subtropical intertidal regions of the world. Coastal defence, fisheries, carbon storage, tourism, water, timber and fuel are the various ecosystem services provided by the mangroves. Coastal areas have the highest population density and are among the most heavily used around the world. Therefore, strong pressure is exerted on coastal environments by pollution, habitat destruction and fragmentation and overexploitation of natural resources. This study included the taxonomy of true mangroves, associated flora, avifauna as well as the development of methodology for the health assessment of mangroves and its ground truthing in Kadalundi-Vallikkunnu Community Reserve (KVCR), Kozhikode. The taxonomic identification of mangrove flora were based on the morphology and anatomy of vegetative characters and the identification of avifauna were done by the naturalists and the local photographers. About 8 species of true mangroves, 5 species of mangrove associated flora and 95 species of birds were identified from KVCR. A multi-disciplinary as well as integrated approach was developed for the Health Assessment of the mangroves. The health assessment study was carried out along three sites of Kadalundi mangroves and it showed that site 3 is more vulnerable to degradation compared to the other two sites. The study has brought out a methodology which can be applied to any mangrove forest of India for its health assessment and the same if followed uniformly, can be used for the conservation management and policy making by the authorities.

Key words: Conservation, Health Assessment, Kadalundi, Management, Mangrove ecosystem



CHONDRILLA MIXTA SCHULZE, 1877 (CHONDROSIDA: CHONDRILLIDAE): FIRST REPORT OF THE SUPPOSEDLY COSMOPOLITAN SPONGE FROM LAKSHADWEEP ISLANDS, INDIA

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The reported studies on the biodiversity of the Lakshadweep archipelago are limited to organisms such as corals, crustaceans, molluscs, echinoderms and fishes. In the present study, we report the occurrence of *Chondrilla mixta*, a species of sponge, for the first time from the Lakshadweep archipelago. We adopted morphological analysis using spicules and physical appearance and molecular taxonomy using mitochondrial DNA (mtDNA) cytochrome oxidase subunit I (COI) to identify the sponge species. This, along with the rounded spherasters and oxyspherasters were crucial in the taxonomic confirmation of the species. This study aims to fill gaps in the standardisation of protocols and knowledge of species distribution of sponges from the Lakshadweep archipelago.

Keywords: *Sponges; Mitochondrial DNA (mtDNA); Cytochrome oxidase subunit I (COI); Spicule; Lakshadweep*

OPTIMIZING MESH SIZE SELECTIVITY & LENGTH FREQUENCY FOR SUSTAINABLE CLAM FISHERY (*VILLORITA CYPRINOIDES*) ALONG VEMBANAD LAKE, KERALA.

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Kerala's Clam fishery centered around Vembanad Lake, faces challenges exacerbated by indiscriminate harvesting practices and inadequate management strategies. Of particular concern is the lack of attention to mesh size selectivity which, leading to juvenile capture and population decline. This study investigates the impact of varying mesh size on the catch composition of black clam (*Villorita cyprinoides*) however, unsustainable harvesting methods and increased fishing pressure have led to concerns about resource depletion and declining clam sizes. Through field surveys conducted at Bhramamangalam and data collection from October to November 2023, this study aimed to assess the length frequency of clams and current fishing practices, including the use of hand-held dredges, and determine the most optimum mesh size for sustainable clam harvesting. Surveys and length frequency assessment revealed a significant increase in fishing units and a decline in clam size, attributed to the use of small mesh sizes and overfishing. Smaller mesh sizes lead to the inadvertent capture of juvenile clams, undermining the sustainability of the fishery. Small clams and other bycatches were retained in the dredge by the use of small mesh size such as 20 to 25 mm. Using in-situ measurements this study evaluated the selectivity of different mesh sizes in capturing clams while minimizing juvenile catch. To finding underscores the urgent need for regulatory measures to enforce minimum mesh size standards and promote selective harvesting practices. Moreover, the study explores the ecological implications of mesh size selectivity, emphasizing the importance of preserving juvenile populations for long term stock sustainability. Recommendations are provided for implementing effective management strategies that prioritize conservation while ensuring the continued viability of clam fishery.

Keywords: Clam fishery, mesh size selectivity, length-frequency, fall through method

**OBSERVATIONS ON MASS SWARMING AND LENGTH–WEIGHT RELATIONSHIP
OF *CHARYBDIS SMITHII* (DECAPODA: BRACHYURA) IN RELATION TO SEX
AND CARAPACE LENGTH ALONG THE WEST COAST OF INDIA**

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Charybdis smithii is an endemic crab species distributed in the Indian Ocean and is one of the very few swimming crabs that exhibit swarming in the open ocean. Mass swarming of this species has been reported along the west coast of India. The present study is conducted to ascertain the association between *Charybdis smithii*'s carapace length and body weight, to get an insight into the development, overall health, and fitness of the species in a marine environment. Samples were collected for two months (October-November 2023) during the onboard fishing trials of research vessel R V Matsyakumari II of ICAR-Central Institute of Fisheries Technology in the traditional fishing ground off Cochin. The operations were conducted at a depth of less than 40 m, using bottom trawls, having cod-end mesh sizes of 25 and 35 mm. A total of 10.83 tons of *C. smithii* were caught in 24 fishing operations and the average catch per day was about 400 kg. The carapace length of males ranged from 1.32 cm. to 5.20 cm, and the total weight varied from 2 gm. to 83 gm. The carapace length of females ranged from 1.33 cm to 4.46 cm and weight varied from 2 to 44 gm. Both sex-wise and the pooled, *b* values were calculated. The *b* values were calculated as 2.57 for males, 2.52 for females and 2.71 after pooling. The length–weight relationship of this crab was represented by the curvilinear model ($W = \alpha \times L^b$) with values for males, females and pooled sexes. This analysis revealed that the crabs exhibited negative allometric development, as shown by average exponent '*b*'=2.64 for pooled data with high correlation coefficient (*r*)=0.91. From this study LWRs of *C. smithii* showed a negative allometric growth and the value of *b* is less than 3, which means species have a slimmer body as the length tends to increase, which might be attributed to environmental conditions or linked to morphological characteristics. The species is now being discarded by the fishers, since it often is a problem hindering the fishing operations. As the seasonal swarming of *C. smithii* is regular along the coast, strategies for effective utilisation of this species for fish meal, value addition, extraction of chitin or screening for biologically active compounds should be attempted aiming to enhance the economic and ecological value of this species .

Keywords: Carapace length, Experimental fishing, Negative allometry, LWR.

MARINE TUBE DWELLING DIATOM *NITZCHIA MARTIANA* (C. A AGARDH) VAN HEURCK (NITZCHIACEAE-BACILLARIOPHYTA) IN MANGROVE ENVIRONMENTS OF SOUTH ANDAMAN, INDIA

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The occurrence of a marine tube dwelling diatom, *Nitzchia martiana* was reported for the first time in Indian waters from South Andaman. Water samples were collected from the mangrove environments of Port Blair, South Andaman. The diatoms were enclosed in wrinkled tubes of their own making. The cells exhibited linear valves with rounded apices and equally placed chloroplasts arranged diagonally and distributed evenly throughout the cell with 16 - 18 numbers per cell. The colony has the tendency to attach to different substrates such as rocks, bivalve shells, and macroalgae. The colonies of *N. martiana* found in the present study were 4-10 mm in length. Each cell was extremely long and narrow, length varied from 250 - 330 µm with a transapical axis of 4 - 5 µm with rounded apices and having yellowish brown colour. The cells were enclosed in externally wrinkled mucilaginous tubes forming bundles of 6-10 cells arranged in parallel. The present study is pointing towards the scope of the tube dwelling diatoms as feed for shell fish culture and also to study in detail the taxonomy and ecology of tube dwelling diatoms which is an unattended area. This observation confirms the presence of *N. martiana* from Indian waters for the first time.

Key words: Mangrove, *Navicula*, *Nitzchia martiana*, phytoplankton, tube dwelling diatom



ECOLOGY AND SYSTEMATICS OF TWO COLONIAL ZOANTHIDS FROM KOLLAM, KERALA, SOUTH WEST COAST OF INDIA

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India harbours an extensive range of diversity that remains unexplored in multiple facets. Within the country, the rocky reefs serve as habitats for a diverse array of flora and fauna. Zooxanthellate zoanthids, a specific type of coral belonging to the Zoantharia order (Anthozoa: Hexacorallia), serve as indicators of a thriving reef ecosystem. However, limited research has been conducted on these organisms in the shallow tropical and sub-tropical environments, which are found only in selected geographic locations. To identify the species of zoanthids and their ecology in the rocky intertidal reef ecosystem of Kollam, Kerala, a morphological investigation was conducted between June 2023 and August 2023. Colonies of zooxanthellate zoantharians, specifically *Palythoa mutuki* and *Zoanthus sansibaricus*, were observed in Kannimel West, Kollam, located along the southwest coast of India. This study represents the initial report on the ecology, taxonomy and systematics of zoanthids from Kerala, situated along the southwest coast of India.

Keywords: Zoanthids, coral reef, ecology, first report, Kollam, Kerala, *Palythoa mutuki*, *Zoanthus sansibaricus*.

SPATIAL ASSESSMENT OF AVIFAUNA DIVERSITY ASSOCIATED WITH CENTRAL VEMBANAD LAKE SYSTEM DURING MONSOON SEASON

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Wetlands support exceptional biodiversity as they provide habitat for numerous migratory and resident avian species. The present study focuses on analyzing the diversity of wetland avifauna and the characteristics of the respective study areas during the monsoon season around the Central Vembanad Lake (CVL). A total of 4155 individual birds from 153 species were recorded during the study period. The most frequently observed wetland and human commensal species were Little Cormorant (*Micarbo niger*), House Crow (*Corvus splendens*), Brahminy Kite (*Haliastur indus*), Indian Pond Heron (*Ardeola grayii*), Great Egret (*Ardea alba*), Black-headed Ibis (*Threskiornis melanocephalus*), and Common Myna (*Acridotheres tristis*). Results indicate that CVL supports high bird diversity, especially in peripheral wetland areas. A higher species richness (140 spp.) was observed in rural wetlands as compared to urban areas (95 spp.) along the lake. Strong positive correlation was observed for submerged wetland habitat ($r=0.86$) and mangrove habitat ($r=0.81$) for wetland-associated bird species. Negative correlation was observed between human commensal species and wetland habitat ($r=-0.74$). The data highlights the importance of wetland/mangrove protection for sustaining wetland avian habitats. Positive correlations were found between Brahminy Kite & House Crow ($r = 0.72$), indicating the prevalence of waste dumping sites and a negative correlation was found between Wetland & Tree (high canopy cover) ($r = -0.28$), indicating a decline in habitat interdependence for feeding and nesting. Urbanization pressures and loss of wetlands in populated areas along the lake are reducing habitat availability for wetland species, as evidenced by fewer wetland species recorded in these areas. Conserving wetlands and mangroves, particularly in urbanisation-prone regions around CVL, is inevitable to maintain habitat for diverse waterbird communities. Continuous monitoring of bird populations and habitat availability is recommended to assess trends over time and develop appropriate management strategies for this Ramsar site.

Keywords: Wetlands, Birds, Mangroves, Urbanization, Conservation, Habitat

SPATIAL VARIABILITY IN MESOZOOPLANKTON ASSEMBLAGE IN THE NORTHERN ARABIAN SEA WITH SPECIAL REFERENCE TO THALIACEANS.

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The Arabian Sea is a highly biologically productive marine ecosystem, influenced by unique monsoon patterns and water currents, enriched with the presence of endemic species adapted to its distinct environmental conditions. Seasonality of the Arabian Sea is mainly regulated by Southwest (summer) and Northeast (winter) monsoon. The winter monsoon period in the Northern Arabian Sea extends from November to February and is demarcated by high primary productivity, often leading to phytoplankton blooms in this region. Swarms of Thaliaceans often accompany these phytoplankton blooms, as they are voracious filter feeders that depend on high primary productivity to sustain their population. The samples collected from seven locations in the Northern Arabian Sea (Winter Monsoon, 2018) form the basis of this study. The prime focus of the present study was to analyze the spatial variability in the community structure of mesozooplankton with special reference to the diversity of thaliaceans. The mesozooplankton were represented by 20 taxonomic groups which include: Chaetognatha, Hydromedusae, Nauplius larvae, Copepoda, Ctenophora, Fish Egg, Fish larvae, Foraminifera, Radiolaria, Megalopa larvae, Bivalve veliger larvae, Gastropod veliger larvae, Mysidacea, Oikopleura, Ostracoda, Polychaete larvae, Salpida, Dolioidea, Zoea larvae, and Siphonophora. Copepoda was the dominant taxa in all the study stations followed by Chaetognatha, Appendicularia, and Cladocera. Thaliaceans were represented by four species namely, *Dolioleta gegenbauri*, *Doliolum nationalis*, *Thalia democratica*, and *Cyclosalpa affinis*. Major environmental factors influencing the distribution of mesozooplankton were nitrite, nitrate, salinity, temperature, silicate, phosphate, and ammonia.

Keywords: Arabian Sea, Winter monsoon, Mesozooplankton, Thaliaceans, Salp

RECORD OF CNIDARIANS, *AEQUOREA PENSILIS* (HAECKEL, 1879) AND
NETROSTOMA COERULESCENS (MAAS, 1903), FROM THE JAIGAD, RATNAGIRI,
WEST COAST OF MAHARASHTRA, INDIA

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In the current study, cnidarians as, *Aequorea pensilis* (crystal jellyfish) and *Netrostoma coerulescens* (crown jellyfish), were reported from the coast of Jaigad, Ratnagiri, Maharashtra, India. The current investigation was carried out at two stations along India's west coast at the Jaigad, Ratnagiri, during post-monsoon season from October 2022 to January 2023. Sampling stations at 10 and 20 Fathoms were fixed using GPS system. At these two locations, monthly samplings were carried out with a motorized commercial trawl fishing boat. Hydrobiological parameters from both the surface and subsurface waters were studied during each trawl operations. Hydrobiological parameters such as Salinity (31-34 psu), Dissolved Oxygen (3.2-3.6 mg/l), Water temperature (28-31.4°C), and Water transparency (140-820 cm), with dominant plankton, comprising *Ceratium sp.*, *Leptocylindrus sp.* and *Ornithocercus sp.* were recorded during the investigation. This paper discusses the monthly variations in jellyfish abundance during post-monsoon season.

Keywords: *Jellyfish, fathom, Netrostoma, trawler, Aequorea, India.*

DIVERSITY AND ECOLOGICAL DYNAMICS OF SEAWEED-ASSOCIATED MACROFAUNA IN THE INTERTIDAL ROCKY SHORE OF BHATKARWADA, RATNAGIRI (MAHARASHTRA)

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The seasonal variations in macrofaunal associations of seaweeds were investigated for the period of one year from July 2022 to June 2023 along the intertidal rocky shore of Bhatkarwada, Ratnagiri (Maharashtra). The monthly samples were collected on the day of lowest low tide using a stratified random sampling method, employing a 100 cm² wooden quadrate frame. A total of 33 species of seaweeds comprising 12 species of Chlorophyta, nine species of Ochrophyta and 12 species of Rhodophyta were recorded. The associated macrofaunal organisms comprised 59 species belonging to 43 genera, 36 families, eight classes and five phyla. A one-way “permutational multivariate analysis of variance” was used to test the significance of differences in seaweed associated macrofaunal density among months. The clustering of months into different groups was performed based on Bray-Curtis similarity index to analyze the month-wise species composition. Among the recorded macrofauna, amphipods were dominant (80%), followed by polychaetes (11%), molluscs (7%), crabs (1%), echinoderms and fishes (1%). The brown and red seaweeds showed a higher abundance of amphipods and polychaetes as compared to green seaweeds. Whereas a dominance of gastropods, especially limpets were observed on green seaweeds. Among the seaweeds, highest associated macrofaunal species richness was recorded on *Sargassum* (14 species), followed by *Padina* (13 species) and *Ulva fasciata* (11 species). The present study highlighted the significant macrofaunal biodiversity supported by the seaweeds. The macrofaunal organisms exhibited significant seasonal variations in composition and abundance with various species of seaweeds. Such ecological interdependencies shows the importance of seaweeds in maintaining biodiversity, influencing community structures and overall ecology of rocky shore ecosystems.

Keywords: Seaweed, biodiversity, association, macrofauna

CULTIVABLE BACTERIAL FLORA ASSOCIATED WITH POTENTIALLY TOXIC HAPTOPHYTE- *PRYMNESIUM PARVUM*

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The phycosphere which is the aquatic analogue of the rhizosphere represents an optimal microenvironment for sustaining microbial communities due to its abundance of organic matter and essential molecules required for microbial proliferation. A previously explored aspect involves the cross-kingdom relationship between bacteria and microalgae within this dynamic phycosphere. Algae-bacteria interactions cover the whole range of symbiotic relationships that are deemed possible- ranging from mutualism, and commensalism, to parasitism. This study aims to investigate the diversity of bacteria associated with the monoculture of the haptophyte *Prymnesium parvum*, a microalga known for its ability to form potentially harmful algal blooms. Emphasis is placed on understanding bacterial dynamics across the four phases of algal growth: lag, log, stationary, and decline. Culture-dependent techniques were employed, followed by phylogenetic analysis of partial 16S rRNA sequences, revealing a high similarity (ranging from 99% to 100%) to known bacterial genera. The maximum total bacterial count, reaching 3.05×10^5 cfu/ml, was observed during the stationary phase of the growth period. Conversely, the decline phase exhibited the lowest total bacterial count (1.18×10^5 cfu/ml). The identified genera included *Muricauda*, *Pseudomonas*, and *Mesorhizobium*, representing the classes *Flavobacterium-Cytophaga-Bacteroides* (FCB) Group, *Gammaproteobacteria*, and *Alphaproteobacteria*, respectively. Three phylotypes were isolated from the log and decline phases, with two identified during the log and stationary stages. The bacterial exoenzyme production and hydrolytic properties of amylase, lipase, and gelatinase secreted by bacteria were detected. The susceptibility or resistance of the bacteria to selected doses of Penicillin, Streptomycin, Gentamycin, Kanamycin, and Colistin antibiotics was also tested. This research endeavours to shed light on the potential impact of individual bacteria on their algal hosts, thereby advancing our understanding of the microecological dynamics involved in forming algal blooms.

Keywords: Phycosphere, algae-bacteria interaction, haptophyte, algal bloom



A CATALOGUE OF *SAPPHIRINA* AND *COPILIA* ((FAMILY: SAPPHIRINIDAE; ORDER: CYCLOPOIDA) COPEPODS BASED ON MITOCHONDRIAL COI (MTCOI) SEQUENCES COUPLED WITH ITS MORPHOLOGY FROM A TROPICAL ISLAND OF SOUTH WESTERN INDIAN OCEAN

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The cruise conducted in the spring intermonsoon (premonsoon) of April 2015 in the frame of a funded project epitomized an open ocean survey that allowed procuring a quasi-synoptic picture of Sapphirinid (Family: Sapphirinidae; Order: Cyclopoida) community in 18 open ocean stations of the Minicoy Island, Lakshadweep islands, South-Western Indian Ocean. Aims of this study were to: develop barcodes based on mtCOI sequences of Sapphirinid copepods (genus *Sapphirina* and genus *Copilia*); derive it's molecular systematics; test if morphology supports molecular data. Analysis developed, a total of 33 sequences for 11 Sapphirinid species with primary barcodes of five species of the family Sapphirinidae ie. *S. auronitens*, *S. stellata*, *S. vorax*, *C. hendorffi* and *C. quadrata* reinforced by morphological data. Also, instituted a stepping stone for a Barcode catalogue of marine cyclopoids from South-Western Indian Ocean. Furthermore, confirmed, mtCOI sequencing as an ideal barcode tool for the genus *Sapphirina* and *Copilia*.

Key words: *Sapphirina*, *Copilia*, *Sapphirinidae*, DNA barcoding, Lakshadweep, Minicoy, Indian Ocean

METAGENOMIC ANALYSIS OF HETEROTROPHIC BACTERIAL DIVERSITY ASSOCIATED WITH *MICROCYSTIS* BLOOM FROM SELECTED AQUATIC ECOSYSTEMS OF SOUTH INDIA

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Microcystis is a potentially toxic, globally spread bloom forming cyanobacteria with great research interest due to its ecological and economic importance. Alterations in various environmental parameters, such as temperature, pH, eutrophication, light attenuation etc. are responsible for the bloom formation and toxin production in these colony-forming genera. Several researches have provided a better understanding of the relation between bloom formation and hydrographical parameters. Their mucilaginous colony is an excellent niche for numerous heterotrophic bacteria that share positive or negative interactions with *Microcystis* growth and development. Recent studies have focused on these interactions and their role in developing and persisting *Microcystis* growth and bloom formation. The present study investigated the associated heterotrophic bacterial diversity from two aquatic ecosystems in central Kerala (south India) during the monsoon season with a continuous bloom of *Microcystis*. The metagenomic analysis from the study areas revealed the presence of 24 phyla, 40 classes, 96 orders, 177 families and 158 genera from station 1 and 18 phyla, 23 classes, 71 orders, 84 families and 79 genera from station 2. Proteobacteria was the most abundant phylum in both study areas, followed by Bacteroidetes. The family Burkholderiaceae showed the highest abundance at station 1 and Acetobacteraceae at station 2. *Cetobacterium* sp. was dominant at station 1, while *Roseomonas* sp. was abundant with *Microcystis* at station 2.

Keywords: *Microcystis*, Heterotrophic bacteria, Metagenomic analysis, south India



RECENT TRENDS ON RISING CILIATE EPIZOISM ON ZOOPLANKTON COMMUNITIES ALONG THE SOUTHWEST COAST OF INDIA

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Epibiosis, an interspecific, facultative, non-symbiotic association between two or more organisms, is a remedy for limited substrate availability in the marine environment. Zooplankton, secondary producers of the ocean, endure epibiotic association on their exoskeleton with many organisms such as diatoms, ciliates, dinoflagellates, etc. The present study observed various ciliate-zooplankton associations along five transects of the southeastern Arabian Sea (SEAS), *viz*, off Goa, off Mangalore, off Calicut, off Kochi and off Thiruvananthapuram. The epibiotic ciliates reported were suctorian, *Paracineta karunakarani*, *Lecanophryella satyanandini*, *Acineta euchaetae*, *Acineta karamani* and *Ephelota coronata* in association with different copepod and ostracod hosts (basibionts). *P. karunakarani* and *L. satyanandini* were specifically associated with ostracods, *Cypridina dentata*, along all transects except off Thiruvananthapuram, either individually or collectively, attaching to the dorsal surface of the body shell. Around 1009 ostracods were observed with these suctorian ciliates at a rate of 2-35 ciliates per host along the entire SEAS. *Acineta karamani* was observed epibiotic with copepods, *Labidocera acuta* (4 females, 12 males (off Mangalore), 6 males (off Calicut), 41 males, one female (off Kochi), 6 males, 2 females (off Thiruvananthapuram)), *Calanopia minor* and *Calanopia* sp. (four and three respectively along off Thiruvananthapuram). On the other hand, *Acineta euchaetae* was associated with copepods, *Paracineta concinna* (one female (off Mangalore)), *Euchaeta* sp. (three (off Mangalore and Calicut), two (off Kochi)) and 46 unidentified copepods (off Thiruvananthapuram). *Ephelota coronata* was epibiotic on copepod *Pontella spinipes* (one male). The suctorian ciliates on the copepod mainly occupied the urosome and posterior cephalothoracic region of the host, with an infestation rate of approximately 2- 30 ciliates per host. *P. karunakarani* and *L. satyanandini* are highly host specific to the ostracod *Cypridina dentata*, whereas the other ciliates show specificity towards calanoid copepod but not to specific genera or species based on the previous literatures. The high number of ciliate-zooplankton associations along the southeastern Arabian Sea suggests extensive research on epibiosis in the planktonic group to understand their role in zooplankton population dynamics and structuring of the marine environment.

Keywords: Ciliate, ostracod, copepod, epibiosis, Arabian Sea



FROM PLANKTONIC HOTBEDS TO FISHERY HARVESTS: UNRAVELING THE COASTAL DYNAMICS OF SOUTHERN INDIA

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In an unprecedented effort, this study investigated the spatial dynamics and distribution of phytoplankton, zooplankton, and associated fishery resources in the coastal and offshore waters of the Bay of Bengal. Comprehensive sampling was conducted across stations along the Tamil Nadu and Pondicherry coast to examine species composition, abundance, diversity, and role in primary, secondary, and tertiary production. Findings revealed significant heterogeneity in plankton communities, with hotspots of diversity and productivity in regions like Pondicherry and Sethubavachattram. Crucially, chlorophyll, inorganic nutrients, and physical parameters exhibited substantial variability, profoundly influencing planktonic assemblage structure and dynamics. Diversity indices highlighted community complexity and evenness, providing insights into ecological resilience. Numerous species of zooplankton and phytoplankton were identified by taxonomic investigations. Notably, biomass estimations revealed substantial variations, with Mimal and Pondicherry exhibiting exceptionally high phytoplankton biomass, potentially indicative of blooms. Intriguingly, zooplankton biomass, though lower, exhibited patterns linked to phytoplankton abundance and water quality. The study documented fish species availability and distribution across locations, shedding light on plankton-fishery linkage. The findings contribute to understand the relationships between plankton, water quality, and fisheries in the Bay of Bengal region. In future the generated data will be modified into models and aid monitoring coastal ecosystem health, promoting sustainable fisheries and conservation. Spatial patterns in diversity, biomass, and community structure emphasize the need for comprehensive sampling and ecosystem-based management approaches to sustain marine resources.

Key word: Phytoplankton, Zooplankton, Saptial distribution, Diversity, Fishery resources

AN ENSEMBLE MODELING APPROACH REVEALS THE MOST SUITABLE NICHES OF *THALASSIA HEMPRICHII*, THE DOMINANT PRIMARY PRODUCER IN COASTAL SEAGRASS COMMUNITIES OF THE INDO-PACIFIC REGION

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Coastal ecosystems, including seagrass, are declining globally. To enhance success, mitigation strategies such as restoration and managed recovery interventions should be informed by an understanding of the environmental niche and geographic boundaries of key species. *Thalassia* is the dominant primary producer in tropical coastal seagrass communities, although other macrophytes like symbionts epiphytic diatoms also contribute to the total community production. This paper presents a species distribution model (SDM) to quantify relationships between environmental variables and habitat suitability of seagrass species *Thalassia hemprichii* of the Indo-Pacific region using unbalanced presence-absence data common in ecology. Ensemble forecasting for species distribution modeling, utilizing the Biodiversity Modelling (BIOMOD2) platform, is conducted to ascertain the distribution of *T. hemprichii*. A total of twelve different modelling algorithms were employed to evaluate the existing distributional patterns of *T. hemprichii* with selected eight variables. The method involved calibrating models using 80% of the data as a training set and assessing performance with the remaining 20% as the validation set. Cross-validation was employed using Area under the Curve (AUC) and True Skill Statistics (TSS). Ensemble models were constructed by combining outputs with models having TSS ≥ 0.8 selected for the ensemble. The results of ensemble modelling indicates that the distribution is majorly influenced by maximum silicate concentration, followed by minimum salinity. These factors contribute to high habitat suitability in the coral triangle region. The developed habitat suitability model can support conservation and monitoring programs regarding this species playing a crucial role in the marine ecosystems of the Indo-Pacific region as a dominant primary producer.

Keywords: Modelling, Primary producers, Habitat, Indian Ocean, Seagrass



RECORD OF RARE JOBFISHES FROM THE SOUTHWEST COAST OF INDIA

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Snappers of the family Lutjanidae contain several of the most important reef-fishery species. Species belonging to the genus *Pristipomoides* are economically important demersal species that are largely distributed along the southwest coast of India. The goldflag jobfish *Pristipomoides auricilla* and the goldbanded jobfish *Pristipomoides multidens* show an occasional occurrence along the coast. There are significant gaps in both systematic and ecological data about these rare species. *P. auricilla* and *P. multidens* were recently recorded from the southeastern Arabian Sea off Kochi, India. Key identification characters of *P. auricilla* include a triangular-shaped tooth patch on the vomer, vertex pointing forward, and the absence of a tooth patch on the tongue. The species also has a 1st-gill arch with gill rakers 10 on the upper limb and 19 on the lower limb and lateral line scales 74. *P. multidens* is characterised by the presence of a triangular vomerine tooth patch with no posterior extension, and the tongue not covered with tooth patch. The study provides the first comprehensive taxonomic description of *P. multidens* and *P. auricilla*, advancing our understanding of snapper diversity along India's southwest coast region.

Keywords: Diversity, Snappers, Arabian Sea, *Pristipomoides auricilla*, Vomerine tooth patch, *Pristipomoides multidens*, Fishery

ASSESSMENT OF HEAVY METAL CONCENTRATION IN THE TISSUE OF EDIBLE OYSTER FROM AYIRAMTHENGU MANGROVE FOREST

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Ayiramthengu mangrove forest is situated in Kollam district of Kerala, covering an area of 25 acres. It is a part of Kayamkulam backwater, adjacent to Arabian sea and was declared as an environmental hotspot after the Tsunami in 2004, by the Government of Kerala. Heavy metal contamination is a global issue and are consistently released into aquatic environments, where they can accumulate in both water and sediment. Bivalves are identified as promising biomonitoring organisms for heavy metal pollution in aquatic ecosystems due to their widespread distribution and sedentary lifestyle. This study investigates the concentrations of heavy metals in edible oyster (*Crassostrea* sp.), its surrounding water and sediment. It helps to assess potential health risks associated with its high consumption rate. The evaluation of the concentrations of nine trace elements (Zn, Cu, Ni, Co, Fe, Mn, Cr, Pb and Cd) in oyster tissue, water and sediment of the site were analysed using ICP-OES, during September 2023. The concentration of heavy metal in the tissue of oyster confirms bioaccumulation, with high levels of Pb (1.614 ppm) and Cd (2.137 ppm), followed by other elements which are higher than the European Union permissible limit of 0.5 mg kg⁻¹ for Pb and 1 mg kg⁻¹ for Cd. Sediment samples show elevated concentrations of Cr (36.554 ppm) and Pb (4.164 ppm). While water samples exhibit high levels of Fe, Zn, and low levels of Pb, Cd. Thus, the study underscores the importance of proactive measures to safeguard both ecosystem health and human well-being.

Keywords: Mangrove, Heavy metal, Edible oyster, Bioaccumulation

DISTRIBUTION PATTERN OF *EMERITA* spp ALONG THE COAST OF THOTTAPPALLY, ALAPPUZHA DISTRICT, KERALA

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Emerita spp. (Order Decapoda; Family Hippidae), commonly known as sand crabs, are macrobenthic organisms present in the tidal wash zones of beach ecosystems. They play important roles in marine ecosystems, such as nutrient cycling, dispersion and burial of sediments, and secondary production. These organisms have a short life span of 2-3 years and have the ability to reproduce in the first year of its life. The present study involves the seasonal distribution of sand crabs along the Thottappally beach during 2023. Thottappally is known as Kuttanad's drain way out to the Arabian sea and have a small seasonal estuary formed by river Pamba. A total of 643 sand crabs were obtained during the study period, among them 54% were male and 46% were females. Males were in large numbers in the pre-monsoon period whereas females dominated in the monsoon period. The total length of *Emerita* collected ranged from 5 mm – 48 mm and total weight ranged from 10 mg to 3380 mg. Females are larger than males in which the size of females ranged from 11 mm (50 mg) to 48 mm (3380 mg) and males ranged from 5 mm (10 mg) to 25 mm (650 mg). Mean size of *Emerita* in the collection during Pre-monsoon, Monsoon and Post-monsoon were found to be 17.115 ± 5.046 , 18.983 ± 3.943 and 17.958 ± 5.793 respectively. This species reported as a protandric hermaphrodite and the present results also supports it.

Key words: *Emerita*, Seasonal distribution, Marine ecosystem



MARINE FISH MONITORING FROM FISHING VESSEL USING COMPUTER VISION FOR THE CONSERVATION OF FISH SPECIES

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Tuna and tuna-like fish species are consumed all around the world. Fishing activities of tuna and tuna-like species happen in high seas and Exclusive Economic Zones (EEZs) coastal states. Illegal and unregulated fishing activities are the leading cause of threat to tuna and tuna-like species. Based on the oceanic region, many organizations like the Indian Ocean Tuna Commission (IOTC), The Inter-American Tropical Tuna Commission (IATTC), etc, are taking measures to prevent illegal and overfishing of tuna and tuna-like fishes with the help of its consortium member countries. Based on the fish stock status provided by its member countries, these organisations prepare policies for member countries to conserve the fish species. The fish stock is measured mainly when the fish capture is reported at a commercial fish landing site. To boost the blue economy, many coastal countries allow foreign vessels to do fishing activities in EEZs under the letter of permission (LoP). These foreign vessels' unregulated and unreported fishing caused the extinction of fish species and fish availability for the next season, and it also affected the livelihood of coastal people. Also, many of its member countries often fail to report their fish catch information to conservation agencies. This has caused fish conservation agencies to draft policies to conserve fish species efficiently. Computer vision can play an important role in monitoring and conserving fish species from illegal and unregulated fishing activities. It can detect different fish species from the onboard camera attached to the vessel, and fish catch information can be automated. In this research, we have experimented with a computer vision algorithm, YOLO (You Look Only Once), to detect tuna and tuna-like species from the images. This model has detected different fish species from the image and achieved a Mean Average Precision (MAP) of 0.89 with 31 frames (fps).

Keywords: Fish detection, Computer Vision, Deep learning, YOLO for fish detection

SOFT CORALS (ORDER- MALACALCYONACEA) OF THE LAKSHADWEEP ARCHIPELAGO, INDIA: DNA BARCODING USING MTMUTS MITOCHONDRIAL GENE

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Soft corals are the second most abundant group of animals in the coral reef system. The soft corals order-Malacalcyonacea comprises 46 families. Most soft coral species belong to the genera *Sinularia*, *Sarcophyton* *Sclerophytum* and *Lobophytum* in the Lakshadweep Archipelago. Previously 37 species of soft corals were reported from Lakshadweep. The identification of the soft corals is based on morphological characters. We used partial DNA sequences of the mtMutS genes obtained from seven species belonging to the families Cladiellidae, Nephtheidae, Sarcophytidae and Sinulariidae for confirmation of the species. Each species was validated by comparing sequences from GenBank. Phylogenetic analysis was conducted using a maximum Likelihood tree (ML) and the genetic distance was determined by the Kimura two-parameter model (K2P). In this study, we investigated the genetic diversity of soft corals in Lakshadweep for the first time. The result indicated that seven studied species were grouped into six clades, including *Cladiella*, *Sinularia*, *Dendronephthya*, *Sclerophytum*, *Lobophytum* and *Sarcophyton*. The average K2P distances between the clades range between 6 to 13%. Of the seven species collected during the present study, four species are new distributional records to the Lakshadweep Archipelago. Monophyly of the Order Malacalcyonacea was resolved from our analysis. The initial results of this study are expected to support the conservation of soft corals in the Lakshadweep Archipelago.

Keywords: Phylogeny, Molecular, Taxonomy, Octocorallia, Mitochondrial DNA

FEEDING ECOLOGY OF SURGEONFISHES (FAMILY: ACANTHURIDAE) FROM ANDAMAN ISLANDS

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Many previous studies have indicated that as reef ecosystems decline, only the generalist species have better chances of survival. However, detailed studies of feeding specificity and feeding ecology of reef fishes from India are comparatively less. In this background, a study was conducted to understand the feeding ecology of five reef fishes. Pilot studies were conducted and *Acanthurus triostegus*, *A.lineatus*, *A.nigicauda*, *Ctenochaetus striatus*, *Zebrasoma scopas* from the Andaman Islands were selected. A detailed feeding ecology study was conducted through underwater surveys, experimental ecology and laboratory analysis. Underwater studies were used to understand preferred food, shoaling behaviour, feeding patterns and territoriality. Live specimens were housed in glass aquaria and feeding trials were conducted to document feeding patterns. Gut content analysis was used to determine dietary preferences, diet overlap, diet breadth and trophic levels. *Enteromorpha clathrata*, a green filamentous alga was the most prevalent dietary item in the gut contents of all the surgeonfish species. The trophic levels ranged from 2 (*A.triostegus*) to 2.14 (*C.striatus*). Analysis showed that all surgeon fishes in the study were herbivores/detritivores. *Acanthurus triostegus* had the lowest diet breadth, preferring only turf algae. *C.striatus* had the highest diet breadth in the study (2.38) owing to its consumption of detrital matter and epilithic algal matrix. *C.striatus* was the only scraper, while all the other surgeonfish species were browsers exhibiting nipping behaviour during feeding. The results of the present study provide a strong baseline for future ecological studies.

Key words: Reef fishes, Herbivorous fishes, Gut content analysis, Trophic levels

DISTRIBUTION AND DRIVERS OF RECENT MASS MANGROVE DIEBACK IN MALDIVES

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Maldives has recently been impacted by a mass dieback of mangroves in its northern islands, particularly the *Bruguiera* species, which holds historical and cultural significance to the local community. There are significant concerns regarding the consequences of such an incident, considering the vital ecological and economic roles played by mangrove ecosystems, as well as the challenges in handling policy and management in the face of the sudden depletion of natural resources, affecting both local and regional levels. In response, this study documented the mangrove distribution and zonation, land use/land cover, as well as the environmental, oceanic, and climatic factors of the affected and control islands. Field and drone-based aerial surveys revealed that a total of 22.12 ha of mangrove area and 44267 trees/ha *B. cylindrica* have died off. Increased soil salinity resulting from elevated temperatures, prolonged drought caused by the triple La Niña phenomenon, and negative Indian Ocean dipole, as well as localized sea level fluctuations are responsible for the massive die-back of mangroves. The study's results offer clear proof that mangroves are highly susceptible to drastic shifts in sea level and climate change, emphasizing the need for their conservation whenever feasible.

Keywords: Die-back, Indian Ocean Dipole, La Niña, Maldives, Mangroves, Sea level rise, Salinity



REEF FISH DIVERSITY IN LAKSHADWEEP LAGOONS: A COMPARATIVE ANALYSIS OF AGATTI AND KAVARATTI ISLANDS

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This study employs Underwater Visual Census (UVC) to quantify seasonal and spatiotemporal patterns in reef fish diversity and also the trophic structure within the lagoons of Agatti and Kavaratti Islands, Lakshadweep. Across pre- and post-monsoon seasons, a total of 58 species were documented. Both islands supported 33 species during the pre-monsoon season. Post-monsoon surveys revealed a slight decline, with 31 and 30 species recorded in Agatti and Kavaratti, respectively. While some species overlapped, dominant taxa differed significantly (38% dissimilarity) between lagoons. Notably, *Chlorurus sordidus* emerged as the dominant herbivore in Kavaratti, while *Stegastes nigricans* held dominance among omnivores in Agatti. Overall species richness was also higher in Agatti. Trophic analysis revealed a contrasting pattern, with Kavaratti exhibiting a predominance of herbivores, suggesting a potential resource-driven influence. This data provides valuable insights into the ecological health of these coral reef ecosystems. The findings contribute to understanding resident fish assemblages and their dynamics, crucial for monitoring long-term changes and formulating effective conservation strategies for sustainable resource management and habitat preservation within Lakshadweep.

Key words: Lakshadweep islands, Underwater Visual Census, reeffish assemblage, trophic structure

ASSESSMENT OF THREATS TO POINT CALIMERE MARINE KEY BIODIVERSITY AREA (KBA) IN THE SOUTHERN INDIA

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Coastal wetlands are low-lying stretches of land saturated with water. This transition zone between the land and the open sea serve as a major habitat, feeding and breeding grounds for many aquatic species. They are the ecosystem located along the coastlines that are affected by urbanization. Hence, it is important to analyze the natural and anthropogenic factors that affect the aquatic ecosystem of the wetland. Present study was conducted to analyse decadal wise changes (2003-2023) in Point Calimere wetland Ramsar site which having been designated as a marine Key Biodiversity Area (KBA) in 2014. Present study identified various natural and anthropogenic stressors that affected the ecosystem and suggested conservation efforts to protect the ecosystem. The natural factors such as sea level rise, cyclone, storm surge, shoreline change, irregular precipitation and sudden temperature changes were damaged the basic characteristics of the wetland ecosystem. Increased anthropogenic factors like agricultural and aquaculture activities, urbanization and encroachment activities lead to sedimentation, exotic species invasion, pollution, habitat destruction and reduction in the area of wetlands. Results of the present study indicated that anthropogenic activities during recent decades were more vulnerable to the ecosystem. Hence present study suggested serious conservation measures towards restoration of marine habitat and estuarine ecosystem.

Keywords: Anthropogenic activities, Coastal wetland, Ramsar site, Urbanization

REPRODUCTIVE BIOLOGY OF CARANGIDS OCCURRING ALONG THE INDIAN COAST: A BRIEF REVIEW

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An attempt was made in the present article to review the reproductive biology of the fishes of the family Carangidae from Indian waters. Carangids commonly known as jacks, trevallies, scads, queen fishes, runners, amberjacks and pompanos constitute commercially one of the most important food fishes in our country. The family is represented by 62 species and 21 genera. They are well distributed in tropical and subtropical regions of Atlantic, Pacific and Indian oceans. Carangids from Indian waters are reported to attain maturity at 113-270 mm TL. Sexual maturation evidently occurs at a slightly smaller size in males than females. In some species such as *Megalaspis cordyla*, *Atule mate* etc. females outnumber males while in some species like *Atropus atropos*, *Alepes djedaba*, *Decapterus russellii* etc. males outnumber females in commercial catches. They are highly fecund, with fecundity ranging from 16458 to 324292 ova. GSI and ova-diameter studies show that most of the carangids are multiple spawners spawning at least twice or thrice in an extended spawning season. Peak spawning in most carangids occurs during March- May prior to southwest monsoon along the West coast and September- November prior to southeast monsoon along the East coast.

Key words: Reproductive biology, Carangids, Indian coast

WATER QUALITY ESTIMATION OF BEACHES IN KOCHI, SOUTH WEST COAST OF INDIA USING CHANGES IN PHYTOPLANKTON COMMUNITY STRUCTURE

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Phytoplankton community structure is sensitive to changes in water quality. The present study aims to investigate the influence of hydrographic parameters and nutrient dynamics on the phytoplankton distribution patterns of seven beaches of Kochi on the coast of south-east Arabian Sea. Water and plankton samples were collected for one year (August 2022 - July 2023) from seven beaches of Kochi that are known either as tourist or fishing beaches. Phytoplankton community structure and total abundance showed notable seasonal variations, with monsoon season having the highest phytoplankton abundance and pre-monsoon having the least abundance. With the exception of Chellanam, where dinoflagellates dominated during the post-monsoon season, all the stations had diatoms as the dominant group in all seasons. The analysis revealed that pH exhibited an inverse correlation with the abundance of all major phytoplankton groups such as diatoms, dinoflagellates, cyanophytes and euglenophytes. Silicate demonstrated a positive correlation with diatom abundance, whereas phosphate and ammonia had an inverse relation with the abundance of diatoms and dinoflagellates. Anthropogenic activities such as tourism, fishing harbour activities and sewage input into nearshore waters upset the phosphorus and ammonia concentrations, leading to fluctuations in phytoplankton community structure. The microbial pollution data of the stations also indicated that the phytoplankton abundance was lesser in polluted waters. The findings underscore the relevance of biological indices in evaluating water quality and overall ecosystem health.

Keywords: Coastal Ecosystem, Ocean Productivity, Nutrient Cycling, Hydrochemistry, Ocean Bio-Optics

EXPLORING SEAWEED AND MOLLUSCAN DIVERSITY AND DISTRIBUTION IN ST. MARY'S ISLANDS, UDUPI: A PRELIMINARY STUDY

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St. Mary's Islands, located off the coast of Udupi, Karnataka, India, is recognized for its exceptional biodiversity. Despite its significance, studies focusing on the diversity and distribution of seaweeds and molluscs in this area remain limited. This preliminary study aims to address this gap by systematically exploring the seaweed and molluscan species inhabiting the intertidal and subtidal zones of St. Mary's Islands. During the study, third-year B.Sc. Aquaculture students from the Research Department of Fisheries and Aquaculture (RDFA), St. Albert's College (Autonomous), collected samples from the study site. Analysis of the collected samples revealed the presence of six species of seaweeds, including *Sargassum* sp., and a diverse molluscan fauna comprising ten species of gastropods, six species of bivalves, and five species of clams. Furthermore, this study provides valuable baseline data on the seaweed and molluscan diversity of St. Mary's Islands, emphasizing the importance of conserving this ecologically significant area. The findings contribute to a broader understanding of coastal ecosystems and may facilitate the formulation of effective conservation strategies for preserving biodiversity hotspots such as St. Mary's Islands. Additionally, detailed descriptions of *Hecuba scortum* (Linnaeus, 1758) are provided herewith, enriching the understanding of the molluscan fauna found in this region.

Keywords: Seaweed diversity, Molluscan diversity, *Sargassum* sp. *Hecuba scortum* St. Mary's Islands, India

NEW RECORD AND MOLECULAR PHYLOGENY OF MORPHOLOGICALLY
COMPLEX GENUS *COENOBITA* (ANOMURA: PAGUROIDEA: COENOBITIDAE)
FROM KERALA COAST, INDIA

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Approximately 60 species of anomuran crabs have been recorded from the Kerala coast, including *Coenobita brevimanus* Dana, 1852, and *Coenobita rugosus* H. Milne Edwards, 1837. The family Coenobitidae includes two genera of terrestrial or semiterrestrial hermit crabs, both of which undergo marine larval stages, with early juveniles being entirely aquatic. Members of the genus *Coenobita* are typical hermit crabs that carry a gastropod shell to protect their soft, asymmetrically coiled pleon. This study reports the new occurrence of *Coenobita violascens* Heller, 1862, from the mainland coasts of India. The identification was confirmed through molecular characterisation. The sample was collected from a mangrove forest in Thalassery (11.45.57.2 N, 75.28.34.6 E) along the southwest coast of India and tissue samples from the pereopods were preserved in 90 percent ethanol for molecular characterisation. The standard identification features are: left cheliped is consistently more considerable than the right, and the antennule's upper flagellum ends in a blunt, stick-like article, with maxillipeds 3 adjacent at the base. Molecular characterisation was done using a standardized 650 bp sequence of cytochrome oxidase subunit 1 (COI) of mitochondrial DNA as a barcoding tool for confirming species. The phylogenetic tree was constructed based on a neighbor-joining tree analysis that shows species-level distances using existing sequences of different species from NCBI.

Keywords: *Coenobita violascens*, New Record, Kerala Coast, Molecular Phylogeny



EXTENSIVE BLOOM OF THE PRYMNESIOPHYTE *PHAEOCYSTIS* AND ITS IMPACT ON PLANKTON DYNAMICS: A CASE STUDY FROM THE COASTAL WATERS OF NORTHERN BAY OF BENGAL

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A dense bloom of vivid green colouration was detected along the northern coastal waters of the Bay of Bengal during the winter monsoon period (December 2022). Analysis of samples collected from the Digha coast and Subarnarekha estuary revealed a significant prevalence of the marine Prymnesiophyte *Phaeocystis* sp., constituting a predominant proportion (> 80%) of the microplankton population within the bloom area. This bloom event coincided with a notable decrease in the abundance of other microplankton and mesozooplankton groups. Elevated levels of inorganic nutrients and chlorophyll were recorded within the bloom regions. While diatoms were abundant among the microplankton, dinoflagellates, radiolarians, ciliates, and copepod nauplii were relatively less. There was a decline in the mesozooplankton population with copepods, bivalves, and chaetognaths being sparsely represented. The *Phaeocystis* cells observed during this study were predominantly in colonial form, embedded within gelatinous matrix. The mechanical disturbance of zooplankton mouthparts caused by the colony mucus likely led to the active rejection of the colonies by the zooplankton, resulting in the avoidance of the bloom area by zooplankton communities. This, in turn, could have facilitated the flourishing and persistence of the bloom in this area. Bioluminescence was observed at both sampling stations, prompting consideration of its potential role in reducing grazing pressure on the blooming species. Foam formation was absent during the blooming period. However, the significant impact of algal blooms on fishing activities in the region, particularly due to net clogging, was evident. This led to the suspension of fishing activities in the affected areas for over a fortnight. Consequently, it appears crucial to ascertain whether the observed increase in *Phaeocystis* blooms globally over the years, and the projected expansion into eutrophicated coastal waters of India in the future, will impact marine food chains, the fisheries sector, and the national economy.

Keywords: *Prymnesiophyte, Phaeocystis, algal bloom, plankton dynamics, northern Bay of Bengal*

JUVENILE ESTIMATION OF *COILIA DUSSUMIERI VALENCIENNES, 1848* FROM DOLNET CATCH OFF MUMBAI COAST

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The presence of *Coilia dussumieri* is of considerable importance to the dolnet fishery along the Mumbai coast, serving as a vital element of the local catch. This species holds significance as a primary food source, whether it is consumed fresh or in its dried form within the local community. Moreover, its ecological role extends to the maintenance of a balanced oceanic food web. Fishermen in Mumbai employ either single day or multiday dolnetters in their fishing practices, utilizing nets with smaller mesh sizes that often result in the capture of juveniles. To assess the potential impact of growth overfishing on the species, the monthly juvenile proportion of *Coilia dussumieri* was estimated across three sites - Madh, Versova, and Manori. The study was based on 461 specimens of *Coilia dussumieri* collected from January 2023 to June 2023 from the traditional dol net fishing grounds of Madh, Versova and Manori. It was observed that *Coilia dussumieri* attains first maturity at a total length of 14.2 cm for males and 14.4 cm for females. As a result, individuals measuring below these defined lengths were recorded and classified as juveniles. The month wise juvenile percentage calculated for *Coilia dussumieri* were 71.52% (January'23), 56.7% (February'23) 44.29% (March'23), 62.51% (April'23), 54.48% (May'23) and 72.20% (June'23). The research findings revealed that among the three sites surveyed, Manori consistently showed the highest proportion of juveniles within the catch for most months, except for April. Versova and Madh exhibited relatively lower counts of juveniles throughout the observed period. This study, which specifically examined the percentage of juveniles, provides valuable insights into the potential effects of growth overfishing associated with dolnet usage. The results have significant implications for understanding the magnitude of losses and can help in the development of strategic management interventions to sustainably manage the targeted species.

Keywords: Dolnet, Growth overfishing, *Coilia dussumieri*, Mesh size, Monthly juvenile proportion



SPATIAL VARIATION OF MESOZOOPLANKTON DISTRIBUTION ALONG THE WEST COAST OF INDIA

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With a wide range of grazing patterns and adaptable feeding techniques, mesozooplankton constitute a complex assemblage that includes herbivores, omnivores, and carnivores. The primary objective of this investigation was to gain insights into the distribution and community composition of mesozooplankton along the west coast of India. The samples were collected from February to March 2023, focusing on three distinct regions: Alappuzha (Kerala), the Malpe-Udyavara stretch (Karnataka), and the Gulf of Kutch (Gujarat). The study centered on assessing spatial variations in mesozooplankton abundance and biomass in relation to key physico-chemical parameters such as temperature, salinity, and pH. During the sampling period, salinity levels increased from north to south along the coast. Mesozooplankton biomass showed a north-to-south decrease and copepods were the predominant group across all stations. Additionally, Malpe-Udyavara exhibited a notably high abundance of cladocerans, likely due to the ample availability of their preferred food sources and the extensive presence of estuarine environments in these areas. Malpe-Udyavara stretch showed higher biomass and abundance when compared to Alappuzha, and relatively lesser biomass and higher abundance when compared to Gujarat, which indicates a higher secondary productivity in that region due to the crustacean plankton.

Keywords: mesozooplankton abundance, composition, crustaceans, coastal waters, Arabian Sea



MICROPLASTIC ANALYSIS FROM SEDIMENTS OF SOUTHWEST COAST OF INDIA

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Marine plastic debris has become a matter of growing global apprehension due to its widespread presence, resistance to degradation, and exceptionally sluggish breakdown process. This investigation provides information on microplastic (MP) contamination originating from the underwater sediments of the Arabian Sea. It indicates a more prevalent occurrence of MPs in the benthic surroundings of the Arabian Sea and underscores the worldwide dispersion of plastic waste. 23 study areas were selected from the southwest coast of India. Subaqueous sediment samples were retrieved through the utilization of grab sampler and the sediment types were meticulously documented. The density floatation technique was employed to extract the MPs, which were classified based on the shape, colour, and the total count at each station. By means of statistical and geostatistical analysis, it was determined that the study area off Mangalore exhibits a greater abundance of microplastics. Notably, fibers and their fragmented counterparts, characterized by irregular shapes and varying colors, were found to be more prevalent. This observation suggests that majority of the microplastics in the Southwest coast of India primarily originate from the fisheries industry. Furthermore, it has been observed that the microplastic density is comparatively lower at greater depths, and that fine-grained sediments tend to capture a greater number of microplastics. Density analysis of the sediments by spatial interpolation techniques using ArcGIS software indicated that the study area off Managalore recorded the highest density per unit area of 3061.98 m^{-2} . This study provides an insight into the extent of plastic pollution along the southwest coast of India.

Keywords: Microplastics, Arabian Sea, Spatial Tool, Density Analysis

SWARM OF HYDROZOA IN THE NETTOOR REGION OF CENTRAL VEMBANAD LAKE, KERALA

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Hydrozoans, the potential indicators of marine pollution, inhabit marine and estuarine waters. Studies on hydrozoans from Vembanad lake date back to early 1990s. Recent observations have not been reported. In view of this, we conducted a comprehensive study, integrating water quality parameters and spatial modeling using IDW interpolation. Our focus was to understand the dominance patterns of hydrozoa species in Vembanad lake system. The results provide valuable insights for conservation efforts in this unique aquatic ecosystem. The data provided is from the Nettoor region. Based on the environmental parameters measured in this region, we analyzed the conditions and assessed their favorability for a potential hydrozoa swarming behaviour. The observed pH value of 6.93 falls within the slightly acidic range, which can be tolerable for many hydrozoan species. The salinity level of 20.3 ppt is within the typical range for marine environments, making it suitable for most hydrozoan species adapted to oceanic conditions. The water temperature of 32.7°C and surface temperature of 32.9°C are relatively high, indicating warm water conditions. These elevated temperatures can promote the growth and reproduction of hydrozoan species that prefer warmer waters. The observed high phosphate level of 379.755 µmol/L may have stimulated phytoplankton growth, providing a rich food source for the hydrozoa. The chlorophyll α concentration of 32.332 µg/L further supports this observation. The sampling station was highly polluted due to sewage influx into the region and hence the negative dissolved oxygen value of -0.89 mg/L is a matter of concern, as it indicates hypoxic conditions. From the primary analysis the hydrozoa belong to the genus *Eirene* and further analysis is being carried out for ascertaining the species. The observed temperature rise, pollution and subsequent nutrient influx could possibly be the reason for the observed swarm of hydrozoa.

Keywords: Hydrozoa, Vembanad lake, Nettoor, Eirene, Indicator

LIQUID TREE: AIR QUALITY ENHANCEMENT USING MICROALGAE

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The Liquid3, also known as the liquid tree, is an innovative solution developed by Serbian scientists to combat greenhouse gas emissions and improve air quality in urban environments. This urban photobioreactor utilizes microorganisms, specifically microalgae, to sequester carbon dioxide and produce oxygen through photosynthesis. The system is equipped with a solar-powered lighting system, enabling continuous photosynthesis even during winter months with limited sunlight. Key components of its design include a pressure pump and bubble column, which intake polluted air and deliver CO₂ to the microalgae. The technology not only reduces CO₂ levels but also enriches the atmosphere with oxygen. Additionally, the microalgae have biosorption capabilities, effectively filtering out harmful heavy metal contaminants from the air. A solar-powered temperature regulation system is integrated into the photobioreactor to ensure optimal conditions for microalgae growth. Algal biomass has recently emerged as a potential source of bioenergy and valuable derivatives. Microalgae, being autotrophic microorganisms, can convert CO₂ into carbohydrates and lipids through photosynthesis. The present study, undertaken on similar lines, involves three marine planktonic microalgae, *Nanochloropsis salina*, *Isochrysis galbana*, and *Chaetoceros calcitrans*. The microalgae were cultured in f/2 medium at 25±2°C, 35 ppt salinity and 12:12 hour photoperiod (light/dark cycle). The chlorophyll content was determined by spectrophotometric method and carbon dioxide assimilation by titration method. This study revealed that *C. calcitrans* has the highest growth and carbon dioxide assimilation potential. Making it as a suitable candidate species for liquid tree. The Liquid3 represents a significant advancement in sustainable urban development, offering a promising pathway towards a cleaner, healthier future. It actively contributes to environmental remediation by absorbing various harmful gases. As cities strive to mitigate pollution and combat climate change, solutions like Liquid3 are increasingly important. The cultivation of microalgae like *C. calcitrans* could help an integrated approach towards climate change mitigation through carbon sequestration.

Keywords: Liquid tree, Greenhouse gas, Air quality, Microalgae, CO₂ sequestration, Biosorption, Algal biomass, CO₂ assimilation, Pollution mitigation, Climate change, carbon sequestration

CHARACTERIZATION OF EXTRACELLULAR POLYMERIC SUBSTANCES FROM BIOFILM CULTIVATED FROM PLASTIC-ASSOCIATED MICROALGAE OF VEMBANAD LAKE

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Microalgae secrete biofilm composed of extracellular polymeric substances (EPS), primarily containing polysaccharides, proteins, and lipids. These EPS play crucial role in immobilizing cells, stabilizing films, supporting adhesion on solid surfaces, and contributing to plastic degradation. The present study is focussed on the characterization of biofilms cultivated *in-situ* from plastic-associated microalgae obtained from Vembanad Lake. The abstract of our study encompasses a thorough examination of a biofilm using various analytical techniques. Scanning electron microscopy (SEM) reveals the intricate structure and architecture of the film. Fourier-transform infrared spectroscopy (FTIR) identifies chemical compositions, notably Chlorine-Substituted Compounds (C-Cl) exhibiting polar interactions, C=C bonds indicating pi-pi interactions, and NH (amine) bonds displaying strong intermolecular forces, which contribute to secure adhesion to surfaces without detachment. The coupling of diatoms to silica surfaces with complementary chemical functionalities enhances adhesion, facilitated by CH, OH, C-H, C-O groups. These findings elucidate the film's strong adhesion properties to diverse plastic materials such as polypropylene (PP), polyethylene (PE), polyurethane (PU), polyethylene terephthalate (PET), low-density polyethylene (LDPE), and polystyrene (PS). Additionally, biochemical assays unveil the saccharide, lipid, and protein content within the biofilm, providing a comprehensive understanding of its composition and adhesion mechanisms. This integrated approach allows us to gain a deeper understanding of the mechanisms underlying the plastic-degrading function of biofilms. By elucidating the interactions between micro algae derived biofilms and different plastic materials, we contribute to the development of sustainable solutions for plastic waste management. Key findings from our study include the identification of specific functional groups within the biofilm that facilitate adhesion and degradation of plastics, highlighting the potential for utilizing biofilm-based strategies in mitigating plastic pollution.

Keywords: Microalgae, Biofilm, Extracellular Polymeric Substances (EPSs), Sustainable Solutions, Plastic Waste Management.

AN EXPLORATORY ASSESSMENT OF ECOLOGICAL GOODS AND SERVICES PROVIDED BY CORAL CARBS FOR SUSTAINING THE HEALTH OF CORAL ECOSYSTEMS

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Health of coral ecosystems depends on the synergistic relationships between the host corals and associated fauna. The diversity of inhabiting fauna and their self-regulating processes for maintaining homeostasis through sharing of resources and complementing in enhancing the ecological integrity lead to sustainability of coral reefs. Studies on assessing the role of natural and anthropogenic factors on coral health, especially those pertaining to the functional ecosystem services provided by these supporting faunas was found warranted. Coral crabs are one such group that show a great diversity in coral ecosystem and perform a wide range of functions to support coral reefs. In this exploratory study, we assess the diversity, distribution and ecological services provided by coral crabs to the reef ecology of Lakshadweep archipelago. Our literature survey shows a total of 169 species of brachyuran crabs from Lakshadweep mostly of the family Xanthidae (36.1%), Portunidae (13.6%) and Leucosiidae (4.7%). They mostly function as obligate symbionts, protecting the corals from the attack of corallivores, clearing sediments from coral surface and facilitating water circulation. In return they receive mucous secreted by the corals as food and shelter. The accumulation of sediment on coral tissue is known to reduce metabolic and tissue growth rates of coral, increasing the probability of bleaching and coral death. Within the reef habitat, some crabs are associated exclusively with the live corals especially the branching corals of the genera *Pocillopora* and *Acropora* as ecto or endocommensals. With the instances of coral bleaching increasing, the survivability of coral crabs is also in peril. Though of late there has been considerable efforts to rebuild or rehabilitate bleached coral patches, mere transplantation processes cannot bring back the natural health of coral. Hence concerted efforts need to be taken to introduce these 'sentinel ecological engineers' to reefs to restore coral health.

Key words: Corals, Coral crabs, Symbionts, Ecosystem services, Predation

SEASONAL VARIATION AND ABUNDANCE OF PHYTOPLANKTON ALONG THE COASTAL WATERS OF SOUTHWEST COAST OF INDIA, OFF KASARGOD

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Phytoplankton diversity along the coastal waters of Kasargod, Kerala was studied for one year, from April 2023 to March 2024. A total of 120 species of phytoplankton belonging to 54 genera, and seven classes were recorded. The dominant taxonomic group identified was Bacillariophyceae (72%) followed by Dinophyceae (16%) and Chlorophyceae (11%). Seasonal variations in phytoplankton diversity were noticed during the study. *Lauderia annulata*, *Ceratium breve*, *Fragilariopsis kerguelensis* and *Pyrophacus steinii* was predominantly found during pre-monsoon season. *Coscinodiscus wailesi*, *Odontella mobilensis*, *Protoperidinium oceanicum* and *Dactyliosolen fragilissimus* dominated in monsoon season whereas, *Ditylum brightwellii*, *Odontella brightwelli*, *Dictyocha fibula* and *Pyrophacus steinii* were common during post monsoon period. An average cell density of 41061 cells L⁻¹ was recorded from the study area with a maximum density during monsoon season (47896 cells L⁻¹). Shannon diversity, H' (loge) was higher in the pre monsoon season (3.681) and lower in monsoon season (3.102). Cluster analysis and MDS analysis portrayed the similarities in species composition during monsoon and post monsoon season. BIOENV analysis explained the effect of temperature, pH, salinity and the concentration of phosphate and nitrate in the distribution of phytoplankton species in the coastal waters of Kasargod. Correlation analysis best explained the effect of pH on the abundance of class Chlorophyceae ($r=0.75$) and dissolved oxygen on phytoflagellates ($r= 0.5$).

Key words: Phytoplankton, diversity, coastal waters



SOME ASPECTS OF THE INTERTIDAL MACROFAUNA ALONG THE MUMBAI COAST

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Mumbai, with a coastline of approximately 150 km, is gifted abundantly with rich faunal biodiversity. Due to the rapid growth of the city in the past few decades and various anthropogenic activities, the intertidal fauna has been disrupted and is diminishing at a rapid rate. This study was aimed to understand the intertidal biodiversity of the Rocky Shores of Juhu, Haji Ali, and Carter's regions of the Mumbai Coast. The quadrat sampling method was primarily used along with random shore walks to gather the data for the study. Low tide time was chosen for data collection at the selected spots in the intertidal regions. A total of 52 observations of various organisms were carried out during the study belonging to 13 different classes, of which the class Gastropoda was dominated over all three study sites, indicating their high adaptability. Polychaete worms belonging to the Genus Diopatra, which is a biological indicator of pollution, were also found abundantly in all three study sites. This study generated baseline data on the present intertidal macrofauna, along with their distribution based on their taxonomical classes, for the conservation of the diverse intertidal biodiversity of Mumbai City.

Keywords: Fauna, Biodiversity, Anthropogenic Activity, Intertidal, Biological indicator

ISOLATION AND CHARACTERIZATION OF INDIGENOUS DIATOM, *Odontella* SP.
OD1 AND ITS ASSOCIATED BACTERIA; IMPLICATIONS ON ALGAL
BIOTECHNOLOGY

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Odontella sp. OD1 was isolated from Dona Paula bay region of the Zuari estuary Goa, India, and morphologically identified with the combined data from light microscopy and scanning electron microscopy images. The isolated diatom strain was cultured in F/2 media and growth was monitored based on pigment profile. Pigment profile clearly showed that the diatom reached maximum growth at the 12th day of incubation and the growth rate decreased after 12th day. The *Odontella* sp. OD1 achieved maximum growth at 12th day of incubation with maximum biomass accumulation of 3.115 mg mL⁻¹ and the dominant pigments were fucoxanthin and chlorophyll a. The bacterial symbiont associated with microalgae was isolated and was found to be belonging to the genera *Nitratireductor* sp. The bacterial associate was halotolerant (5-90 ppt) and capable of producing algal growth promoters such as siderophores. There was a significant increase in the growth rate, pigment profile and antioxidant activity of *Odontella* sp. OD1 when enriched with bacterial symbiont which clearly indicate the stimulatory impact of bacterial symbiont on growth and metabolism of algal host which could be further explored for mass cultivation and other biotechnological applications of microalgae.

Keywords: *Odontella* sp., Associated bacteria, Algal growth promoters, Pigment profile, *Nitratireductor*.

TAXONOMY OF SIGANIDAE FAMILY WITH SPECIAL REFERENCE TO THE BIOLOGY OF *SIGANUS VERMICULATUS* (VALENCIENNES, 1835)

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The present study attempted to provide information on the taxonomy of Siganidae family, and biology of the species *Siganus vermiculatus* along the coast of Andaman Island. The Siganidae family is characterized by a deep, compressed body covered in scales, with key features including D. XIII, 10; P. 16-17; V. II, 3; A. VII, 9. The various species of the Siganidae family can be identified by differences in their colors and patterns along with the morphometrics and meristic characters. A total number of eight species were identified during the study. *Siganus vermiculatus* is characterized by the presence of vermiculated pattern throughout the body. To understand the biology of rabbitfish, 88 specimens of *Siganus vermiculatus* were examined during the study period. The sex ratio of females to males (1:9.25) in this species found to be significantly different ($p<0.001$) from the theoretical 1:1 ratio. Knowledge about the length-weight relationship and relative condition factor (Kn) is important for the assessment and management of fish resources. The length-weight relationship established was $W= 0.015L^{3.064}$ for pooled data ($p>0.05$), showing an isometric growth pattern. In this study, the coefficient of determination value was high ($r^2>0.94$). The condition factor (Kn) was found to be 1.006 ± 0.013 indicating good well-being of the fish population. The food and feeding analysis were conducted using the largest index of preponderance. Upon analysis of the gut content, red algae (41.103%) were found to be the dominant food component followed by seagrass (20.076%) and brown algae (14.681%). These results substantiate the herbivorous nature of *Siganus vermiculatus*, while also indicating incidental consumption of crustaceans, molluscs, and other items. Rabbitfishes are ideal candidates for aquaculture, emphasizing the importance of comprehending their biological characteristics to enhance their aquaculture endeavors.

Keywords: Siganidae, *Siganus vermiculatus*, morphometric and meristic characters, length-weight relationship, Gut content analysis

MORPHOLOGY OF *TUBUCA ALCOCKI* (SHIH, CHAN & NG, 2018) (CRUSTACEA: DECAPODA: OCYPODIDAE), A PSEUDOCRYPTIC FIDDLER CRAB FROM THE TROPICAL MANGROVE ECOSYSTEM, WITH MOLECULAR EVIDENCE

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Tubuca alcocki (Shih, Chan & Ng, 2018) is an Indo-West Pacific narrow-fronted fiddler crab species of the largest Ocypodid subfamily, Gelasiminae Miers, 1886. The species exhibits pronounced heterochely, resulting in extreme asymmetry, and two types of chelate legs, namely brachychelous and leptochelous. The current study reports *T. alcocki* from the Vembanad mangrove ecosystem with marked morphological similarity to its sister taxon, *Tubuca urvillei* (H. Milne Edwards, 1852), a southeast African species. To resolve the taxonomic ambiguity between brachychelous and leptochelous individuals, key morphological characters such as the antero-lateral angle of the carapace, urocardiac ossicle of the gastric mill, and male first gonopod (G1) structure were examined in addition to molecular barcoding using CO1. Although the brachychelous crabs of the *Tubuca alcocki* show marked morphological similarity to *T. urvillei*, they exhibited significant differences in molecular analysis. The genetic divergence between these two sister species was found to be 4.0%. Therefore, the current sample can be identified as a cryptic species of *T. urvillei*. Although reports on fiddler crabs, especially of the genus *Tubuca*, are sparse in the Indian subcontinent, two previous reports have documented the presence of *T. urvillei*. Recent phylogenetic relationship analysis based on the mitochondrial cytochrome oxidase subunit I (COI) gene clearly distinguishes *T. alcocki* from *T. urvillei*, with the former being more restricted to Northern part of Indian Ocean. Thus, the previous records of *T. urvillei* from the Indian subcontinent should be updated to reflect *T. alcocki* only. The distribution of these highly bioturbating mangrove crabs was dependent on factors such as the particle size of the sediments (loamy sand) and mangrove vegetation.

Keywords: *Tubuca Alcocki*, *Tubuca Urvillei*, Morphology, Morphometry, Cytochrome Oxidase Subunit I (COI) Gene, Phylogeny.

HETEROTROPHIC DIVERSITY OF CORE SEDIMENT BACTERIA: A CASE STUDY FROM COCHIN ESTUARY

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The Cochin estuary (CE) is the largest among many extensive estuarine systems along the southwest coast of India. It has been identified as one of the most productive estuarine systems along the west coast of India. There are several bacterial diversity studies from the Cochin estuary, but deep core samples from CE have not been addressed previously. Sediment microorganisms have a significant role in regulating major geochemical and ecological processes in aquatic ecosystems, including nutrient dynamics and biogeochemical cycles. In the present study, we estimated the bacterial abundance and their diversity from surface (0cm surface) and bottom (250 cm) core sediment. More than 70 bacterial strains from the surface (0cm) and about 60 bacterial strains from the bottom (250cm) are subjected to biochemical characterization and enzyme screening. For further confirmation, bacterial strains were subjected to 16s rRNA sequencing. The total plate count of bacteria was high in the surface sample. The majority of the surface sediment sample was *Bacillus* species including *Bacillus paralicheniformis*, *Bacillus toyonensis*, *Bacillus altitudinis*, etc. whereas in the bottom sample *Pseudomonas* (*Pseudomonas alcaliphila*, *Pseudomonas oleovorans*), and *Rheinheimera* species (*Rheinheimera aquimaris*) were the major bacterial genera. The results show that the core sediment collected from the Cochin estuary contains a high diversity of bacterial populations and diversity and richness were significantly higher in the surface sediment sample compared to the bottom sediment sample.

Keywords: Cochin estuary, Sediment core, *Bacillus*, Bacterial diversity, 16s rRNA sequencing

BIOMETRIC AND TAXONOMIC STUDY OF *SARDINELLA MELANURA* (CUVIER, 1829) AND *DUSSUMIERIA ACUTA* VALENCIENNES, 1847 FROM THE ANDAMAN AND NICOBAR ISLANDS.

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A taxonomic and biometric study of two species i.e., *Sardinella melanura* and *Dussumieria acuta* was carried out based on the samples collected from the landing center at Junglighat and Corbyn's Cove, caught by fishermen from various parts of the Andaman Island. 46 specimens of *Sardinella melanura* and 124 specimens of *Dussumieria acuta* were examined for meristic and morphometric characteristics. The mean and standard deviation of meristic and morphometric characters were recorded. Based on the present investigation on meristic characters, the fin formula of *Sardinella melanura* can be written as B6D17P14V8A17-18C19S28G(27-29)+(49-50) and *Dussumieria acuta* as B14-15D18-19P14V8A14-15C19G(10-11)+(21-22). The ratio of the morphometric characters against the total length, standard length, and head length were calculated. The relationship between various morphometric characters against total length, standard length, and head length was analyzed. A high correlation coefficient(r) was obtained on comparing the total length and standard length against pre-anal length, fork length, and pre-ventral length. The present study was compared with the previous literature as well as with the closely related species. The length-weight relationship and condition factor were found to know more about the growth and relative well-being of the species. The length-weight relationship for *Sardinella melanura* was found to be $W = 0.005L^{3.22}$ and for *Dussumieria acuta* it was $W = 0.006L^{3.14}$; since $p > 0.05$, both the species exhibited isometric growth. The condition factor for *Sardinella melanura* was found to be 1.0028 and 1.0032 for *Dussumieria acuta*. The study established that the population of *Sardinella melanura* and *Dussumieria acuta* are healthy and stable in the Andaman and Nicobar Islands.

Keywords: *Sardinella melanura*, *Dussumieria acuta*, Morphometric and meristic characters, Biometric, Andaman & Nicobar Islands



FAUNAL DIVERSITY OF ROCKY SHORE REGIONS ALONG THE COAST OF PORT BLAIR, SOUTH ANDAMAN ISLANDS

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Rocky beaches are coastal areas characterized by enormous formations of "bedrock" in an irregular structure of ledges, overhangs, fissures, and depressions where water collects. Rocky beaches host a wide variety of animals, making them biologically rich. Andaman has very few regional studies about its rocky shores and its faunal diversity. The present study gives an insight into the faunal diversity of rocky shores of Port Blair. The study was conducted at Burmanallah, Kodiyaghat, Science Centre and Brookshabad during February 2023 to April 2023. Sampling was carried out in high water line, mid water line and low water line. At each location, two transects were laid. Duplicate samples were recorded from each water line using a 50cm x 50cm quadrat during the lowest low tide. The four stations differ from each other in aspects of the type of rocks, wave exposure and sand cover. Overall, Mollusca was the predominant group among the rocky shore fauna. All the diversity indices were highest in the station Burmanallah. The study also reveals a clear zonation pattern among the gastropods. The study also recorded shingle urchin, *Colobocentrotus atratus* a rarely reported sea urchin from these islands. The study supplements the faunal diversity of the rocky shore along the coast of south Andaman Islands.

Keywords: Rocky Shore, Diversity, Andaman Islands, Mollusca

SPATIOTEMPORAL VARIATION IN DIVERSITY AND ABUNDANCE OF MACROBENTHOS IN THE KADALUNDI ESTUARY.

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The present study is an attempt to document the abundance and diversity of Kadalundi estuarine ecosystem for the first time. This estuary is the first Community Reserve in Kerala located in Malappuram – Kozhikode districts. Triplicate grab samples were taken from six stations located in the Kadalundi Estuary during 2021 – 2022 (premonsoon, monsoon and postmonsoon) period. Sampling stations were mudflat, true estuarine region, rivermouth, mangrove dominated by *Rhizophora mucronata*, mangrove dominated by *Avicennia officinalis* and the sand bar. Highest abundance of macrobenthos was observed at true estuarine region during monsoon and lowest at the rivermouth during premonsoon. 74 species of macrobenthos belongs to seven different groups (malacostraca 44.8%, polychaeta 24.94%, gastropoda 18.29%, bivalvia 5.52%, oligochaeta 2.7% and others 4%) were encountered during the study period from six different habitats of Kadalundi estuarine ecosystem. In which, malacostraca was dominant group. Highest diversity (30 species) was observed during premonsoon at true estuarine region and lowest (7 species) during postmonsoon at sand bar. Among the six habitats of Kadalundi estuary relatively high diversity was recorded at true estuarine region. The sand accretion might be the possible cause of lower macrobenthic diversity at the sand bar. The outcome of the study forms the baseline information on macrobenthos in Kadalundi estuary.

Key words: *Macrobenthos, abundance, estuary, rivermouth, sand bar, malacostraca*

MORPHOLOGICAL AND MOLECULAR DESCRIPTION OF EXOTIC MEXICAN MOLLY, *POECILIA MEXICANA* (CYPRINODONTIFORMES: POECILIIDAE) FROM THE MANGROVE ECOSYSTEM OF THE SOUTHWEST COAST OF INDIA

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Poecilia mexicana (Steindachner 1863) is native to fresh and brackish water habitats in Mexico and Guatemala. In this study, we report the occurrence of the Mexican Molly within the mangrove ecosystems of the southwest coast of India. Scoop net sampling conducted in the mangrove areas of Ernakulam district unveiled the occurrence of *P. mexicana* populations. Live samples were collected for describing morphology and developing DNA barcodes for species identification. Mitochondrial cytochrome oxidase subunit 1 (COI) gene sequences from the samples confirmed 99.84% identity with sequences of the species developed from its type locality. The occurrence of this non-native poecilid species in the tropical brackish water mangrove areas indicates its adaptability to diverse environmental conditions. This study points out the need for conducting in-depth ecological studies on its potential interactions with indigenous fish species and also in assessing its impact on other mangrove fauna. This discovery contributes alarming insights into the expanding range of alien species and underscores the supporting role of mangrove habitats for their survival. Further research is necessary to investigate the dynamics of the species' feeding ecology to elucidate the ecological consequences in mangrove areas along the southwest coast of India.

Keywords: Alien Species, Geographical Range Expansion, Tropical Wetlands, Short-Fin Molly, Non-Indigenous Fish

MYRISTICA SWAMPS: PRISTINE ENVIRONMENT TO BE EXPLORED FOR DOCUMENTING AQUATIC BIODIVERSITY

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Myristica swamps, characterized by their unique vegetation dominated by Myristicaceae species, are vital yet critically threatened ecosystems in the Western Ghats. These swamps serve as biodiversity hotspots, harbouring numerous endemic and endangered species while providing invaluable ecosystem services such as water regulation, carbon sequestration, and soil stabilisation. According to Nair et al. (2007) swamps have 23% butterflies, 11% spiders, 8.4 % fishes, over 50 % amphibians, more than 20 % reptiles, 26.6% birds, 6.6 % mammal species of Kerala. In the Western Ghats, there are about 218 species of freshwater fishes. Of these, 53% of all these fish species are endemic, of which 14 were described as being from Myristica swamps. Despite their ecological significance, Myristica swamps face escalating anthropogenic pressures, including habitat destruction, fragmentation, and degradation due to land conversion, logging, and agricultural expansion. This study explores the potential of DNA barcoding to conserve fishes and shellfish of Myristica swamps, emphasising its role in species identification, biodiversity assessment, and monitoring of genetic diversity. DNA barcoding offers a powerful approach for accurate and rapid species identification, facilitating the discovery of cryptic or rare taxa crucial for effective conservation management. PAGR (ICAR-NBFGR) intends to provide a practical approach for species-level identifications using species-specific molecular tags produced from the COI gene. The study aims to explore and genetically catalogue all finfish and shellfish of the Myristica swamps in India by appending molecular tools. The work will be helpful in the quick identification of known species and the speedy discovery of unnamed species in these localities. This would help accurately document the fish biodiversity of these critical wetlands of India. By leveraging the power of molecular taxonomy, we can enhance the efficacy of conservation strategies, mitigate threats to Myristica swamps, and preserve these unique ecosystems for future generations.

Keywords: *Myristica swamps, wetlands, molecular taxonomy, COI gene, biodiversity conservation*

COMPARATIVE STUDY ON BIOLOGY AND BIOMETRICS OF SELAR CRUMENOPHTHALMUS (BLOCH 1793) FROM NEENDAKARA, KERALA AND ANDAMAN AND NICOBAR ISLANDS

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This is a comparative study of Selar crumenophthalmus (Bloch 1793) belonging to the Carangidae family. They are moderately compressed fishes with very large eyes. 50 samples were collected from Neendakara landing centre in Kollam district of Kerala and 71 samples were collected from Junglighat fish landing centre in Andaman and Nicobar Islands. The samples collected from Neendakara has an average total length of 20.82cm and average head length of 5.52 cm. The correlation of total length against other morphometric characters shows high correlation of 0.97 against fork length. The samples collected from Andaman has an average total length of 21.97cm and average head length of 5.59cm. The correlation value of total length against morphometric characters has a highest value of 0.95 against fork length. The sex ratio of *S. crumenophthalmus* from Kerala and Andaman is 1:1.777 and 1:3.636 respectively. The LWR value turned out to be $W = 0.0049L^2$ for Kerala samples showing negative allometric growth and $W = 0.0064x22$ for Andaman samples, again indicating negative allometric growth. Mean GaSI of *S. crumenophthalmus* from Kerala is 1.27 and that from Andaman is 0.98. Mean GSI from Kerala is 0.056 and that from Andaman is 1.32. There is also considerable difference in the stomach contents of the fish in both areas, with shrimps being dominant feed in samples from Neendakara and fishes being major feed along with a diversity of other food in samples from Andaman. The proximate composition of the flesh sample from Neendakara showed 13.8g/100g protein, 1.1g/100g ash, 76.3g/100g moisture and 0.2% fat. Although there is difference in GaSI, GSI, sex ratio, feeding, feeding intensity and gonadal maturity stages, some factors like meristics and morphometrics show similarity in the samples from both regions.

Keywords: *Selar crumenophthalmus*, Neendakara, Andaman, Morphometrics



OPPORTUNISTIC FORAGING BEHAVIOUR OF LESSER BLACK-BACKED GULLS (*Larus fuscus*) FROM PONNANI, KERALA: A SUPPORTING EVIDENCE FOR 'JUNK FOOD HYPOTHESIS'

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Gulls exhibit a widespread distribution across the globe. Their scavenging behaviour has been extensively studied due to their adaptability and generalist foraging patterns, which encompass a broad spectrum of available food resources in their immediate surroundings. This study focuses specifically on the foraging habits of *Larus fuscus* in the proximity of the bycatch drying centers at Ponnai fishing harbour, Kerala. In our study, we specifically examine the foraging habits of *Larus fuscus* in the vicinity of the bycatch drying centers. The observations reveal that these gulls predominantly engage in foraging activities at the bycatch processing centers and adjacent water bodies, with their diet comprising dried crustaceans and fishes. Notably, instances were documented where gulls ingested plastic while attempting to access food covered with nets. These findings indicate a substantial time spent by gulls near the processing area and shoreline, deviating from their generalist foraging habitat and showing distinct preference for the bycatch. Notably, opportunistic behaviour was observed in gulls migrating to the Kerala coast and their abundance was observed from March-May every year. This preference for bycatch provides an easy meal, which reduces foraging efforts and it supports the aspects of the 'Junk food hypothesis', (food preference towards less nutrient content food). The study illustrates how local environments and anthropogenic activities influence the ethology of migratory species, especially those with versatile foraging habits. It highlights the species' adaptability to readily available food resources within their foraging grounds, shedding light on the intricate dynamics between gulls and their evolving ecosystems.

Keywords: Facilitated behaviour, Ethology, Laridae, Seabirds, Charadriiformes



**REPORT OF *Calcinus morgani* RAHAYU & FOREST 1999 (CRUSTACEA:
DECAPODA: ANOMURA: DIOGENIDAE) AFTER
158 YEARS FROM ANDAMAN & NICOBAR ISLANDS, INDIA**

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During the present study, the hermit crab *Calcinus morgani*, belonging to the family Diogenidae, was reported after 158 years from the Andaman and Nicobar groups of islands. The study was carried out on the south-east coast of Andaman. It was reported earlier from the Nicobar Islands in 1865 by Camill Heller and was identified as *Calcinus gaimardii*. In 1999, *Calcinus morgani* was differentiated from *Calcinus gaimardii* by Dwi Listyo Rahayu and Jacques Forest, mainly based on the colour differences in the ocular peduncles, shield, and second and third pereopods. Subsequently, the Nicobar specimens of *Calcinus gaimardii* were re-identified as *Calcinus morgani* by P.A. McLaughlin and P.C. Dworschak in 2001. After that, it is the first time that *Calcinus morgani* has been reported from the Andaman and Nicobar Islands. This is the first time that a detailed morphological description of this species has presented reported from the Andaman and Nicobar Islands. From India, it is reported only from the south-west coast of Kerala.

Keywords: Anomura, *Calcinus*, Crustacea, Diogenidae, Hermit crab, South Andaman.

FIRST REPORT OF THE COMMERCIAL SEA CUCUMBER, *Bhadschia atra* (TIGERFISH), FROM THE ANDAMAN ISLANDS

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The present work confirms the geographical record of *Bohadschia atra* Massin, Rasolofonirina, Conand, and Samyn (1999) from the intertidal region of South Andaman by following the collection concerns of the scheduled species under Category I of the Wildlife (Protection Act), India, 1972. The species was confirmed based on the analysis of the standard taxonomic key and ossicle structure. The species' only known distribution record was restricted to the Arabian Sea in India. This article deals with the range extension in the distribution of *B. atra* for the first time to the Andaman Islands with morphological and ossicle characterization. Massin et. al (1999) first identified and described *B. atra* from the Western Indian Ocean (Madagascar); however, it was not recorded from Indian waters until its occurrence was confirmed from the Lakshadweep Islands by Nithyanathan and Marimuthu (2021). The present report from the Andaman archipelago is the first confirmed distribution record of *B. atra* in the eastern waters of India, approximately 1360 nautical miles and the other side of the Indian subcontinental landmass from the Lakshadweep Islands.

Keywords: Andaman Islands, *Bohadschia atra*, Holothuroidea, tigerfish, red-eyed sea cucumber.





Advancement in Aquaculture



SOLAR POWER BASED INTENSIVE CAGE CULTURE OF *ETROPLUS SURATENSIS* AT THE INLAND WATER BODIES OF MANGROVE ISLAND KOLLAM, KERALA, INDIA: A FEASIBILITY STUDY

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There are several inland waterbodies having difficulty in accessing to electricity for aquaculture operations. Alternatively, renewable energy sources such as the solar and wind can provide steady power in remote areas where electricity is a concern, especially places with no grid connectivity. Solar energy is one of the cleanest among all sources, environmentally benign, and not contributing to global warming. Accordingly, a study was carried out in a solar power-based intensive cage culture of *Etroplus suratensis* in the Mangrove Island, Nedungolam, Kollam district in which the aeration was supported with the stored energy during night hours. As part of the investigation growth rate, FCR, water and sediment quality, general fish health, percent survival were assessed as the measurable parameters supporting sustainable pearl spot culture. Nine 3.3m x 3.3m x 1.3m high-density polyethylene (HDPE) floating cages were constructed with 210D nylon knotless nets having mesh size of 10 mm. Fishes with an initial weight of 4.19 ± 0.94 g were stocked and fed on commercial pellet feed at a rate of 5-3% of their body weight daily. During the six-month culture period, the water quality parameters such as pH (7.56 ± 0.03), salinity (5-15), alkalinity (163.5 ± 1.99), calcium hardness (40.2 ± 1.94), magnesium hardness (231.5 ± 1.71), total hardness (271.7 ± 3.8), ammonia (NH₃) (0.04 ± 0.01), nitrite (0.04 ± 0.01), nitrate (0.12 ± 0.02), dissolved oxygen (6.0 ± 0.38) were found remain within the optimum limits. The mean $\pm SD$ of phytoplankton value was recorded as 55.9 ± 12.13 cells/ml, and the mean $\pm SD$ of zooplankton value was recorded as 5.4 ± 2.2 organisms/ml. The sediment pH (7.9 ± 0.28), and redox potential (Eh) (-177.76 ± 19.33) were found to be congenial. After 180 days of the culture period, the fish grew to 212.03 ± 20.78 g. The growth performance in terms of means weight gain (207.84 ± 20.87 g), average daily weight gain (1.14 ± 0.11 g), average daily length gain (0.05 ± 0.00 g), specific growth rate (2.18 ± 0.13 g), and food conversion ratio (1.74 ± 0.17), total number of harvested fishes (392.4 ± 18.47), survival rate (78.49 ± 3.69) suggested that the solar powered intensive cage culture could be adopted in any water body, as oxygen deficiency during night hours remain a perennial problem in the open water bodies in Kerala.

Keywords: Solar energy, Cage culture, Water and sediment quality, Phytoplankton, Zooplankton, SGR, FCR



ENRICHMENT OF LIVE FEED ROTIFER *BRACHIONUS ROTUNDIFORMIS* USING FOUR DIFFERENT MARINE MICROALGAE

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The study targeted the enhancement of polyunsaturated fatty acids (PUFAs) in the rotifer, *Brachionus rotundiformis* when enriched with monocultures of marine microalgae – *Chaetoceros calcitrans*, *Isochrysis galbana*, *Nannochloropsis oculata* and *Thalassiosira weissflogii*. The rotifer at a rate of 600 nos./mL was fed with the algae at a rate of 2×10^6 cells/mL in triplicate and the changes in the PUFA especially Eicosapentaenoic Acid (EPA), Docosahexaenoic Acid (DHA), and Arachidonic Acid (ARA), at 0, 6, 12, and 24 hrs of feeding were analyzed using Gas Chromatography. Statistical analysis (ANOVA) showed significantly higher ($p < 0.05$) content of EPA (0.369 ± 0.01 mg/g dry weight of rotifer), along with DHA (0.1365 ± 0.004 mg/g dry weight), ARA (0.00597 ± 0.0001 mg/g dry weight,) and total PUFA (0.706 ± 0.021 mg/g dry weight) in *Brachionus rotundiformis* fed for 24 hrs with *Chaetoceros calcitrans*. *Brachionus rotundiformis* when enriched with *Isochrysis galbana*, for 12 hrs. showed a significantly higher ($p < 0.05$) amount of DHA (0.365 ± 0.007 mg/g dry weight), along with EPA (0.03 ± 0.0006 mg/g dry weight), ARA (0.0007 mg/g dry weight) and total PUFA content of 0.5229 ± 0.009 mg/g dry weight. Enrichment of *Brachionus rotundiformis* for six hours with *Nannochloropsis oculata* or *Thalassiosira weissflogii* gave significantly higher ($p < 0.05$) content of the EPA (0.149 ± 0.008 and 0.3887 ± 0.192 mg/g dry weight respectively), DHA (0.18 ± 0.004 and 0.0898 ± 0.029 mg/g dry weight respectively), ARA (0.0205 ± 0.0016 , 0.0217 ± 0.024 mg/g dry weight respectively) and PUFA (0.506 ± 0.052 , 1.169 ± 0.164 mg/g dry weight respectively), than for 12 or 24 hrs of enrichment. The results optimize the duration for the selective enhancement of PUFAs in rotifers when using different microalgae for enrichment.

Keywords: *Brachionus rotundiformis*, *Chaetoceros calcitrans*, *Isochrysis galbana*, *Nannochloropsis oculata*, *Thalassiosira weissflogii*, Polyunsaturated fatty acids.



ENHANCED ANTIFOULING PERFORMANCE OF AQUACULTURE CAGE NETS THROUGH PHOTOCATALYTIC NANO CARBON DOT-TITANIUM OXIDE-IRON OXIDE COMPOSITE COATING

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Biofouling poses a significant challenge to aquaculture cage nets, leading to compromised water flow dynamics, increased hydrodynamic resistance, and heightened susceptibility to disease, thereby impeding marine organism health and aquaculture efficiency. In this study, polyethylene aquaculture cage nets were surface-modified with a polysiloxane polymer and coated with a photocatalytic composite comprising nano iron oxide (Fe_2O_3), titanium dioxide (TiO_2), and carbon dots (CDs). Titanium dioxide is a widely used photocatalyst, less efficient under light due to higher band gap, whose hole – electron recombination activity was enhanced by incorporating nano iron oxide and carbon dots. Carbon dots, known for their light-harvesting and antimicrobial properties, further augmented the composite's potential as antifouling agent by producing free radicals and reduced pH in the vicinity enable to deter the micro and macro organism. UV-visible spectroscopy confirmed the integration of TiO_2 , Fe_2O_3 , and CDs, extending the photocatalytic activity from the UV to the visible region. Fourier-transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD) analyses validated the formation of the composite. Dye degradation tests demonstrated excellent photocatalytic activity of the composite. Antifouling efficacy was evaluated by exposing the coated nets in Cochin estuary, revealing that nets coated with 0.01% of the photocatalytic composite exhibited the highest fouling resistance. This study confirms the synergistic action of $\text{TiO}_2\text{-Fe}_2\text{O}_3$ composite with CDs, enhancing the antifouling properties of the coating.

Keywords: Biofouling mitigation, Photocatalytic composite, Surface modification



NEW INSIGHTS ON THE INCREASED GROWTH AND BIOMASS PRODUCTION OF *ISOCHRYYSIS GALBANA* IN A CONSORTIUM OF *ACETOBACTER* AND *LACTOBACILLUS* FOR AQUACULTURE

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Symbiotic interactions of bacteria and microalgae play a vital role in the production and quality of live feed. *Isochrysis galbana* is one of the important haptophytes used as live feed in aquaculture. The present study explored the growth of *Isochrysis galbana* in a consortium of heterotrophic bacteria of *Acetobacter sp.* and *Lactobacillus sp.*. There was an increase in algal biomass production in terms of cell count, dry weight, and chlorophyll in the presence of added bacteria. The results showed the growth-promoting role in the microalgae may be due to that these strains released plenty of available nitrogen as a macronutrient in the form of ammonia. The experiment was conducted under controlled physical conditions for 30 days. In the experiment, five bacteria inoculum treatment concentrations were applied (0.01%, 0.05%, 0.1%, 0.15%, and 0.2%) and done in triplicates. Growth parameters and ammonia concentrations were checked on every 5th day. The maximum cell density obtained was 635×10^4 cells ml⁻¹ and the peak dry weight was 0.0034 mg ml⁻¹ in 0.15% treatment on the 30th day at NH₃ 0.0103 mg ml⁻¹. Whereas the peak value of Chlorophyll a (4.707 µg ml⁻¹) is obtained in 0.15% treatment on the 20th day at an NH₃ level of 0.0095 mg ml⁻¹. The peak values of all parameters were observed in xenic cultures only. This study's findings showed that mutually beneficial interactions exist between *I. galbana* and the added heterotrophic bacteria which can be further improved to obtain maximum productivity and sustainability of algal rearing systems for aquaculture as well as various mankind purposes.

Keywords: Co-culture, *Isochrysis galbana*, *Lactobacillus*, *Acetobacter* Chlorophyll a, Dry weight, Cell count.



EVALUATION OF GROWTH AND SURVIVAL OF *PANGASIANODON HYPOPHTHALMUS* AT LOW TEMPERATURE

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In Northern India, the winter season brings mass mortality of *Pangasianodon hypophthalmus* in aquaculture ponds. At low or below optimum temperature, fishes are susceptible to disease that ultimately results in reduced growth and survival. Moreover, the CTmax and CTmin for *P. hypophthalmus* were found to be 15.98 °C and 41.77 °C, respectively. So, to evaluate the effect of low temperature on growth performance and survival in striped catfish, *Pangasianodon hypophthalmus*, a 60-day trial was carried out at a low temperature (18.0 ± 1.0 °C) recirculatory aquaculture system (RAS) with a flow rate of 1.6 L/min. During the experimental period of 8 weeks, a practical diet containing 37% crude protein, 9% crude lipid, and 412 kcal digestible energy/100 g was prepared and fed to fish twice daily. All water quality parameters were closely monitored and found in optimum range with continuous maintenance of low temperature. At the end of the trial, there was no mortality observed in any of the experimental tanks, while a 17.32% growth rate only could be achieved by fish. Even though feeding was done at satiation levels, the digestive and metabolic enzyme activities were also reduced during low temperature exposure. Hence, with this study, we can conclude that low temperature affects, feed intake growth and metabolism in striped catfish and good management practices can improve the survival and growth rate of *P. hypophthalmus* at low temperatures.

Keywords: Low temperature; Winter, Recirculatory aquaculture system (RAS); Growth performance, Survival, *Pangasianodon hypophthalmus*



THE EFFECT OF MAJOR NUTRIENTS ON THE BIOCHEMICAL COMPOSITION
OF ESTUARINE DIATOM *Halamphora sp.* KOCIOLEK IN THREE LEVELS F
MEDIUM FOR AQUACULTURE PURPOSES

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The present work was done to evaluate the effect of major nutrients on the biochemical composition of the estuarine diatom *Halamphora sp.* Kocielek in four culture media viz. f, 2f, f/2, f/4 in which f medium was taken as reference. Standard protocol was followed for the culture of *Halamphora sp.* under laboratory conditions. The species collected from Munambam-Azheekode estuary, Kerala, India was isolated and identified by detailed light and scanning electron microscopy and molecular taxonomical studies. *Halamphora sp.* is a new taxon to India as evident from molecular taxonomic profiling. *Halamphora sp.* grown in different levels of f medium was harvested during different growth phases viz. exponential and stationary. Protein, carbohydrate, lipids and essential fatty acids were determined during exponential and stationary growth phases of culture. Fatty acids were analyzed using gas chromatography. It was found that an increased content of protein during exponential phase and then to be decreased. Lipid and carbohydrate were found to be increased during the stationary growth phase. With higher lipid production, the dominant polyunsaturated fatty acids (PUFA) was docosahexaenoic acid (DHA). In comparison with other media f/2 medium is more feasible for the culture of *Halamphora sp.* The presence good nutrient value supports the use of *Halamphora sp.* as an alternative and sustainable source for aquafeed to partially replace the use of fishery by-products. So this particular species can be used as live-food or feed supplement for the larval rearing of marine organisms suggests potential biotechnological applications for aquaculture.

Keywords: Diatom, *Halamphora sp.* culture medium, polyunsaturated fatty acids, EPA, DHA.



AMYLASE FROM MARINE BACTERIA ISOLATED FROM SEDIMENT OF COCHIN BACKWATER: DEVELOPMENT OF BIOPROCESS FOR COMMERCIAL PRODUCTION

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Amylase production from marine bacteria presents a significant opportunity for biotechnological applications due to the enzyme's unique properties and the bacteria's adaptation to extreme environments. The role of Amylase in breaking complex polymers into simple sugars could be utilized to digest the macromolecules present in the food and feed ingredients of both human and animal importance. The use of such enzymes in the feed industry could have three levels of benefits such as feed input cost reduction, enhanced FCR, and better environment management through bioremediation and biotransformation of agricultural or plant waste as feed ingredients. This study was focused on the isolation of amylase-producing bacteria from the sediment of the Cochin backwater, a biodiversity-rich estuary in India. Through a systematic screening process, isolates that exhibited robust amylase activity in saline conditions were identified. The selected bacterial isolate was subjected to optimization protocols to enhance amylase production, considering factors such as temperature, pH, salinity, and media composition. Subsequent screening and characterization of the enzyme confirmed its potential for industrial applications. The cell free supernatant was lyophilized and converted to user-friendly product and was found to have unit activity of 75.77 U/mg. This product can find application in food and feed industry in the hydrolysis of starch.

Keywords: Amylase, Marine bacteria, Aquatic Animal feed, FCR



APPLICATION OF MARINE BACTERIA-MICROALGAL CONSORTIA FOR BIOREMEDIATION OF AQUACULTURE EFFLUENT – A SUSTAINABLE STEP TOWARDS BLUE ECONOMY

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Effluent treatments have been a rising concern with almost all the industries and the ever-growing demand for these industrial sectors keep the demand for the functioning ongoing and increasing. One such sector would be aquaculture industry which is directly linked with the protein supply demand with respect to the population expansion. Along with the deforestation of coastal regions, the discharge of aquaculture effluents causes eutrophication and destruction of marine biodiversity. Beyond depending on earthen ponds for aquaculture practices, intensification and use of indoor tanks with recirculation of water have been sustainable approach. This demands the bioremediation of effluents within the system and a feasible futuristic approach would be the use of marine-bacteria-microalgal consortia which aims in the removal of nutrients and the release of oxygen. This is made possible with the interdependence of bacteria and microalgae. The synergistic interactions exist between algae and bacteria exchange dissolved oxygen, respiratory CO₂, mineralized nutrients, hormones, vitamins. The present study involved the screening of bacteria with multiple activity (denitrification, methane oxidation, sulfur oxidation, phosphate solubilization, phosphate accumulation) and designed consortia with microalgal species under immobilized condition. From the various combinations of bacteria-microalgal consortia, the *Chlorella vulgaris* - *Nannochloropsis salina* - Bacteria (E8-E80-Y27) was found to be a potential bacterial-microalgal consortia for aquaculture bioremediation with 80% of nitrate removal and 91% of phosphate removal in 10 days. Immobilized cells were more efficient with nutrient removal, biomass production with ease in biomass harvest, better revival and convenience with water reuse and ecologically safe. Thus, the results of this study revealed that multiple algal-bacterial species can be exploited in the development of aquaculture bioremediative consortia which in turn supports the sustainable development and Blue Economy for the nation.

Keywords – Aquaculture, bioremediation, effluent, bacteria-microalgal consortia, blue economy,



Efficiency of Aquatic weed *Eichhornia crassipes* on growth, survival, and proximate composition of Genetically Improved Farmed Tilapia reared in biofloc system

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The biofloc system is one of the cutting-edge sustainable aquaculture technologies that could help achieve FAO Sustainable Development Goals for food security. The system being efficient by lowering feed input and water use and can improve sustainable aquaculture. The aim of this study was to investigate the effects of *Eichhornia crassipes* as a carbon source in biofloc technology. The study aimed to compare the efficiency of the aquatic weed, (*Eichhornia crassipes*) on growth, survival, and proximate composition of GIFT tilapia in a biofloc system as well as water quality, and biofloc composition. The study consists of five biofloc treatments with different carbon sources such as Rice water (T1), Jaggery (T2), Sugar (T3), *E. crassipes* (T4) and mixture of *E. crassipes* & Jaggery (T5) in triplicate with a Control group (T6). GIFT tilapia of average weight (1.57 ± 0.003 g) were stocked in 70 Litre FRP tanks at 10 fish per tank and fed on a commercial diet (30%) for 60 days. Feeding was done twice daily at 5% body weight. Total Weight Gain was higher in T2 (22.89) followed by T5, T4, T1, T3 and T6. Highest SGR (1.98) and lowest FCR (1.45) in T2 and T5 follows the trend. T6 has lowest SGR and highest FCR. PER peaks in T2 (2.29) followed by T5 and lowest in T6 (1.61). Hundred percentage survival rate was observed in all treatments except T1 and T6 (93.3%). The fish protein and floc protein were highest in T4, followed by T5 and lowest in T6. The fat and ash content was highest in T1 and T3 respectively. The average water temperature and pH did not show significant difference among all treatments, whereas DO was fluctuated between 5.1-7.8 mg/l. TAN was significantly higher in the control group ($0.45\text{--}1.7$ mg L⁻¹) than in biofloc treatments ($0.15\text{--}0.35$ mg L⁻¹). Lower nitrite and higher nitrates were observed in biofloc based treatments than in the control group. The floc volume ranges from 4-29 ml/L during culture period. The floc porosity shows an inverse pattern with the culture days in all treatments. FDI higher in T5 and FVI in T2. Overall results suggest that water hyacinth can be used as cost effective and eco-friendly carbon source in biofloc systems which enhance growth, feed utilization when compared to commercially used carbon sources.

Keywords: Biofloc, GIFT tilapia, Water hyacinth, Biofloc proximate, Water quality



EFFECT OF SOLID STATE FERMENTED SOYBEAN MEAL WITH YEAST, *SACCHAROMYCES CEREVISIAE* ON GROWTH AND NUTRIENT UTILIZATION IN

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Solid State Fermentation (SSF) has gained attention as a pivotal process in sustainable aquaculture due to its potential to revolutionize feed production and enhance environmental stewardship. Soybean meal (SBM) is a widely used protein source in aquafeed formulation; however, its nutritional profile often requires enhancement to meet the specific dietary needs of aquatic organisms. Solid state fermentation (SSF) presents a promising strategy to enrich SBM with essential nutrients, thereby improving its suitability for aquaculture diets while promoting sustainability. This study investigates the nutrient enrichment of SBM through SSF, focusing on optimizing process parameters to maximize nutritional quality and minimize environmental impact. Commercial solvent extracted soybean meal (SBM) was fermented with yeast, *Saccharomyces cerevisiae* at 60-65% moisture for three days and was evaluated as a fishmeal alternative in the diet of *Penaeus vannamei*. A 45-days' feeding trial was performed using nine iso-nitrogenous and iso-lipidic diets in 500 l fiber reinforced tanks. Nine iso-nitrogenous diets were formulated by replacing fishmeal (w/w) using untreated/fermented SBM (200, 250, 300, 350 and 400 g/kg). Each diet was randomly allotted to three tanks with 20 shrimp per tank. Results revealed that the inclusion of fermented SBM up to 350 g/kg had no significant difference in growth compared to control, whereas, the inclusion was limited to 250 g/kg for the unfermented SBM. The feed efficiency measures were better with fermented ingredients compared to the respective level of untreated ingredients. The results indicate that the yeast fermented ingredients could be used as a potential protein sources rather than untreated materials in the diet of *P. vannamei*. SSF led to a reduction in anti-nutritional factors improving the overall nutrient bioavailability in the feeds. Further research is warranted to optimize SSF protocols, scale up production, and evaluate the performance of SSF-enriched SBM in practical aquaculture settings.

Keywords: *Saccharomyces cerevisiae*, Aquafeed, Solid state fermentation



COMPARISON OF GROWTH OF ASIAN SEABASS, *LATES CALCARIFER* (BLOCH, 1790) IN OPEN-WATER CAGES WITH DIFFERENT FEEDS

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Cage culture has become a prominent method for aquaculture production, offering benefits such as efficient space utilization and reduced environmental impact. However, to ensure the long-term sustainability of cage culture systems, attention must be given to feed management. This study highlights the critical role of feed quality in optimizing production efficiency, minimizing environmental impacts, and promoting the overall sustainability of cage culture operations. Asian Seabass fingerlings were stocked in 4×4×4 m cages. Three feed types (T1, T2 & T3) were evaluated. Growth rates and environmental parameters were recorded monthly and proximate and enzyme analyses were recorded at the end of the experiment. Results show that overall growth performances and fish survival rates between the feed types were significantly different. The mean weight gain after the harvest of Seabass grown in treatments was highest (1270 ± 51.60) in treatment T2 and lowest in (1012 ± 38.11) treatment T3. Maximum survival rate (87.7%) was obtained from T2 treatment. Significantly better FCR (1.5) was obtained in commercially available pellet feed treatment. Crude protein, lipid, moisture, and fiber levels of the experimental fish differ ($P<0.001$) among the fish fed with different diets. T2 treatment had significantly greater protease activity followed by T1 and T3 groups. Lipase activity ranged from 4.944 ± 0.011 , 6.327 ± 0.015 , and 3.985 ± 0.006 for T1, T2 & T3. There were no significant differences in water quality levels between sites. Results have indicated that fish-fed commercial pellets showed improved growth, survival, body composition, and enzyme activity.

Keywords: Asian Seabass, Feed, Growth, Body composition, Water quality



FATTY ACID PROFILE AND POPULATION DEVELOPMENT OF COPEPOD *P.malayalus* FED ON DIFFERENT MICROALGAL DIETS

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The objective of this study is the optimization of the fatty acid profile of copepod *Psuedodiaptomus malayalus*, by feeding different algal diets to develop it as a potential live feed for marine larviculture. Calanoid copepod nauplii are the best alternatives for rotifers and artemia as marine fin fish larval feed. The present study investigated the fatty acid profile and population development of *P. malayalus* fed different microalgal diets. The experiment was done in twelve 75 L culture tanks and the copepods were cultured using three different microalgae, *Isochrysis galbana*, *Nannochloropsis salina*, and *Dicrateria inornata*. The three microalgae used for the study were cultured in 30 L carboy bottles separately. The experiment was done at the CMFRI hatchery for 30 days. In this experiment, a comparative analysis of four different microalgal diets (two monoalgal and two mixed-algal diets) was done. Microalgal diets were decided based on the DHA (C22:6 n-3) and EPA (C20:5 n-3) content of the microalgae. Here, the two monoalgal diets of each *I. galbana*, *N. salina* and 1: 1 combination of *I. galbana* + *N. salina*, *D. inornata* + *N. salina* were used. The results revealed that the 1:1 combination of *D. inornata* + *N. salina* had the highest DHA/EPA ratio, and the monoalgal diet of *D. inornata* and the 1:1 combination diet of *D. inornata* + *N. salina* gave the highest population number. Results showed that the fatty acid profile and population number of *P. malayalus* can be modified by its diet modifications. Therefore it is confirmed and concluded that *P. malayalus* is a potential and promising live feed for many marine larvae, and its population number and nutritional profile can be modified as per the requirements of the marine fish larvae.

Keywords: Fatty Acid, Copepod, Algal Diets



EFFECT OF CULTURE MEDIA, LIGHT INTENSITY, AND PHOTOPERIODICITY ON THE POLYUNSATURATED FATTY ACID PROFILE OF MARINE MICROALGA

Chaetoceros calcitrans

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Suitability of marine microalga *Chaetoceros calcitrans* to produce Eicosa Pentaenoic Acid (EPA), Docosa Hexanoic Acid (DHA), and Arachidonic Acid (ARA), in the exponential phase, under different conditions of culture media (f/2, Miquel, TMRL and Walne's), light intensity (1500, 3000, 4500 and 6000 lux), and photoperiodicity (06:18, 12:12; 18:06, 24:0 hrs Light: Dark) was tested, in triplicate, by culturing at 25°C. Statistical analysis (ANOVA) of Fatty Acids (Gas Chromatography) indicates a significant difference ($p<0.05$) in EPA production with the highest in f/2 medium (1.33 ± 0.027 mg/g dry weight of algae), followed by TMRL culture medium (0.71 ± 0.065 mg/g dry weight); no significant difference ($p>0.05$) in the production of DHA, between f/2 (0.17 ± 0.003 mg/g dry weight) and TMRL (0.32 ± 0.18 mg/g dry weight), and significantly higher ($p<0.05$) ARA in TMRL (0.71 ± 0.05 mg/g dry weight) than f/2 (0.11 ± 0.002 mg/g dry weight). EPA was significantly highest ($p<0.05$) at (1.33 ± 0.027 mg/g dry weight), at the lowest level of light intensity 1500 lux, followed by 3000 lux (0.42 mg/g dry weight). DHA was not significantly different ($p>0.05$) at any level (0.11 to 0.41mg/g dry weight). ARA was significantly the highest ($p<0.05$) at 1500 lux (0.11 ± 0.002 mg/g dry weight). EPA was significantly highest ($p<0.05$) at a photoperiodicity of 18 hrs: 06 hrs (1.92 ± 0.029 mg/g dry weight), followed by 12 hrs: 12 hrs L: D (1.33 mg/g dry weight). DHA content was significantly higher ($p<0.05$) at 18:6 hrs (4.16 ± 0.063 mg/g dry weight) and ARA at 12:12 hrs L: D (0.11 ± 0.0019 mg/g dry weight). The results indicate that the maximum production of EPA (1.92 ± 0.029 mg/g dry weight of algae) and DHA (4.16 ± 0.063 mg/g) could be obtained in *Chaetoceros calcitrans* in f/2 medium, salinity 27‰, temperature 25°C, light 1500 lux, and photoperiodicity 18:6 Light: Dark hrs. The results find its application in the enrichment of live feed with microalgae for the larval rearing of aquaculture species.

Keywords: *Chaetoceros calcitrans*, culture media, light intensity, photoperiodicity, polyunsaturated fatty acids



EVALUATION OF FORMULATED PELLET FEED AND SQUID MEAT ON THE GROWTH AND BIOCHEMICAL PARAMETERS IN PICNIC SEABREAM, *Acanthopagrus berda*

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Seabreams are commercially important group of food fish with immense potential for mariculture and other land-based aquaculture activities. The picnic seabream, *Acanthopagrus berda* is a candidate species among seabreams with good growth rate, tolerate fluctuations in environmental conditions like temperature & salinity, excellent meat quality and have high consumer demand. ICAR-Central Marine Fisheries Research Institute has recently developed and standardized hatchery technology for the seed production of *A. berda*. With mariculture activities growing in India, this species holds great promise in the expansion of mariculture in India. In the present study, growth and biochemical parameters in juveniles of *A. berda* was evaluated for a period of 30 days at Karwar Regional Centre of CMFRI. Fish with initial average weight of 155 ± 8.1 g were randomly distributed into two experimental groups. In the first group, raw squid meat was offered as feed and in the other group, formulated pellet feed (crude protein= 40 %, and lipid= 10 %) was given. After the feeding trial, there were no significant difference in the growth (weight gain percentage, 24.72% vs 23.27%; SGR 0.83 vs 0.88), survival (96.4 vs 98.6%) and condition factor (2.31 vs 2.24) of the fish among the squid and pellet fed groups, respectively. The serum biochemical parameters showed significant differences with a higher total protein (g/dl) content in pellet fed group (8.36 ± 1.19) than the squid fed group (5.87 ± 1.38). The serum total cholesterol (mg/dl) (62.4 ± 7.9 vs 70.1 ± 8.8), and triglycerides (mg/dl) (369.6 ± 61.9 vs 420.73 ± 79.6) were lower in the pellet fed group. The results of this study indicates that *A. berda* can adapt well to formulated feeds without any adverse effects on the growth and biochemical indices. This study forms the first report on the feeding trial using formulated feed in *A. berda*.

Keywords: Seabreams, *Acanthopagrus berda*, Feed, Growth, Biochemical parameters



USE OF INTERNET OF THINGS AND MACHINE INTELLIGENCE FOR WATER QUALITY MONITORING IN SHRIMP AQUACULTURE

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Shrimp aquaculture holds significant importance in contributing to India's economy and livelihood. The overall export of frozen shrimp reached 7,11,099 MT, which earned \$5481.63 million during 2022-23. Maintaining optimum water quality in shrimp culture ponds is important to achieve higher production and profits. Traditional practices for water quality monitoring are complex with classical available analytical techniques, which are time-consuming and measured at regular intervals. This study explores the integration of Internet of Things (IoT) technology in shrimp aquaculture, specifically focusing on monitoring water parameters pH, temperature, dissolved oxygen (DO), total dissolved solids (TDS) and turbidity. The sensors for these parameters were procured commercially and calibrated in the laboratory with different salinity levels (0, 15 and 30 ppt) and temperatures (20, 28 & 35°C) as these parameters are dynamic and vary with place and time. The sensors were attached in a solar-powered buoy (device) which also includes a reconfigurable PCB board designed to accommodate essential components, including a display, Wi-Fi receiver, battery, and a memory card for storing data. The device was also equipped with a self-healing mechanism, which included cleaning of the sensor, interpreting the faulty sensor data, and acknowledging the farmers regarding the action taken. The collected data can be wirelessly transmitted to a cloud platform which enables remote monitoring. The preliminary results showed accurate values for pH, temperature, turbidity and TDS, but not for DO, raising apprehensions on the reliability of DO sensors. The device can monitor water parameters 24*7 enabling the farmers to identify the water quality issues and take corrective actions immediately during farming.

Keywords: IoT, Sensors, Shrimp Aquaculture, Water Quality



UTILIZATION OF *PmLyO-SF9* CELLS FOR THE CRYOPRESERVATION OF IHHNV (INFECTIOUS HYPODERMAL HEMATOPOIETIC NECROSIS VIRUS / PSTDVI) AND MBV (MONODON BACULO VIRUS / PMNV) FOR LONG TERM

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As long term cryo-preservation of virus encountered with loss of infectivity titre, current study was undertaken to cryo-preserve IHHNV (Infectious hypodermal hematopoietic necrosis virus/ PstDVI) and MBV (Mondon baculo virus /PmNV) in a host cell line *PmLyO-Sf9* in an infected state prior to burst and release. Cryo-protectant (CPA) was standardized and prepared with a mixture of shrimp cell culture medium (SCCM), dimethyl sulfoxide (DMSO), fetal bovine serum (FBS) at a ratio 7:1:2 respectively. On revival of the infected cells at different time periods (2 months, 6months, 12 months, 24 months), more than 80% of cells were viable as determined through trypan blue assay. The revived cells exhibited increased attachment rate and rapid onset of CPE due to virus such as vacuolation, syncytia formation, enlargement leading to the death of the cells in all the samples. Also, virus titer could further be enhanced by seeding the cryo-revived cells on to a new monolayer of *PmLyO-Sf9*. Virus replication in the cells was confirmed through electron microscopy and demonstration of viral gene expression in the cells. The virions released in to the culture medium were infective as demonstrated through multiple passages in new cell monolayers. The present study effectively utilized *PmLyO-Sf9* as a platform for cryopreservation of shrimp viruses for long term storage.

Keywords: Cryopreservation, IHHNV, Cryo-protectant



STUDY OF REARING AND BREEDING OF ANGEL FISH (*Pterophyllum scalare*) IN GLASS AQUARIUM: A SUSTAINABLE INCOME SOURCE FOR STUDENT ENTREPRENEURS

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This study investigates the feasibility of cultivating and breeding ornamental fish, particularly angelfish (*Pterophyllum scalare*), in limited spaces as a supplementary source of income for student entrepreneurs. A twenty gallon glass aquarium that was equipped with a filter and air pump was used for the culture and breeding processes. Continuous monitoring of water quality parameters and regular water exchanges were conducted to maintain optimal conditions. Daily assessments included temperature; pH, dissolved oxygen, and ammonia, especially during the breeding period. Successful breeding of angelfish was achieved from January 2024 to March 2024, at the hatchery complex of the Research Department of Fisheries and Aquaculture, St. Albert's College (Autonomous) in Ernakulam. Employing group mating systems, we focused on key physical attributes such as size, shape, colour, and maintained a balanced sex ratio of 1:1. Our study observed promising results, with an average of 380 ± 20 eggs deposited per female, yielding 340 ± 15 viable eggs. Subsequently, 250 ± 25 eggs hatched within 4 days, and 110 ± 15 fingerlings survived after one week. Despite the relatively low egg count, constraints such as limited brooder size, restricted rearing space, and brief exposure to natural environmental conditions likely influenced the breeding outcomes. This study underscores the potential for small-scale ornamental fish breeding as a sustainable income-generating venture, particularly for student entrepreneurs in resource-constrained settings.

Keywords: Breeding and Rearing, *Pterophyllum scalare*, Ornamental Fish Culture, Small-scale Aquaculture, Student Entrepreneurs



ADVANCEMENTS IN RECIRCULATORY AQUACULTURE SYSTEM TOWARDS SUSTAINABLE AQUACULTURE

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Recirculatory Aquaculture Systems (RAS) have emerged as transformative solutions for sustainable fish farming. These closed-loop systems address critical challenges faced by traditional aquaculture, such as water scarcity, environmental pollution, and resource inefficiency. Recent advancements in RAS focus on can be on biological filtration, digital technologies, and food recycling. In terms of biological filtration, RAS employs specialized filters that harbor beneficial bacteria, converting toxic compounds like ammonia into less harmful forms. Innovations in filter media design, optimized flow rates, and microbial communities enhance water clarity, reduce stress on fish, and minimize pollutant release. Digital technologies play a pivotal role in modern RAS. Real-time sensors continuously monitor water parameters—temperature, dissolved oxygen levels, pH, and ammonia concentration. Smart algorithms adjust system parameters, ensuring optimal conditions for fish growth. Remote monitoring allows timely interventions, preventing adverse events and maximizing efficiency. Additionally, RAS systems embrace a circular economy approach by recycling uneaten feed and fish excreta. Nutrient-rich water from fish tanks is diverted to hydroponic or aquaponic systems, where plants utilize these nutrients for growth. This closed-loop nutrient management reduces waste, conserves resources, and makes RAS more economically viable and ecologically sound. In summary, RAS technologies contribute significantly to sustainable aquaculture by minimizing water usage, enhancing water quality, and mitigating environmental impacts. As we continue to refine and adopt these advancements, RAS holds promise for meeting the growing global demand for food while safeguarding natural resources.

Keywords: Recirculatory Aquaculture System, sustainable aquaculture, biosensors, nitrification



NANOBUBBLE TECHNOLOGY: REVOLUTION IN AQUACULTURE FOR ENHANCED FISH HEALTH AND PRODUCTION

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The aquaculture industry is witnessing a transformative phase with the integration of advanced technologies aimed at enhancing sustainability and productivity. Among these, nanobubble technology emerges as a groundbreaking innovation, particularly in the realms of fish health management and environmental conservation. This innovative approach leverages the unique properties of nanobubbles—exceptionally small gas bubbles with a high internal pressure and large surface area to volume ratio—to address critical challenges in fish farming. Nanobubbles exhibit remarkable stability in aqueous solutions, providing sustained oxygenation that is vital for the metabolic processes of aquatic organisms. Their diminutive size facilitates deep penetration into fish tissues, ensuring efficient delivery and uptake of oxygen at the cellular level. Moreover, nanobubble technology has shown promise in the administration of vaccines, offering a non-invasive route that circumvents the stress and potential harm associated with traditional injection methods. Encapsulation of vaccine antigens within nanobubbles protects them from enzymatic degradation, thereby preserving their immunogenicity. The controlled release properties of nanobubbles allow for a gradual exposure of the immune system to the antigen, fostering a robust and long-lasting immune response. Recent empirical evidence suggests that pre-treatment with ozone nanobubbles can prime the fish immune system, upregulating the expression of genes associated with immune defense mechanisms. This preconditioning effect may enhance the efficacy of subsequent vaccinations, fortifying fish against a spectrum of pathogens. The integration of nanobubble technology with precision aquaculture practices—such as real-time monitoring of water quality and fish behavior—can optimize the health and growth conditions of cultured species. Additionally, the development of eco-friendly feeds that synergize with nanobubble-mediated oxygenation can further diminish the environmental footprint of aquaculture. In conclusion, nanobubble technology stands at the forefront of aquacultural innovation, offering a multifaceted solution that not only elevates fish health and productivity but also aligns with the principles of environmental stewardship and sustainability.

Keywords: Cryopreservation, IHHNV, Cryo-protectant



DIVERSITY AND ABUNDANCE OF AMMONIA OXIDIZING ARCHAEA (AOA) IN AQUAPONIC SYSTEMS

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Aquaponics is the integration of fish culture with vegetable hydroponics in a recirculating system, having the potential to recover nitrogenous wastes. Ammonia oxidation is an important process in the removal of ammonia generated from feed and metabolic wastes in aquaponic systems. In the past, aerobic ammonia oxidation was believed to be conducted solely by ammonia-oxidizing bacteria (AOB). However, many recent studies have demonstrated the importance of ammonia-oxidizing archaea (AOA) in ammonia oxidation. In this study, growbeds of aquaponic systems (triplicate) were used to investigate the diversity and abundance of archaeal ammonia-oxidizing communities based on ammonia monooxygenase A (*amoA*) gene. Samples were collected from Cherayi, Arookutty and Cherthala aquaponics systems in Ernakulam district. Nitrification potential of aquaponics systems were estimated by checking the concentrations of ammonia, nitrite and nitrate. Analysis of archaeal *amoA* gene sequences revealed that most ammonia oxidizers were related to Uncultured Crenarcheota. The *amoA* gene copy numbers in the grow beds are 2.02×10^5 , 4.91×10^4 , and 1.08×10^2 copies/ μg of DNA. This study showed that the grow beds of the aquaponics system are the major site of ammonia oxidation. The data obtained in this study would be useful to elucidate the role of ammonia-oxidizing archaea in the nitrogen cycle of freshwater ecosystems.

Keywords: Ammonia monooxygenase gene, Ammonia oxidizing archaea, Aquaponics, Nitrification



NANOBUBBLE TECHNOLOGY: AN ULTRAFINE SOLUTION TO EMERGING CHALLENGES IN AQUACULTURE

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Nanobubbles (NB) with a diameter of less than 100 nm have shown promising results in improving water quality in aquaculture systems, increasing dissolved oxygen availability, and improving the overall health of candidate cultured organisms. However, extensive research and standardization must be done to optimize conditions for the application of nanobubbles in culture systems to understand their chronic effects on species growth and overall production. However, it is worth noting that existing aquaculture practices often unknown the importance of oxygen nanobubbles. This technology extends beyond oxygen augmentation, assuming a pivotal role in the orchestrated management of both organic and inorganic waste matrices within cultivation containers. By facilitating the supply of dissolved oxygen to the water, nanobubbles provide a valuable resource for the microbes responsible for decomposing organic waste, thus aiding in waste processing and management. Nanobubbles excel in efficiently dissolving gases like oxygen and ozone into water, which in turn enhances the oxygen levels in aquatic environments and facilitates the effective elimination of excess gases. Some potential applications include enhancing dissolved oxygen levels, delivering nutrients and probiotics to aquatic organisms, improving water quality through contaminant removal, and targeted drug delivery for disease treatment. However, nanobubble technology faces certain constraints, including cost, stability, environmental impact, and regulatory considerations. By responsibly harnessing the capabilities of nanobubbles, we can unlock new opportunities to address pressing global challenges and contribute to more sustainable and efficient practices in aquaculture and beyond.

Keywords: Nanobubble technology, Aquaculture systems, Cultured organisms



A SUSTAINABLE PROTEIN SOLUTION: UTILIZING BLACK SOLDIER FLY LARVAE AS PROTEIN SOURCE

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Aquaculture, the booming sector producing over 60% of our animal protein, shines as a bright spot in global food production. However, the sector faces critical challenges such as the environmental impact of adulterated and low-quality fish feed, hampering both ecological sustainability and the profitability of fish farming. In response, a transformative approach utilizing Black Soldier Fly Larvae (BSFL) has emerged, replacing traditional fish meal with alternative protein sources to address production costs, raw material demand, and environmental concerns. Utilizing various biodegradable wastes to cultivate Black Soldier Fly larvae, offers a groundbreaking and sustainable solution that converts waste into valuable biomass and attracts wild BSF effectively, leading to exceptionally high BSFL production. The high levels of Omega-3 fatty acids found in BSFL not only enhance fish health but also contribute to increased production. A study was conducted to understand the proximate composition of both fish meal and BSFL. The fish meal was prepared by processing fresh trash fish from the market. The fish including the fins, scales, head and viscera were chopped and cooked in boiling water. After cooling, excess water was squeezed out and the product was left to dry overnight at room temperature before being oven-dried for proximate analysis. While, BSFL was cultured in a plastic bin with perforated round lids. Culture mediums are rotten wheat and mixture of rotten coconut oil cake and rice bran. They were attracted by the putrid scent emanating from the decomposing medium female BSF entered the bin and deposited eggs. Within an optimal temperature range of 26-30°C, Larvae emerged from the eggs in a span of 4-5 days, initiating a voracious feeding phase on the decomposed materials. Subsequently, after a developmental period of 15-21 days, the larvae transitioned into pre-pupae and autonomously exited the bin by crawling along a designed pathway, completing a self-harvesting process. The average Individual length of the larvae grown on different wastes were 1.57cm and 1.03cm for rotten wheat and mixture of coconut oil cake and rice bran respectively. The study revealed that Fish meal contains Moisture: 5%, Crude Protein: 61.2%, Crude Fat: 10%, Ash: 15%, NFE (Nitrogen-free Extract): 8.8%, DE (Calculated Digestible Energy): 370. The BSFL contains Moisture: 7%, Crude Protein: 40%, Crude Fat: 35%, Ash: 10%, NFE (Nitrogen-free Extract): 8%, DE (Calculated Digestible Energy): 507%. These findings demonstrate the promising nutritional value of both fish meal and BSFL, indicating their potential as sustainable protein sources for aquaculture.

Keywords: Black Soldier Fly, BSFL, Fish meal, sustainable protein



**ISOLATION AND IDENTIFICATION OF A PROBIOTIC BACTERIA
FROM THE GASTRO INTESTINAL TRACT OF SNUBNOSE POMPANO,
*TRACHINOTUS BLOCHII***

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In contemporary aquaculture industries, the primary focus has shifted away from the utilization of medicines and chemical additives. This shift is due to the recognized adverse effects of chemicals and antibiotics on both the environment and fish health, leading to a discouragement of their application. Consequently, alternative methods are being explored. One notable approach gaining recognition within the aquaculture industry involves the use of beneficial or probiotic bacteria. Historically, aquaculture research predominantly concentrated on well-established probiotic strains derived from terrestrial hosts, neglecting crucial distinctions in the physiology of cultured species and the specific environment where the respective microbial communities evolved, whether aquatic or terrestrial. The isolation of probiotics from the gastrointestinal tract of a host is considered the optimal approach for selecting candidate species. The snubnose pompano stands out as a leading candidate species for mariculture due to its rapid growth, excellent meat quality, and high market demand. This species is cultured in varying salinities, making it suitable for coastal mariculture in India. About five adult snubnose pompano, each weighing around approximately 500 gms, were collected from cage culture in Ashtamudi Lake. The gut was dissected, and homogenate was plated on nonselective media, nutrient agar. The plates were then incubated at 37 °C for 24 hours. Eight colonies exhibiting distinct morphological characteristics were selected. Identification of bacteria with probiotic characteristics was carried out through various tests, including bile salt tolerance, tolerance to acidic pH, salinity tolerance, and acid production. Based on these tests, four bacteria were selected with probiotic nature.

Keywords: Probiotic Bacteria, Snubnose Pompano, Antibiotics



EXPLORING THE EFFECTS OF SALINITY ON SURVIVAL AND REPRODUCTIVE CHARACTERISTICS OF ARTEMIA POPULATIONS IN LABORATORY CONDITIONS

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Artemia commonly known as brine shrimp, a widely studied aquatic organism due to its adaptability and significance in various fields, serves as the focal point of this investigation into the impact of salinity levels on survival and reproductive characteristics under laboratory conditions. *Artemia* sp. cultivated in 200 L beakers across a salinity gradient ranging from 25ppt to 80ppt. The experimental setup maintained a temperature of 24 ± 2 °C, continuous light exposure, aeration, and pH levels between 7.5 and 8.5. They were nourished twice daily with *Chlorella marina* a marine microalgae. Upon attaining sexual maturity, individuals were separated to assess reproductive characteristics. Our findings indicate a positive relationship between salinity levels and both survival rates and reproductive parameters across all *Artemia* populations. These results provide valuable insights into the adaptive responses of *Artemia* to varying salinity conditions in laboratory settings, with implications for their potential utilization in aquaculture and ornamental fish industries.

Keywords: *Artemia, salinity, reproductive characteristics, laboratory conditions, Chlorella marina, aquaculture*



EFFICACY OF CLOSED WATER DEPURATION SYSTEM TO DEPURATE *Villorita cyprinoides* FROM COCHIN ESTUARY

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The bacteriological quality of *Villorita cyprinoides* from the Cochin estuary was assessed in terms of Total Plate Count (TPC), Total Coliforms (TC), Fecal Coliforms (FC), *E. coli*, and *Vibrio*-like organisms. For depuration, a closed circulation system was set up within a glass tank. The system incorporated a sponge filter at the top to remove contaminants from the circulating water. To achieve significant bacterial reduction, the depuration process was conducted over 24- 48 hours. To assess the effectiveness of the depuration system, the clams were tested for the above bacterial parameters after 24 and 48 hours. The tests included Total Aerobic Plate Count (TPC) to measure overall bacterial levels, and the Most Probable Number (MPN) to specifically quantify total and fecal coliforms, which are indicators of fecal contamination. These tests were performed on the clams initially (zero hour), and then again after 24 and 48 hours of depuration. The results showed a considerable reduction in the TPC, and coliforms (FC and TC) demonstrating the effectiveness of the system in purifying clams. Biochemical characterization of *E. coli*, a specific indicator of fecal contamination, was also carried out. The experiment observed biofilm formation on the inner walls of the glass tank, which highlights the need for research to assess the impact of biofilm formation on depuration efficacy. Unlike traditional depuration systems that require large volumes of water, this closed system offers a more sustainable and cost-effective approach. Its simplicity makes it ideal for small-scale farmers and households. By recirculating and treating the water within the system, it minimizes wastage of water, while effectively reducing the contaminant load to acceptable levels.

Keywords: *Villorita cyprinoides*, Cochin estuary, Depuration, TPC, TC, FC.



ENHANCING AQUACULTURE SUSTAINABILITY: INVESTIGATING THE IMPACT OF SYNTHETIC PEPTIDE THYMOGIN ON MICROALGAE GROWTH

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The sustainability of aquaculture and fish health is seriously threatened by the rise of antibiotic resistance in aquaculture pathogens and their persistence in aquatic environments. Synthetic antimicrobial peptides (SAMPs) offer promising alternatives to conventional antibiotics in aquaculture, characterized by broad-spectrum activity, low toxicity, and high potency. Thymosin beta, a peptide synthesized from tilapia fish, represents one such SAMP. Previous research results suggest that thymosin functions as a type of antimicrobial peptide that is engaged in immune responses against microorganisms. This study investigates the impact of thymosin beta on unicellular organisms, particularly microalgae, crucial as aquaculture live feed. Through experimentation with various concentrations of thymosin beta and three microalgae strains including *Chlorella marina*, *Nannochloropsis salina*, and *Chaetoceros calcitrans*, dose-dependent effects on algal growth could be observed. It was found that low peptide concentrations stimulated algal growth, while higher concentrations inhibited it. These findings underscore the potential of synthetic antimicrobial peptides to modulate microalgae populations in aquaculture systems. Careful dosage optimization is essential to maximize benefits while minimizing unintended consequences.

Keywords: Synthetic antimicrobial peptides (SAMPs), Thymosin, Microalgae, Aquaculture



MANIPULATION OF SEX IN DWARF GOURAMI, *Trichogaster lalius* (HAMILTON,1822)

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Dwarf gourami (*Trichogaster lalius*), is a very popular ornamental fish, adored by aquarists due to their striking coloration and docile nature. Flame red dwarf gourami, which is a colour morph developed from dwarf gourami through selective breeding. In view of the growing concern over use of synthetic hormones for sex manipulation, the present study was conducted with the aim of introducing an eco-friendly, plant-derived aromatase inhibitor, proanthocyanidin (from grape seed extract), for sex manipulation through discrete immersion treatment. Different doses of proanthocyanidin *viz.* 500, 750, 1000 and 1250 µg/l for 3 h daily on third, fifth and eighth day after hatching, along with 17 α MT (1000 µg/l) as a positive control. In *T. lalius*, the highest percentage of males (60.75%) and the highest post treatment survival (90.80%) were obtained at 1250 µg/l proanthocyanidin treatment, whereas in positive control, 87.20% post-treatment survival and 80.62% males were observed with 12.90% fin deformity. In the flame red dwarf gourami, highest proportion of males (72.15%) was obtained at 1250 µg/l and the highest post-treatment survival (94.02%) was obtained at 750 µg/l of Proanthocyanidin. In positive control, 82.45% males and 93.44% post treatment survival were observed. The female GSI of the proanthocyanidin treated fish and positive control group revealed significant suppression of the ovarian development compared to control in both the strains. Histological examination showed the appearance of suppressed atretic oocytes and more immature oocytes in positive and proanthocyanidin treatment (1250 µg/l) groups. No significant difference was observed in total body carotenoid content in proanthocyanidin-treated and control groups in dwarf gourami. In the flame red strain, a significant difference was found between proanthocyanidin treatment, positive and negative control groups, but no significant difference was found among proanthocyanidin treatment groups.

Keywords: Sex manipulation, Proanthocyanidin, Dwarf gourami



QUANTITATIVE ANALYSIS OF HYDROLASES MEDIATING DIGESTION IN *ARTEMIA NAUPLII*: A PREMIER LIVE FOOD FOR AQUACULTURE

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The present study analyzed variations in the profile of hydrolases mediating the digestion of macronutrients in *Artemia* metanauplii when fed different algae-based diets. Marine microalgae-*Nannochloropsis salina*, *Chaetoceros muelleri*, *Isochrysis galbana*, and the Thraustochyrid-*Aurantiochytrium limacinum* were mixed in different combinations to form the test diets. Thus, the test diets included the following combinations such as *N. salina* + *I. galbana* (Treatment 1), *C. muelleri* + *I. galbana* (Treatment 2), *N. salina* + *C. muelleri* (Treatment 3), *N. salina* + *I. galbana* + Thraustochyrid (Treatment 4), and Thraustochyrid (Treatment 5). *Artemia* metanauplii were stocked for enrichment (Treatments) or starvation (Control) at density 200 nos./mL. Latent to 12 hours, about 1 mL samples were removed from the control and every treatment batch for the extraction of crude enzyme. Crude extract was used as the source for quantifying the levels of hydrolases like protease, trypsin, lipase, and amylase. Except for trypsin, the other three enzymes showed significant variations between the control and treated batches and in between the treated batches themselves. Protease was the dominant digestive enzyme observed in enriched metanauplii with the estimates ranging up to 80.69 U/mG protein. The Highest protease activity was noted for the metanauplii drawn from treatment 4 (80.69 U/mG protein, p<0.05). Activity of trypsin varied from 4.20 to 5.18 U/mG protein with insignificant differences (p>0.05). Relative activity of lipase and amylase was intense (p<0.05) in nauplii drawn from treatment 1 (lipase - 1.02 U/mG protein, amylase - 3.61 U/mG protein). Starved batches manifested the lowest activities of lipase and amylase. However, the protease activity was observed to have been severely enhanced during starvation. In summary, the study suggests treatment 1 (*N. salina* + *I. galbana*) as the best di-algal diet to enrich *Artemia* metanauplii as it elevated the relative activities of trypsin, lipase, and amylase in the organism.

Keywords: *Nannochloropsis salina*, *Chaetoceros muelleri*, *Isochrysis galbana*, *Aurantiochytrium limacinum*, *Artemia franciscana*.



EFFECT OF YEAST FERMENTATION OF SUNFLOWER OIL CAKE ON GROWTH AND NUTRIENT UTILIZATION IN *P.vannamei*

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Aquaculture, particularly shrimp farming, is a significant contributor to the global seafood market. However, ensuring sustainable and cost-effective feed sources remains a challenge. Sunflower oil cake, a byproduct of the oil extraction process, is abundant in protein and lower levels of lipids, making it a potential candidate for aquafeed formulation. However, its high fiber content and presence of anti-nutritional factors limit its direct utilization in aquafeeds. Yeast fermentation has been proposed as a method to enhance the nutritional profile and digestibility of feed ingredients. This study investigated the impact of yeast fermentation of sunflower oil cake on the growth performance and nutrient utilization of Pacific white shrimp (*Penaeus vannamei*). Sunflower oil cake was fermented with yeast, *Saccharomyces cerevisiae* at 60-65% moisture for three days. For optimization of the inclusion level in shrimp feed, nine test feeds having 0, 2.5, 5.0, 7.5 and 10% levels of raw and yeast fermented SFC were prepared by replacing fishmeal. The results indicated that yeast fermented SFC can be included up to 7.5% whereas raw SFC could be included up to 2.5% in *P. vannamei*. The enhanced inclusion level of fermented SFC can be attributed to reduction of saponins (mg/100 g DMB) from 641.52 ± 39.57 to 207.01 ± 18.99 and hemicellulose (% on DMB) from 16.27 ± 0.44 to 12.69 ± 0.59 , respectively. Results indicate that yeast fermentation of sunflower oil cake significantly improves its nutritional quality, leading to enhanced growth performance in *P. vannamei*. Shrimp fed with fermented sunflower oil cake exhibited higher weight gain and improved feed conversion ratio compared to those fed with unfermented counterparts. Furthermore, enhanced nutrient utilization, evidenced by improved protein efficiency ratio and apparent digestibility coefficients, suggests better assimilation of nutrients from the fermented diet. Incorporating fermented sunflower oil cake into shrimp diets can contribute to sustainable aquaculture practices by utilizing a cost-effective and environmentally friendly feed ingredient while promoting growth and maximizing nutrient utilization in *P. vannamei*.

Keywords: *Saccharomyces cerevisiae*, *Penaeus vannamei*, Fermentation, Sunflower oil



FOOD AND FEEDING HABITS OF *Abudefduf vaigiensis* (QUOY & GAIMARD, 1825)

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The evaluation of the food and feeding habits of commercially significant marine ornamental fish *Abudefduf vaigiensis* from the Gulf of Mannar revealed that it is an omnivorous species. A total of 360 fishes were analyzed for stomach contents by characterizing the dominant food items and morphometric features, the results showed that food items comprised of seaweeds, cladoceras, copepods, and insects. Feeding intensity studies showed most fish had stomachs filled to either 1/4th, 1/2th, or 3/4th capacity. The highest percentage (5.5%) of empty stomachs occurred in September, while the maximum percentage (56.3%) of full stomachs was recorded in June. Among most length classes, the index of preponderance highlighted a preference for seaweeds as the primary food item, except for those falling within the 80-89 and 100-109 length classes, where a preference towards copepods was evident. Monthly analysis indicated that seaweed *Spongomorpha* sp. was the primary dietary component. In July, males reached their peak Gastro-somatic index (GaSI), declining to its lowest point in November. Similarly, females recorded their highest value in July and their lowest in January. The GaSI pattern observed in male and female fishes was almost identical. Hepato somatic index (HSI) exhibited a similar trend in both males and females, peaking from December to February in males and from October to February in females. Given their trade's reliance on wild collection, these findings emphasize the importance of implementing regulatory measures to ensure sustainable fish exploitation during specific periods.

Keywords: *Abudefduf vaigiensis*, food and feeding, gastro somatic index, hepato somatic index, seaweeds.



EFFECT OF SALINITY ON THE REPRODUCTION AND POPULATION GROWTH OF CLADOCERA *Diaphanosoma celebensis* STINGELIN, 1900.

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Cladocerans commonly known as water fleas are one of the most important crustacean zooplankton and an abundant primary consumer group in marine and brackish water environments owing to their wide salinity and temperature tolerance (Aravind *et al.*, 2021, Ivleva, 1973). Due to the ease of cultivation and minimal space requirement, cladoceras are relatively inexpensive to produce, which makes them economical for aquaculture. However, cladoceras were the least explored group among aquatic live feeds (Gogoi *et al.*, 2016). The brackishwater cladocera *Diaphanosoma celebensis* is one of the important species being used in the hatchery. Therefore, a study was undertaken to find out their optimum culture conditions for its mass production, and the salinity was found to be the most influencing parameter in their life history. Influence of different salinities (12, 15, 18, 21, 24, 27, 30 ppt) on population growth and reproductive parameters like the number of reproductions, age at first reproduction (days), clutch size, longevity (days), no. of offspring, etc., of *D. celebensis* at 29°C with a 10h L: 14 D photoperiod in the hatchery were investigated. *Isochrysis galbana* at 105 cells/ml was used as the microalgal diet. The results revealed that *D. celebensis* showed maximum no. of neonate production (~50nos/individual/life cycle) at 18 ppt salinity followed by 15 ppt and 12 ppt. The population growth rate was also highest at 18 ppt with an average of ~8nos/ml. Longevity was observed to be highest (19 days) at the lowest salinity and the age at first reproduction was observed at the 5th day, which was similar in all treatments. The study concluded that 18 ppt is the optimum salinity for its maximum population growth and *D. celebensis* could be used as a potential live feed in the hatchery owing to its mass production possibility, varying size, and wide acceptance by larvae and their survival.

Keywords: Cladocera, *D. celebensis*, zooplanktons, salinity, life history parameters, population growth



ANTIBACTERIAL PHOTODYNAMIC THERAPY(APDT): A NON-THERMAL TECHNOLOGY FOR BACTERIAL INACTIVATION IN SEAFOOD

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Antibacterial photodynamic therapy (aPDT) is a promising tool, which offers a non-thermal, chemical-free method to improve food safety and shelf life, and has become a viable option for reducing bacterial contamination in seafood products. Antibacterial photodynamic therapy combines photosensitizer, light, and reactive oxygen species. There are various strategies for enhancing the efficacy of aPDT, such as combination therapies, nanotechnology-based delivery systems, and optimization of treatment parameters, etc. Essential elements such as the choice of photosensitizer, optimization of the light source, and exposure time are considered, thereby emphasizing their applicability to seafood processing. Additionally, cutting-edge methodologies are being investigated for their potential to enhance practicality and efficacy in seafood applications. This technique can improve food safety and quality by extending the shelf life of seafood by lowering microbial infection and spoiling. Furthermore, as aPDT leaves no chemical trace and is non-thermal, it is a potential solution for preserving perishable commodities like seafood. This study investigated the antibacterial potency of a natural phytoextract mediated blue light emitting diode (LED) photodynamic inactivation on seafood samples spiked with ATCC cultures like Methicillin-resistant *staphylococcus aureus* (MRSA), *Bacillus subtilis*, *Escherichia coli*, and *Pseudomonas aeruginosa*. After the treatment the number of bacteria decreased significantly ($p < 0.05$). These results suggest that aPDT using natural phytoextract can be considered as a potential strategy for the inactivation of bacteria. However, more investigation is required to guarantee optimal effectiveness without compromising the sensory quality of seafood by optimizing variables including photosensitizer concentration, light intensity, and exposure duration. This study highlights the potential of aPDT as a safe, environmentally friendly, and efficient method for improving the microbial safety, quality, and preservation of marine food products thereby supporting the sustainability of the seafood industries.

Keywords: Antibacterial, Seafood, Bacterial inactivation



EFFECT OF MELATONIN ON THE REPRODUCTIVE PERFORMANCE OF *Devario aequipinnatus* (MCCELLAND, 1839)

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A 60-day trial was conducted to investigate the effect of melatonin on the reproductive status of *Devario aequipinnatus*. Five experimental diets were prepared by incorporating melatonin @ 2mg, 10mg, 50mg, 100mg and 0 mg per 100 g of feed which were designated as T1, T2, T3, T4 and Control, respectively. The key reproductive features that provide an understanding of the maturation indices like gonadosomatic index, fecundity, egg diameter and histological studies were analysed on the 30th and 60th day of the experiment. At the end of the trial, the results revealed that the fishes fed with 50mg of melatonin (MEL) 100g⁻¹ had significant effect on reproductive parameters and growth as compared to the other treatments. Initially, at 30th day, the gonadosomatic index (GSI) increased in highest level of melatonin supplementation (100mg 100g⁻¹), thereafter, on 60th day, the GSI showed significantly increased in lower supplementation group (50mg 100g⁻¹). The histological observation also revealed the advanced stages of oocytes at 50mg 100g⁻¹ melatonin supplemented group which is correlated with GSI and fecundity whereas, the suppressive effect on oocyte maturation was found in the higher melatonin supplemented group. The similar observation was also seen in case of testicular development. The testosterone hormone level in male fish and vitellogenin levels in female fish has been observed to be highest in 50mg 100g⁻¹ melatonin supplemented group. From the current study, it can be concluded that the administration of dietary melatonin to *Devario aequipinnatus* @50mg 100g⁻¹ will improve the reproductive performance in terms of attainment of maturation.

Keywords: Melatonin, Gonado somatic Index, fecundity, egg diameter, *Devario aequipinnatus*



MARKETING CHALLENGES IN TILAPIA FARMING: A QUALITATIVE CASE STUDY FROM KERALA

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Tilapia aquaculture has been touted as a promising avenue for fish production in Kerala, India. This white-fleshed fish, prized for its rapid growth and disease resilience, has seen a significant surge in production in recent years. However, despite its economic potential, anecdotal evidence suggests many tilapia farmers in the different regions of Kerala face potential roadblocks hindering the marketing and the success of tilapia farming in the state. This qualitative case study explores consumer attitudes and marketing challenges Kerala tilapia farmers face by using semi-structured interviews with tilapia farmers. The farmer's in-depth knowledge of tilapia production practices, existing marketing channels, the prices they receive, and their perceived difficulties in selling Tilapia was unveiled through this research. The findings revealed a range of marketing issues in Tilapia, among which consumer preferences play a crucial role in tilapia sales. Many consumers in Kerala prefer traditional fish varieties over Tilapia, citing reasons such as harboring misconceptions about Tilapia's quality taste and a lack of limited awareness about its nutritional value. Unlike other traditionally consumed fish varieties, Tilapia is a relatively new entrant in the market, and these attitudes also contribute to limited demand for Tilapia in the local market. Lack of access to market channels is another challenge. Limited distribution channels, the dominance of mediators in the market chain, and price fluctuations were cited as significant impediments to selling Tilapia. These challenges often result in a surplus of stagnant Tilapia in farms, leading to additional huge expenses and further increasing the extra financial burden for farmers. By employing a qualitative approach through this research, the findings provide more profound insights into Kerala's tilapia farmers' faces and pave the way for targeted interventions and the future to ensure the success and sustainability of tilapia aquaculture in the region.

Keywords: *Tilapia, Kerala, Aquaculture, Marketing, Sustainability.*



LARVAL REARING OF GIANT MUD CRAB *SCYLLA SERRATA* (FORSSKÅL, 1755) FROM MEGALOPA TO CRAB INSTAR USING *ARTEMIA* NAUPLII ENRICHED WITH THREE DIFFERENT MARINE MICROALGAE

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Larval rearing of giant mud crab *Scylla serrata* was conducted for fourteen days, from megalopa to crab instar 5 stage, using live feed *Artemia* nauplii enriched with three different marine microalgae - *Chaetoceros calcitrans* (CRCC), *Isochrysis galbana* (CRIG), and *Nannochloropsis oculata* (CRNO), in triplicate, and the survival, growth performance, and Polyunsaturated PUFA, especially, Eicosa Pentaenoic Acid (EPA), Docosa Hexanoic Acid (DHA), and Arachidonic Acid (ARA) contents of crab instars were compared with those fed with unenriched *Artemia* nauplii (Control). Throughout the experiment, the temperature remained within the range of $29\pm1^{\circ}\text{C}$, and salinity $28\pm2\%$. The *Artemia* nauplii were administered at 3-5 nauplii per millilitre, twice daily and water replacement was done at 30-50% daily. The survival rate was significantly higher ($p<0.05$) in crab instar fed with CRNO ($94\pm4\%$) and CRCC ($93.67\pm5.56\%$) than CRIG ($77.33\pm13.87\%$). The survival rate was significantly the lowest ($p<0.05$) in control ($54\pm3.61\%$). The crab instar fed with CRNO or CRCC did not show any significant difference ($p>0.05$) in survival rate or EPA content (2.46 ± 0.10 and 1.62 ± 1.026 mg/g dry weight, respectively). DHA (1.28 ± 0.012 mg/g dry weight), ARA (0.60 ± 0.14 mg/g dry weight), and PUFA (20.25 ± 2.81 mg/g dry weight) contents were significantly higher ($p<0.05$) in crab instar fed with CRNO than with CRCC or CRIG. The gain in carapace width/length and weight was significantly higher ($p<0.05$) in crab instar fed with CRCC ($5.63\pm0.21\text{mm}/3.93\pm0.15\text{mm}$, $47.545\pm6.61\text{mg}$, respectively) followed by CRNO ($3.67\pm0.25\text{mm}/2.33\pm0.21\text{mm}$, $36.575\pm5.26\text{mg}$, respectively), CRIG $2.7\pm0.1\text{mm}/1.47\pm0.15\text{mm}$, $20.2\pm3.59\text{mg}$, respectively), and control ($2.17\pm0.15\text{mm}/0.87\pm0.21\text{mm}$, $14.1\pm2.89\text{mg}$, respectively). The study indicates that significant improvement in the survival and growth of giant mud crab *Scylla serrata* larvae could be achieved along with significant improvements in the content of EPA, DHA, and ARA, by incorporating *Artemia salina* nauplii enriched with microalgae from megalopa to crab instar stage of larvae

Keywords: *Scylla serrata*, larval rearing, *Artemia* nauplii, enrichment, marine microalgae, Polyunsaturated fatty acids



FUNGUS - BACTERIUM ASSOCIATION IN THE PRODUCTION OF CELLULASES DETECTED IN A BRACKISH WATER SEDIMENT: A CASE STUDY

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Every year tons of cellulose wastes are produced in the Country having large amount of potential energy but because of lack of an appropriate bioprocess it gets wasted. Considering this requirement an investigation was made to isolate potent cellulase producing microorganisms from the sediments of Cochin backwater system. While doing so a unique fungus-bacterium association was discovered existing in the sediment and having experienced extreme difficulty in separating them. The cellulase production was significantly higher when it was in association with the bacterium indicating lifting of the catabolic repression by the bacterium while culturing. This combination was used to produce cellulase and recorded 412 IU/ml in liquid and 16.15 IU/mg activity in a lyophilized form. The lyophilized product can find commercial application.

Keyword: cellulase; association; fungus; bacterium; lyophilized;





Remote Sensing Applications in Earth System Sciences



SOIL EROSION SUSCEPTIBILITY ZONATION OF MUTHIRAPUZHA RIVER BASIN OF WESTERN GHATS USING MULTI CRITERIA ANALYSIS AND GEOGRAPHIC INFORMATION SYSTEM

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The western Ghats is the prominent physiographic feature of the peninsular India feeding a number of drainage systems of South-India. The longest river system of Kerala the Periyar River is drained by the Ghat region. The Western Ghat also facilitates the precipitation during the monsoon responsible, for the peculiar climatic regime in the state of Kerala. This intense rainfall also triggers landslide events during the season. Even though the highlands of the Periyar River basin (PRB) are vulnerable to landslides, for the past few years the area have witnessed tremendous damages due to disastrous landslides related to climate change and extreme monsoon events. This study aims to identify the areas of soil erosion prone regions of one of the sub-basins of the PRB, the Muthirapuzha Watershed (MW) using morphometric indices in a multi- criteria analytical (MCA) framework. The drainage network of the area is extracted from Digital Elevation Model (DEM) of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) using ArcGIS software. The ArcGIS and MS office Excel were used for the computation of morphometric parameters and to perform the MCA. The linear, shape and relief morphometric parameters were ranked and the compound parameter for each sub watershed calculated. In this study 15 sub watersheds of MW are prioritized based on soil erosion of which SW11 is highly vulnerable to soil erosion. The sub watersheds are categorised into low, medium and high according to susceptibility to soil erosion. The use of drainage network extracted from DEM and the zones delineated using the MCA allows even the zonation of inaccessible areas.

Keywords: Soil erosion, Compound parameter, Multi criteria analysis, Muthirapuzha, Morphometry



THE ROLE OF SOIL PARAMETERS IN THE LANDSLIDE MODELLING AN xAI APPROACH

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Landslides are cataclysmic events affects globally, especially mountainous regions, often lead to loss of life and properties. Landslide susceptibility mapping is a vital tool for mitigation strategies and reduce future calamities. In general, most of the landslide susceptibility research utilised morphological parameters as covariates, which are simple derivatives of digital elevation models. Soil parameters, perhaps the most important landslide influencing variables are least considered in landslide susceptibility studies. The present study aims to address this research gap by utilising extensive soil data. In this study a total of 33 soil parameters along with widely used morphological and lithological parameters used for landslide susceptibility modelling in a tropical river basin viz, Muthirapuzha basin. For this, a total of 372 landslides are mapped and Machine learning random forest modelling is used for landslide susceptibility mapping. Moreover SHAP (SHapley Additive exPlanations), an xAI approach is used to explain the predicted model. Results shows that, slope angle is the most influencing parameter followed by soil parameters including field capacity, permanent wilting point, liquid limit plasticity index and unsaturated hydraulic conductivity have significant role in landslide susceptibility modelling. Other parameters such as distance from the road and topographic wetness index also have moderate influence. The findings of this research indicate that soil parameters are essential for landslide susceptibility modelling.

Keywords: *Landslide, soil, machine learning, xAI*



MULTIPLATFORM OBSERVATIONS OF CONVECTIVE PRECIPITATING SYSTEM: AN ANALYSIS ON INTENSITY, VERTICAL STRUCTURE, AND MICROPHYSICAL CHARACTERISTICS

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This study investigates the microphysical properties of convective precipitating systems occurred during the pre- and post-monsoon seasons of 2022 over a tropical coastal location. Simultaneous observations from microwave radiometer, disdrometer and micro rain radar are utilized to infer the thermodynamic and microphysical processes in precipitation. The evolution and dominant hydrometeor features during the evolution of the system are observed with a C-band polarimetric radar. Convective and stratiform cores are identified with horizontal reflectivity for events occurred on 23rd May and 11th November. The cloud to ground lightning flashes measured using lightning location network (LLN) are more prominent in pre-monsoon events. The brightness temperature were mostly below 220 K suggesting the deep convective rainfall systems over coastal station in the pre-monsoon season. The humidity profiles in the were identified with more than 80% from surface to 5 km or above for the convective systems in the post monsoon season. The lightning flash occurrence are coinciding with selected convective systems. Enhanced reflectivity in the convective-transition-stratiform region indicates ice-initiated rain with strong updrafts and faint bright band signature. The relationship between rainfall and lightning occurrences needs to be examined for further analysis.

Keywords: Convective systems, C-band radar, Precipitation Microphysics, Microwave Radiometer



NET PRIMARY PRODUCTIVITY ESTIMATION FOR THE HETEROGENOUS LANDSCAPE OF THODUPUZHA TALUK, KERALA

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The study was conducted to thoroughly assess terrestrial ecosystems net primary productivity (NPP) to understand how it varies across different vegetation types and whether the changing climate has impacted the study area. The work aimed to provide a baseline estimation of NPP in different vegetation types, including forest, teak plantations, rubber plantations, and mixed plantations in the study area. The Carnegie-Ames-Stanford-Approach (CASA) model was used in the present study for the estimation of NPP. Quantitative analysis of NPP was carried out based on standard methods by calculating the monthly average solar radiation, temperature, and precipitation. In the present study, using this model, a change analysis of NPP during pre-monsoon, monsoon, and post-monsoon periods was carried out, and a seasonal-wise NPP map was created. When comparing the years 2008 and 2021, the NPP of the studied area in 2021 revealed a significant annual spatial variation. In 2008, the magnitude of annual NPPs was estimated to be between 710.05 and 828.45 gC/m² per year. The annual NPP declines in 2021 (varies from 590.70 gC/m² year-1 to 729.03 gC m² year-1). It shows that productivity rates were higher during the period of 2008 when compared to 2021. The result also shows that the forest area has significantly higher productivity than other vegetation types. The major finding is that there was an increased rainfall pattern during 2021, which led to a decrease in solar radiation and temperature, which affected the NPP level, resulting in a decline in the NPP level. The current analysis showed that NPP has been significantly impacted by the variations in rainfall and temperature and the solar radiation brought on by climate change. The study also predicted that an optimal level of solar radiation, temperature, and rainfall is good for NPP; if there is any fluctuation, it will affect the overall productivity.

Keywords: NPP (*net primary productivity*)



LONG-TERM CHANGES IN THE SURFACE TEMPERATURE AND LAND-USE PATTERNS ACROSS THE INDIAN SUBCONTINENT

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This work presents the changes in maximum and minimum temperatures across India from 1980 to 2020, alongside an examination of long-term land use, land cover (LULC) changes reflected in ISAM-HYDE estimates from 1975 to 2010. Both maximum and minimum temperatures demonstrate significant upward trends, with maximum temperatures increasing by 0.4°C per decade. Variations in temperature changes are observed among different regions and months. The Indo-Gangetic Plain, encompassing Nepal, Sikkim, Uttarakhand, and Himachal Pradesh, experiences a significant decrease in maximum temperature during January and December (around 0.4°C per decade). Conversely, southern regions such as Andhra Pradesh, Tamil Nadu, Karnataka, and Kerala exhibit an increasing trend, with maximum temperatures rising by up to 0.3°C per decade. In contrast to maximum temperature trends, the trend in minimum temperature generally shows a positive or near-zero trend. The northern and southern extremities of India witness statistically significant temperature increases year-round, with slight variations in trends from month to month (0.1–0.4°C per decade). Northeast India experiences a noteworthy positive trend in minimum temperature from May to September. The analysis of land use indicates a substantial decline in the tropical deciduous forests from 1975 to 2010, decreasing by 50-75 percent. Rapid urbanization, with certain regions displaying up to a 200 percent increase since 1975, is also evident. Three regions—southern peninsular India, the northwestern region, and northeastern India—demonstrate significant rises in both maximum and minimum temperatures. The mean annual temperatures in these areas increase at a rate of approximately 0.1 to 0.2°C per decade. The forest area experienced a sharp decline until around 1995, after which the rate of decrease slowed. Conversely, cropland and urban areas exhibit an upward trajectory. The surge in crop growth during the 1970-80 period aligns with India's post-green revolution era.

Keywords: Land use land change, Surface temperature



ASSESSMENT OF DRAINAGE NETWORK CHARACTERISTICS OF PENNAR RIVER, EASTERN GHATS, SOUTH INDIA

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This article discusses the drainage morphometric analysis of the Pennar River Basin (PERB), originating from the Eastern Ghats. PERB (basin area: 55076.28 km²) is a diverse terrain with a unique geomorphic feature: Gandikotta Canyon, referred to as India's Grand Canyon. We computed 18 linear, 13 aerial, and 2 relief parameters from the drainage data derived from SRTM using ArcGIS 10.2 software. Analysis revealed a total of 22227 stream segments, predominantly comprising first-order streams (77.8%). Notably, an abrupt decline in third and fourth order streams hints at geomorphic anomalies. PERB streams measured a total stream length of 46714.72 km, with a notable increase in mean stream length from first to eighth order. However, the stream length ratio exhibited wide variation, indicating site specific geologic influences. Bifurcation ratios ranged from 3 to 4.55, suggesting less interference by structural elements, except in specific subbasins. The Rho coefficient indicated a higher water storage capacity for the entire basin, with subbasins exhibiting variable capacities. The form factor, elongation ratio, and circularity ratio values revealed the basin's elongated shape, implying lower peak flows of longer duration and low relief. Texture analysis categorised the basin as coarse, with low drainage density and frequency indicating its geological and physiographic characteristics. Low drainage intensity and infiltration numbers suggest vulnerability to erosion and flooding. The length of overland flow varied inversely with basin slope, affecting hydrologic and physiographic development. The constant of channel maintenance values reflects the texture and variation in the erosion. Statistical analysis was carried out to interpret the interrelationship between the morphometric parameters. In this article, we also made an attempt to compare the general drainage network characteristics of the Eastern Ghats and the Western Ghats. Overall, the study sheds light on the drainage characteristics of PERB, and future basin management and hydrological research can utilize this data.

Keywords: GIS, Morphometric Analysis, Statistical analysis, River network, Eastern and Western Ghats



EXPLORING REMOTE SENSING TECHNIQUE TO LOCATE THE SPECIES-SPECIFIC POTENTIAL FISHING GROUNDS IN THE NORTH-EASTERN ARABIAN SEA

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Satellite remote sensing, focusing on ocean environmental factors like Chlorophyll-a (CHL), Sea Surface Temperature (SST), and Sea Surface Height anomaly (SSHa), offers crucial data with superior spatial and temporal resolution, enabling effective ecosystem monitoring and sustainable exploration of marine fishery resources by identifying fish aggregation areas. This study investigated the monthly variability in environmental factors impacting the catch rate and the spatio-temporal distribution patterns of fish along northwest coast of India (NWCI). Generalized Additive Model (GAM) applied to the catch rate of mid-water trawlers found that CHL and euphotic depth (Zeu) were the most influential variables for ribbonfish distribution, while CHL and SST influence squid distribution and SST and SSHa influence cuttlefish distribution. The total deviation explained 37.70%, 10.70%, and 22.28% in the final model for predicting the potential fishing grounds of ribbonfish, squid, and cuttlefish, respectively. Spatio-temporal distribution patterns of fishery resources from mid-water trawlers showed that they were related to biophysical changes in the northwest coast of India. The high catch rate was observed in the northern latitudes during the post-monsoon (October), the major fishing season in the region. However, it shrank and shifted to southern latitudes during the winter (January). This study could aid in decision-making for policymakers and resource managers to formulate strategies for holistic marine fishery management and sustainable resource exploitation.

Keywords: PFZ, Fishing grounds, Chlorophyll, Remote sensing, GAM



ASSESSING URBAN GROWTH AND ITS IMPACTS ON SURFACE URBAN HEAT ISLAND IN THE COCHIN REGION, KERALA (INDIA)

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Urbanization is characterized by the increasing concentration of population in urban areas, resulting in the expansion and densification of cities, which in turn affects the local climate. This study analyzes changes in land surface temperature (LST) and Surface Urban Heat Island (SUHI) phenomenon over the Cochin region in Kerala, India. The changes are assessed for Cochin Corporation and five adjacent municipalities (CCM), from the period 2003 to 2020 using a spatiotemporal gap-filled MODIS LST data from Zhang et al. (2022). The analysis is done for premonsoon (March to May), post-monsoon (October to November), and winter (December to February) seasons, except for monsoon months (June to September) due to large cloud cover in the season. Our study shows that the highest daytime and nighttime LST is observed during winter, followed by pre-monsoon. The mean daytime LST increased by about 1.1°C, 0.43°C, and 0.73°C per decade for the pre-monsoon, post-monsoon, and winter periods, respectively. For nighttime, these changes are 0.52°C, 0.41°C, and 0.07°C per decade, respectively. Relative to a 20 km wide sub-urban region, an average daytime SUHI of about 1.5°C observed during the pre-monsoon and post-monsoon and about 1°C during the winter. In summer, nighttime SUHI observed is approximately 1°C relative to the sub-urban region. The impact of changes in Land-use/Landcover (LULC) in LST are analyzed using Landsat data, which reveal a significant expansion of the built-up area in the study region. Over the 18 years, the built-up area increased from about 26.94% to 61.33% of the total area (~209 km²), with approximately 76.37 km² of vegetation cover converted into the built-up area. Our results show a notable decline in vegetation cover in the urban region, raising concerns over ecological balance and sustainability. The study provides valuable insights for policy-making, urban planning, and UHI mitigation strategies of the Cochin region.

Keywords: LST, Urban heat island, Remote sensing, Urbanization



APPLICATION OF UAV TECHNOLOGY FOR 2D MAPPING OF MANGROVES AND INVASIVE SPECIES IN PAPPAKANNI ESTUARY, MANORA, TAMIL NADU

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Unmanned Aerial Vehicle (UAV) systems are used for mapping coastal habitats. It helps to understand the present status accurately for conservation planning and management of coastal habitats, including mangroves, mangrove associates and saltmarshes. This study was carried out using a UAV system (DJI Air 2S microdrone) in February 2024 to understand the extent of mangroves, saltmarshes and invasive species (*Prosopis juliflora*) in an islet of Pappakani estuary in Manora, Thanjavur District, Tamil Nadu. For systematic capture of images, drone harmony flight execution software was used, which is an automated data acquisition process with drones. The drone flight plan was created around the study area to fix the specific height (120m) and route for taking aerial photos. The collected jpeg images were loaded into Agisoft Metashape software to create technical workflow models such as point cloud, mesh and texture to obtain an orthomosaic image. The study measured the different components of the islet by using georeferenced, orthoimage in ArcGIS Pro. The total area of the islet was 5.96 Ha. The orthoimage distinctively showed mangrove areas in bright green colour with rounded canopy (2.83 ha (47.5%)), *Prosopis juliflora* with dark green colour (1.16 ha (19.5%)) with elongated single branches, mangrove die-back areas in grey colour with dead branches with hypersaline backwaters (0.44 ha (7.5%)) and open dry land with sparse distribution of saltmarshes (1.5 ha (25.5%)) were observed. This study showed the extent of invasive species (*Prosopis juliflora*) in this islet, which may further extend in the near future, so removal of *Prosopis juliflora* is recommended. Natural growth of *Avicennia marina* trees, saplings and seedlings was observed in the islet. *Rhizophora mucronata* seedlings were observed in the fringes of the islet, which were planted in recent years. Salt marsh *Suaeda maritima* occupied the upper intertidal areas. The mangrove dieback area can be restored to healthy mangroves by desilting the tidal canals and planting new mangrove seedlings during the monsoon season.

Keywords: Agisoft, ArcGIS Pro, UAV, Mangrove, Saltmarsh Invasive species



CRUSTAL DEFORMATION AND LAVA FLOW ASSOCIATED WITH THE 2022 MAUNA LOA (HAWAII) VOLCANIC ERUPTION USING INTERFEROMETRIC AND POLARIMETRIC ANALYSIS OF EOS-4 AND SENTINEL-1 SAR DATA

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Mauna Loa volcano, located on the Hawaii Island, is the world's largest subaerial volcano. It has been dormant since the 1984 eruption until the recent eruption occurred from 27 November 2022 to 13 December 2022. In this work, an attempt has been made to understand the surface deformation and lava flow associated with the 2022 eruption of the Mauna Loa volcano using Synthetic Aperture Radar (SAR) images from ISRO's EOS-4 and Sentinel-1 satellites. Co-eruptive interferometric analysis of Sentinel-1 SAR data revealed Line of Sight (LOS) deformation of $\sim \pm 50$ cm along the NE and SW rift zones of the Mauna Loa. The complex bipolar deformation pattern in ascending and descending tracks suggests significant vertical and horizontal deformation associated with the subsurface magma ascent and spreading, respectively. InSAR analysis of EOS-4 data suggested concentric interferometric fringes east of the caldera between 9 December 2022 and 29 January 2023. This near-circular deformation lobe (~ 15 cm) could be interpreted either as a post-eruptive volcanic deflation or topographically correlated atmospheric artefacts. Further, polarimetric and InSAR coherence based analysis revealed the lava pathways emerged during the 2022 volcanic eruption sequence. The analysis suggests extensive lava flow along the SW and NE rifts for about 15 km and further towards north from the end of NERZ for about 16 km along a pre-existing topographic channel. Polarimetric radar analysis of a fresh lava flow channel associated with the NE rift zone revealed a transition between smooth pāhoehoe and rough a'a flow textures along its current extent. The present study demonstrates the interferometric and polarimetric capabilities of EOS-4 satellite for geophysical applications.

Keywords: EOS-4, InSAR, Polarimetry, Mauna Loa Volcano, Surface deformation, Lava flow



INSTRUMENTAL ERROR QUANTIFICATION FOR SPECTRAL-WIDTH-BASED UTLS TURBULENCE MEASUREMENTS WITH ST RADAR

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Turbulence is a crucial element of atmospheric dynamics, found in different regions of the atmosphere. This chaotic movement of air influences diverse fields. Engineers consider it when designing aircraft and radar systems, while meteorologists study it to understand weather patterns and how pollutants disperse. Turbulence even plays a role in the Earth's overall energy balance and circulation patterns. The aviation industry bears a significant financial burden from turbulence. Costs arise from aircraft damage, maintenance, and even passenger and crew injuries. Wind profiling radars operating in very high frequency/ultra-high frequency (VHF/UHF) bands show promise for measuring turbulent kinetic energy per unit mass (TKE) with exceptional vertical and time resolution. The spectral width method is the most widely accepted way to measure turbulence. It works by assuming that the broadening of a radar signal's spectrum is caused by small-scale air movements within the area the radar is scanning. However, spectral width is broadened not only by turbulence but also by the uniform motion of wind across the finite angular extent of the beam. This second term can be a significant contributor to the final spectral width. Several other factors can also affect this estimate. While estimating TKE In using existing theories leading to unrealistic negative TKE in the upper troposphere and lower stratosphere (UTLS) region. Though theoretical formulations for negative TKE are explained in various research works, their real-world consistency is sparsely studied. Further refinement in the theoretical calculation of turbulence and its real-world applications, like forecasting of Clear Air Turbulence (CAT) in the UTLS, are required. We conducted a special research campaign focused on UTLS turbulence. The campaign involved a continuous seven day observation of the 12-20 km height range (November 3rd -11th, 2022). This experiment tries to quantify these issues by using the capabilities of the Stratosphere Troposphere radar (ST) at CUSAT to test widely used formulations. Results are presented in this paper.

Keywords: ST radar, Turbulence



UNDERSTANDING MID-TROPOSPHERIC TURBULENCE FROM 205 MHZ S-T RADAR AT KOCHI, INDIA

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Turbulent kinetic energy dissipation rate (ε) in the mid-troposphere (5-12 km) using the data from 205 MHz S-T wind profiler radar located at Kochi (10.04° , 76.33°) is studied. ε denotes the N/E rate at which turbulent kinetic energy is transformed into thermal energy (heat) through minute turbulent motions in the atmosphere. It exhibits considerable variation due to the influence of background atmospheric conditions such as temperature, wind speed, vertical wind shear, altitude, location and season. We use the spectral width method of ε estimation for 1595 days, from March 2017 to December 2022, at a vertical resolution of 180 m. After the initial data filtering, the correction for the non-turbulent contribution to the observed spectral which includes the beam and shear broadening is employed. It is observed that there is only a marginal decrease in height. The background wind conditions also play a minimal role vertically. Our study found that turbulence is more significantly affected by wind speed and wind direction. Even though the westerly wind is infrequent in the mid-troposphere, it is observed to be a major contributor to the elevated turbulence values due to the dynamic interplay of land-sea contrast and orography. The presence of Tropical Easterly Jet increases the wind speed and shear during the monsoon season, aligning with the increase in turbulence.

Keywords: S-T Radar, Turbulence, Spectral Width



UTILIZATION OF SATELLITE DATA AND IN-SITU BUOY DATA FOR THE PERFORMANCE EVALUATION OF THE GLOBAL WAVEWATCH III MODEL

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This study focuses on the comprehensive validation of the WAVEWATCH III (WWIII) model version 6.07 for the IO using remote sensed data as well as in-situ buoy data. Altimeter data from JASON – 3 satellite, and buoy data for the period between January 2018 to December 2018 were used for the validation of the WWIII output for the Indian Ocean region. Prior to model validation, buoy data with positional errors were removed to ensure data accuracy, resulting in increased statistical confidence. Collocation of corrected buoy and satellite data was done with a 25 km spatial and 30-minute temporal window. Limitations with buoy data availability restricted validation to specific regions. Encouragingly, satellite-derived significant wave heights (H_s) from JASON-3 showed strong correlation with buoy observations (scatter index: 0.11, correlation coefficient: 0.97). The good match between Jason-3 data and buoy data for the Indian ocean region justifies the use of satellite data for spatial validation of model output. Since the buoy data was limited, and for the sake of doing a spatial validation for a larger area, Jason-3 satellite output was compared with model output. Our analysis revealed strong agreement between model forecasts and satellite observations for H_s . Statistical metrics such as bias (0.05), root mean square error (0.44), correlation coefficient (0.97), and scatter index (0.13) confirmed the accuracy of WWIII in simulating wave parameters. These spatial comparisons, along with the validations with buoy observations gave a clear picture of the quality of the model output. This study underscores the pivotal role of remote sensing data in Earth system modeling applications, facilitating improved predictive capabilities and understanding of ocean dynamics. The use of satellite altimeter data enhances model validation capabilities, reinforcing the reliability of wave forecasting systems for operational applications.

Keywords: Indian Ocean, WAVEWATCHIII, Wave prediction, Remote sensing, Satellite altimeter data, Validation



COMPREHENSIVE EXPLORATION OF CRUSTAL DEFORMATION AND IONOSPHERIC PERTURBATIONS LINKED TO THE 6 FEBRUARY 2023 KAHRAMANMARAŞ EARTHQUAKE DOUBLET IN SOUTH-EASTERN TÜRKİYE

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Ionospheric electron density disturbances, known as Co-seismic Ionospheric Perturbations (CIP), arise as a consequence of mechanical waves produced in the aftermath of large-magnitude earthquakes. This study investigates the CIP and ground deformations resulting from the consecutive earthquakes of magnitude Mw 7.8 and Mw 7.6 that occurred in Turkey on February 6, 2023. Utilizing GPS and InSAR data, crustal deformation analysis reveals a complex rupture pattern across the East Anatolian Fault and the Sürgü-Çardak Fault. The earthquakes induce significant ionospheric electron density disturbances, as detected from GPS Total Electron Content (TEC) measurements. Surprisingly, the Mw 7.6 event exhibits higher amplitude CIP despite its lower magnitude, displaying directional asymmetry and pronounced effects south of the epicenter. The study introduces a "geomagnetic coupling factor" to quantify the influence of the geomagnetic field, indicating a higher likelihood of CIP evolution towards the south. Ambient electron density, influenced by background ionization, emerges as a crucial factor, with lower ionization levels during the first earthquake potentially explaining its reduced CIP amplitudes. This multi-faceted analysis underscores the importance of combining ground and ionospheric observations for a comprehensive understanding of earthquake processes and impacts.

Keywords: Co-seismic Ionospheric Perturbations (CIP), Co-seismic crustal deformation, GPS-TEC, InSAR, Kahramanmaraş, Türkiye





Quaternary Environment & Paleoclimate



PALEO-WEATHERING AND PALEOCLIMATE DURING LATE QUATERNARY PERIOD INFERRED USING MINERAL MAGNETIC PROPERTIES OF THE CONTINENTAL SHELF SEDIMENTS ALONG THE SOUTH-EASTERN COAST OF INDIA

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The contribution of peninsular Indian rivers to the sediment load of the continental shelf in south-eastern India, the western Bay of Bengal, is relatively less appreciated. The current research infers terrigenous influx, palaeo-weathering, and palaeo-rainfall conditions over the past 23 ka, employing mineral magnetic proxies which is corroborated by particle size, diffuse reflectance spectroscopic, and Fourier Transform Infrared Spectroscopic techniques. The rock magnetic parameters indicating magnetic mineral concentration (SIRM, χ ARM, χ lf), grain size (χ ARM/SIRM, SIRM/ χ lf, and χ ARM/ χ lf), and mineralogy (s-ratio) is used to understand the changes in terrigenous influx and chemical weathering. The magnetic data is substantiated by proxies such as hematite/goethite ratio, particle size (percentages of sand, silt, clay), CaCO₃, and kaolinite content. A gradual increase in the winter monsoon is documented during the period from 23000-17000 cal. years B.P. (Last Glacial Maxima), followed by a steady phase (17000-10000cal. years B.P.). However, a brief decline in rainfall is observed around ~13900cal. years B.P. (Bølling-Allerød), with an increase during ~12900-11800 cal. years B.P. (Younger Dryas). The Early Holocene period is characterized by increased detrital influx to the core site, strong pedogenesis, and chemical weathering in the continental areas in response to high rainfall conditions. A significant shift in sediment provenance in the continental shelf region of the core site, coupled with a weakening of monsoon, is observed since 4900 cal. years B.P.

Keywords: Continental shelf, Terrigenous influx, Mineral magnetism, Monsoon, Provenance, Peninsular Rivers.



EXTANT AND SUB-FOSSIL COCCOLITHOPHORES IN THE INDIAN SECTOR OF THE SOUTHERN OCEAN AND GOVERNING FACTORS

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Coccolithophores are pivotal members of phytoplankton communities, exerting substantial influence on the climate system and carbon cycle within the ocean. This study explores the biogeographic distribution and assemblages of coccolithophores in the Indian sector of the Southern Ocean, shedding light on the factors shaping their biogeographic distribution and preservation in the surface water and sediment. Both abundance and diversity of coccolithophores diminish from Subtropical to Polar Frontal Zones. Notably, plankton samples from the Antarctic Zone exhibit an absence of coccolithophores, likely due to the extreme conditions that favor diatoms over coccolithophores. Temperature is a critical limiting factor for most coccolithophore species, with only *Emiliania huxleyi* type C thriving in environments with lower sea surface temperatures and benefiting from reduced silicic acid levels post-spring diatom blooms in the Polar Frontal Zone. The study further details the impact of latitudinal variation in temperature, surface calcite saturation, and sediment depth on coccolith abundance, dissolution index, and carbonate mass that decline from the Subtropical Zone to the Polar Frontal Zone. Coccoliths are notably absent in surface sediment samples taken from south of the Polar and in the Antarctic Zones, primarily attributable to the lower temperatures prevalent in these regions. The diversity of coccoliths in sediment is linked to factors such as species abundance and dominance along with warmer ocean currents facilitating the advection of warm water coccolithophore species like *Gephyrocapsa oceanica*. Larger species, rather than more abundant species, contribute a greater portion of CaCO₃ production and export. This study underscores the importance of evaluating the response of key coccolithophore species to projected environmental changes in the Southern Ocean and advocates for future research focusing on sediment trap studies and in-depth investigations into the top-down factors influencing coccolithophore distribution and preservation.

Keywords: *Coccolithophores, Frontal zones, Southern Ocean*



RECONSTRUCTION OF LATE QUATERNARY PALEOCLIMATIC VARIABILITY FROM THE SEDIMENTARY ARCHIVE OF THE WESTERN BAY OF BENGAL

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The Bay of Bengal (BOB), a prominent sub-basin of the Northern Indian Ocean, receives rainfall contributions mainly from the Indian Summer Monsoon (ISM) and partly from the Northeast Monsoon (NEM). Further, the basin receives a large quantity of fluvial sediment discharges from both the Himalayan and peninsular rivers. Considering the uniqueness of the geo-environmental settings and teleconnection of the system with global climate forcings, an attempt has been made in this study to address the paleoclimatic variations and their plausible linkages with the global climate system using a marine sediment core of ~2.90 m retrieved from the western BoB. The core was chronologically supported by AMS radiocarbon dates and the paleoclimatic records in the core were decoded using multiproxy analyses. Texturally, the sediment core is composed predominantly of silty clay facies thereby underscoring the existence of a calm and low-energy environment that prevailed during the deposition of sediments at the core site. Higher TOC/TN along with enriched d₁₃C values plausibly suggests the dominance of C₄ plants of terrestrial origin during 45-15 ka. Enhanced calcareous productivity was noticed during 25-14 ka and the last 4 ka suggesting poor freshwater stratification. On the contrary, the enhanced ISM during 12-4 ka caused prominent freshwater inputs/stratification in western BOB thereby inhibiting calcareous productivity. Negative biogenic barium values suggest an overall low primary productivity in the region. The present study provides evidence of millennial-scale hydroclimate changes in the BOB which in turn are teleconnected with the regional and global climate dynamics.

Keywords: Sediment, Bay of Bengal, Quaternary, Paleoclimate, Productivity



CLIMATIC REPERCUSSIONS OF CENTRAL EQUATORIAL INDIAN OCEAN (CEIO): A CLUE TO MID PLEISTOCENE TRANSITION (MPT)

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The Central Equatorial Indian Ocean (CEIO), is renowned for its significant water exchange between basins, influenced by both the southwest and northeast monsoons. The present investigation in the CEIO enabled the record of remarkable diversity and abundance of Uvigerinids, with reporting of a few of the oldest Oligocene genera. The study area exhibits a moderate to high level of productivity and a moderate sedimentation rate. The CEIO is an ideal place to explore the evolutionary trajectory of Uvigerinids from the Tertiary period to the Present day. The proxy record reveals centennial-scale changes in the diversity, abundance, and morphological changes in Uvigerinids, and the distribution pattern is significantly influenced by glacial-interglacial cycles. The present investigation is the preliminary comprehensive study of *Uvigerina cocoaensis* and its subspecies from the Indian Ocean. The observed range of morphological intricacies in the recorded benthic foraminifers, specifically within the genera Nodolarsians and Uvigerinids, implies that these organisms have undergone periods characterized by severe cold climatic conditions. The appearance, disappearance, and reappearance of a few benthic foraminiferal species indicate clues towards the Mid Pleistocene Transition (MPT).

Keywords: CEIO, Uvigerinids, Mid Pliocene Transition, Climatic cycles



ARE OSTRACODA GOOD REGISTERS IN READING THE PALEOENVIRONMENTAL CHANGES? A CASE STUDY USING ELECTRON PROBE MICRO ANALYSIS (EPMA)

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Despite the numerous advancements in microprobe analysis, a thorough and meticulous examination is necessary to interpret the paleoenvironmental shifts of diverse niche. Electron Probe Micro Analysis (EPMA) in the carapace of Bairdoppilata (Bairdoppilata) alcyonicola to decipher the paleoenvironmental data using Mg/Ca ratio estimation in Ostracoda carapace from two short cores collected from the innershelf off Visakhapatnam, Andhra Pradesh, South Central coast of India is dealt in the present study. Random points measuring Mg/Ca ratio using EPMA were marked in the preselected polished carapace interior. EPMA analysis revealed multiple bands in the Ostracoda carapace with respect to Mg/Ca partitioning. The band decodes the ecdysis influence in the Ostracoda carapace. Correlating with the $\delta^{18}\text{O}$ isotopic ratio to EPMA results, it is observed that the paleoenvironmental characteristics of the short cores are not exhibiting much variations. Different instars of Ostracoda, during the moulting stage marks an impression of Mg/Ca band in the shell epicuticle. Evident from the study is that, even in the same core sediments, the carapace characteristics is varying for different Ostracoda species. The contrasting bands of different colours in the Ostracoda carapace are not because of the paleoenvironmental shift, but of the ecdysis impact during the growth stages. The study strongly recommends for multiple point analysis in the Ostracoda carapace to deal with the paleoenvironmental studies using EPMA.

Keywords: EPMA, Ostracoda, Paleoenvironment, Bay of Bengal, Visakhapatnam



RADIOLARIANS OF THE NORTHWESTERN BAY OF BENGAL AND THEIR MONSOONAL VARIATIONS DURING THE HOLOCENE

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The Bay of Bengal (BoB), the north-eastern part of the Indian Ocean is largely influenced by the Indian monsoonal system. Both southwest and northeast monsoons have a significant role in the oceanographic variations of BoB. The Northwestern BoB is prone to turbid conditions, hence the study from the area is significantly less. Marine microfossils particularly foraminifers, had been widely used by the researchers whereas the radiolarian group of microfossils is the less attempted group, especially in the BoB. Radiolarians are marine planktic protists with siliceous skeletons that are well preserved in the sediments compared to the calcareous groups of microfossils. The present study is focused on the temporal distribution pattern of radiolarians from the Northwestern BoB. The present investigation enables us to record 26 species of radiolarians belonging to 17 genera, 6 families, and 2 suborders. Among the 26 radiolarian species identified, 11 were reported for the first time from the Northwestern BoB. The study also documented paleo monsoonal variations for the past 7 kyr based on the distribution pattern of radiolarians and total organic carbon (TOC). The study recorded a higher abundance of the suborder Spumellaria over the suborder Nassellaria. This dominance might be due to their preference for low salinity, high Sea Surface Temperature, and poor primary productivity associated with increased southwest monsoonal rainfall. The study also documented alternate episodes of strong monsoonal-high riverine discharge events and weaker monsoonal-strong upwelling events in the BoB during 7 kyr. Simultaneous occurrence of both intense monsoonal precipitation and upwelling activity were also noticed in the northwestern BoB. The present study is the first of its kind to validate the application of radiolarians in the paleoceanographic as well as paleoclimatic reconstructions from a complex dynamic oceanographic setting like the Northwestern BoB.

Keywords: Radiolarians, Spumellaria, Nassellaria, Bay of Bengal, Monsoon



LAST 28 KA PALEOPRODUCTIVITY PATTERN OF THE CENTRAL PRYDZ BAY, RECONSTRUCTED THROUGH SEDIMENTARY INORGANIC PROXIES.

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Regional productivity of the central Prydz Bay shows an annually enhancing trend and is capable of sequestering atmospheric carbon-di-oxide content, while past variations are yet to be studied. The micronutrients released through glacial melt-water initiate regional productivity and the flux of micronutrients are mediated by biogenic phases settling in the water column with secondary control of ice volume and scavenging. Hence, relative variation in the time series of productivity and micronutrients inorganic proxies can provide a paleoproductivity pattern of the Prydz Bay. A sediment core from a water depth of 3000 m collected during the Indian Expedition to the Southern Ocean 2020 is utilized for this study. Radiocarbon dates suggested that the sediment succession belongs to the last 28 ka. The digested sediment samples are measured for major and minor elemental concentrations using ICP OES. The time series of productivity and micronutrient inorganic proxies provided its variation for the last 28 ka. The Holocene productivity is relatively higher than the glacial period. The glacial productivity has shown a decreasing trend towards the deglacial period. Two rapid productivity peaks are identified during periods of two deglacial melt-water pulses (14.5 and 12.5 ka). The midHolocene (8-4 ka) witnessed a gradual increase, while the late Holocene (4 ka to modern) underwent a rapid productivity rise. The mid-Holocene productivity periods are probably driven by atmospheric-induced ice melt and the late Holocene rapid productivity rise can be co-driven by the ice melts and hydrographic changes along with the sea level rise.

Keywords: Productivity, Ice melt, Micronutrients, Meltwater pulses



UNVEILING PALEOCLIMATE OF SOUTHERN OCEAN USING DIATOMS AS A PROXY

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The Southern Ocean is known as the hub of atmospheric CO₂ and silica. It also plays a pivotal role in the hydrographic changes occurring globally. Due to its remoteness and limited accessibility of data minute changes within the ocean which are not evident through unaided eye but are captured by the phytoplankton thriving within the subsurface. The silica rich water of the Southern Ocean appears to be a favorable realm for diatoms. The pioneer study of the core top sample MD-19 3578 retrieved from the Indian sector of Southern Ocean located at Latitude: 46°05.709'S, Longitude: 49°07.594'E of the western Crozet Island include qualitative and quantitative analysis of diatoms. It is utmost useful in providing a better visualization of the paleoenvironment and through which it can anticipate in reconstruction of paleovariations in the SST and fluctuations in Sea Ice cover. The core location is characterized by higher total diatom abundance wherein out of 35+ species recorded dominance of *T. lentiginosa* varying in 2.79-56.94% in abundance and *F. kerguelensis* with a range of 17.92-89.16% of relative abundance depicting a range of variation from 0-10°C SST portraying a warmer climate. The Permanent Open Ocean Zone (POOZ) group is abundant with relative abundance of 86.77% followed by the Water Stratification Group with 8.68%. 4 major abrupt downfalls noted in POOZ diatoms connoting a drop in SST. Chaet spores, *P. Sulcata* and *R. Crassa* all three species replicate exactly the same trend wherein a spike in diatom abundance is seen from surface to first 100m depth, which may point to air-sea fluxes. Antarctic Circumpolar Current and Weddell gyre plays a large role in heat exchange in this region which may lead to plausible northward shift of the polar front and winter sea ice.

Keywords: Phytoplankton, Western Crozet, Air-Sea flux, Weddell gyre



INSIGHTS INTO SOUTHERN OCEAN PALEO OCEANOGRAPHY: HIGH-RESOLUTION ANALYSIS OF SEA SURFACE TEMPERATURE AND SEA ICE EXTENT IN THE INDIAN SECTOR AROUND KERGUELEN PLATEAU OVER THE LAST 42,000 YEARS

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The Southern Ocean plays a crucial role in global climate dynamics, yet there is a dearth of paleo oceanographic and sea ice records from the Indian sector of this region. The intricate nature of paleoceanography in the Indian sector is further complicated by the presence of islands and plateaus, which impede the flow of the Antarctic Circumpolar Current. Our current investigation aims to elucidate the past sea ice extent (SIE) and frontal positions, as well as their interplay with ocean circulation over the past 42,000 years (42 kyr). This study offers a detailed examination of Sea Surface Temperature (SST) and SIE based on diatom census counts, providing valuable insights into the oceanographic evolution around the Kerguelen Plateau. Located east of the Kerguelen Plateau at 44°40' S, 80°23'E, in the Indian Sector of the Southern Ocean, our sediment core analysis reveals SST fluctuations ranging from 5° to 12°C. Notably, a significant warming trend is observed during 16 – 13 kyr, while glacial periods are marked by temperatures dropping to as low as 4°C. Presently, the recorded temperature at the site stands at 10.80°C. Analysis of the core indicates sporadic occurrences of sea ice during Marine Isotope Stage 2 (MIS 2), with overall diatom abundance varying between 60-80 x 10⁶ valves/g of sediments. A comparative examination of our core with neighboring regions suggests a migration of the Antarctic Polar front to our core location during 20 – 17 kyr.

Keywords: Diatom, Kerguelen Plateau, SST, Antarctic Polar Front



INFERRING PALEOCLIMATE OF SOUTHERN OCEAN USING DIATOM AS A PROXY: A STUDY BASED ON SEDIMENT CORE

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Diatoms are unicellular eukaryotic algae whose cell walls are made up of silica and they form an essential component in the planktic food chain. With their high biological pump efficiency for carbon dioxide (CO₂) exchange, they serve as an important tool for interpreting paleoclimate and paleo oceanographic processes in pristine regions such as the Southern Ocean (SO). The current study focuses on a sediment core MD 12 3401 cq in order to gain a better understanding of climate change and the role of diatoms. The core is collected from latitude 44°40.73 South and longitude 80°23.58 East onboard Marion Dufresne. The study emphasizes on a part of a sediment core from 42 kyr to 58 kyr which is characterized by Marine Isotopic Stage 3 (MIS 3). Data shows *F. kergulensis* and *T. lentiginosa* are the most abundant species having relative abundance of 75% and 42 % respectively which dominates in the POOZ diatom group. Based on the diatom abundance sea surface temperature (SST) is quantitatively estimated using a Modern Analogue Technique (MAT) transfer function. The SSTs range between 2 to 10° C at the core site. The SSTs were warmest at the core site between 55 to 52 kyr and 47.8 to 46 kyr. However, cooler SSTs of 1°C to 2.5°C were also seen between 45.5 kyr to 42 kyr. As a result of which increase in Sea ice was seen at the core location. The warm SSTs between 55 to 52 Kyr and 47.8 to 46 Kyr can be related to the influence of warm surface water from the low latitudes at the core location coming from Kerguelen Island Region.

Keywords: Diatoms, Southern Ocean, Marine Isotopic Stage 3, Sea Surface Temperature





Environmental Geosciences & Geohazards



EXPLORING SUBMARINE CANYON-CHANNEL SYSTEMS: NEW INSIGHTS FROM THE CAUVERY BASIN, EASTERN CONTINENTAL MARGIN OF INDIA

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Submarine canyon-channel systems represent intriguing geological features that play a crucial role in the structural formation of continental margins worldwide. These complex formations, characterized by steep-walled valleys carved into the seabed, often extend from the shallow continental shelf, mostly in alignment with the mouths of large rivers, into the deep abyssal plains. Canyons, channels, levees, overbank wedges, and lobe deposits are the typical architectural components comprising a canyon-channel system. Understanding the morphology and dynamics of these submarine canyon systems is essential for unraveling their geological significance, impact on offshore structures, biodiversity assessment, geohazard characterization, and mineral exploration studies. A prime example of a submarine canyon-channel system in the Indian margin is found in the Cauvery Basin. The Cauvery Basin is situated in the southern part of the eastern continental margin of India. It extends offshore into the Bay of Bengal, distinguished by a narrow, concave continental shelf (12 - 20 km) and a gentle slope (average slope < 2°). The basin receives significant inflows from three major rivers: the Cauvery, Ponnaiyar, and Palar, nourishing its southern, central, and northern sectors, respectively. These rivers collectively supply substantial volumes of water and sediments, creating an ideal environment for the formation of submarine canyons. To understand the detailed geomorphological characteristics of submarine canyons, high-resolution multibeam bathymetry data collected from this region as part of the EEZ programme was used. The bathymetry data of the Cauvery Basin reveals a well-developed Submarine Canyon-Channel System. It consists of six major shelf-incising canyons, each with sinuous channels flowing downslope. Additionally, there are several smaller canyons and channels in this region that indent the shelf edge or slope, flowing into the deep. The high-resolution seismic reflection sections from this region reveal that the upper portions of identified submarine canyon-channels are characterized by deeply incised, narrow, V-shaped valleys, indicating strong erosional activity. However, analysis of the multibeam data indicates that the valleys broaden towards the lower portions, and as they descend deeper, these features eventually merge into the deeper regime. By revealing the intricate morphology of the Cauvery Submarine Canyon-Channel System, this study provides valuable insights into the geological processes shaping the southern part of the eastern continental margin of India.

Keywords: Submarine Canyon-Channel System; Cauvery Basin; Geomorphology; Multibeam Bathymetry; Eastern Continental Margin of India.



SUBMARINE GEOHAZARD ASSESSMENT ALONG THE INDIAN CONTINENTAL MARGINS: CASE STUDIES, CHALLENGES AND FUTURE PERSPECTIVE

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Submarine geohazards encompass a spectrum of phenomena induced by natural processes and anthropogenic activity including submarine slides, slumps, turbidity currents, earthquakes, tsunamis, and more. Given the ocean's significance as a reservoir for alternative energy, mineral wealth, the foundation of future sustainable development and the blue economy, multidisciplinary research efforts on submarine geohazards are of prime importance. Researchers face significant challenges in characterising such events, mostly because of the scarcity of marine geophysical/geological data, the event's unpredictability, and the extensive resources required, like manpower and marine survey infrastructure. Small to large-scale submarine slope failure events have been mapped in the Kerala-Konkan, Kutch-Saurashtra, Cauvery-Palar, and Krishna-Godavari Basin. As a part of the "Geoscientific studies of the Exclusive Economic Zone of India" program, extensive studies are being undertaken to identify the potential hazardous zones along the Indian continental margins. Swath bathymetric mapping in the Cochin offshore region characterised a large-scale submarine landslide which extends to the Laccadive Basin and shows a characteristic U-shaped scar with a dimension of ~50 km x 50 km. Extensive slope failure events have been mapped in the Konkan Basin that exhibit stair-like morphologies with multiple head scarps and steep sidewalls. A disintegrative landslide zone is identified in the off Chennai region associated with wide cracks in the continental shelf-slope. The factors that mainly influence slope failure events are sedimentation, sea level changes, increase in pore pressure, gas seepages, tectonic elements/neotectonic activities and earthquake events. These factors can act as single cause or combinations of multiple factors, varying from region to region. Improving the knowledge from this perspective can directly contribute to predicting areas prone to failure, model the associated probabilistic tsunamis, and assess the potential risks involved in offshore infrastructures/industry. Given the substantial socio-economic impact of submarine geohazards, this field of research demands high-priority interdisciplinary research along the Indian continental margins.

Keywords: Submarine geohazards; Continental Margins; Neotectonics; Indian EEZ



EVALUATION OF SURFACE WATER AND GROUNDWATER QUALITY IN AND AROUND CHAKKAMKANDAM LAKE

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Chakkamkandam Lake situated near Guruvayur, renowned for pilgrimage tourism, forms part of the central Kerala wetland within the Vembanad Kole wetland, a Ramsar conservation site. Previously a vital source of livelihood through fishing, farming, Pookali cultivation, and the coir industry, the lake now faces adversity due to environmental degradation. Despite its picturesque appearance, the lake is polluted by untreated sewage from commercial and residential developments in Guruvayur temple town, which caters to religious tourism. This led to poor surface water and groundwater quality, posing health and livelihood challenges for surrounding villages. This study evaluated the current water quality status in and around Chakkamkandam Lake, which has been deteriorating. A total of 21 water samples from the lake (S, n=6), and open well (G, n=15) were collected during the dry season in February 2024 and analyzed for physicochemical parameters using the APHA methods. The results showed variation within the following ranges for groundwater samples: pH (5.71- 7.58), EC (211-6000 $\mu\text{S}/\text{cm}$), TDS (118.5-3500 mg/l), turbidity (0.12-69.5 NTU), alkalinity (28-232 mg/l), total hardness (28-980 mg/l), chloride (10-1799.44 mg/l), nitrate (0-2.75mg/l) and sulphate (6-180 mg/l) and for surface water samples: pH (7.28-7.83), EC (9800-46800 $\mu\text{S}/\text{cm}$), TDS (5500-25900 mg/l), turbidity (3.04-51.8 NTU), alkalinity (96-240 mg/l), total hardness (1000-11400 mg/l), chloride (3109.03-31990 mg/l), nitrate (0.55-1mg/l), sulphate (650-8000 mg/l), DO (4.1-8 mg/l), and BOD (2.4-14.4 mg/l). All surface water samples exceeded the permissible limits of BIS standards for drinking water quality, except for pH, alkalinity, and nitrate and groundwater samples taken from both the northern and southern banks of the lake showed elevated levels of various water quality parameters due to sewage discharge, seawater intrusion, and agricultural wastes.

Keywords: Chakkamkandam Lake, Water pollution, surface/ground water quality



HEALTH RISK ASSESSMENT OF RADON (^{222}Rn) IN GROUNDWATER IN A TROPICAL RIVER BASIN

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Radon is a naturally occurring radioactive inert gas found in the earth's crust and is transported to groundwater through soil. ^{222}Rn in groundwater was analyzed in 36 dug wells during the pre and post-monsoon seasons of Achankovil river basin (ARB). During the pre-monsoon season, the concentration of ^{222}Rn ranged from 0.23 to 68.77 Bq/l, with a mean of 10.85 Bq/l. In the post-monsoon season, the levels fluctuated between 0.6 and 37.5 Bq/l, averaging at 10.22 Bq/l. Results indicated that 25% of the samples exceeded the permissible limit set by USEPA (11,000 Bq/L) for ^{222}Rn activity. Higher concentration of ^{222}Rn causes increased risks of stomach and gastrointestinal cancer when consuming groundwater. The annual effective doses due to inhalation and ingestion of groundwater radon have been assessed for adults, children and infants, and the average doses for all three types have been found to be well above the reference dose level (RDL) of 0.1 mSv/y proposed by the WHO & USEPA. While, Infants varies from 3 to 904 mSv y-1, 1.6 to 483 mSv y-1 for children, and 1.42 to 436 mSv y-1 for adults. In post-monsoon, 9.8 to 457.2 mSv y-1 for infants, 4.2 to 244.5 mSv y-1 for children, and 3.8 to 220.4 mSv y-1 for adults. The total annual effective dose from both inhalation and ingestion was determined to be higher in infants in comparison to children and adults. This study contributes to the growing body of knowledge elucidating the radon activity, advancing our understanding of groundwater radon dynamics for improved environmental and health risk assessment.

Keywords: Groundwater, Radon, Lithologic variability, Health hazard, Achankovil river basin, Kerala



GEOCHEMICAL DISTRIBUTION STATUS OF BIOCHEMICAL COMPONENTS IN FOREST SOILS, CENTRAL KERALA

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Biochemical composition of surface soils of Vazhachal forest region were analyzed in order to evaluate the quality of soil organic matter (SOM). Soil samples were collected during April-May, 2021 from nine stations representing different vegetation types. Soil samples exhibited acidic pH (5.25 ± 0.47). Highly significant spatial variation was noted for soil texture with silt (11.5 -70.32%) and sand (12.17 - 66.43%) as the dominant fractions in majority of the sites ($p < 0.01$). Soil organic carbon ($2.49 \pm 0.82\%$) and SOM (4.31 ± 1.42) exhibited maximum in teak plantations ($p < 0.01$). Enriched levels of silt favour the accumulation of SOM. Total organic nitrogen content (TON) (1.72 - 4.08%) exhibited higher values in evergreen forests. The C/N ratio recorded variation due to marked differences in environmental conditions across the vegetation. Concentration of biochemical parameters displayed the trend as follows: total carbohydrates > total lipids > total protein > tannin and lignin. Higher concentrations of carbohydrate and lipid were recorded in teak plantations implying greater contribution of vascular plant debris. Semi-evergreen forests recorded higher values of protein and tannin - lignin content. SOM exhibited strong positive correlation with carbohydrate and protein indicated contribution of vascular plant debris. Significant correlation of tannin and lignin with TON, carbohydrate and protein reflected their origin from common sources. Present study suggested that most of SOM was dominated by labile compounds and the amounts of highly recalcitrant compounds were particularly low. The distribution of biochemical components reflected the influence of forest type on labile SOM as it is considered a quickly reactive indicator of soil fertility and health.

Keywords: Forest, Soil organic matter, Biochemical composition



ASSESSING FLUORIDE POLLUTION AND RELATED HEALTH CONCERNS TO HUMANS IN THE PULLAMAPATTI WATERSHED IN NORTHERN TAMILNADU, SOUTH INDIA

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Assessing the quality of groundwater is imperative for both ecosystem sustainability and human well-being. Present study focuses on the evaluation of fluoride contamination in the Pullamapatti watershed in Northern Tamil Nadu, South India. A total of 70 ground water samples, representing the entire watershed were collected during pre-monsoon period. Analysis of these samples, in accordance with BIS and WHO standards, encompassed various cations and anions such as F⁻, Ca²⁺, Mg²⁺, Cl⁻, HCO₃⁻, Na⁺, and K⁺. Findings indicate that 27 samples from the Pullamapatti watershed exhibit fluoride contamination, particularly in areas including Dharmapuri, Karimangalam, Manicknoor, Mittanahalli, Timmanapuram, Nallampalli, Bandarahalli, and Kongarapatti. Moreover, Gibbs plots were used to understand geochemical evolution of groundwater. The study reveals that rock-water interaction is the major contributor for fluoride contamination in this area. Health risk assessment indicates that non-carcinogenic health risks associated with fluoride exposure through drinking water surpass acceptable levels for infants, children, and adults in the Pullamapatti watershed (Hazard Quotient > 1). This underscores the potential adverse health impact, necessitating urgent attention to safeguard the health of the local population facing risks due to fluoride-contaminated groundwater.

Keywords: Groundwater Quality, Fluoride Contamination, Health risk assessment



GIS-BASED STUDY ON HYDROCHEMICAL PROPERTIES OF DEEPER AQUIFERS FOR EVALUATING GROUNDWATER QUALITY IN THE PONDICHERRY REGION OF THE UNION TERRITORY OF PONDICHERRY

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Groundwater, accounting for 0.6% of the world's freshwater resources, plays a vital role as a primary source of drinking water, sustaining life on Earth. Approximately 1.5 billion people rely directly or indirectly on groundwater for drinking, withdrawing a substantial volume each year, constituting 20% of worldwide groundwater use. However, the pressures of rapid industrialization, urbanization, and a growing population strain the environment. Over recent decades, extensive usage of groundwater for domestic, agricultural, and industrial purposes has led to alterations in its chemical composition. Furthermore, natural factors such as ion-exchange, redox potential, residence time, geological conditions, and rock types contribute to the presence of various contaminants in water bodies. Groundwater quality assessment in Pondicherry's coastal aquifers is the central focus of this study, aided by Geographic Information Systems (GIS) to visualize the regional distribution of groundwater quality. The study entails the analysis of 63 groundwater samples, encompassing various physico-chemical parameters, including Total Dissolved Solids (TDS), Electrical Conductivity (EC), Chloride (Cl), Calcium (Ca), Bicarbonate (HCO_3), and Sulfate (SO_4). The findings reveal wide variations and substantial standard deviations in these parameters, indicative of anthropogenic contamination and seawater intrusion in the coastal aquifers. However, most of the groundwater in the area is generally safe for potable and domestic purposes. In terms of irrigation suitability, 95.3% of the groundwater samples, based on Sodium Adsorption Ratio (SAR) values, are suitable for irrigation across different soil types with a low risk of exchangeable sodium. Nonetheless, the Wilcox Plot classification categorizes most samples as permissible-doubtful for irrigation, necessitating careful considerations. The USSL classification suggests that most samples have high to very high salinity with minimal sodium risks. Effective drainage planning is vital to address this issue and ensure sustainable irrigation practices. The permeability index (PI) values classify most groundwater samples as class I, making them suitable for irrigation. The study underscores the importance of regular groundwater monitoring to mitigate potential environmental risks. This comprehensive assessment provides valuable insights into groundwater quality and its implications for various uses of coastal aquifers in the Pondicherry region.

Keywords: Groundwater Quality, Deeper Aquifer, Irrigation suitability



CHEMICAL CHARACTERISTICS AND SOURCE MECHANISM OF DISSOLVED SOLUTES IN SPRING WATER FROM LESSER HIMALAYA: A CASE STUDY OF THE CHAKRATA TEHSIL OF THE DEHRADUN DISTRICT, UTTARAKHAND, INDIA

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Groundwater, a significant freshwater ecosystem following the cryosphere, notably influences aquatic and terrestrial ecosystems. In the Indian Himalayan Mountains, springs known as "dharas" play a crucial role in providing freshwater for drinking and domestic use. When compared to surface water, spring water is often considered safer for drinking due to its natural infiltration process. A spring water sample from the Chakrata region was analyzed. The drainage pattern in the region generally follows the natural contours of the terrain. The study area is characterized by a diverse range of geological formations with significant carbonate content, exhibiting a karstic nature. The temperature of the region ranges from subtropical to temperate. Springwater samples ($n=46$) were obtained from the region. The spatial distribution of ions in the area shows significantly elevated levels of bicarbonate and magnesium ions. Two key processes influence the ionic makeup of spring water: silicate weathering, followed by calcite and dolomite dissolution. The primary water type identified is calcium-magnesium-bicarbonate $\text{Ca}^{2+} - \text{Mg}^{2+} - \text{HCO}_3^-$. The study shows that minerals like dolomite, gypsum, and anhydrite are undergoing dissolution within the spring water.

Keywords: Spring water, Lesser Himalaya, calcium-magnesium-bicarbonate



SPATIAL DISTRIBUTION OF MICROPLASTICS IN BHARATHAPUZHA RIVER

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Microplastic pollution represents a critical global environmental challenge, posing risks to both aquatic ecosystems and human health. Extensive research has been conducted on marine microplastics, but comparatively little attention has been given to understanding the presence of microplastics in riverine environments, despite rivers serving as significant pathways for microplastic transport to the oceans. The investigation focused on the identification and quantification of microplastics in surface water of the Bharathapuzha River, Kerala. Bharathapuzha is the lifeline for almost one-eighth of Kerala's population, a major drinking water source for Palakkad, Malappuram, and Thrissur districts. Studies related to microplastics in the Bharathapuzha River have not yet been conducted. The study area for investigating microplastic pollution in the Bharathapuzha River is designated from Shornnur to Pattithara, chosen based on factors such as industrial presence, population density, urbanization, and tourism. Shornnur is identified as the upstream point, with an additional nine points selected downstream at approximately 4-kilometer intervals along the river. After analysis of water samples microplastics were detected from all 10 sites and 232 particles were recovered from a total of 10 L of water with a mean abundance of 24.2 particles and a standard deviation of 20.68. Microscopic examination revealed fibers (79.8%) as predominant plastics followed by fragments (9.9%), filaments (9.4%), and films (2.1%). From Fourier transform infrared spectroscopy analysis (FTIR) polyethylene and polystyrene type polymers are identified. The size of most of the microplastics in the study sites is within the range of 50-600 micrometers. Arc GIS software is used for showing spatial distribution map of microplastics in the Bharathapuzha river. This study provides a piece of baseline information on the occurrence, distribution, shape, size, and polymer types of microplastic in the surface water of the Bharathapuzha River.

Keywords: Microplastic, Bharathapuzha River, spatial distribution map



IRON CONTAMINATION IN GROUNDWATER OF KERALA: AN ANALYSIS

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Iron contamination in groundwater significantly impacts human health and the aquifer environment of Kerala. It is one of the major problems in many areas especially in the laterite and alluvial aquifers. It can lead to various issues including the development of an unpleasant taste and odor in water. This can result in staining of plumbing fixtures and laundry, as well as the potential for clogging pipes and reducing water flow. The BIS limit of iron in drinking water is 0.3mg/L. Laterite aquifers are mostly prone to iron contamination, as their high iron content can easily leach into groundwater. As part of the study, 15 water samples are collected from in and around Trivandrum district. They show elevated levels of iron as per the analysis using a UV-visible spectrophotometer. The pH of the groundwater is found to be acidic. The study finds that groundwater is an important medium in which Fe transformations occur. Fe transformations strongly affect Fe migration and bioaccumulation. The rock water interaction in the aquifers causes an increase in Fe (II) concentration, a reduction and dissolution of Fe(III) from laterite and accumulation of Fe(II) in anoxic groundwater.

Keywords: Iron contamination, pH, Laterite aquifers



HYDROGEOCHEMICAL STUDIES OF THE ALUVA-KOCHI-INDUSTRIAL BELT, KERALA, INDIA

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The rapid increase in population, industrialization, and urban development has led to a significant issue of water resources contamination. Unregulated discharge of industrial waste into water bodies and the accumulation of sludge contribute to severe pollution in industrial areas. This pilot study is aimed at assessing the quality of water resources in the Industrial belt of Ernakulam district. Samples from both groundwater and surface water sources were collected within the vicinity of the area. The physical and chemical characteristics were examined to assess the suitability of the water for diverse uses, including drinking, and agricultural, applications. The results indicate that elevated levels of electrical conductivity, total dissolved solids, water hardness, and ions such as Cl, SO₄, Ca, Mg, Na, and K exceed the permissible limit set by the Bureau of Indian Standards primarily for surface water. Irrigation water quality parameters such as SAR, MAR, K-Ratio, SSP, RSBC, PI, and Na % were assessed and indicated that the surface water source is unsuitable for irrigation.

Keywords: Hydrogeology, water resources contamination, industrial belt, Irrigation Parameters



PHYTOREMEDIATION OF OSCAR FISH AQUACULTURE WASTEWATER WITH SELECTED COMMERCIALLY IMPORTANT AQUARIUM PLANTS

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The sustainable management of clean water is a major challenge in Oscar fish aquaculture. Though various filtration systems are used in the industry, farmers have to maintain the water quality by continuous siphoning, due to the energy consumption and feeding habit of the fish. This study was aimed to characterize the quality of the wastewater in Oscar rearing tanks and to evaluate efficacy of wastewater treatment with two species of commercially important aquarium plants, *Echinodorus cordifolius* and *Hydrocotyle umbellata*. Two experimental methods (Batch experiment and Continuous flow experiment) were followed for the treatment of wastewater using the above plants as phytoremediators for 20 days. After the treatment nitrogenous wastes and COD were significantly reduced. The sample treated with *H.umbellata*, showed a reduction of 91% in COD, and in those treated with *E.cordifolius*, it was reduced by 87%. The percentage reduction in limiting nutrient parameters such as ammonia and nitrate was above 99% after treatment. Similarly, reduction of alkalinity, total hardness, phosphate and potassium was also observed in both treatments. This study proves that these two aquarium plants are efficient for phytoremediation of Oscar rearing effluents. In addition, it was observed that the wastewater from Oscar fish rearing could be reused after phytoremediation. The plants also showed improved growth after the treatment, with an increase in the length and weight of the plant. The amount of nutrients used up by plants relates directly with the increase in biomass.

Keywords: Oscar fish, *Echinodorus cordifolius*, *Hydrocotyle umbellata*.



INVESTIGATION ON DIURNAL VARIABILITY OF ATMOSPHERIC ELECTRIC FIELD OVER THUMBA

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This paper presents the seasonal mean electric field (EF) variations at the surface associated with the thunderstorms and lightning over a coastal station Thumba (8.53°N , 76.87°E). The primary dataset consist of Electric Field Meter (Campbell make) observations collected during September 2015 to November 2022 over Thumba. The thunderstorms and lightning observed over three seasons (pre-monsoon: March-May, Monsoon: June-September and post-monsoon: October - December) are investigated in detail. The results show a distinct diurnal seasonal variation of EF pattern in three seasons. In general, the seasonal mean diurnal variation of EF shows a typical double maxima pattern during these three seasons with maximum peak observed in Pre-monsoon and minimum during Monsoon season. A detailed discussion on the causative mechanism of the double peaks are presented in the paper.

Keywords: Atmospheric electric field, thunderstorm, monsoon



**DELINEATION OF SHALLOW AQUIFER BY USING ELECTRICAL RESISTIVITY
METHOD IN WESTERN COAST OF SUVARNA RIVER BASIN,
UDUPI DISTRICT, KARNATAKA**

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Geophysical method is a vital tool in groundwater exploration. The geophysical methods are aimed to understand the hidden subsurface hydrogeological conditions adequately and accurately. Vertical Electrical Survey (VES) are conducted in the western coast of Suvarna river basin within Udupi district of Karnataka state using Schlumberger array. The study area is part of the Suvarna river basin is mainly underlain by Granitic gneisses with occasional laterite capping type of rock formation. The emphasis was mainly on geological soundings which is most commonly used geophysical surveys. The sounding gives us an idea on the thickness of various layers and thus the ground water potential in areas. For this purpose, we carried out 20 soundings by Schlumberger arrays. All the field data were plotted and interpreted qualitatively and quantitatively with the help of IP2WIN software and Pseudo sections were prepared in comparison with the subsurface strata to validate the results. The sounding curves are of K, Q, and HK types resulting in 3–4-layer sequence. The curves are prominently of Q and K type indicating the presence of three layer and combination of curve HK indicating the four layers sub surface layers. Among the total twenty VES locations, there are eighteen locations having three-layer cases and these three layers are topsoil, laterite and the weathered zone. These studies helped in locating Groundwater potential zone and to investigate the depth to hard rock in the surveyed points.

Keywords: Vertical Electrical Survey, Groundwater potential zone, Suvarna river basin



SURFACE SEDIMENT DYNAMICS AND ORGANIC MATTER RECORDS LINKED TO NATURAL AND ANTHROPOGENIC INPUTS IN THE MANASBAL LAKE: IMPLICATION TO CURRENT ENVIRONMENTAL STATUS

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The climate, hydrology, catchment geology, and land use within watersheds play key roles in governing the sediment chemistry of lacustrine systems. The sediment organic matter along with geochemical records have been utilized widely in the lacustrine systems to infer pollution dynamics, eutrophic status and inputs linked to catchments dynamics. Interestingly, lake sediment studies from Kashmir Himalaya have revealed that sediment physical and chemical characteristics are governed by both natural and anthropogenic influences including catchment geology, and lake biomass. Here, we utilize the physico-chemical characteristics of twentythree surface sediments coupled with land-use/land-cover mapping to provide insights into the natural and human induced environmental dynamics of the Manasbal lake. The finer silt-clay rich sediments reveal organic matter (avg. 19.32) and CaCO₃ (avg. 12.96) contents linked to catchment influences and show higher values when compared to other regional lakes. We also explore the potential influences from increased urbanization, eutrophication and other land-use changes to the lake environment. The present study will provide useful information to understand the current sediment dynamics and environmental status of the Manasbal lake.

Keywords: Lake sediments, Himalaya, organic matter, catchment dynamics, anthropogenic impacts



ASSESSING LANDSLIDE RISK AND MITIGATION STRATEGIES THROUGH INTEGRATED GEOLOGICAL, GEOPHYSICAL, AND GEOSPATIAL TECHNIQUES IN CENTRAL KERALA, WITH EMPHASIS ON LINEAMENT MAPPING

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Landslides in Kerala, India, exhibit a complex interplay of various factors, including geological features, topographical attributes, climatic patterns, and lithological properties. Kerala's diverse geological formations, characterized by lineaments and fault zones, significantly influence the susceptibility to landslides. The present study aims a focused analysis on the role of lineaments, slope gradients, rainfall patterns, and rock types in triggering landslide events within the region. The utilization of geophysical parameters like gravity and magnetic data is integral for the identification of faults and lineaments, facilitating the process of geological mapping. Moreover, steep slopes prevalent in mountainous terrains amplify the gravitational forces acting on the slopes, making them prone to instability during periods of intense rainfall. The seasonal monsoon rains, with their erratic distribution and intensity, play a pivotal role in landslide initiation and progression. Additionally, the lithological composition of rocks, including their strength, weathering characteristics, and permeability, further modulates the landslide dynamics in Kerala. This abstract underscore the importance of integrating geological and geospatial analysis along with the remote sensing techniques to understand the spatial distribution and temporal evolution of landslides in the central part of Kerala especially in three districts (Ernakulam, Kottayam and Idukki). By incorporating the previous studies, a comprehensive landslide susceptibility map can be generated which will show the potential landslide prone areas within the study area. Such insights are crucial for devising effective risk assessment and mitigation strategies to minimize the adverse impacts of landslide hazards on lives, infrastructure, and ecosystems in the region.

Keywords: Lineaments, Landslides, slope stability, Lithology, Rainfall and Risk Assessment



A PRELIMINARY STUDY OF THE IMPACT OF THERMAL POWERPLANT ON THE WATER QUALITY OF SURROUNDING OPEN WELLS, PADUBIDRI, SOUTHWEST COAST OF INDIA

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Groundwater contamination is the most discussed topic from a global context. The majority population of India relies on groundwater for drinking purposes. The investigation of the water quality is very important to preserve and protect the natural ecosystem. The analysis of water quality was carried out from different dug wells located in and around Padubidri town, Karnataka, India, which is within the 10 km radius of UPCL (Udupi Power Corporation Limited) Thermal Powerplant. The physicochemical parameters of eighteen groundwater samples from open wells were examined to determine their quality and suitability for usage. The subjected physicochemical parameters for the water quality estimation are pH, electrical conductivity, total dissolved solids (TDS), dissolved oxygen, salinity, and total organic carbon (TOC). The obtained values are compared with World Health Organization (WHO) standard values. The dug well which is closer to the thermal powerplant reported the highest conductivity (1292 $\mu\text{S}/\text{cm}$) and TDS (613 mg/L) values. The rest of the sampling stations reported conductivity (39 $\mu\text{S}/\text{cm}$ - 577 $\mu\text{S}/\text{cm}$) and TDS (8 mg/L to 280 mg/L) values within the permissible limit proposed by WHO. The TOC ranges between 0.47 mg/L and 2.93 mg/L, which is within the permissible limit for consumption, and hence the study area is not contaminated with any organic substances. Plant biomass majorly contributed to the carbon content within the specified limit. Higher values in TDS and conductivity revealed that the thermal powerplant exhaust can influence the groundwater resources near its vicinity. The physicochemical parameters from the remaining locations suggest that the water is safe for consumption. The study of the physicochemical parameters of groundwater seasonally helps in continuously monitoring the water quality impacts on public health and also justifies the geological factors contributing to the contamination.

Keywords: Groundwater, powerplant, TDS, conductivity, contamination



Fisheries for Food Security

&

Sustainable Livelihoods



ASSESSING VULNERABILITY FACTORS IN ESTUARINE FISHERIES: A STAKEHOLDER'S PERCEPTIONS

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This study aims to assess the various vulnerability factors affecting fisheries from a bottom-up approach i.e., based on fishers' fishing experience, knowledge, and perceptions. To perform this task, a social vulnerability assessment was conducted among the fisherfolk along two estuaries, Valapattanam (VAL) and Dharmadam (DHA) from Feb 2021 to Nov 2022. The vulnerability factor was assessed based on the data collected through a structured questionnaire, and surveys conducted. The questionnaire covers all aspects such as the social, economic, environmental, and institutional characteristics of each estuary. The vulnerability was calculated following the equation by Adger and Vincent 2005. For the study total of 200 responders (100 each) under five different categories of fishers and allied works (Subsistence fisherfolk, Recreational fisherfolk, Fishing and allied activities, Vendors, Bivalve collectors, Fisheries cooperative members) were chosen. Overall, the results indicated that the two studied regions have a moderate to high vulnerability and that the DHA estuary was slightly more vulnerable (0.62 score) than the VAL (0.53 score) estuary. It was observed that the VAL estuary was more exposed to annual rainfall, extent of saltwater intrusion and water quality. Whereas the DHA estuary was more exposed to annual rainfall, estuarine depth reduction, and sewage disposal. VAL estuary is more sensitive to changes in fish size, changes in fish population, and changes in catch. DHA estuary is mostly sensitive to revenues from others, changes in fish size, and changes in harvest species. Adaptive measures could only be implemented taking into account the unique socioeconomic characteristics of each region to lessen the vulnerability in the fisheries sector. Some of the adaptive solutions based on the fisherfolk's opinion include alternative opportunities, government compensation for fishing losses, and financial support for alternative training if fishing is discontinued. In summary, it is not possible to identify a single component that will reduce the susceptibility of the fishing industry; rather, a combination of factors must be investigated

Keywords: Fisherfolk, Sustainability, Livelihood, North Kerala



SHELF LIFE STABILITY OF SILVER POMPANO FISH SAUSAGE FORTIFIED WITH WHOLE CHIA SEED POWDER.

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The study aimed to standardize and evaluate the shelf-life of fish sausage derived from *Trachinotus blochii*, an emerging aquaculture species. The product was enriched with dietary fiber from Whole Chia Seed Powder (WCSP) at three different percentages: WCSP 2%, WCSP 4%, and WCSP 6%. Through sensory evaluation and statistical analysis, the best combination of the product was determined as WCSP 2%. The Control (C) and WCSP 2% sausages were vacuum packed and stored under refrigerated condition (4°C) and the biochemical (pH, TMA, TVBN, FFA, PV), sensory and microbiological evaluation (TPC, PC) were carried out at a set interval of three days. Higher values for pH, TMA, TVBN, PV and FFA were recorded for control samples than WCSP 2% sausages. The shelf-life of control sausage was observed as 9 days and that of WCSP 2% sausage was 12 days. The study revealed that WCSP 2% enhanced the shelf-life of the silver pompano fish sausage.

Keywords: Shelf life, Chia seed, Fish Sausage, Peroxide Value



BIOCONVERSION OF SHRIMP SHELL WASTE FOR EXTRACTING CHITIN USING BACILLUS LICHENIFORMIS AND LACTOBACILLUS FERMENTUM

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Waste generated during the processing of crustaceans has been increasing globally. Shrimp waste comprises the head, shell, and tail portions, which account for 40–50% of the total weight. In India, around 445,000 MT of shellfish waste is generated annually. Some of them are utilised as feed for aquaculture, but the majority of them are dumped openly in landfills or in the sea, which seriously pollutes the environment. Chitin (β -(1–4)-N-acetyl-D-glucosamine), the second-most abundant biopolymer next to cellulose, is widely prepared from the exoskeleton of invertebrates, crustaceans, insects, and the cell walls of fungi and yeasts. It is recognised as a potential material in the fields of food, pharmaceutical, textile, agricultural, biomedical, and industrial. The study was aimed to extract chitin from shrimp shell waste using successive fermentation of a protease-producing bacterium, *Bacillus licheniformis*, and an acid-producing bacterium, *Lactobacillus fermentum*. The shrimp shell was first fermented with *B. licheniformis*, followed by *L. fermentum*; the deproteinization (DP) and demineralization (DM) efficiencies were 90.21 and 87.47%, respectively, with a chitin recovery of 40.96%. The FTIR spectra of chitin exhibited similar structural characteristics as commercial chitin. The culture supernatant after fermentation exhibited high DPPH free radical activity and protease activity at a rate of 78.2 % and 1108.74 ± 3.94 U/ml, respectively. The results indicate fermented supernatants are a good source of natural antioxidants. This work provides a simple, eco-friendly, and feasible method to produce chitin from shrimp shell waste

Keywords: Chitin, fermentation, deproteinization, demineralization



EFFECT OF THERMAL PROCESSING STEPS ON PROXIMATE, AMINO ACID, FATTY ACID AND MINERAL COMPOSITION OF GENETICALLY IMPROVED FARMED TILAPIA, OREOCHROMIS NILOTICUS

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Thermal processing is proven to be an excellent technology for preserving highly perishable food commodities like seafood. However, processing steps employed during thermal processing have a significant influence on nutrients present in food. This study was conducted to investigate the influence of various processing steps, viz., pre-cooking, pre-frying, and thermal processing in various media (brine, oil, and curry), on the proximate, amino acid, fatty acid, and mineral compositions of genetically improved farmed tilapia. Moisture content in raw fish was found to be $79.99 \pm 0.1\%$. Crude protein, crude lipids and ash content was $16.44 \pm 0.06\%$, $1.59 \pm 0.03\%$, and $1.7 \pm 0.07\%$, respectively. Saturated fatty acids accounted 42.89% of total fatty acids in raw fish, followed by Monounsaturated fatty acid (37.44% of total fatty acids) and Polyunsaturated fatty acids (18.99% of total fatty acids). Linoleic (12.03% of total fatty acid), Docosahexaenoic (2.47% of total fatty acid) and Arachidonic (2.37% of total fatty acid) were the dominant polyunsaturated fatty acids present in raw fish. Among the saturated fatty acids, palmitic acid (29.89% of the total fatty acid) was found to be the highest. Essential amino acids formed 55.89% of total amino acids in raw fish followed by non-essential amino acids accounting 44.11% of total amino acids. Phosphorus (1557 ± 7.5 ppm), Sodium (275.5 ± 4.57 ppm), and Calcium (137.3 ± 1.3 ppm) were the dominant macro-minerals. Iron (6.0 ± 0.26 ppm) and Zinc (3.87 ± 0.03 ppm) were the micro-minerals found in highest quantities. Both pre-cooking and pre-frying of raw fish resulted in an obvious decrease in moisture content to $73.54 \pm 0.12\%$ and $69.88 \pm 0.02\%$, respectively. Pre-cooking and pre-frying resulted in a decrease in the content of leucine and lysine. Pre-cooking also resulted in a proportional increase in Na, Ca, P, Fe, and Zn content compared to raw fish; however, K and Mg content showed a decrease after pre-cooking. The media used for thermal processing also had a significant influence on the mineral content.

Keywords: Genetically Improved Farmed Tilapia (GIFT), proximate composition, fatty acid, amino acid, mineral content



FOOD BORNE ILLNESS SYMPTOMS ENCOUNTERED BY SEAFOOD CONSUMERS OF KERALA: A MIXED-METHODS STUDY

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Foodborne illnesses are a significant food safety concern mainly caused by microorganisms such as bacteria, viruses, parasites and chemical substances. Nutritional benefits of seafood have led to an increase in seafood consumption yet unsafe handling practice of fish can lead to foodborne illness. The fish supply chain faces various challenges, from poor harvesting or post-harvest to pre-processing or processing and transportation, unhygienic conditions in food markets and outlets or at the consumer level. Therefore, the study looked into the symptoms of food borne illness encountered post seafood consumption by surveying 2079 seafood consumers in Kerala state, India using mixed method approach. Among the respondents, 177 (8.5%) reported the facing of seafood borne illness symptoms. Common food borne illness symptoms observed were Vomiting (35.6%), Allergic reactions (23.7%), Diarrhoea (20.3%), abdominal pain (12.4%) and Headache (7.9%). Of the 63 respondents who experienced vomiting, 20.6% indicated their vomiting was linked to mussel consumption. The 42 respondents who faced allergy symptoms, 47.6% had allergic reactions, 26.2% had skin allergy with itchiness (26.2% each) and this underscored the risk of allergen contamination in seafood products. The area of residence of the respondents such as Urban, Suburban and Rural indicated significant association between reported food borne illness ($p < .003$). This addresses the regional variations in food-related health risks and emphasizes the importance of ensuring food safety by raising public health awareness among seafood consumers through targeted educational campaigns in different areas of residence. The health of consumers have to be safeguarded through disease surveillance, prevention, and control strategies at all levels of supply chains.

Keywords: Food Safety, Food Borne Illness, Seafood, Public Health, Mixed-method study



COUNTRY FOCUS IN TECHNOLOGICAL EVOLUTION OF SEAFOOD PROCESSING: A BIBLIOGRAPHICAL COUPLING ANALYSIS

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This study explores the transformative landscape of seafood processing technology, fueled by advancements in machines, automation, and quality control measures. With global demand for seafood products on the rise, stringent food safety regulations and a growing emphasis on efficiency and sustainability have sparked a revolution in processing methods. Utilizing bibliographic coupling, this research categorizes technological developments by nation, analyzing the interconnectedness of scientific literature referencing countries' publications. Through this approach, the study identifies key nations driving innovation in seafood processing technologies and uncovers trends and patterns within their methodologies. A comparative analysis with BRICS countries highlights diverse technological contributions to global innovation. Developed nations like the United States, Canada, and Europe emerge as leaders, prioritizing automation, quality control, and sustainability, while emerging economies such as China, Thailand, and select European countries demonstrate rapid technological advancements. Additionally, the study identifies areas for future research and collaboration, particularly in integrating emerging technologies like blockchain and artificial intelligence into seafood processing practices.

Keywords: Seafood processing, Industrial revolution, Technology, Bibliography coupling.



STANDARDISATION OF RECIPE FOR MILLET INCORPORATED FISH CUTLETS PREPARED FROM SILVER POMPANO (*Trachinotus blochii*)

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Silver Pompano (*Trachinotus blochii*), an emerging mariculture species was used for the preparation of cutlets. The cutlets were developed by standardising various ingredients like potato, onion, green chilly and salt in different ratios. Keeping this standardized product as the control, Barnyard millet (BM) and little millet (LM) were incorporated into the product in the ratios of 15%, 20% and 25%, with respect to the weight of the substrate. Sensory analysis was carried out on various parameters like appearance, odour, flavour, texture and overall acceptability by using hedonic scale system. In order to standardise these products, sensory scores were analysed using Kruskal-Wallis test. BM 25% and LM 15% were found to be the best among different samples. Proximate analysis and nutritional labelling of the standardised products were carried out and compared with the control sample. It was found out that millet incorporated cutlets had higher percentages of protein, carbohydrates and energy value (Kcal) than the control. Among the samples, proximate composition and nutritional labelling values of BM were found to be better than LM and control.

Keywords: Millets, Fish cutlets, Silver Pompano, Standardisation, Nutritional labelling



EXPLORING COMMUNITY PERSPECTIVES: ATTITUDE OF PEOPLE TOWARDS LIVELIHOOD ENHANCEMENT INITIATIVES IN COASTAL AREAS

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Livelihood of coastal communities is largely dependent on the revenue from traditional activities like fishing, agriculture and related employment. Nowadays it is becoming increasingly challenging for them to depend only on one type of employment for their livelihood. This study delves into the attitudes of coastal community members towards livelihood enhancement initiatives, aiming to understand their perceptions and experiences in the context of sustainable development. The geographical coverage of the study includes the coastal panchayats of Njarakkal, Kadakkudy, Kuzhuppilly and Pallipuram in the district of Ernakulam in Kerala. Coastal areas, often characterized by ecological richness and vulnerability, are increasingly subject to interventions aimed at improving livelihoods while conserving natural resources. Through a mixed-methods approach encompassing surveys, interviews, and focus group discussions, this research examines the multifaceted dimensions of community perspectives. The study scrutinizes factors influencing attitudes, including socio-economic status, cultural norms, environmental awareness, and past experiences with development projects. By exploring diverse viewpoints, it seeks to identify key determinants shaping acceptance or resistance towards livelihood enhancement initiatives. Insights gained from this study are vital for policymakers, practitioners, and stakeholders engaged in coastal development initiatives. By fostering a deeper understanding of community attitudes, it aims to inform the design and implementation of more effective, inclusive, and sustainable interventions. Ultimately, this research contributes to advancing the discourse on community-centered approaches to livelihood enhancement in coastal areas, with implications for fostering resilience, equity, and environmental stewardship.

Keywords: Coastal communities, attitude towards Livelihood enhancement, Sustainable development, Community perspectives



PREPARATION AND CHARACTERIZATION OF DIFFERENT-SIZED ZNO-NANOPARTICLES: COMPARING THE DIFFERENT ANALYTICAL METHODS TO IDENTIFY THE POTENTIAL NANOPARTICLE FOR ANTIBACTERIAL APPLICATIONS

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Zinc Oxide Nanoparticles (ZnO-NP) possess potential antibacterial properties, and research into their use is expanding day-to-day. Prior to the procurement of nanoparticles, a variety of application-related criteria must be considered, i.e., UV-spectra (λ max), dynamic light spectroscopy (DLS), Fourier transforms infrared (FTIR), scanning electron microscopy (SEM), minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC). In every biological application, nanoparticles of smaller size shown greater activity than nanoparticles of larger size. The concept of the blue shift is an important property of the ZnO- NP, i.e., the conversion of nanosized from the bulk size can be easily recognized by checking the absorption maxima (λ max) of the ZnO-NP. In the present study, various sized of ZnO-NP were prepared by the sol-gel method by altering the molarity of the NaOH and ZnCl. The various λ max possessing ZnO-Nanoparticles (ZnO-NP) were obtained viz., 350nm, 355nm, 360nm, 365nm and 370nm. All ZnO-NP were further characterized using DLS, FTIR and SEM, MIC and MBC and the results were correlated and compared with bulk particles (380nm). Based on the result, it has been observed that λ max is not more appropriate for assessing the size of the nanoparticles; but the distribution pattern of the UV spectrum was well correlated with the MIC and MBC values. It is concluded that the MIC technique is more suitable to the criteria for the purchase of ZnO-NP for any bactericidal applications, followed by SEM, DLS and λ max. The hierarchy for comparing the activity of better nanoparticles is as follows: MIC>MBC>SEM>DLS> λ max> FTIR.

Keywords: ZnO Nanoparticles, Antibacterial, FTIR, SEM



RESOURCE PARTITIONING AMONG THREE SYMPATRIC SCIAENIDS IN A TROPICAL ESTUARY, INDIA

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Knowledge of food resource partitioning among sympatric fish species is crucial for understanding the potential mechanisms of species coexistence. Feeding ecology, diet overlap and trophic interactions of three sympatric sciaenids (croakers) inhabiting Cochin Estuary (*Daysciaena albida*, *Johnius belangerii* and *J. dussumieri*) were investigated using gut-content analyses between February 2023 to January 2024. Specimens were caught using gill net and a total number of 335 guts were analysed. The analysis of relative importance indices indicated that the primary prey items found in their stomachs were prawns followed by fishes. The highest diet breadth values (0.46) were recorded in *J. dussumieri*, while the lowest was recorded in *J. belangerii* (0.40). The calculated diet overlap revealed significant niche overlap between *J. belangerii* and *J. dussumieri* (0.93), *D. albida* and *J. belangerii* (0.90) and *D. albida* and *J. dussumieri* (0.87). The trophic level ranged from 3.23 to 3.42, classifying the three species of croakers as mid-level carnivores. The findings of the present study offer valuable information into the feeding interactions between two sympatric species of sciaenids, providing a framework for their conservation and management in the estuarine ecosystem.

Keywords: Diet overlap, Niche breadth, Carnivores, Trophic level, Cochin estuary



GENETIC DIVERSITY OF SALMONELLA PARATYPHI B ISOLATED FROM SEAFOOD IN COCHIN, KERALA

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Salmonella Paratyphi B poses a potential public health risk by causing paratyphoid B infections which are significantly severe and life threatening occasionally. In this study, out of 470 fresh seafood samples screened, 39 isolates were identified as *S. Paratyphi B* with antigenic formulae 1,4,[5],12: b:1,2 by serotyping. To determine the genetic diversity of *S. Paratyphi B* isolates, Multi Locus Sequence Typing (MLST) was employed that targets the internal fragments of seven housekeeping genes *aroC* (826 bp), *dnaN* (833bp), *hemD* (666 bp), *hisD* (894 bp), *purE* (510 bp), *sucA* (643 bp) and *thrA* (852 bp). All the 39 (Polakkandom, n=36 & Thevara, n=3) isolates of *S. Paratyphi B* from seafood of Cochin region were assigned to two different ST using MLST. All the isolates of *S. Paratyphi B* from Polakkandom fish market belonged to a single sequence type (ST 3675) while *S. Paratyphi B* from Thevara retail market were categorized into two sequence types; ST 3675 (66.7%; n=2) and ST 1510 (33.3%; n=1). ST 3675 of *S. Paratyphi* exhibited 2 locus variations from the parental clone ST 42 while ST 1510 exhibited 6 locus variations from ST 42 indicating a higher divergence of ST 1510 than ST 3675 from parental clone ST 42. This study found ST 3675 as the most prevalent sequence type of *S. Paratyphi B* in the markets analyzed. The present information adds to the knowledge on the global circulation of *S. Paratyphi B* sequence types and assists in future genomic surveillance of *S. Paratyphi B* to understand their evolutionary history.

Keywords: *Salmonella Paratyphi B, MLST, Genetic diversity*



INNOVATIVE GREEN TECHNOLOGIES FOR SEAFOOD WASTE UTILIZATION TOWARDS THE CIRCULAR ECONOMY

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Fish production affected by fishing pressure, overfishing, increase amount of bycatch and other several reasons. Similarly, the seafood industry generate lot of amount of nutrient rich waste, effluents, which is a valuable source of nutrients and energy. Innovative green technologies process this nutrient rich waste and effluent of seafood industry towards zero waste that can improve sustainable development goals (SDG) and encourage circular economy.

Keywords: *Fish production, Seafood industry, Seafood waste, Effluent, Green technologies, Sustainable development goals, Circular economy*



VALORISATION OF GROPER FISH SKIN WASTE INTO LEATHER AND VALUE ADDITION

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Grouper (*Cephalopholis sonneratii*), a widely traded fish generates a large quantity of waste from processing units especially skin from filleting. The present study aimed to develop fish leather from Grouper skin waste using non-chrome treatment method. Fresh, green fleshed grouper skin was initially treated with calcium carbonate, sodium hydroxide and then treated with three different ratios (1:0.5:1, 1:1 and 0.5:1) of isopropyl alcohol and glycerine for a period of 4,7,14 and 30 days. The proximate composition and collagen content of raw grouper skin was determined. Textural properties, histological analysis and sensory characteristics of developed leather were analysed. Collagen, the primary component of skin protein was $37.30 \pm 1.38\%$, which plays an important role in the production of leather. The microstructure of collagen extracted from Grouper skin was examined using Scanning Electron Microscopy (SEM). According to histological research, the arrangement of collagen fibres before and after the treatment process showed the adequacy of the treatment method. The textural properties such as tear resistance and tensile strength of the developed leather showed better results. The non-chrome treatment has the potential to address the global issue of fish waste management and provide a viable alternative to exotic animal leather for value addition.

Keywords: Fish leather, Collagen, Non-chrome treatment, Tear resistance, SEM, Histology.



ASSESSMENT OF HEAVY METAL CONTAMINATION IN DRIED FISH FROM FISHING VILLAGES OF KERALA, SOUTH INDIA.

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The levels of heavy metals in dried fish were assessed from four fishing villages along the Kerala coast in India: Kannamaly, Munambam, Kalamukku, and Azhikode. Atomic absorption spectrophotometry was employed to evaluate 36 dried fish species for the presence of five metals: essential metals [copper (Cu) and zinc (Zn)], non-essential metals [cadmium (Cd) and lead (Pb)], and chromium (Cr), which can be classified as both essential and non-essential depending on its valence state. The metal concentrations in dried fish exhibited a decreasing order: Zn (12–89.66 PPM) > Pb (BDL–10.11 PPM) > Cu (BDL–3.88 PPM) > Cr (BDL–1.20 PPM) > Cd (BDL–0.06 PPM). While the levels of Cu, Zn, and Cd were within acceptable thresholds, the concentrations of Pb and Cr were found to be elevated. This increased accumulation of Pb may be attributed to persistent anthropogenic metal sources along India's southwest coast, particularly the Kerala coast, resulting from widespread industrialization, urbanization, port operations, and fishing activities. Notably, dried fish collected from the Azhikode and Munambam zones exhibited higher metal accumulations compared to the other sites. The findings from this metal pollution assessment of dried fish suggest that the levels of Pb and Cr are higher along the Kerala coast. Therefore, further research is warranted across a wider range of dried fish species and other preserved seafood to ensure that products processed from these polluted coastal areas do not pose any harm to consumers.

Keywords: Dried fish, toxic metals, salt-dried, seafood, food safety, Kerala coast.



CHARACTERIZATION OF MICROALGINATE BEADS COATED WITH CHITOSAN

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The study investigates the possibility of using chitosan and sodium alginate from marine sources to develop microbeads with multiple food applications. An emulsion technique combined with extrusion technique is used to develop chitosan coated alginate beads (CCALG). Concentration of sodium alginate, chitosan, oil and CaCl_2 were optimized to obtain beads with desired characteristics. The results showed that increasing alginate concentration up to 2% w/w can improve the morphological characteristics of the beads and 1% Chitosan coating improved the stability of beads and increased stability. 1% oil improved uniform emulsion and suspension of the beads. The optimized microbeads were characterized with regard to structure morphology, particle size and its distribution, stability, swelling rate and degradation. Survivability and stability of CCALG beads were experimented by degradation study in different pH solutions of pH 1, pH 6.8 and pH 12. Results show that an average bead diameter of about $2\pm0.2\text{mm}$ with a swelling rate more than $70\pm2\%$. These were unstable in acidic (1) and alkaline pH (12) and stable at neutral pH (6.8) possibly emphasizing its survivability under gastrointestinal conditions. Therefore, this encapsulation system could be suggested as an appropriate for delivering vehicle for sensitive compounds in various foods.

Keywords: sodium alginate, chitosan, probiotics, encapsulation



STUDY OF PLANKTONIC BIODIVERSITY IN CULTURE POND UNDER SODIC SOIL CONDITIONS

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The Fragilaria genera of the group Bacillariophyceae in phytoplankton and Cyclops genera of the Copepods play a major role in planktonic biodiversity of culture pond in College of Fisheries, Ayodhya. The phytoplanktonic diversity was observed high in pond -3 for phytoplankton and zooplankton diversity in pond-1. These group play a crucial role as a food source of herbivorous fishes of culture pond. The physico-chemical parameter was found high in pond 4. The diversity of plankton was found to be maximum during the end of the February due to availability of sunlight and daylight. The minimum diversity was observed in the starting of the January. They play an essential role in ecological balance of the pond to maintaining a balanced freshwater food web. Even in the adverse condition, the production of plankton and the productivity of the pond had been affected but sometimes it maintained. The selected water quality parameters were investigated along with the plankton to assess their diversity. The Simpson diversity index indicated the highest diversity in pond 3. This study concluded that pond 3 is more diverse than other pond. The parameter found that the pH ranged from 7.12 ± 1.71 to 7.83 ± 0.61 , temperature varied from 14.23 ± 4.11 to 30.17 ± 1.37 , dissolve oxygen (DO) varied from 7.12 ± 1.71 to 7.95 ± 1.10 mg/l, Total dissolve solids (TDS) varied from 200 ± 11.06 to 350 ± 39.30 mg/l, alkalinity varied from 240.67 ± 3.80 to 360.67 ± 6.16 mg/l. There are 28 genera of plankton, including 15 genera of phytoplankton and 13 genera of zooplankton were identified from different group during December 2022 to March 2023. Among the identified phytoplankton genera Bacillariophyceae formed the dominant group followed by Cyanophyceae and Chlorophyceae whereas in case of zooplankton genera the Copepods formed the dominant group followed by Cladocera and Rotifer. This study will certainly be helpful in planning of management strategy for pisciculture. However, it needs to carry out the further research accordingly.

Keywords: Physico-chemical parameters, diversity indices, plankton diversity.



POTENTIAL OF GASTROPOD RESOURCES IN INDIA FROM BYCATCH

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The gastropods are very diverse group of soft bodied organisms with calcareous external shell distributed in wide range of habitats from terrestrial to aquatic. Generally gastropods can be utilized as a source of meat for edible purpose and of shell for handicrafts and lime industry. Indian coastal waters have rich gastropod resources and it thus forms one of the major components in the trawl bycatch. But this exploited component is underutilized till now due to either the lack of knowledge/facility for utilization or the lack of awareness of its potential in the domestic as well as international markets. The present study is an attempt of analyze the problems and prospects of gastropods resource in the coastal waters. The study based on the field observation done as a part of ongoing master research programme along east coast of India. Pooled secondary information for the last few decades were also taken into account. The observation showed that the common species utilised for meat are *Babylonia spirata*, *Babylonia zeylanica*, *Melo melo*, *Tonna dolium*, *Volegalea cochlidium*, *Lambis lambis*, *Laevistrombus turturella*, *Chicoreus ramosus*, *Turbinella pyrum*. All the species have high demand in the domestic market and *Babylonia spirata*, *Babylonia zeylanica* have international market value which is exported to East Asian and Pacific countries. Shell craft industry and lime industry, which depends on the gastropod resource are still in small scale sector along the coastal regions. The ornaments and handicrafts made out of shells are highly priced objects in Indian as well as foreign markets. The gastropod forms a 4521 tonnes catch in total landings of India which shows its potential in Indian coastal waters. For complete utilisation of this resource more scientific studies are required to explore all the possibilities of utilisation of gastropods and to frame management policies for the effective utilisation of the available catch. The rich resource availability shows the potential to scale up the shell craft industry from the small to large with the intervention of concerned Public\ Private institutions

Keywords: *Gastropods, Nutrient profile, economic value*



EXPLORING UNDERUTILIZED STOMATOPODS OF INDIAN WATERS AS A VALUABLE RESOURCE

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Stomatopods, commonly known as mantis shrimps, are a diverse group of marine crustaceans inhabiting tropical and subtropical waters worldwide. Despite their abundance along the Indian coast, stomatopods have largely remained overlooked in terms of their potential as a valuable resource. Present study aims to shed light on the underutilized status of stomatopods and explore their diverse ecological, economic, and biomedical significance. The study, based on published records of stomatopods from Indian waters from the first study to the present date. A total of 75 species belonging to 36 genera in 10 families are reported from Indian waters. Recent studies have highlighted the potential of stomatopods in bio-prospecting and bioinspired technology due to their remarkable visual and mechanical capabilities. The stomatopods are one of the major components in the trawl bycatch, and are with economic importance as fishery as well as ornament purposes. In India the total estimated landings of stomatopod in 2022 is 10535 tonnes. Studies show that stomatopods are currently underutilized in India's fishing industry while they represent a valuable resource both ecologically and economically. Since the 1970s, there have been research works on the utility of stomatopods, but to date, there has been no development of this potential resource in India. Moreover, they are thrown overboard as soon as they are caught, and the large quantity of the landed portion in our harbours is condemned as trash fish and sold at a very low price. The lacuna as to why this potential resource is not being commercially exploited is still unfilled. Exploring their potential could lead to new opportunities for sustainable fisheries and contribute to the diversification of India's seafood sector.

Keywords: Mantis shrimp, Bycatch, Underutilized, Indian coast.



STUDIES ON GROUPERS (EPINEPHELUS) LANDING IN JUNGLIGHAT LANDING CENTRE OF PORT BLAIR, SOUTH ANDAMAN'S COAST.

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The Andaman & Nicobar Islands houses 27 species of groupers of the genus Epinephelus in its diverse range of habitats, primarily coral reefs, rocky areas, seagrass beds, and estuaries. This study presents a comprehensive analysis of Epinephelus grouper diversity in the South Andaman region, focusing on three key landing centers: Junglighat, Wandoor, and Guptapara from January to March, 2023. Through detailed observations, 19 species of Epinephelus groupers were identified from these landing centers. A significant center for morning grouper fishing, Junglighat produced a wide variety of groupers and a total catch of 31605.89 kg of Epinephelus groupers. Wandoor, situated near the Mahatma Gandhi Marine National Park, predominantly contributes export-quality catches such as groupers and snappers during evening fishing sessions. Guptapara, with fluctuating landing frequencies, also plays a significant role in the grouper catch. The study employs standard identification keys and morphometric measurements for species identification, highlighting the challenges of obtaining species-specific landing data. Additionally, the length-weight relationship (LWR) and condition factor analysis of Epinephelus areolatus and Epinephelus chlorostigma were carried out. Based on statistical analysis, E. areolatus was showing isometric growth and assumed to have poor growth conditions ($KR = 0.97$). On the contrary, E. chlorostigma has been shown to have positive allometric growth and is assumed to possess good conditions for growth ($KR = 1.03$) which implies chances of its overfishing in the future. The research underscores the importance of effective conservation measures to safeguard grouper populations in the South Andaman region.

Keywords: Groupers, landings, condition factor



HEAT PENETRATION CHARACTERISTICS AND QUALITY ALTERATIONS OF SQUID MASALA (*LOLIGO DUVAUCELII*) PROCESSED USING FLEXIBLE RETORTABLE POUCHES

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Thermal processing is a frequently employed technique of food preservation to extend shelf life and ensure safety of food products. The impacts of heat penetration during processing can have a major impact on the quality features of seafood, including squid. This study investigates the post-processing effects of heat penetration on thermally processed squid masala (*Loligo duvaucelii*). Squid masala was prepared and packed in flexible retort pouches. The pouches were then sterilised at F0 value of 7min. The heat penetration characteristics were analysed using data obtained by Ellab (Thermal validation and temperature monitoring system). Cook value was 69.84 min with a Total process time of 25.64 min. Heating lag factor (J_h) and Cooling lag factor (J_c) were 1.02 and 0.97 respectively. The impact of heat penetration on the textural, biochemical and sensory characteristics of squid masala were analysed. The findings showed that heat penetration during thermal processing had an impact on the product texture, biochemical characteristics and sensory qualities. These results provided important information about the effects of heat penetration on thermally processed squid masala, which is useful for optimizing processing parameters and ensuring the quality of seafood products.

Keywords: Thermal Processing, Heat penetration characteristics, Squid Masala, Retort pouches.



CARAPACE WIDTH-WEIGHT RELATIONSHIP OF SCYLLA OLIVACEA (HERBST, 1796): GENDER-SPECIFIC GROWTH PATTERNS FROM THE COCHIN ESTUARY, SOUTHWEST COAST OF INDIA

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The present study investigates the carapace width-weight relationship and interrelationships between various morphometric characters, such as carapace width and length and chelar propodus length and height in males, as well as carapace width and length and abdominal width and length in females, were estimated using a total of 4138 crabs comprising 2157 males and 1981 females of *Scylla olivacea*, a commercially important mud crab species, from the Cochin estuary. The purpose of this study is to understand the gender-specific variations, growth patterns and morphometric characteristics of *S. olivacea*. From June 2020- May 2023, a systematic collection of morphometric data was conducted, including carapace width, carapace length, chelar propodus length, chelar propodus width, abdominal width, abdominal length, and weight. Statistical analyses were employed to derive the Carapace width-weight relationship for both male and female crabs and pooled data. The results indicate a significant correlation between carapace length and weight, revealing potential sex-specific variations in the growth patterns of *S. olivacea* for males, the carapace width-weight relationship is expressed as $W=0.0000716 \times CW^{3.212}$. At the same time, for females, it is $W=0.000276 \times CW^{2.875}$. Additionally, the relationship for the pooled data, combining both males and females, is $W=0.000120 \times CW^{3.077}$. The 'b' values for carapace width-weight in males and females were 3.212 and 2.875, respectively, and for carapace length-weight, they were 2.498 and 2.705, respectively. The allometric relationships between the characters are positive and highly significant. The results show a significant deviation from an isometric growth pattern. The derived equations provide gender-specific insights into the growth patterns of *S. olivacea*, offering robust tools for estimating individual weights based on carapace length. The high R² values for both male and female models underscore their reliability in capturing the observed variations in weight. Understanding these length-weight relationships is vital for precise biomass estimation, determining size at maturity, implementing effective fisheries management, and contributing to the broader understanding of *S. olivacea* biology.

Keywords: *Scylla olivacea*, carapace width weight relationship, Cochin estuary, Growth patterns, Gender-specific growth, Allometric growth.



ECOLOGICAL TRANSFORMATIONS: LOCAL FISHER PERSPECTIVES ON DECLINING FISH CATCH IN CHETTUVA ESTUARY

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The Chettuva estuary, situated on the western coast of India and part of the Ramsar-listed Vembanad – Kole wetlands, has experienced a decline in both fish catch and habitats according to recent studies. This study utilizes the local ecological knowledge (LEK) of estuary-dependent fishers to identify ecological changes. Local Ecological Knowledge and community participation plays a pivotal role in enhancing our comprehension and sustainable management of aquatic ecosystems undergoing significant environmental shifts. Through semi-structured interviews (n=60), we analysed the links between the ecological changes and fish decline as perceived by the fishers. Various interconnected factors were highlighted as drivers of these changes, including siltation, temperature rise, dissolved oxygen depletion, increased CO₂ levels, eutrophication, land reclamation, sand mining, and weed infestation. Fishers also stressed the link between diminishing catches and habitat destruction.

Keywords: Chettuva, Local ecological knowledge, Fishery



TRIBAL FISHERIES AND FISH CATCH PATTERN FROM THOTTIYAR RESERVOIR AND ASSOCIATED CHANNELS, IDUKKI ALONG WESTERN GHAT FOOT HILLS: A MARKET ANALYSIS FOR LIVELIHOOD SUSTAINABILITY

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Western Ghats forms an abode for a variety of flora and fauna including ichthyofauna and characterized by high degree of endemism and peculiar distribution of rare and endangered freshwater fish species. The variety of fishes include mahseers in cold water, and high altitude areas to brackish water species in down streams along the foothills of Ghat section. Many people depend on these bio-resources for their livelihood as fisheries and aquaculture in non-reserve forest areas and tribal depend on fisheries along reserved forest areas. Since the fisheries along reserve forest areas are restricted to tribal fisher folk, the diversity and abundance from forest areas can be assessed only when they sell the fishes to the public in local market. An attempt was made to assess the fisheries and fish catch pattern of tribal folk of Thottiyar reservoir (check dam) and associated rivulets/channels to understand the fish landing composition and pattern by analysing the local markets of the area, during November 2023 to February 2024. Results of the present study reveals that there were 16 freshwater fish species marketed, of which five to seven species are sold as single species. Rest of the catch sold as small fishes (podimeen) of mixed species. The availability of the large fishes is seasonal and varies as catch depends on fishers and their effort. Fishing using gill nets alone is not suitable for large fish caught in high range rivulets without proper netting zones except in reservoir. Hence tribes opt for non-formal fishing methods too. Since there were only few tribal fisher folks engaged in fishing, who depend on fishing for their livelihood, the market is constant without much price and consumer variation. Since the fisher folk and consumer folk know each other for long time period, only the size and species of the fish caught contribute to the cost variation. A constant monitoring and assessment of the inland tribal fishers is recommended for their unscrupulous and unethical fishing practices.

Keywords: Check dam Fishery, Ichthyofauna, Unethical Fishing, Endemic Fishes, Mahseer



DOES PEARLSPOT EXHIBIT LIFELONG (CLASSICAL) MONOGAMY? UNVEILING THE BREEDING HABIT OF PEARLSPOT THROUGH AN INVESTIGATIVE STUDY.

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The state fish of Kerala, *Etroplus suratensis*, holds the distinction as the largest Indian cichlid inhabiting peninsular India and Sri Lanka. Renowned for its adaptability to both brackish and freshwater environments, this species stands out in aquaculture due to its resilience, broad salinity tolerance, and lucrative market value. Notably, it is celebrated for its unique parental care practices and purported monogamous mating behavior, a notion warranting scrutiny. In this investigation, we aimed to re-assess the presumed lifelong (classical) monogamy observed in Pearlspot breeding pairs, as documented in prior studies. Collaborating with ICAR-NBFGR at the Government fish farm, ADAK, Ayiramthengu, as part of the "PEARL SPOT BROOD BANK PROJECT," an experiment has been conducted. This experiment involved isolating breeding pairs in separate compartments within an RCC tank and allowing them to breed naturally. Subsequently, spawned females were swapped between pairs, allowing meticulous observation of breeding patterns, pairing behaviors, and pit-making habits. Contrary to prevailing beliefs, we observed that Pearlspot individuals readily mate with swapped females within a brief timeframe. This study confirms that *E. suratensis* exhibits serial monogamy. In contrast to the natural pairing behavior observed in *E. suratensis*, our study provides additional evidence that selective pairing and successful breeding can be effectively facilitated within captive environments. Our study offers significant insights into the breeding biology and eco-biology of Pearlspot fish, shedding light on their environmental relationships and evolutionary adaptations. By unraveling the complexities of Pearlspot mating behavior, we contribute to a deeper understanding of this species' ecological dynamics and inform sustainable management practices in aquaculture and natural habitats.

Keywords: *Etroplus suratensis*, State fish, Reproductive behaviour, Aquaculture.





Marine Bio - Prospecting - Natural Products & Drugs



PURIFICATION AND CHARACTERIZATION OF COLD-ACTIVE LIPASE: EXPLORING ITS APPLICATION IN BIOFILM DEGRADATION AND GENE EXPRESSION STUDIESIN SUNSCREEN LOTIONS

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Cold-active enzymes, known as extremozymes, are produced by psychrophiles and have garnered significant attention for their resilience in harsh industrial conditions. Among these, lipases are key biocatalysts, facilitating the hydrolysis of long-chain triglycerides and widespread use across various biotechnological fields. Cold-active lipases have become the preferred choice for professionals spanning organic chemistry, biophysics, pharmacology, biotechnology, microbiology, and biochemistry. This study explored the lipolytic activity of 220 bacterial isolates from Arctic fjords using qualitative and quantitative methods, with lipase activity assessed through p-nitrophenyl palmitate (p-NPP) assays. *Bacillus cereus* I13 emerged as the most proficient lipase producer among the isolates, prompting its selection for further investigation. The influence of incubation temperature, duration, and carbon/nitrogen sources on lipase production by *Bacillus cereus* I13 was examined. Following a five-step purification process, lipase from *Bacillus cereus* I13 exhibited a 26-fold purification, reaching a final yield of 278.5 U/mg. SDS-PAGE analysis confirmed the presence of a monomeric protein with a molecular weight of 31 kDa in the purified lipase sample. Assessment of its antibiofilm properties against pathogenic bacteria demonstrated significant alterations in biofilm morphology and density upon lipase treatment. Moreover, RT-PCR analysis revealed the downregulation of biofilm-related genes and major toxin-related genes (can, luxo, luxN, Vpsr, nuc) following lipase treatment. These findings underscore the potential of purified lipase from *B. cereus* I13 as a promising candidate for combating biofilm-associated infections. This research sheds light on the therapeutic applications of cold-active lipases in addressing biofilm-related challenges, with implications for biotechnology and biomedicine.

Keywords: Cold-active enzymes, Lipases, Biofilm, *Bacillus cereus*, Gene expression



BIOPROSPECTING INDIGENOUS MICROALGA *ACUTODESMUS ACUMINATUS* MB. 24: EXPLORING BIOACTIVITY, BIOFUEL POTENTIAL, AND SUSTAINABLE CULTIVATION WITH FISH SILAGE

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Phycoprospecting facilitates the discovery of economically valuable biochemical resources through the exploration of potential microalgae, as seen in diverse bioprospecting endeavors targeting *Scenedesmus* sp. for eco-friendly bio-diesel synthesis. In India, particularly in Kerala, where microalgal culturing practices for bioactive compounds lag behind other countries, the current study focuses on isolating and cultivating *Acutodesmus acuminatus* MB.24 (*Scenedesmus acuminatus*) from the tropical Cochin estuary to assess its potential for biofuels and natural bioactive compounds while exploring sustainable cultivation with fish silage to contribute to a zero-waste green bio-economy. Analysis revealed that the strain exhibits significant protein (23.98%), carbohydrate (27.43%), and lipid (25.33%) content, along with the ability to accumulate chlorophylls and carotenoids, particularly β -carotene (33.947%) and Astaxanthin (7.60%). *A. acuminatus* demonstrated notable scavenging activity against DPPH (36.91%) and ABTS⁺ radicals (38.003%), with a substantial phenolic content of 24.09 μ g GAE/mg, and exhibited EPS production capacity (0.278 mg/mL). HPTLC-MS analysis identified the strain as a potential source of various phytochemicals, including alkaloids, flavonoids, tannins, glycosides, and saponins. Nile red staining and FAME analysis underscored the microalga's suitability as biodiesel feedstock and fuel properties assessed using empirical formulas and the 'Biodiesel Analyser' software, satisfied the ASTM D-6751 and IS 15607 standards. Cultivation with fish silage demonstrated robust growth (2433.89×10^4 cells/mL), and biomass production (2.86 g/L), coupled with substantial reductions (up to 90%) in nitrate, phosphorus, and ammonia concentrations in the final silage, affirming *A. acuminatus*' efficacy

Keywords: *A. acuminatus*, biodiesel, carotenoids, fish silage, phytochemicals



BIOACTIVE POTENTIAL OF THE ENDOPHYTIC FUNGUS *ASPERGILLUS CARNEUS* SGF178 FROM SEAGRASS AND ITS APPLICATION IN THE *OREOCHROMIS NILOTICUS* CULTURE SYSTEM

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Marine endophytic fungi, dwelling within the internal tissues of marine flora, form symbiotic relationships with their hosts, yielding bioactive compounds with potent antimicrobial, antiviral, and antifungal properties. These compounds serve as powerful weapons against pathogens in aquatic organisms. This study elucidates the multifaceted roles of marine endophytic fungi and their bioactive potential in aquaculture. About 200 endophytic fungi isolated from the seagrass, *Thalassia hemprichii* were screened for antibacterial activity, and a potent strain viz., *Aspergillus carneus* (SGF178) was used for further study. The *Aspergillus carneus* (SGF178) was cultured in potato dextrose broth and after 10 days of incubation, the bioactive compound was separated using Amberlite XAD7HP followed by elution of the compound using acetone. The crude extract was dried using a Rotary Evaporator and its antibacterial properties were assessed against fish pathogens. Subsequently, the efficacy of the crude extract as a drug for the control of bacterial infection in *Oreochromis niloticus* was tested in a controlled experimental setup. For this, the *Oreochromis niloticus* were challenged with *Streptococcus agalactiae* and *Aeromonas hydrophila*. On the onset of symptoms of infection, the drug was administered via feed and water separately for 15 days. The experiment was continued for 30 days till all the animals in the control group died. The immune gene expression analysis was conducted during the experimental period and the survival of the fishes were noted daily. An upregulation in gene expression could be witnessed, suggesting the effectiveness of the crude extract from *Aspergillus carneus* administered via feed and water. The study holds considerable promise for the management of aquatic animal health contributing to sustainable aquaculture.

Keywords: Marine endophytic fungi, bioactive compounds, antagonistic activity, gene expression analysis.



DISCOVERY AND BIOPROSPECTING POTENTIAL OF A NOVEL MARINE ACTINOMYCETES *STREPTOMYCES KRISHNENSIS* SP. NOV., ISOLATED FROM AN ARCTIC FJORD

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The Arctic, characterized by its freezing temperatures and diverse microscopic organisms, presents an environment ripe for exploration. An actinobacterium, was isolated from Kongsfjorden, Ny-Ålesund, Norway and initially designated as MMCC100^T. Phylogenetic analysis based on 16S rRNA gene revealed a distinct cluster within its closely related *Streptomyces* species. Subsequently, whole-genome sequencing was conducted for species identification, resulting in a genome size of 8.32 Mb with a G+C content of 71.7 mol%. The DNA-DNA hybridization (dDDH), average nucleotide identity (ANI), and average amino acid identity (AAI) analyses between MMCC100^T and phylogenetically related species, were highest with *Streptomyces rubrogriseus*, measuring 48.30, 91.80 and 91.95 respectively, however, which falls below the established threshold for species delineation (70% for dDDH, and 95% for both ANI and AAI) and clearly establish the isolate as novel species under the genus *Streptomyces*. As a result, we propose the name *Streptomyces krishnensis* sp. nov. for this novel actinobacterial species. Comparative analysis revealed unique secondary metabolite Biosynthetic Gene Clusters (smBGCs) in MMCC100^T compared to other closely related 23 *Streptomyces* sp. The MMCC100^T possesses 32 smBGCs, of which ten gene clusters are not found elsewhere in the clade, potentially encoding the production of novel secondary metabolites. Metabolic profiling using liquid chromatography-mass spectrometry (LC-MS) identified several uncharacterized metabolites. Orthologous cluster and synteny analysis shed light on the evolutionary dynamics of secondary metabolism clusters, emphasizing the roles of horizontal gene transfer and gene gain/loss. The presence of these smBGCs among genomic islands suggests that this strain may have used gene transfer to enhance its adaptation and biosynthetic potential in a competitive environment. Subsequently, a crude extract of MMCC100^T showed antibacterial activity against *Staphylococcus aureus* and *Mycobacterium smegmatis*, human pathogens, in a culture-based assay. These findings underscore MMCC100^T a rich repertoire of uncharacterized metabolites, shaped by evolutionary mechanisms, and highlight its significance in bioprospecting endeavours.

Keywords: *Streptomyces krishnensis* sp. nov., Secondary metabolite biosynthetic gene clusters (smBGCs), Horizontal gene transfer, Metabolic profiling, Antibacterial activity



**ISOLATION OF POTENTIAL ANTIMYCOBACTERIAL COMPOUND FROM A
MARINE MANGROVE ACTINOMYCETES *STREPTOMYCES SP.* JKA52
*SACCHAROPOLYSPORA SP.***

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Multidrug-resistant tuberculosis (MDR-TB) is a form of TB caused by bacteria resistant to the most effective first-line TB drugs, rifampicin and isoniazid. MDR-TB is treatable and curable by second-line drugs, but the options are limited and require extensive chemotherapy. A general approach to counter antibiotic resistance is to introduce new molecules into the treatment pipeline to replace ineffective ones. The marine ecosystem, harbouring a wide variety of organisms, is becoming a hot spot for identifying novel drug leads. Marine actinomycetes are prolific producers of secondary metabolites that show a wide range of biological activities, including antimicrobial and anticancer. As part of our marine drug discovery program, we have isolated around 59 marine actinomycetes from Puthuvype marine mangroves and have screened against different bacterial pathogens. Among those isolates, JKA52 has shown potential antimicrobial properties against *Mycobacterium smegmatis*. The 16S rRNA gene sequencing and subsequent NCBI Blast analysis the isolate JKA52 was identified to belonging to the genus *Streptomyces*. The crude extract from *Streptomyces sp.* JKA52 was first subjected to normal-phase flash chromatography with silica column as stationary phase, with different polarity mobile phases. Fractions extracted in ethyl acetate showed potential activity against *M. smegmatis*. This fraction was subjected to HPLC for further purification. The fraction eluted in 90% water, and 10% methanol retained antimycobacterial activity, and further characterisation of the compound is ongoing. The study showcases the potential of marine actinomycetes as a source of antimycobacterial compounds that can be developed as potential drug candidates against tuberculosis.

Keywords: *Marine Actinomycetes, Marine bioprospecting, Mycobacterium smegmatis*



ASSESSING THE BIOACTIVE POTENTIAL OF ACTINOMYCETES ISOLATED FROM MANGROVE SEDIMENTS OF NORTH KERALA

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The quest to uncover novel microbial resources from previously unexplored environments is crucial for discovering potent secondary metabolites and enzymes with diverse biotechnological applications. Among prokaryotes, actinomycetes are renowned for their ability to produce a vast array of secondary metabolites and extracellular enzymes. The present study focused on isolating actinomycetes from sediment samples obtained from Mangrove areas near Thalassery, Kannur, Kerala, aiming to identify strains with promising bioactive properties. Eight actinomycete were isolated purified and subsequently evaluated the anti-cancer and anti-bacterial activities through specific assays. Among the isolates, three exhibited antibacterial activity against *S. aureus*, while two (K2 & DG1) displayed potential cytotoxicity against NCI-H460 lung cancer cell line. Further, bioassay-guided fractionation of crude extracts was carried out, followed by purification of lead molecules through HPLC. The ongoing research efforts include structural elucidation of lead molecules from different fractions of the two isolates and confirmation of their potential pharmacological significance. This study underscores the importance of exploring untapped regional resources for discovering novel bioactive compounds with therapeutic potential, thereby paving the way for drug discovery and development.

Keywords: *Actinomycetes, Mangrove sediment, cytotoxic*



INDUCED BIOSYNTHESIS OF CRYPTIC NATURAL PRODUCTS WITH POTENT ANTIMICROBIAL ACTIVITY FROM MARINE ACTINOMYCETE SACCHAROPOLYSPORA SP.

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Marine microbes are a vast reservoir of bioactive compounds, showcasing unparalleled chemical diversity, pivotal in natural product drug discovery. Their unique biochemical compositions offer promising leads for pharmaceutical research, advancing the development of novel medicines to combat various diseases and ailments. Cryptic natural products are elusive bioactive compounds synthesised by organisms, typically microorganisms, which remain dormant or undiscovered under standard laboratory conditions. The present study sheds light on the induced biosynthesis of cryptic natural products from marine actinomycetes. The marine actinomycete MMCC62, originally isolated from sediment samples of Norway and identified as *Saccharopolyspora sp.* was subjected to genome analysis. The whole genome sequence of the isolate analyzed by using antiSMASH platform for rapid genome-wide identification, annotation, and study of secondary metabolite biosynthetic gene clusters (BGCs), including antimicrobial lanthipeptide and lassopeptides, thus confirming the biosynthetic potential of this isolate. Since these genes remain silent and do not produce any detectable metabolites under normal conditions, selected epigenetic modifiers were used to activate these silent BGCs to produce compounds with potent bioactivity. The pilot scale production of MMCC62 augmented with a protein synthesis inhibitor Lincomycin at two varied concentrations was done. A resin-based extraction of secondary metabolites was adopted using XAD Amberlite beads. Methanolic compounds extracted from the culture were tested for bioactivity against bacterial pathogens. These extracts exhibited significant antimicrobial activity against *Staphylococcus aureus*, showing growth-inhibiting zones upon performing the Kirby Bauer assay. This experiment highlights the role of lincomycin in expressing the silent BGCs of *Saccharopolyspora sp.* resulting in the production of bioactive compounds. Further extensive investigation into the genomic induction triggered by lincomycin in the organism and the subsequent production of a new antimicrobial metabolite is warranted in future studies.

Keywords: Actinomycetes, Induced biosynthesis, *Saccharopolyspora sp.*, antiSMASH, BGCs, Antimicrobial



SCREENING OF PROCESS VARIABLES FOR THE EXTRACTION OF GELATIN FROM RAY FISH (*GYMNURA POECILURA*) SKIN USING RESPONSE SURFACE METHODOLOGY (RSM)

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The rising interest in the valorisation of fish waste has drawn increased attention towards fish discards like skin, scale and bone etc. The extraction of collagen and gelatin could be a better way of utilizing the fish side stream, due to their effective applications in food, biomedical and pharmaceutical industries. Gelatin is a biopolymer obtained by the partial hydrolysis of collagen, the main structural mammalian protein. The aim of the present study is to efficiently determine the critical control variables from a large number of potential variables for the extraction of gelatin. NaOH concentration (mol/L), CH₃COOH concentration (mol/L), Pretreatment time (minutes), Skin/water (ratio), Extraction time (hours), Extraction temperature (degree Celsius) was chosen as the process variables. The responses measured in the study was yield. A fractional factorial design (Resolution-IV) consisting of 16 experimental runs were used to screen the most important process variables. A half normal plot and Pareto chart were used for screening important process variables. After selection of important variables, the analysis of variance (ANOVA) model was generated along with its significance level (P< 0.05). The model significance was tested and was used for model navigation and finding important factors in yield. From the screening experiment, four variables were identified as critical variables that had a significant effect on gelatin extraction from ray fish skin. The variables are Pretreatment minutes, Skin to water ratio, Extraction temperature and Extraction time.

Keywords: Ray fish, valorization, Gelatin, Screening, Process variables, RSM



SCREENING AND OPTIMIZATION OF PROCESS PARAMETERS FOR THE ALKALINE PHOSPHATASE PRODUCTION BY *BACILLUS CEREUS* ISOLATED FROM ARCTIC SEDIMENTS

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Phosphatases, pivotal enzymes catalyzing the hydrolysis and synthesis of organic esters of phosphoric acid, play indispensable roles in various biological processes. Among microbial kingdoms, fungi and bacteria are prolific producers of phosphatases, holding promise for diverse applications. This study delves into the exploration of the phosphatase production potential of microbes inhabiting the sediments of the Arctic region. Molecular identification of the potent isolate showed the maximum resemblance of the isolate to *Bacillus cereus*. This study investigated how different fermentation conditions affect phosphatase production by systematically changing one factor at a time. The effect of pH, temperature, inoculum size, incubation period, agitation speed, substrates, carbon and nitrogen sources, and metal ions on *B. cereus* growth and phosphatase production were investigated during the study. The effect of various concentrations of substrate disodium phenyl phosphate (DPP) on *B. cereus* growth and phosphatase production was also evaluated. *B. cereus* was found able to grow and produce phosphatase enzyme at its optimum level when the fermentation medium contained tryptone (0.5 %) as nitrogen source, xylose (0.5 %) as carbon source, Mg²⁺ (10 mM) and DPP (3 mM) is inoculated with 1% inoculum. The optimum pH and temperature for the highest growth and phosphatase production were 7 and 30°C respectively. It was noted that the growth was stable in all the agitation speeds selected. However, the enzyme production was significantly low in all the fermentation flasks kept at agitated condition compared to flasks kept in static condition. The study revealed that *B. cereus* phosphatase from Arctic sediments exhibits catalytic properties suitable for various biotechnological applications.

Keywords: Arctic sediment; *Bacillus cereus*; Bioprocess Optimization; Enzyme Production; Microbial Phosphatase



ISOLATION, CHARACTERIZATION AND EVALUATION OF ANTI-OSTEOARTHRITIC EFFECT OF PROTEOGLYCANS FROM SHARK CARTILAGE

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The present study was aimed at isolation and characterization of PGs (proteoglycans) from deep sea shark (*Echinorhinus brucus*) cartilage, and evaluation of their anti-osteoarthritic effect by using monosodium iodoacetate-induced osteoarthritic animal model. PGs were isolated by chaeotropic digestion and anion-exchange chromatography. Chemical composition, gel electrophoresis and peptide-based LC-MS/MS analysis were used for characterization. Total protein, total carbohydrate, uronic acid, hexosamine and sulfated glycosaminoglycans (GAGs) values were observed to be 0.468 mg/mg, 0.530 mg/mg, 0.098 mg/mg, 0.20 mg/mg and 0.06 mg/mg respectively. Agarose gel electrophoresis revealed presence of both high molecular and low molecular weight PG. Presence of GAGs part of PGs was confirmed by polyacrylamide gel electrophoresis (PAGE) in the isolated sample. The mass spectrum analysis of the purified PGs obtained from bramble shark cartilage revealed the presence of two unique peptides including AGWLSDGSVR and LDGNPINLSK, that showed sequence similarity with aggrecan core-protein and epiphycan, respectively. PGs of four concentrations namely 25mg/Kg, 50 mg/kg, 100 mg/kg and 200 mg/kg were used to assess their anti-osteoarthritic efficacy study in rat animal model. The levels of C-reactive protein and uric acid in the OA rats were reduced when treated with PGs. Histopathology analysis displayed less progression of cartilage erosion in PGs treated group. It was further confirmed by the gene expressions of the inflammatory biomarkers such as TNF- α , IL-1 β , MMP13, NOS2, IL-10 and COX-2. In addition, PG treatment group showed better anti-oxidant defence system status such as elevated SOD and catalase enzymes and a higher GSH content. In conclusion, we could observe preliminary evidences for the anti-osteoarthritic properties of PGs. Furthermore, we recommend more pre-clinical and clinical evaluations to confirm full potential of PGs as promising anti-osteoarthritic agents for future applications.

Keywords: Proteoglycans, Shark cartilage, Characterization, Anti-osteoarthritic study



UV-PROTECTING DIPYRROLOBENZOQUINONES FROM MARINE SPONGE-DERIVED *ASPERGILLUS SP.* MCCF102: PHOTOSTABILITY AND APPLICATION IN SUNSCREEN LOTIONS

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Marine organisms dwelling in intertidal, epipelagic, and even planktonic and benthic organisms, to some depth, get exposed to harmful UV radiation. Under this highly stressful environmental condition, organisms produce secondary metabolites, protecting them from UV radiation. A dipyrrolobenzoquinone called Terreusinone was isolated from the marine sponge-derived fungus *Aspergillus tamarii* (MCCF102). Since the molecule's UV absorption profile is similar to commercial UV filters such as avobenzone, the project focuses on the isolation of terreusinone and its analogs from marine fungi *Aspergillus tamarii* (MCCF102) and the biological studies to determine its efficiency to be used as a safe UV quenching cosmetic material having commercialization potential. The crude extract is obtained after mass culturing of *Aspergillus tamarii* (MCCF102) followed by solvent-solvent extraction method. It was then subjected to flash chromatography followed by High-Pressure Liquid Chromatography (HPLC) purification of fractions to obtain terreusinone and its analogues. The biological efficiency of the purified metabolite was determined using DPPH (2,2-Diphenyl-1-picrylhydrazyl) Free Radical Scavenging Assay, ABTS (2,2-azinobis-3-ethylbenzothiazoline-6-sulfonic acid) Assay and Reactive Oxygen Species Scavenging Activity using Neonatal Mouse dermal fibroblast cell line. Terreusinone exhibits ABTS scavenging activity, thereby revealing the molecule's significant anti-oxidant property. We have found that the isolated compound remains photostable for up to 6 hours of exposure to UV radiation, which was again confirmed by photodegradation analysis using LC-MS. Further studies are on the way to determine the efficacy of Terreusinone as a UV protective agent and its formulation

Keywords: dipyrrolobenzoquinone, marine natural product, anti-oxidant, UV protectant.



ANTIBACTERIAL AND ANTICANCER ACTIVITIES OF *STREPTOMYCES* SP. MMCC30 ISOLATED FROM ARABIAN SEA SEDIMENT

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During the last century, natural products as drugs enabled humans to combat deadly diseases, thereby increasing the lifespan of millions. The emergence of pathogens resistant to the available drugs pose a grave threat often described as the 'silent pandemic'. The discovery of novel small molecules decreased considerably after the 1970s, and the rediscovery of known compounds alienated pharmaceutical companies from natural product research. However, the recent explosion of information in genomics and approaches to harness microbial diversity of underexplored environments has led to renewed interest in natural products. In this regard, marine actinomycetes and their secondary metabolites hold immense potential, sparking hope for future drug discoveries. For this study, we selected an actinomycete designated as MMCC30, which was isolated from sediment collected from the Arabian Sea following preliminary screening. Subsequent 16S rRNA analysis identified the strain as belonging to the *Streptomyces* genus. The strain was cultured in a production media for two weeks and secondary metabolites were extracted using ethyl acetate. The solvent was evaporated under vacuum, yielding a crude extract. The antimicrobial activity of this extract was assessed against six pathogens through disc-diffusion assay. Remarkably, at a concentration of 1mg/mL, the extract exhibited significant zones of inhibition, specifically against gram-positive pathogens. Furthermore, its potential as an anti-cancer agent was investigated using an MTT assay against the NCI-H460 lung cancer cell line. At a concentration of 50µg/mL, the extract demonstrated over 80% cytotoxicity, suggesting promising anti-cancer properties. The analysis of the whole genome sequence of *Streptomyces* sp. MMCC30 revealed the presence of 38 biosynthetic gene clusters, indicating significant potential for producing bioactive compounds. To elucidate the specific bioactive molecules responsible for its potency, further investigation through bioassay-guided fractionation is essential. This process will enable the identification of lead compounds within the crude extract, facilitating a deeper understanding of its bioactivities.

Keywords: marine actinomycete, Arabian sea sediment, anti-bacterial, cytotoxic, biosynthetic gene clusters



ANTIMALIGNANT POTENTIAL OF ERGOSTEROL ISOLATED AND CHARACTERIZED FROM *Perna Viridis* IN COCHIN COASTLINE BEDS, SOUTHWEST COAST OF INDIA

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Indian Green Mussel *Perna viridis*, collected from the natural beds of the Cochin coastline area of Chellanam, Cochin southwest coast of India. Species identified using Molecular methodology in COI region and Gen Bank accession No is MH664002. Mussel species are considered sentinel organisms; many secondary metabolites discovered are associated with microbial diversity. The sterols were considered secondary metabolites fractionated using hexane-ethyl acetate (85:15) from the concentrated residue of methanol chloroform extract of lyophilized flesh of the *Perna viridis*. Ergosterol, a mycosterol from the steroid fraction, was isolated and was identified using pure standard Ergosterol within a TLC plate. The compound was further confirmed with GC-MS-MS. The compound was characterized using spectroscopy methods (UV, FTIR, GC-MSMS, NMR- H¹ and C¹³). Antimaligency was tested against Breast cancer cell line (MCF-7) and Human colorectal carcinoma cell line (HCT116) and exhibited significance from 200 to 800 µgm/ml for MCF and 800 µgm/ml for HCF116. The Ergosterol, was first isolated and characterized from the species *Perna viridis* and showed a prominent future for cell line studies.

Keywords: *Perna viridis*, Ergosterol, spectroscopy, Breast cancer cell line (MCF-7), Human colorectal carcinoma cell line (HCT116).



THE IMPACT OF LIGHT INTENSITY ON THE GROWTH AND FATTY ACID PROFILE OF THE DIATOM *SELLAPHORA MINIMA* (GRUNOW) MANN, 1990 FOR POTENTIAL COMMERCIAL APPLICATIONS

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The present study aimed to investigate the impact of light intensity on the growth and fatty acid composition of the freshwater diatom *Sellaphora minima*. *S. minima* was collected from the Aluva region ($NL10^{\circ}5'40'' EL76^{\circ}28'15''$) of the River Periyar. The organism was isolated by serial dilution followed by agar plating in 1% agar enriched with f/2 medium and the genus- level identification was done with the help of light microscope and scanning electron microscope images (Length 6-15 μm and width 3-5 μm). Molecular identification was performed for species- level confirmation. Four light intensities viz. 1500 lux, 3000 lux, 4500 lux, and 6000 lux were employed for the experiments. To assess the growth kinetics of *S. minima*, cell counts were monitored on alternate days during the cultivation period. The highest cell count (80×10^4 cells/ml) for *S. minima* was observed under 6000 lux light intensity. The lipid and fatty acid percentages were statistically analyzed (One-way ANOVA). Notably, the lipid content exhibited significant differences ($p \leq 0.05$) across different light intensities i.e. 8.61%, 7.04%, 5.51%, and 4.27% in the exponential phase and 20.26%, 17.38%, 12.3%, and 10.24% in the stationary phase under 1500 lux, 3000 lux, 4500 lux, and 6000 lux, respectively. The lipid extracted from *S. minima* comprised predominantly of myristic acid, palmitic acid, palmitoleic acid, oleic acid, linoleic acid, linolenic acid, arachidonic acid, and eicosapentaenoic acid. The highest production of Saturated Fatty Acids (SFA) was observed under 6000 lux light. Conversely, the production of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) peaked under 1500 lux light. During the transition from exponential phase to the stationary phase, both SFA and MUFA production increased, while PUFA production decreased. The fatty acid composition of *S. minima* suggests its potential for commercial applications in larval aquaculture nutrition and biodiesel production.

Keywords: *Sellaphora minima*, light intensity, lipid, fatty acids



EXPLORING THE POTENTIAL OF SEAWEED KOMBUCHA FERMENTATION FOR ENHANCED BIOACTIVITY AND NUTRITIONAL BENEFITS

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Seaweeds are a repository of many bioactive compounds. Utilizing microbial fermentation offers a sustainable approach to enrich the nutritional and sensory attributes of seaweed. It also enhances the bioactivity and the bioavailability of the compounds within the biomass. In this study, brown seaweed *Turbinaria conoides* was fermented using a symbiotic consortium of bacteria and yeast, known as SCODY, traditionally used to ferment tea. The resulting product, known as kombucha, is renowned for its health benefits. With tea kombucha as control, seaweed kombucha was developed in a hygienic controlled environment. Analysis of the fermented products revealed that seaweed kombucha exhibited significantly higher antioxidant activity, total phenolic, and total flavonoid content ($p < 0.05$). Furthermore, the levels of heavy metals in the kombucha remained within safe limits, as confirmed by ICP-OES analysis. Untargeted metabolomic analysis using LC-HRMS, coupled with chemometrics, identified various beneficial compounds such as organic acids, phenolics, flavonoids, and vitamins within the fermented extracts. Microbiota quantification through aerobic plate count, LAB count, acetic acid bacteria count, and yeast and mold count revealed the presence of specific microbial populations responsible for the fermentation process. Colony purification and DNA sequencing identified a betaproteobacteria and two yeast species within the kombucha samples. Overall, this study demonstrates the potential of seaweed fermentation to produce a functional beverage with enhanced nutritional and bioactive properties. And it presents a promising avenue for the utilization of seaweed as a sustainable source of bioactive compounds.

Keywords: Seaweed kombucha, fermentation, functional beverage



A COMPARATIVE STUDY ON ANTIBIOFILM ACTIVITY OF THE MgO-NANOPARTICLES-CHITOSAN-COMPOSITE AND ITS COUNTERPART WITH VARYING DEGREE OF BIOFILMS

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Biofilms pose a persistent challenge in the health and fishery sector, and magnesium oxide nanoparticles (MgO-NPs) have proven effective antibiofilm properties. Recent studies have shown that Chitosan fortified with MgO-NP (CH-MgO-NP) has a powerful anti-biofilm activity. However, the studies are incomplete until it has been compared with their counterparts i.e., Magnesium Oxide Bulk Particles (MgO-BPs) and chitosan-fortified MgO-Bulk particles (CH-MgO-BP). So, the study compared the antibiofilm activity of MgO-NP, MgO-BP, CH-MgO-NPs, CH-MgO-BPs and Chitosan (CH) with varying degrees of biofilms viz., weak, moderate, and strong biofilm. The nano and the bulk size of the MgO were confirmed by various techniques viz. FTIR, DLS, SEM, XRD, and UV-vis spectra and found that the size of the nano and bulk particles were around 60 nm and 1700nm, respectively. The antibacterial activity data demonstrated that CH-MgO-BP and CH-MgO-NP had a minimum inhibitory concentration (MIC) of 29.29µg/ml. Antibiofilm activity was assessed at a sub-MIC concentration of 20µg/ml, and the findings demonstrated that, in comparison to the control, CH-MgO-BP and CH-MgO-NP reduced the biofilm-formation by 71% and 69.60% for weak biofilm, 82.10% and 82.70% for moderate biofilm, and 94.10% and 94% for strong biofilm. Minimum biofilm inhibitory concentration (MBIC) and Minimum biofilm eradication concentration (MBEC) were analysed for the biofilm-forming isolates and found that the strong biofilm was not completely eradicated by CH-MgO-NP and CH-MgO-BP, but it became weak. At a very low concentration, the composites completely eradicated the moderate biofilm. Weak biofilms were eliminated by composites at much lower concentration. It is concluded that the comparable capacity of the bulk and nano composites with chitosan to eradicate biofilms makes them more viable for use in the future to address the growing issues related to biofilms that are resistant to antibiotics in the health and fishery sectors.

Keywords: Nanoparticle, Bulk particle, Chitosan, Biofilm



EFFECTS OF SEASONAL VARIATION AND PHYSICO-CHEMICAL FACTORS ON BIOCHEMICAL COMPOSITION AND ANTIOXIDANT ACTIVITY OF ROCKY INTERTIDAL SEAWEEDS

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Seaweed is emerging as a prominent functional food, driven by the growing recognition of its nutritional advantages. During Pre-monsoon season, *Caulerpa peltata* exhibited high protein content (97.89 ± 19.8 mg. g⁻¹ dw) and dietary fiber (15.3 ± 0.1 mg. g⁻¹ dw), while *Padina boryana* had high lipid ($36 \pm 5.7\%$) and ash content ($54.6 \pm 0.1\%$). In post-monsoon season, *Chondria dasypHYLLA* showed considerably high protein content (102.6 ± 13.9 mg. g⁻¹ dw), and *Padina boryana* displayed high carbohydrate levels (29.2 ± 0.01 mg. g⁻¹ dw) with increased dietary fiber (18.1 ± 0.1 mg. g⁻¹ dw) and ash content ($47.9 \pm 0.1\%$). *Ulva lactuca* showed high carbohydrate content in both pre-monsoon (22.2 ± 2.4 mg. g⁻¹ dw) and post-monsoon season (29.2 ± 0.01 mg. g⁻¹ dw), along with high lipid content ($58.7 \pm 6\%$) and abundant vitamins (Vitamin A, B1, B12, E, and C) across both seasons. The analysis of total phenolic content (TPC) from the seaweed extracts indicated that *Padina tetrastromatica* had the highest levels of TPC during both pre-monsoon season (19.8 ± 2.4 mg GAE/g) and the post-monsoon season (26.9 ± 1 mg GAE/g). Carbohydrate, lipid content, TPC, and FRAP showed significant seasonal variations ($p < 0.05$), at the same time DPPH displayed highly significant seasonal variations ($p < 0.01$). Similarly, significant correlations were observed between TPC and DPPH scavenging activity ($p < 0.05$) in the post-monsoon season. The analysis of the effect of seasonal variation between environmental parameters and seaweed biochemistry by Canonical corresponding analysis (CCA) revealed protein, carbohydrate, dietary fiber, TPC, H₂O₂, ABTS, and FRAP correlate with salinity and temperature in pre-monsoon. However, during post-monsoon season, TPC, DPPH, ABTS, H₂O₂, and FRAP correlated with NO₂, PO₄, NO₃, and salinity. Seasonal variations and physico-chemical factors such as salinity, temperature, and nutrients played key role in the biochemistry, total phenolic content, and antioxidant activity in seaweeds.

Keywords: Seaweed, antioxidant, seasonal variation, nutrient, vitamins



BIOACTIVE POTENTIALS OF MANGLICOLOUS YEAST BETA-GLUCAN: AN INVITRO APPROACH

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β -glucans, one of the important constituents of yeast cell wall have received much attention in past few years. Nowadays, these biomacromolecules have been extensively used in pharmaceutical, food and cosmetic industries. Although some physiological functionalities of these sustainable polymers have been confirmed, the bioactive potential of Manglicolous yeast β -glucan remain unexplored. Mangrove is one of the rare and distinctive ecosystems that offers numerous microhabitats with the potential of harbouring yeast communities. The present study was aimed to determine the bioactive potential of β -glucan from mangrove yeast isolates available in the laboratory. β -glucan extracted from 100 isolates were initially screened for α -amylase inhibition using plate assay. The β -glucan from the potent isolates were further examined for various pharmaceutical potential such as antioxidant, antimicrobial, anti-diabetic and anti-inflammatory activity. The yield of β -glucan extracted by an acid-base method varied depending on isolates (100-500mg/g of cells). Among the 100 isolates the β -glucan from 7 isolates (PV5, PV12, PV21, PV28, PV56, PV60, PV62) were identified as potent as they exhibited complete inhibition of α -amylase enzyme. Further, this was confirmed quantitatively by α -amylase inhibition assay, in which PV62 showed an inhibition of $75.8 \pm 0.02\%$. These β -glucan samples also exhibit scavenging potential against DPPH and ABTS radicals and maximum activity was observed for PV28. A significant antibacterial activity against various pathogens were exhibited by β -glucan from PV21 sample. However, these β -glucan samples do not express any anti-inflammatory and α -Glucosidase inhibition potential. Thus, the findings of study suggests that manglicolous yeasts too are a value source of β -glucan which have potential to be applied in fields of nutraceuticals, food and pharmaceuticals.

Keywords: Manglicolous yeast, Beta-Glucan, Bioactivity



UNVEILING ARTEMIN: A NOVEL ANTIMICROBIAL PEPTIDE FROM ARTEMIA SP. AND ITS INFLUENCE ON MICROALGAL GROWTH

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The present study unveils Artemin, a novel antimicrobial peptide family identified from the Brine Shrimp, *Artemia* sp. Through gene sequence analysis, a 109 amino acid peptide encoded by a 327 nucleotide ORF was characterized. Molecular weight determination revealed a weight of 12.21 kDa, with a net charge of +12.75 for the Artemin peptide. In depth *in silico* analysis pinpointed a bactericidal region spanning amino acids I10 to S29 within Artemin. This specific peptide segment was synthesized chemically, and its effects on microalgae growth were investigated across a range of concentrations and with various algal strains, including *Chlorella marina*, *Nannochloropsis salina*, and *Chaetoceros marina*. Results underscore the concentration-dependent influence of the peptide segment on the growth dynamics of these algal strains. The identification of Artemin as a potent antimicrobial peptide with a specific bactericidal region underscores its potential utility in controlling microbial populations in aquaculture settings. The concentration-dependent effects observed on microalgae growth highlight the importance of precise dosing strategies when implementing Artemin in aquaculture systems.

Keywords: Antimicrobial peptides, Artemin, Innate immunity, *Artemia* sp., Microalgae



SYNTHESIS, CHARACTERIZATION, AND BIOIMAGING APPLICATIONS OF SEAWEED-DERIVED CARBON NANODOTS

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Nanomaterials, particularly fluorescent materials, exhibit significant potential across various sectors such as medicine, biosensing, energy, and catalysis due to their distinctive properties. Among these materials, carbon nanodots (CNDs) are notable for their low toxicity, compatibility with biological systems, and ease of surface modifications. This study employs a green synthesis method to produce and refine CNDs derived from *Sargassum longifolium*, a seaweed known for its biomedical uses. The synthesis process involves microwave irradiation followed by purification steps including filtration, dialysis, and centrifugation. Optical properties are evaluated using UV-visible and fluorescence spectra, while characterization is performed through FTIR analysis. Staining capabilities are assessed using bacterial cells. The synthesized carbon nanodots exhibit robust fluorescence with excitation wavelengths at 280 nm and emission at 650 nm. Furthermore, CNDs derived from brown seaweed demonstrate notable staining capabilities on bacterial cells. Future research endeavours are directed towards utilizing modified CNDs with enhanced fluorescence for imaging applications.

Keywords: Carbon nanodot, Seaweed, Fluorescence, Bioimaging



APPLICATION OF VARIOUS PRETREATMENT METHODS FOR THE ISOLATION OF ACTINOMYCETES FROM COCHIN ESTUARY

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Marine environments are often overlooked sources for isolating new microorganisms that can produce active secondary metabolites. Actinomycetes are of particular interest due to their ability to produce chemically diverse compounds with a wide range of biological activities. In recent years, actinobacteria have gained considerable attention due to their ability to produce natural products and enzyme inhibitors, enzymes, and antibiotics. Many novel bioactive substances have been discovered from the rare actinomycetes. Thus, isolation methods of rare actinomycetes have received a lot of attention. The main focus of the present study will be to isolate the actinomycetes strains from marine sediment, especially from the Cochin estuary. The isolation of rare actinomycetes from sediment will be tested using various pretreatment methods and selective media. We propose that a combination of chemical physical pretreatment and different media can isolate different rare actinomycetes. In this particular study, a total of 20 methods are used for the pre-treatment of the sediment samples. To isolate as many as unknown actinomycetes, researchers should be familiar with all the knowledge about the physiology and taxonomies of actinobacteria and other microbes and the role of each isolation factor (including components and concentration of media, pH, inhibitor, cultural temperature, etc.), and they should have rich experience. Isolation procedures should be continuously renewed and improved. The isolation method of actinomycetes is on the road and has no end. This study will analyze different pre-treatment methods and isolation of rare actinomycetes.

Keywords: *Actinomycetes, Cochin estuary, Sediment, Pre-treatment*



MARINE MICRO-ALGAE BIOPROSPECTING AS SUSTAINABLE BIO-FACTORIES FOR HIGHER-VALUE ADDED COMPOUND

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The field of marine bioprospecting has attracted significant attention in recent times due to its potential for creating ecologically friendly and sustainable manufacturing methods for a wide variety of new compounds that are obtained from extensive marine lifeforms. The development of marine microalgae as a potential source for the process of creating value-added compounds (VACs), which have a wide range of uses in industries like food, cosmetics, pharmaceuticals, and other biotechnological sectors. Nevertheless, there are a number of obstacles to the synthesis and marketing of these chemicals from marine algae, such as the need to choose a low-yielding strain, inadequate screening of the target component, reduced productivity, a lack of social awareness, and stringent regulatory regulations. By utilizing appropriate screening, optimization, and metabolic engineering techniques, this review aims to present a comprehensive overview of the current state of knowledge on bioprospecting marine microalgae as sustainable bio-factories for the manufacture of VACs. It also includes the classification of various kinds of chemicals and their industrial uses, as well as the social acceptability and regulatory frameworks pertaining to the microalgal products that are sold on the market. The assessment offers suggestions for future directions in the field of marine microalgal bioprospecting, which could result in creative and environmentally friendly methods of production along the algae value chain.

Keywords: *Marine Actinomycetes, Marine bioprospecting, Mycobacterium smegmatis*



BIOPROSPECTING POTENTIAL OF ACTINOMYCETES ISOLATED FROM MANGROVE SEDIMENTS OF KANNUR, KERALA

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The scientific world is in continuous investigation for novel compounds with biological activities. Actinomycetes are well known for their secondary metabolites with antimicrobial and anticancer activities. Marine ecosystems are sources of diverse microbes with potential to explore novel bioactive compounds. Marine mangroves of Kerala are largely unexplored area for its microbial biodiversity and bioactive potentials. Mangrove sediment samples were collected from Ezhome, Kannur, Kerala. Following pretreatment, the samples underwent spread plating on actinomycetes isolation agar (AIA) and Zobell marine agar. Identification and isolation of actinomycetes were performed based on morphological characteristics. Subsequently, pure isolates were cultured on a larger scale, and crude extracts were prepared. The cytotoxic activity of these crude extracts was assessed using a single concentration of 50µg/mL on the NCI-H460 non-small cell human lung cancer (NSCLC) cell line through MTT assay. Additionally, the antimicrobial activity of the crude extracts was evaluated against three human pathogens—*S. typhi*, *S. aureus*, and *E. coli*—at a concentration of 1mg/mL, employing the Kirby-Bauer disk diffusion method. A total of 10 strains were isolated, out of which 8 were from Zobell marine agar and 2 were from AIA. On screening for cytotoxicity, MSM1 (53.19 %), MSM4 (53.53 %), MSM 24 (74.20%) and MSM 25(88.5%) showed more than 50% cell death. On antimicrobial activity screening, MSM2 and MSM13 showed zone of inhibition against *S. aureus*. This study emphasizes how crucial it is to look into unexploited indigenous assets in order to find novel bioactive molecules that could potentially possess medicinal value, unlocking a path for the discovery of new drugs. More than half of the isolates screened were showed either anticancer or antimicrobial property. This points towards the fact that an unprecedentedly high number of biologically active isolates could be harvested from mangrove ecosystem. Furthermore, molecular identification as well as purification and elucidation of lead compounds is to be conducted.

Keywords: Antimicrobial activity, Anti-cancer activity, Cytotoxicity, MTT assay, Kirby-Bauer disk diffusion assay



EXPLORING THE ANTIMICROBIAL, ANTIOXIDANT, AND QUORUM QUENCHING ACTIVITIES OF ACTINOBACTERIAL ISOLATES ASSOCIATED WITH MANGROVES IN ERNAKULAM DISTRICT

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Actinobacteria are ecologically and economically important prokaryotes with the unprecedented ability to produce novel metabolites. They are widely distributed in nature due to their physiological and metabolic versatility. In the current study, Actinobacteria were isolated from mangroves located in Ernakulam district, Kerala, India. Mangrove sediment samples were collected from four different mangrove ecosystems: Kumbalam, Puthuvyppu, Maalippuram, and Valanthakkadu located in Ernakulam district. A total of 69 isolates were screened initially based on their morphology and gram staining. Among the 69 isolates, 10 samples exhibited good antimicrobial, antioxidant, and quorum quenching activity. After 16S rRNA gene sequencing of the ten isolates confirmed that they belong to Actinobacteria. The antimicrobial activity of the 62 isolates was tested against four pathogens: *Escherichia coli*, *Bacillus cereus*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. Among the 69 isolates, only 10 displayed antagonistic activity in the range of 6 mm to 22 mm inhibition zone formation. The highest activity was exhibited by the EMA1 isolate (218.33 ± 0.12 AU/ml) against *B. cereus*. The free radical scavenging activity of the isolates was also tested through the DPPH assay. The highest antioxidant activity (89.64 ± 0.08 %) was exhibited by the isolate EMA2 at a concentration of 100 μ g/ml. In the study, the qualitative and quantitative quorum quenching activity of the isolates were also analyzed. The isolate EMA2 exhibited the highest QQ activity (61.62 ± 0.05 %). BLAST analysis showed that among the ten isolates, 5 (EMA2, EMA3, EMA4, EMA9 & EMA10) fall under *Streptomyces* sp, 3 (EMA1, EMA7, & EMA8) belong to *Nocardia* sp, EMA5 confirmed as *Actinomycetes bacterium*, and the isolate EMA6 confirmed as *Prauserella muralis*. The current study corroborates the bioactive potential of mangrove-associated actinobacteria.

Keywords: *Actinobacteria, Bioactive compounds, Mangrove, Quorum quenching*



GOLD MINES OF OSSEOUS ENGINEERING: UNVEILING THE POTENTIAL OF MARINE SPONGE BIOMATERIALS

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Marine life and biodiversity are a rich source of possible new goods for mankind. Surprisingly, marine creatures remain a largely untapped resource for biotech applications. It is well recognized that compounds from marine sponges that are sedentary animals of the Porifera class have enormous therapeutic promise in a variety of applications, owing to their anticancer, antiviral, anti-inflammatory, and antibiotic properties. Marine sources have demonstrated satisfactory clinical outcomes and have been deemed safe for use. They also feature a rich calcium phosphate-containing scaffold over which new cells develop due to their porosity and 3D grain structure. The structural qualities of sponges make them appealing as bone replacements. Most species have an effective linked porous design facilitating fluid movement that aids in filtering large volumes of water to capture nutrients while also, being similar to an ideal bone scaffold. Sponges contain an organic component called spongin, which is similar to vertebral collagen, the most often employed natural polymer for tissue regeneration. The collagen found in marine sources has demonstrated somewhat superior effects than the current synthetic substitutes. Finally, sea sponges' osteogenic characteristics are enhanced by their mineral content, which includes bio-silica and other chemicals that can support cell proliferation while also stimulating bone formation and mineralization.

Keywords: antibiotic, Marine sources, collagen, Sponges



POLYSACCHAIDES EXTRACTED FROM SARGASSUM WIGHTII BOOSTED IMMUNITY IN ORNAMENTAL GOLD FISH AGAINST AEROMONAS HYDROPHILA CHALLENGE

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Crude polysaccharides extracted from the brown seaweed *Sargassum wightii* which was collected from the east coast of Kanyakumari, Tamilnadu during October 2023. The crude polysaccharide was characterized by FT-IR and X-ray Diffraction (XRD) pattern to confirm the complex structure with both amorphous and semi-crystalline characteristics. Further the crude polysaccharide was incorporated with the artificial pellet feed with various concentrations (100, 200, 400 and 600 mg/kg of feed) and fed to the ornamental gold fish *Carassius auratus* weighed almost 32±2 g for 45 days. After the feeding experimental period, fish groups were challenged with highly virulent *Aeromonas hydrophila* and studied the survival, haematology and immunological parameters etc. The fish groups received the control diets, devoid of polysaccharides were succumbed to death cent percentage within five days after challenged with *A. hydrophila*, whereas 200, 400 and 600 mg/kg polysaccharides incorporated diet fed fish had highest survival rate of 62, 78 and 90 % respectively and significantly differed ($P < 0.001$) after 10 days of challenge. The total RBC was significantly higher in the experimental groups and the maximum level was observed of 1.94mm³ in 400 mg/kg of diet fed groups and the haemoglobin level also higher in 400 mg/kg diet fed group and significantly increased ($P < 0.05$). The experimental diet helped to significantly ($P < 0.001$) improved the serum bactericidal activity, phagocytic activity, serum bactericidal activity, total immunoglobulin level, myeloperoxidase activity and lysozyme activity. The present findings revealed that, the crude polysaccharide was boosting the immune system against bacterial infection.

Keywords: *Aeromonas hydrophila*, *Carassius auratus*, Immunostimulants, Polysaccharides, *Sargassum wightii*



EFFICACY OF CHITOSAN NANOPARTICLES AGAINST EXTENDED SPECTRUM BETA-LACTAMASE (ESBL) PRODUCING *E. coli*

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Chitosan nanoparticles have recently gained considerable attention as potential candidates for their applications in antimicrobial therapy. The current study aims to synthesize, characterize, and evaluate the antibacterial efficacy of chitosan nanoparticles against extended spectrum beta-lactamase (ESBL) producing *E. coli*. Antibacterial resistance is an emerging concern with significant morbidity and mortality, necessitating immediate attention. With a limited number of new antibiotics and effective therapeutics currently available, the findings of this study propose a novel strategy for effectively addressing antibacterial resistance. Beta-lactam-resistant strains of *E. coli* were isolated from diverse samples and identified by morphological and biochemical characterization studies. The study also focused on identifying the gene responsible for conferring beta-lactam resistance in the *E. coli* samples, for this purpose, molecular techniques such as plasmid isolation, electrophoresis, and PCR were employed. Following these procedures, the isolated gene underwent sequencing and was subsequently subjected to BLAST analysis for identification. To yield chitosan nanoparticles, the synthesis process adopted was ionic gelation, and further, the nanoparticles were characterized by UV-Vis spectroscopy. The antibacterial activity of chitosan nanoparticles against beta-lactam-resistant *E. coli* were evaluated by the well diffusion method. The results revealed a pronounced antibacterial activity, highlighting the potential use of chitosan nanoparticles as a potent antibacterial agent.

Keywords: Chitosan nanoparticles, ESBL-producing *E. coli*, antibacterial resistance, ionic gelation, UV-Vis spectroscopy



SCREENING OF CRITICAL PARAMETERS FOR GELATIN EXTRACTION FROM CUTTLEFISH (*SEPIA PHARAONIS*) SKIN WASTE FOR SUSTAINABLE RESOURCE UTILIZATION: A RESPONSE SURFACE METHODOLOGY APPROACH

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Gelatin, a biopolymer derived from thermohydrolysis of collagen molecules present in skin, bones, and scale of animals. Due to its unique functional properties, it finds extensive applications in various industries such as food, pharmaceuticals and cosmetics. Cuttlefish skin, a major waste of cuttlefish (*Sepia pharaonis*) processing industry, though rich in collagen is typically discarded, polluting the environment. The aim of the present study is to determine the critical variables for cuttlefish skin gelatin extraction with a fractional factorial design through the Response Surface Methodology (RSM) approach using Design Expert v.12 software. Seven potential variables, pretreatment temperature, pretreatment time, concentration of NaOH, concentration of acetic acid, extraction temperature, extraction time, and skin/water ratio were investigated to identify the critical variables for cuttlefish skin gelatin extraction. In the study, yield was used as response measure. According to the 2^{7-3} fractional factorial design, 16 runs were performed for maximizing gelatin yield. The Pareto chart suggest that 4 variables, pretreatment temperature, concentration of NaOH, concentration of acetic acid, and extraction temperature, have significant effects on gelatin extraction and ANOVA model was constructed with significant level ($p<0.05$).

Keywords: Gelatin, Cuttlefish, RSM, Screening, Critical variables





Deep Continental Studies & Geodynamics



SURVIVAL OF CONTINENTS THROUGH TIME: A VIEW FROM EVOLUTION OF THE WESTERN MARGIN OF INDIA AND THE WESTERN GHATS OF KERALA, INDIA

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In this work an effort is made to synthesise geophysical signatures with the geological features over a part of Western Ghats in central Kerala to generate insights into their deep continental structure and evolution. The study area is bound by the Palghat-Cauvery lineament in the north, and the Kambam lineament in the east, both of which are of Precambrian age. In the west, the bounding West Coast fault is related to episodic Mesozoic rifting and Deccan volcanism and its precursors. The region has a bi-temporal evolution, a polyorogenic evolution in the Precambrian and a more passive evolution in the Late Mesozoic-Cenozoic. Precambrian formations of high metamorphic facies, namely charnockites and associated gneisses dominate the region. They have a Pre-Cambrian history of exhumation from lower to mid-crustal levels and accompanying retrogression to amphibolite facies. The area is dissected by significant tectonic lineaments of which the Kerala, Periyar, and Idamalayar dyke lineaments have the most prominent surface expressions. These lineaments host small swarms of late Mesozoic dykes (~ 90 to 65Ma in age) and bear witness to the Late Mesozoic continental magmatic (basaltic) events and distensional fracturing that overprinted the Pre-Cambrian continental margin. Gravity modelling along two profile over the Periyar Plateau, in the Sahayadris of central Kerala and adjoining regions has revealed that the upper layer containing exhumed lower crustal rocks is more or less homogeneous, except for variations in intracrustal layers of decharnockitised hornblendic gneisses and intrusive granite bodies. Below this layer the Moho depth of the order of 40-41 km below the Periyar plateau has a tendency to thin up to 34-35 km along the West Coast, possibly due the rifting of the West Coast during the 65 million year episode of coastal evolution synchronising with Deccan magmatism. In view of the high concentration of dykes in the high-gradient zone southwest of the Periyar lineament, the 2.85 gm/cc layer (Layer A) overlying the MOHO, could possibly be a zone of underplating with sill-like emplacement of basalts that, among other factors, may have contributed to enhancing the density of the original 2.76 gm/cc layer.

Keywords: Gravity, Crustal Structure, Periyar Plateau



CRUSTAL STRUCTURE AND TECTONIC EVOLUTION OF THE CAUVERY BASIN, EASTERN CONTINENTAL MARGIN OF INDIA: A GEOPHYSICAL REVISIT

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Cauvery basin stands out among the east coast basins of India due to its distinctive evolution, characterized by a sheared margin hosting a sedimentary sequence spanning from the Late Jurassic to the recent period. This research presents findings from a comprehensive analysis integrating gravity and magnetic (GM) data, alongside Multichannel seismic reflection, refraction, and drilled well data, serving as constraints to delineate the crustal structure and associated tectonic elements. Advanced techniques including band pass filtering of varying wavelengths and edge enhancement methodologies such as Analytical Signal and derivatives were used to differentiate structural boundaries and tectonic characteristics. The analysed gravity and magnetic anomaly map, coupled with its image enhanced map, delineated NE-SW oriented basement highs that partition the basin into alternating ridge and sub-basin areas, each forming discrete fault-bound blocks. The E-W trending basement-related features observed in the enhanced maps are interpreted as components of a shear zone extending into the offshore region. Delineating tectonic elements using different wavelength filters insights into their structural continuity at various depths. A seismically constrained 2D crustal model, derived from Gravity magnetic data, reveals that the crust beneath the southeast Indian shield margin is ~36 km thick, thinning to depths as shallow as 13–16 km in the Ocean Continent Transition (OCT) region, and increasing to 19–21 km towards the deeper oceanic regions of the basin. The faulted Moho geometry in the Cauvery basin, suggests shearing or low-angle rifting during the breakup between India–Sri Lanka and East Antarctica. The geophysical crustal model further highlights deep crustal-scale faults associated with the extended shear zone in the offshore region

Keywords: Cauvery basin, Eastern Continental Margin of India, Crustal Model, Shear Zone



CRUSTAL STRUCTURE AND TECTONIC PROCESSES IN THE KERALA-KONKAN BASIN: INSIGHTS FROM GRAVITY AND MAGNETIC DATA

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Konkan-Kerala basin situated in the southern segment of the Western Continental Margin of India (WCMI) underwent various tectonic processes during its early rift and subsequent post-rift phases. This study presents findings from an integrated analysis of gravity and magnetic (GM) data along with Multichannel seismic reflection, refraction and drilled well data as constraints to delineate the crustal structure and associated tectonic elements. The signal processing techniques, including bandpass filtering of differing wavelengths and edge enhancement methodologies such as Analytical Signal, Vertical derivative, and Tilt derivative, were applied to determine structural boundaries and tectonic characteristics. The compiled gravity and magnetic anomaly map coupled with their image enhanced map, was correlated with the geologic structure on the continent region and clearly demarcating the major tectonic features in the offshore region. The distinct delineation of tectonic elements across different bandpass filters provides insights into their structural continuity at various depths. Seismically constrained joint 2D Gravity and Magnetic modeling approach was employed to reveal crustal variations from onshore locales to the deep offshore domain and to delimit the structure of the Laccadive plateau. The derived crustal models reveal a crustal thickness of ~40 km beneath the onshore region and tapering to approximately 28 km within the Continental Shelf region, and around 25-26 km beneath the Laccadive plateau and an oceanic crust of ~6 km is observed in the Arabian basin. Moreover, the derived crustal structure highlights the presence of traps, underplating, and rift-related volcanic intrusions, all of which are characteristic features shaping the basin tectonic framework.

Keywords: Kerala-Konkan basin, Gravity and magnetic analysis, Crustal structure, Signal processing



BANDED IRON FORMATIONS FROM THE ATTAPPADI VALLEY, KERALA, SOUTHERN INDIA: IMPLICATIONS FOR THE PRECAMBRIAN ALGOMA-TYPE ORIGIN

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Banded Iron Formations (BIFs) are chemical sedimentary rocks composed of alternate bands of iron and silica-rich minerals and are formed in the Precambrian. In the geological framework of Peninsular India, Attappadi Valley (study area) in the Palakkad district of Kerala falls within the western termination of the Bhavani Shear Zone within the Southern Granulite Terrane (SGT) and preserves the Archean supra crustal complex of rocks. Metamorphosed BIF are among the significant rock types in the area, together with TTG (tonalite-trondhjemite-granodiorite) gneisses, charnockites, meta-ultramafics, amphibolites, felsic volcanics, and metapelites. BIFs in the study area occur as narrow, isolated bands in association with ultramafic rocks, and they are characterised by the presence of oxide (magnetite, hematite), silicate (grunerite, pyroxene, garnet amphibole) and sulphide facies (pyrite, chalcopyrite, arsenopyrite) minerals. The whole-rock major element data of selected samples from ten sample locations are analysed using X-ray Fluorescence (XRF) spectrometry. The samples are enriched in SiO_2 (36.8-85.8 wt.%) and Fe_2O_3 (10.6-54.6 wt.%). Since BIFs are pure chemical sediments, they have deficient levels of TiO_2 and Al_2O_3 , but the slight enrichment of Al_2O_3 (2.78 wt.%) in the sample with garnet indicates the influence of continental input in close proximity to the BIF deposition. All samples in the SiO_2 Vs Al_2O_3 plot fall within the hydrothermal field. The Fe/Ti Vs $\text{Al}/(\text{Al}+\text{Fe}+\text{Mn})$ and the ternary diagram using Fe, Al and Mn also indicate the relative contribution of hydrothermal components in the sediments. The marine environment of deposition of BIFs is evidenced by a relatively lower ratio of $\text{CaO}/(\text{CaO}+\text{MgO})$ (0.3) in the samples compared to freshwater (>0.70) as well as from the ternary plots using CaO , Na_2O , MgO and CaO , K_2O , MgO . The time of deposition of BIF is constrained as Precambrian from the ternary diagrams using SiO_2 , Al_2O_3 , Fe_2O_3 and $(\text{CaO}+\text{MgO})$, Fe, SiO_2 . From the field relations, petrography and major element geochemistry, the BIFs in the study area are considered Precambrian Algoma-type iron formations formed in a marine environment with significant input from hydrothermal sources.

Keywords: Banded Iron Formations (BIFs), Precambrian, Southern Granulite Terrane (SGT), facies, XRF, major element geochemistry, Algoma.



EVIDENCE OF LAYERED GABBRO-ANORTHOSITE COMPLEX FROM THE COORG BLOCK, SOUTHERN INDIA

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The Coorg Block, in southern India, has been recognized as one of the most ancient crustal fragments globally and has been the subject of numerous studies exploring its role in Earth's early crustal evolution and Mesoarchean plate tectonic processes. The Coorg Block is predominantly composed of arc magmatic rocks and is bordered on its northern boundary by the Mercara Suture Zone. This study reports the discovery of a dismembered layered gabbro-anorthosite complex of rocks from the northern margin of the Coorg Block. The sequence consists of layered gabbro-anorthosite and gabbroic anorthosite as felsic and mafic units. The mafic type of this sequence is composed of metagabbro, while the metaultramafic type is composed of metapyroxenite. These sequences of rocks occur either as thin conformable bands, enclaves, or as linear lensoidal bodies within the basement charnockite and TTG gneisses. The petrographic analysis of the gabbroic anorthosite reveals that it comprises plagioclase, clinopyroxene, and orthopyroxene as the major minerals, with hornblende, magnetite, and ilmenite occurring as minor minerals. The layered gabbroic anorthosite exhibits compositional layering that is observable under the microscope, with domains of anorthosite and gabbroic layers. The anorthosite layer is composed of plagioclase along with minor clinopyroxene, orthopyroxene, retrograded hornblende, opaque's, and secondary quartz. Conversely, the gabbroic layer consists of plagioclase, clinopyroxene, and orthopyroxene, with Fe-Ti oxides. The garnet-bearing metagabbro is characterized by garnet, plagioclase, clinopyroxene, and orthopyroxene as major minerals, with hornblende, ilmenite, rutile, and zircon as minor minerals. The metapyroxenite comprises orthopyroxene, clinopyroxene, retrograded hornblende, and plagioclase as major minerals, accompanied by secondary quartz and opaque's (magnetite and ilmenite). The geochemical characteristics of the gabbro-anorthosite complex of rocks exhibit subalkaline affinities, as evidenced by their plots in the sub-alkaline basalt field on the SiO₂ vs. Na₂O + K₂O (Irvine and Baragar, 1971), Zr/Ti vs. Nb/Y (Pearce, 1996), and Zr/TiO₂ vs. Nb/Y (Winchester and Floyd, 1976) diagrams. The Zr vs Nb/Zr diagram (Thieblemont and Tegey, 1994) indicates that the rocks from the gabbro-anorthosite complex have a subduction-related tectonic affinity. The rocks' arc environment is further confirmed with the help of tectonic discrimination diagrams such as the Hf-Th-Nb triangular diagram (Wood, 1980), Zr-Ti (Pearce, 1982), 10MnO-TiO₂-10P₂O₅ (Mullen, 1983), Ti (ppm) vs. V (ppm) (Shervais, 1982), and Y (ppm) vs. Cr (ppm) (Pearce and Norry, 1979). Based on these petrogenetic and geochemical data, the layered gabbro-anorthosite complex of rocks discovered from the Coorg Block represents a fractionated sequence from mafic-ultramafic to anorthosite domain end member with a subduction-related island arc affinity.

Keywords: Coorg block, Layered mafic-ultramafic complex, Geochemistry



PETROCHEMICAL STUDY OF MAFIC-ULTRAMAFIC ROCKS OF KARWAR BLOCK, SW INDIA

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The mafic-ultramafic rocks in Archean terranes are significant in understanding the geodynamic evolution of early Earth. The Western Dharwar Craton (WDC) and the Karwar Block (KB) in southern Peninsular India preserve some of the oldest records of craton building processes in the Archean Earth. The tectonic affinity of the Karwar Block that lies at the western periphery of the WDC remains uncertain. The present research work focuses on the integrated study of mafic-ultramafic rock suite from Karwar block using petrology, and whole-rock geochemistry data. The study area constitutes a part of the north-western extension of the Shimoga schist belt of the WDC. The mafic-ultramafic rock suite consists of talc-tremolite schist, metapyroxenite, metagabbro and metabasalt and these occur as deformed and dismembered units within basement granitic gneiss. The rocks in the area have undergone greenschist to lower amphibolite grade of regional metamorphism and minor hydrothermal alteration to talc-chlorite-tremolite-serpentine-magnetite assemblage. From the petrographic studies, the primary igneous minerals such as pyroxene and plagioclase show variable degrees of alteration. Unaltered domains of metapyroxenite and metagabbro preserve typical textures and their constituent mineralogy. Prominent island arc signatures are evident from the geochemical analysis. The rocks show negative Nb anomalies and prominent Pb enrichment. The uniform enrichment of Th and U over Nb- Ta indicates the influence of metasomatic fluids in the mantle wedge. The geochemical data indicate that these rocks were derived from basaltic magmas generated within a subduction metasomatised mantle wedge in an intra-oceanic arc setting without any significant crustal contamination.

Keywords: Karwar block, Mafic-ultramafic rocks, Arc magmatism



EVIDENCE OF LAYERED GABBRO-ANORTHOSITE SUITE FROM ATTAPPADI VALLEY, KERALA, SOUTHERN INDIA

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The southern boundary of the Dharwar Craton in the Peninsular region of India retains geological evidence indicative of a dynamic convergent plate boundary operational in the Neoarchean. The Attappadi region is a wide valley that slopes in a northeast-southwest direction, characterized by a broad synformal structure. This area is situated between the Nilgiri charnockite hill ranges to the north and the Vellingiri granitoid hill ranges to the south, marking the western end of the Bhavani Shear Zone. Here, we report a fragmented suite of layered gabbro-anorthosite situated along the western termination of the Bhavani shear zone in the Nilgiri block. The field relations, petrological, and geochemical data are used to understand the nature of magmatism and to elucidate the tectonic history. Attappadi Valley comprises the predominant lithologies such as layered metagabbroic anorthosite, anorthositic metagabbro, garnet-bearing metagabbroic anorthosite, garnet-bearing metagabbro, metagabbro, metapyroxenite, pyroxene granulite. The northeastern part of the study area exposes the gabbro-anorthosite suite associated with metapyroxenite, metagabbro, and pyroxene granulite. The anorthosite layer is composed of medium-grained, leucocratic and gabbroic layer is medium grained and constitutes pyroxenes graine. The mafic and ultramafics in the study area are coarse to fine-grained and talc-tremolite schist shows schistose structure due to intense deformation. The petrographic features of the layered gabbro-anorthosite reveal the layered structure and the major felsic as well as mafic minerals assemblages. Based on the major oxides and trace diagrams, the mafic and ultramafic lithologies show moderate chemical variations. In the Harker variation diagram, Al₂O₃, Fe₂O₃, and TiO₂ show negative coordination with silica, and high MgO and Mg# (75-90) attest to their ultramafic origin. The study area represents low-K, tholeiitic rocks formed in a high magnesian-rich parental melt. Specifically, the analysis reveals an enrichment of large ion-lithophile elements coupled with a concomitant depletion of high field-strength elements, and these geochemical interpretations suggest the magmatism to a subduction zone setting, marked by distinct arc-related characteristics. Integration of the results from the petrography and geochemical data suggests that the gabbro-anorthosite suite and the mafic-ultramafic lithologies of the Attappadi Valley are arc magmatic rocks formed in a subduction-related setting.

Keywords: Layered gabbro-anorthosite, Petrography, Geochemistry, subduction tectonics



UNDERSTANDING THE VARIATION OF CRUSTAL STRUCTURE ALONG 85° EAST RIDGE: AN INTEGRATED GEOPHYSICAL STUDY

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The 85°E Ridge, considered as 3000 km long continuous feature starting from the Mahanadhi Basin in the north and extending upto Afanasy-Nikitin Seamount in the south. Geophysical analysis of this ridge has been conducted using various data sets including satellite-derived gravity and magnetic anomaly grids, GEBCO bathymetry grids, as well as multichannel seismic reflection and refraction profiles. This study reveals that the 85°E Ridge exhibits significant segmentation along its length, with distinct structural, physical, and genetic characteristics observed in different segments. The seismic profiles illustrate that the northern segment is covered by thick Bay of Bengal sediments, which gradually decrease towards the southern end. Additionally, evidence of faulted basement is observed in the north, while the southern region displays a deformed crust. Crustal models derived from gravity and magnetic data, constrained by seismic information, depict a three-layered crust in the northern and middle segments, with thick volcanic layers in the upper crust. This indicates that the ridge is predominantly volcanic in nature. On the contrary, the southern segment lacks any distinct ridge structure and instead shows evidence of highly deformed oceanic crust. The formation of the 85°E Ridge is believed to be influenced by various processes, including hotspot volcanism in the north, magmatism associated with leaky transform faults in the middle segment, and compression-induced deformation in the south. This study underscores the complex interplay of tectonic and magmatic processes in shaping the structure of the 85°E Ridge, providing a basis for further investigations into this intriguing geological phenomenon.

Keywords: 85°E Ridge, Bay of Bengal, Afanasy-Nikitin Seamount, Crustal Structure, Hotspot volcanism, Leaky fracture zones



PETROGRAPHIC AND FLUID INCUSION STUDIES IN HIGH GRADE METAMORPHIC ROCKS OF COORG AND MERCARA SUTURE ZONE, SOUTHERN GRANULITE TERRAIN, SOUTH INDIA

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The Southern granulite terrain (SGT) is one of the classical granulite terrain in the world which is famous for mosaic of distinct high grade metamorphic blocks and is situated in the southern tip of peninsular India below the Archean Dharwar craton. The SGT is regionally categorized into several distinct tectonic blocks dissected by crustal scale shear/suture zones. Among this, the Coorg block is one of the oldest crustal blocks and is renowned for its Mesoarchean magmatic rocks. The present study relies on field investigation, petrography and fluid inclusion analyses of high grade metamorphic rocks collected from different localities in and around Coorg block and Mercara suture zone. Field investigation and petrographic studies reveals the high pressure and medium grade temperature of metamorphism along the Mercara suture zone and Coorg block. Furthermore, microthermometric studies reveals the presence of primary, secondary and pseudo secondary type inclusions which is identified as CO₂ type fluid having moderate to high density, indirectly indicating the dry nature and peak grade of metamorphism occur along the Coorg and Mercara suture zone.

Keywords: SGT, Coorg block, Fluid Inclusion, Mercara suture zone



Coupled Ocean Atmospheric Modelling



OBSERVATIONAL AND MODELLING STUDY OF THE MID TROPOSPHERIC DYNAMICS OF A SUPERCELL TORNADIC THUNDERSTORM OVER INDIAN REGION

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The severe tornadic thunderstorm event occurred over Indian region (over Odisha on 31 March 2009) is simulated using the Weather Research Forecast (WRF) model. The dynamical changes occurring in the atmosphere especially mid troposphere prior and during the event is well simulated with a horizontal resolution of 1 km. The simulated output fields such as reflectivity, vertical velocity, vorticity etc are analysed to understand the structure and evolution of the storm and the results could clearly depict the spatial distribution and temporal evolution of clouds. The presence of a strong updraft with a vertical velocity of 30 m/s and a strong vorticity of 0.01 s^{-1} in the mid-upper troposphere shows the existence of a meso-cyclone which characterizes the supercell formation. This study could identify and analyze many interesting features such as huge single updraft, double vortex circulation, mesocyclone formation, cell splitting and secondary cell formation in the mid troposphere. A highly active layer of the troposphere extending from 6 – 12 km before the occurrence of the severe weather event and the co-existence of a very high positive vertical vorticity of 0.01 s^{-1} and a negative vertical vorticity of the same magnitude one hour ahead of the occurrence of the severe weather event are also identified. The study could reveal that the mid troposphere and upper troposphere is showing significant dynamical changes a few hours ahead of the event. Hence a close monitoring of the upper and mid tropospheric dynamics can provide valuable information for better understanding of deep convective systems over the Indian region especially for further research in the field of cloud microphysics and also useful for the nowcasting of severe convective weather events. However numerical simulation of more events over Indian region with very high horizontal resolution are required to generalize the structure and evolution of supercell storms.

Keywords: Deep Convection, Numerical Modelling, Mesocyclone Formation, Mid-Tropospheric dynamics.



ASSESSMENT OF NITROGEN DYNAMICS AND PRODUCTION REGIMES IN THE NORTH INDIAN OCEAN: A COUPLED MODELING PERSPECTIVE

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Nitrogen dynamics are essential for nutrient cycling, net primary productivity (NPP), and the health and sustenance of marine organisms in North Indian Ocean (NIO). Nitrate is the key component of nitrogen cycling, which limits phytoplankton growth. Here, we use a coupled ocean-biophysical atmosphere model to comprehend the nitrate dynamics across some biologically active regimes in NIO from 2013 to 2020, which is the first attempt in this region. The coupled model reproduces the nitrate up to 100 m with a good correlation of 0.91 in the Arabian Sea (AS) and 0.95 in the Bay of Bengal (BoB). The coupled model is then used to study the key processes that contribute to the nitrogen budget and primary productivity in the selected upwelling regions in NIO. The selected regions are the Oman Coast, Northern AS, West Coast of India, South of Sri Lanka, Sri Lanka Dome and East Coast of India. We compute the nitrogen budget averaged in the mixed layer for these regions. Vertical advection is dominant in most upwelling regions, except in the Sri Lanka Dome, where horizontal advection is positive. The positive value of horizontal advection helps to maintain colder temperatures during monsoon season. The entrainment plays a major role in nitrogen budget in upwelling regions. Uptake by phytoplankton is the dominant biological process in all regions, except in northern AS, where denitrification is the major biological process. New production contributes to NPP in most upwelling regions, except in the northern AS and Sri Lanka Dome, where regenerated production is higher than the new production. This is in accordance with the dominance of denitrification in the northern AS. We computed the f-ratio in these regions and speculate that most upwelling regimes are dominated by new production.

Keywords: Coupled Model, NIO, Nitrogen Budget, NPP



COMPARATIVE ANALYSIS OF OCEAN SURFACE pCO₂ IN THE CENTRAL BAY OF BENGAL: COUPLED MODEL VERSUS MACHINE LEARNING APPROACHES

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As anthropogenic activities contribute to rising atmospheric CO₂ levels, the oceans absorb more CO₂. It results in the weakening of oceanic carbon sinks as the capacity of the oceans to sequester carbon diminishes. Consequently, this trend poses significant risks to marine ecosystems, as elevated CO₂ levels contribute to ocean acidification that negatively impacts marine life. Here, we set up a coupled atmosphere-ocean-biogeochemistry model that simulates ocean carbon chemistry for North Indian Ocean (NIO). In addition, we use the Random Forest Regression Ensemble (RFRE), a machine learning algorithm, to model the ocean surface pCO₂ in NIO with satellite and reanalysis datasets. The RFRE model is trained with SOCAT data in NIO. Two experiments are designed with RFRE. They are 1. RFRE_SAT: RFRE model with satellite/reanalysis data to predict ocean surface pCO₂ at central BoB and 2. RFRE_BOBOA: RFRE model with BOBOA data to predict ocean surface pCO₂. We compare the coupled model simulated ocean surface pCO₂ and the RFRE pCO₂ in the central Bay of Bengal (BoB), where the BoB Ocean Acidification (BOBOA), a RAMA buoy, is located. BOBOA measures ocean surface pCO₂ at three hourly intervals from 2013 to 2018, with a data gap in 2015. We assess whether the coupled model at a 25 km horizontal resolution and the RFRE model can capture the variability of pCO₂ at the central BoB. We find that the coupled model captures the pCO₂ variability at central BoB with a mean bias of $25.19 \pm 16.54 \mu\text{atm}$. RFRE_SAT has a mean bias of $31.28 \pm 15.89 \mu\text{atm}$, and RFRE_BOBOA has a mean bias of $21.21 \pm 19.6 \mu\text{atm}$. A more detailed analysis of the efficiency of the models will be presented in detail.

Keywords: Coupled model, Ocean surface pCO₂, NIO, RFRE



IDENTIFYING EXTREME SOUTH WEST MONSOON PRECIPITATION CIRCULATION PATTERNS USING CONVOLUTIONAL NEURAL NETWORKS

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Extreme monsoon rainfall events and subsequent flooding pose a major environmental threat in South Asia, particularly in India. This study explores the potential of convolutional neural networks (CNNs) to identify and analyze the atmospheric circulation patterns associated with extreme precipitation during Indian summer monsoon, and its evolution under a warming climate. Our research focuses on six homogeneous precipitation regions across India. We used daily atmospheric data (mean sea level pressure, geopotential height (500 and 850hPa), and vertical velocity) from the NCEP/NCAR Reanalysis dataset to identify the circulation patterns using the CNN. Indian Meteorological Department daily precipitation data is used for model training, where days with precipitation over 95th percentile value for each homogeneous region are considered as extreme precipitation days. The CNN classifies days with and without extreme precipitation events as extreme precipitation circulation pattern days (EPCPs) and non-EPCP days respectively. The trained CNN achieves high skill in identifying EPCP days with recall scores exceeding 80% for all regions and variable combinations. Composites of EPCP days reveals a consistent signature: anomalous negative sea level pressure patterns associated with anomalous westerly wind at 850hPa, which shifts relative to the homogeneous regions selected. These patterns, in turn, strengthen the low-level jet stream (LLJ), enhancing moisture transport and leading to increased precipitation over the respective regions. Conversely, the CNN detects no such anomalous patterns during non-EPCP days. Further analysis suggests increasing frequency of EPCP days across the homogeneous regions over the past two decades, with the exception for Himalayan and North West regions. However, the intensity of precipitation during these events doesn't exhibit a significant upward trend. The study highlights the potential of CNNs as a powerful tool for gaining insights into the physical mechanisms driving changes in extreme monsoon circulation patterns.

Keywords: Rainfall extremes in India, Machine learning and extreme precipitation, Summer monsoon Extreme precipitation circulation patterns, Summer, SLP anomalies, and Extreme circulation patterns





Air – Sea Interactions



DYNAMICAL ASPECTS OF HEAVY RAINFALL EVENTS OVER SOUTHERN PENINSULAR INDIA DURING NORTHEAST MONSOON SEASON AND ITS ASSOCIATION WITH INDIAN OCEAN WARMING AND MADDEN JULIAN OSCILLATION

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Southeastern Peninsular India witnessed heavy rainfall events (HRE) during the recent El Nino year 2015 and La Nina year 2021 in November and early December. Both these events were associated with enhanced easterly wave activity and active MJO over the Maritime continent. The MJO was on the fourth (MJO-4) phase for 15 and 17 days in Nov 2015 and Nov 2021 respectively. A weakening in the positive correlation between El Nino and Northeast monsoon rainfall and a strengthening of the positive correlation between the MJO-4 and HRE have also been observed in very recent years. This study revealed that the unequal changes in sea surface temperature i.e., warming over the eastern Indian Ocean and cooling over the western Pacific Ocean can be a crucial factor for the increased occurrence of MJO-4 and HRE over southern peninsular India. The easterly wind anomalies towards southern BoB and southeastern Peninsular India and westerly wind anomalies over the central equatorial Indian Ocean is significantly correlated with HRE in the recent epoch. Warming in eastern IO brings easterlies from the cool western Pacific and westerlies from the western IO, which helps the MJO to remain active over the maritime continent and inhibit its further eastward propagation. It is also observed that the heavy rainfall events are now associated with the low-pressure system and cyclonic circulation over southern Peninsular India, which brings moisture from the Arabian Sea towards peninsular India. At the same time, the HRE in the early epoch were related with BoB anticyclonic circulation and moisture transport from the BoB and the southeastern Indian Ocean. A proposed mechanism for the HRE in the recent epoch is as follows. The SST gradient in the Indo-Pacific Ocean is conducive for the moistening of MJO-4 centre. It is favourable for the enhanced easterly wave activity and the formation of low-pressure systems, which get strengthened while moving towards southern peninsular India due to the presence of strong equatorial westerlies over the Indian Ocean. Strong ascending wind anomalies over southern Peninsular India and strong descending anomalies over the Central Indian Ocean, which are associated with the strengthened low-pressure systems produce heavy rainfall events over southern Peninsular India.

Keywords: Northeast Monsoon, Heavy rainfall events, Easterly waves, MJO



EFFECT OF ATMOSPHERIC HEAT-FLUX IN THE NORTHERN ARABIAN SEA SURFACE CHLOROPHYLL BLOOM

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The spring phytoplankton bloom is a seasonal characteristic of temperate and subpolar waters. The Arabian Sea, a tropical basin, also hosts a winter-spring bloom. This study explores the applicability of the convection shutdown hypothesis, previously successful in identifying spring bloom initiations in subpolar and midlatitudes, to the Arabian Sea. For this we utilize chlorophyll data from ESA Ocean Color Climate Change Initiative (ESA-OCCI) merged satellite products spanning the past two decades (1998 to 2022) and heat flux data from ERA5 reanalysis. Our findings suggest that the rapid Schl growth coincides with the transition from atmospheric cooling to atmospheric heating. The results provide enhanced insights into the dynamics of surface blooms in the northern Arabian Sea, a region having sparse insitu MLD data.

Keywords: Surface Chlorophyll, Winter Chlorophyll bloom, Arabian Sea, Surface heat flux, Mixed Layer Depth, Wind Speed



ANALYSIS OF LIGHTNING ACTIVITY OVER KERALA AND ITS RELATIONSHIP WITH THERMODYNAMIC PARAMETERS

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The study primarily investigates the relationship between lightning activity and meteorological factors in the active lightning state of India, Kerala. Based on the climatological analysis lightning activity over the region, it is revealed that the active lightning period predominantly occurs in April, during the pre-monsoon season. Consequently, the study focuses on analyzing the meteorological factors during this specific season. The analysis explores the influence of Convective Available Potential Energy (CAPE), Sea Surface Temperature (SST), wind vectors at 10 m, Specific Humidity (q) and vertical velocity (ω) on lightning activity. The diurnal climatology of lightning activity is uncovered, with a distinct peak at 3 PM local time, attributed to the presence of thunderclouds formed during the morning hours. The study establishes a clear link between CAPE, SST, and lightning activity, particularly during the pre-monsoon season, as revealed by the spatial, trend and correlation analysis. Vertical velocity at 500 hPa indicates the highest atmospheric instability in active lightning regions within the state of Kerala. The study indicates a connection between temperature anomalies and lightning activity, notably observed in the year 2010. This underscores the correlation between temperature variations and changes in lightning frequency over time. The present study enhances the influence of the meteorological parameters, including CAPE, vertical velocity, SST and atmospheric instability on the lightning activity in Kerala.

Keywords: Lightning activity, Sea Surface Temperature, Specific Humidity, Vertical velocity



REANALYSIS OF LONG-TERM VARIATIONS IN THE FREQUENCY OF NORTH INDIAN OCEAN STORMS USING TRACKING ALGORITHMS

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Low-pressure systems (LPS) like tropical cyclones (TC) and monsoon depressions (MD) in the North Indian Ocean (NIO) region contribute significantly to extreme precipitation events and catastrophic floods in India. This study aims to investigate the long-term variations in LPS activity and associated environmental factors in NIO from reanalysis datasets such as ERA5 (1940 to 2022) and the 20th Century Reanalysis (20CR; 1880 to 2015) using tracking algorithms. We employed algorithms by Zarzycki and Ullrich (2017; UZ) and Tory et al. (2013; OWZ) to track the TCs and an objective algorithm by Vishnu et al. (2020) to track the MDs. The long-term changes in frequencies of TCs are analysed for the two prominent seasons: pre-monsoon (AM) and post-monsoon season (OND). The results show that the OWZ and UZ tracking algorithms performed well, with a 75% and 76% probability of detection (POD) for tracking TC, respectively, compared to the IBTrACS dataset. They also showed reasonable agreement in TC genesis and track distribution relative to IBTrACS, instilling confidence for long-term analysis. Long-term trends in the frequency of TCs in NIO are not significant in reanalysis datasets. However, prominent variability is observed in decadal scales with a long-term oscillation with periods of relatively high (from 1965 to 1975 and 2005 to 2015) and low (from 1945 to 1955 and 1985 to 1995) frequency in TC genesis. Analysis of the role of environmental factors using a Genesis Potential Index shows that the long-term changes in maximum potential intensity and relative humidity could have contributed to the observed long-term changes in TC activity over NIO. For MDs, the tracked datasets show no significant trends in frequency from the period 1940 to 2022 where ERA5 data is available.

Keywords: Tropical Cyclones, Tracking Algorithms, Tropical Cyclone reanalysis, Multidecadal Variability



VARIABILITY OF INLAND PRECIPITATION MICROPHYSICS OVER SOUTHERN PENINSULAR INDIA DURING TROPICAL CYCLONE

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The present study examines the microphysical characteristics of precipitation induced by tropical cyclones over the inland locations of southern peninsular India with observations from two coastal locations, one mid-land and an elevated location. A total of 12 cyclones formed over the North Indian Ocean for the period of 2017-2022 are considered in this study. Maximum rainfall in each station during the cyclones are received from the outer rainbands (approx. >200km) especially in the pre-monsoon season. The cyclone 'Nisarga' generated a peak rainfall of 86.91 mm at coastal location in the pre-monsoon whereas cyclone Ockhi is registered with 173.89 mm at a mid-land station in the post-monsoon season. It is observed that pre-monsoon cyclones produce roughly 3% more severe rainfall than post-monsoon cyclones in a shorter period. Distinct features are observed for raindrop size distribution in diurnal scale between coastal and elevated observations. Results suggest that stratiform fraction dominates the convective rain with large mean diameter (D_m) and relatively small drop concentration (N_w) during the peak hours of cyclonic rainfall over the elevated terrains of southern peninsula. Also, the relationship between rain integral parameters is distinct between seasons and locations due to differences in thermodynamic and microphysical processes. Quantifying and analysing the rainfall events during an extreme weather event like a tropical cyclone is crucial for representing the microphysical processes in mesoscale models and also for quantitative precipitation estimation (QPE).

Keywords: Tropical Cyclone, Precipitation microphysics, North Indian Ocean



HEATWAVE TRENDS AND IMPACTS IN INDIA: A STUDY OF PRE-MONSOON SEASONS (1981–2022) AND RECENT TRENDS (2018–2022)

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Globally, there has been an increase in the frequency and severity of extreme heat events attributed to human emissions. India falls in tropical and subtropical zones and receives plenty of sunshine throughout the year. India has a distinct summer season which is followed by monsoon season. Since the middle of the 20th century, India has experienced an increase in the features of HW, which have had several adverse impacts on the health, ecosystem, and economy. Our research aimed to evaluate monthly arithmetic mean (AM), standard deviation (SD), and causes of HW along with long-term trends of temperature for the pre-monsoon (March–May) season during 1981–2022. Recent studies show that the air temperature has increased in recent years in the Indian region, so our analysis was conducted for the recent five years (2018–2022). HW events were determined using revised criteria given by the India Meteorological Department (IMD) using hourly gridded 2m maximum temperature data at $0.25^\circ \times 0.25^\circ$ resolution from European Centre for Medium-Range Weather Forecasts (ECMWF)-ERA5- global atmospheric reanalysis. The trend analysis shows that the temperature is increasing in the pre-monsoon months. High-soil-temperature regions coincide with the high-temperature regions, which indicates local radiative heating and thereby causes the development of HW.

Keywords: Heatwaves, Climate Change, Temperature Trend





Regional Climate Modelling



SENSITIVITY OF A HEATWAVE EVENT TO INITIAL SOIL MOISTURE CONDITIONS

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Soil moisture is an essential parameter in numerical weather prediction models because it plays a significant role in the exchange of water and energy fluxes between the atmosphere and the land surface. Hence, proper initialization of soil moisture is crucial for simulating extreme temperature events like heatwaves and droughts in a numerical model. Even though large scale dynamics of heat wave drivers over India are studied in detail, there has been a lack of studies relating soil moisture influence on heatwave events. In this study, we utilize the WRF model to explore the impact of different initial soil moisture conditions on the modulation of an extreme heatwave event in 2009. Various initial conditions are generated by modifying actual soil moisture conditions. We investigate the sensitivity of soil moisture to the maximum temperature, spatial extent, and duration of the heatwave event. Additionally, we conduct a comprehensive analysis of the changes in surface fluxes and radiation fluxes. When comparing observed temperatures with those from the control simulation, we find that the WRF could faithfully reproduce the heatwave event. Our results indicate that the maximum temperature decreases as the soil moisture increases and vice versa. The spatial extent of heatwave is seen to be reduced in wetting experiments. Modifying soil moisture levels has a nonlinear effect on temperature, with wetting experiments showing more remarkable temperature changes than drying experiments. Furthermore, wetting the land surface results in an increase in latent heat flux and a decrease in sensible heat flux.

Keywords: Soil moisture, WRF, Heat wave



Monsoon Prediction & Predictability



RECONSTRUCTION OF INDIAN SUMMER MONSOON RAINFALL FOR THE LAST ~200 YEARS USING SPATIALLY DISTRIBUTED TREE RING

$\delta^{18}\text{O}$ NETWORK

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Tree ring cellulose $\delta^{18}\text{O}$ ($\delta^{18}\text{O}_c$) has been considered as a powerful tool for reconstructing past hydroclimates over various parts of the world. However, the climate parameters that drive $\delta^{18}\text{O}_c$ have shown considerable variation, depending on the geographical location and climate regime. Additionally, the $\delta^{18}\text{O}_c$ dataset is very limited in India, hindering a robust reconstruction of the Indian Summer Monsoon Rainfall (ISMR). Recently, there have been global efforts utilizing the large-scale isotopic patterns associated with various modes of climate variability to reconstruct their variability in the past using a network of $\delta^{18}\text{O}$ -based proxies. The Iso2k project part of the PAGES 2k Network, offers a vital tool for studying hydroclimate variability over the past 2000 years. This study utilizes the Iso2k database, a comprehensive collection of global paleo- $\delta^{18}\text{O}$ data spanning the Common Era, to conduct a multilinear regression analysis to reconstruct the ISMR. Leveraging the Iso2k project $\delta^{18}\text{O}$ data from 16 tree ring records sourced from the Himalayan and Chinese regions, we constructed a multi-linear regression model for the Indian Summer Monsoon Rainfall (ISMR) with period 1901 to 1988 as the training period for the model. The model shows good skill ($r = 0.73$) in reproducing observed ISMR. To check whether this predictability is coming from the ENSO-driven circulation/hydroclimate changes in the area, we again constructed a similar model with a target variable as ENSO variability removed ISMR (i.e., the residual of observed ISMR-Niño 3.4 regression). This model yielded a correlation coefficient of 0.65 between observation and prediction. This suggests that the $\delta^{18}\text{O}$ -based model effectively captures variability in observed ISMR data even after accounting for ENSO influences. The study plans to employ an extended $\delta^{18}\text{O}$ dataset to broaden the historical scope of our analysis, allowing for a more detailed investigation into the distinct drought and wet phases of the monsoon. Our study highlights the usefulness of a network of $\delta^{18}\text{O}_c$ spread across the Asian region in reconstructing ISMR variability and points out the necessity of generating more tree ring $\delta^{18}\text{O}_c$ in this region.

Keywords: Iso2k, $\delta^{18}\text{O}$, Rainfall reconstruction.



AN ASSESSMENT OF EXTREME PRECIPITATION EVENT OVER SOUTHERN WESTERN GHATS BASED ON IN-SITU OBSERVATIONS AND HIGH-RESOLUTION MODEL SIMULATIONS

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The study investigates the characteristics of an extremely heavy rainfall event that occurred during 06-10th August 2019 in Rajamallay Munnar, Southern Western Ghats region. An accumulated rainfall exceeding 50 mm/hour on 8th August 2019 caused extensive damage and flooding in the town. Heavy rainfall was associated with a depression formed in the Bay of Bengal during the southwest monsoon period. High-resolution cloud permitting simulations were performed with ERA-Interim data as initial and boundary conditions. Microphysical features explain that suggest that the extreme heavy rainfall is initiated as warm rain processes and narrow spectrum to a wider spectrum specially at the near surface level. But both the simulations show the deficiency in capturing the radar reflectivity and cloud base height at the base station of Rajamallay. The surface layers were saturated and prevailing south-westerly winds with an enhanced LLJ supplied moisture, which was conducive for the heavy rainfall event at Rajamallay area. Vertical profiles of reflectivity are found to be consistent with the rainfall, supporting the extent of the low-level jet stream and surface humidity conditions. Model simulated rainfall was compared against the observations made at three locations around 20 km apart. Overall performance of the simulation using ERA-Interim was closer with the observed rainfall compared with the simulation using ERA5 but shows limitations in simulating time evolution of precipitation rates.

Keywords: *Western Ghats, Kerala Flood 2019, Extreme Precipitation*



CHARACTERISTICS OF MESOSCALE CONVECTIVE SYSTEM OVER THE SOUTHWEST COAST DURING HEAVY RAINFALL EVENTS FROM HIGH-RESOLUTION SATELLITE OBSERVATIONS

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A mesoscale convective system, a collection of thunderstorms, accounts for the majority of rainfall over the tropics and can cause extreme heavy rainfall events. The modeling MCS is highly challenging, and the weather forecasting models have limitations in resolving MCS, even if they were to simulate in their highest possible horizontal resolutions (1 or 2 km). Alternatively, satellite measurements can be ideally used to track mesoscale convective systems and their temporal evolution. This study investigates the characteristics of Mesoscale Convective Systems (MCSs) for the heavy rainfall events observed over the southwest coast of India during the summer monsoon period 2018-2022. The study identifies nine high-impact weather events during this period using Indian meteorological department rainfall datasets. The MCS are tracked for these events from high temporal (15min) and spatial resolution (3 km) Meteosat SEVIRI geostationary satellite images. The MCSs are detected from the infrared window channel brightness temperature. MCS's spatial and temporal evolution are studied, and their relationship with extreme rainfall is explored. Out of nine heavy rainfall events during 2018-2022, the MCS characteristics for the years 2018 and 2019 stand out as unique. The MCSs for these years show an area of about 10^{13} - 10^{14} km 2 . Compared to 2018, the extreme rainfall events of 2019 were particularly notable, with the clustering of MCSs and an area of around 10^{14} km 2 . The observations indicate that MCSs persisted for several hours over the southwest coast and inland in 2018 and 2019, producing torrential rainfall. This study underscores the relevance of monitoring extreme weather events like the one in this study through satellite imagery over the southwest coast.

Keywords: Extreme rainfall, Mesoscale Convective Systems, Monsoon



PLANETARY BOUNDARY LAYER CHARACTERISTICS AND ITS ASSOCIATION WITH MONSOON RAINFALL OVER HIMACHAL PRADESH USING REGIONAL REANALYSIS DATA IMDAA

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The lowest layer of atmosphere also known as Planetary Boundary Layer (PBL) has direct contact with the earth surface and which have influence on other meteorological phenomena. PBL characteristics over mountainous terrain of Himachal Pradesh has less explored. Current study aims to understand the PBL characteristics over Himachal Pradesh during monsoon season and its association with observed rainfall pattern using high resolution regional reanalysis data IMDAA having a spatial resolution of 12 km for the period 1989 to 2020. Study analyzed the seasonal and monthly climatology of PBLH and Rainfall for monsoon season. Correlation has been estimated between the PBLH and Rainfall using Pearson correlation coefficient at 5 % significance level. Study further analyzed the diurnal pattern of both variables averaged over the entire state as well as over few locations. Using wind rose diagrams effect of cross-valley circulations has been analyzed over few of those locations. A low PBL height has been observed over the foothill regions of Himachal Pradesh during monsoon season. PBL height is found to be lowest during the active monsoon months. PBLH exhibits a negative correlation with rainfall which is significant at 5% significance level over foothills region of Himachal Pradesh. Night-time winds over majority of locations are North-westerly and daytime winds are mostly south westerlies which gives some evidence about the effect of cross-valley circulations over the observed patterns of PBLH and Rainfall.

Keywords: Planetary boundary layer, IMDAA, Pearson Correlation coefficient, cross-valley circulations, Foothills



ANOMALOUS RAINFALL EVENT DURING 8 TO 10 JULY 2023 OVER HIMACHAL PRADESH

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The Indian summer monsoon, a complex interplay of atmospheric and oceanic factors, brings both relief and challenges to the diverse landscape of the subcontinent. In recent years, there has been a noticeable trend towards extreme rainfall events during this crucial period, presenting a formidable challenge to infrastructure, agriculture, and disaster management systems. The summer monsoon of 2023 witnessed catastrophic rainfall occurrences across various regions of Himachal Pradesh, prompting this study to examine the characteristics of the anomalous precipitation observed from July 8 to 10, 2023. Utilizing half-hourly GPM_IMERG data with a resolution of $0.1 \times 0.1^\circ$ and ERA-5 data at a resolution of $0.25 \times 0.25^\circ$, we investigated the rainfall patterns and synoptic conditions associated with this event. Himachal Pradesh predominantly consists of elevated terrains, with most regions situated at altitudes surpassing 2000 m, amidst the foothills of the Himalayas. This diverse topography significantly influences the distribution of rainfall across the region. Typically, low-lying valley regions and upslope areas receive the highest rainfall, but during this extreme event, precipitation extended to higher elevations than usual. Many regions exhibited rainfall anomalies exceeding 150 mm/day during this period. A robust moisture transport from the Arabian Sea towards the Himalayan highlands, coupled with strong lower-level convergence, cyclonic vorticity, and ascending motion, created favourable conditions for cloud formation and heavy rainfall. Prolonged periods of rainfall exceeding 20 mm/h were observed in numerous areas, along with mini-cloud burst events producing 50 to 100 mm of rainfall within consecutive hours. Moreover, a notable increase in rainfall over these regions has been observed in the past five years (2019-2023) compared to the early 2000s (2000-2004), likely attributable to climate change.

Keywords: Indian summer monsoon, Himachal Pradesh, Extreme rainfall



ANALYSIS OF RAINFALL VARIABILITY IN THE CHALIYAR RIVER BASIN: A STATISTICAL PERSPECTIVE

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The Chaliyar river basin, a crucial ecological and agricultural region, experiences diverse rainfall patterns vital for regional water management and ecosystem sustainability. This study presents a comprehensive analysis of rainfall variability within the basin using data spanning from January 2000 to March 2024. The inclusion of 275 watersheds significantly enhances spatial resolution, allowing for a more detailed analysis of rainfall variability. The study utilized the monthly rainfall dataset obtained from the Kerala Water Resource Information System. Three key datasets are utilized: normal rainfall (mm), actual rainfall (mm), and deviation from normal rainfall (%) for the present study. Statistical analysis reveals insights into the temporal and spatial distribution of rainfall variability across the Chaliyar river basin. Mean normal rainfall of 581081mm and mean actual rainfall of 34552mm are calculated to provide average precipitation values for the study period. Additionally, the mean deviation from normal rainfall is -23557.076mm. The watersheds of Chaliyar river basin is showing a negative deviation, indicating that on an average, the actual rainfall in the Chaliyar river basin is lower than the normal rainfall for the given period. This negative deviation suggests that the basin, as a whole, is experiencing below-average rainfall compared to what is typically expected. The findings of this study contribute to a deeper understanding of rainfall dynamics within the Chaliyar river basin, facilitating informed decision-making in water resource management, agricultural planning, and environmental conservation efforts.

Keywords: Chaliyar river basin, Rainfall Variability, Deviation



THE PRE-MONSOON RAINFALL VARIABILITY OVER INDIA IN ASSOCIATION WITH ENSO AND MJO

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Pre monsoon Rainfall in India is of paramount importance. Its accurate prediction helps the authorities to plan water management and crop cultivation over different regions. This study explores the interannual and intraseasonal variability of pre monsoon rainfall over different regions of India in association with El Nino southern Oscillation and Madden Julian Oscillation. An increase in pre monsoon rainfall over southern Peninsular India and some parts of northeast India is observed in the recent years. Preliminary analysis reveals that El Nino (La Nina) favours (weakens) the pre monsoon activity over Northeast India while it weakens (strengthens) the pre monsoon activity over Peninsular India in the recent decades. The intraseasonal variability of pre monsoon rainfall is found to be modulated by Madden Julian Oscillation. The analysis is carried out in the early (1981-2000) and recent (2001-2021) epochs. Northeastern part of India receives above (below) normal rainfall in the 4th phase of MJO in the recent (early) epoch. While in the 6th phase of MJO, Northeastern part of India receives below (above) normal rainfall in the recent (early) epoch. Third and fourth MJO phases favours the rainfall formation over the Southern Peninsula in general, but its effect has become much more evident in recent years.

Keywords: MJO, El Nino, Pre monsoon, La Nina



NONLINEAR ANALYSIS OF REGIONAL RAINFALL IN INDIA

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Understanding the variability of regional rainfall patterns is crucial in the context of climate change. This study focuses on analyzing the historical rainfall patterns of Bangalore and Mangalore, two key regions in India. Rainfall data are downloaded from <https://www.imdpune.gov.in/cmpg/Griddata/Rainfall1NetCDF.html> (dated 20.07.2023). It is high spatial resolution daily rainfall data of 122 years starting from 1901 to 2022 over India. Initially, the raw daily rainfall data for Bangalore and Mangalore are transformed into monthly datasets to facilitate a comprehensive examination of the long-term trends and fluctuations. Phase space reconstruction is a popular method to explore the underlying dynamics that a time series exhibit. Singular Spectral Analysis is used to reconstruct the phase space portraits of the rainfall data of Bangalore and Mangalore. The findings reveal notable changes in the characteristics of rainfall patterns in both Bangalore and Mangalore regions, particularly in recent years. Linear autoregression techniques prove inadequate in modeling the rainfall data for the latter decades, in contrast to their suitability for earlier periods. This divergence suggests a potential consequence of climate change, wherein the dynamics of rainfall in these regions have evolved over time. The implications of these findings extend beyond mere observation, offering valuable insights for improving regional rainfall prediction models. This study underscores the importance of ongoing monitoring and analysis of regional climate data to inform effective adaptation strategies in the face of climate change uncertainty.

Keywords: Rainfall patterns, phase space portraits, climate change, prediction, notable changes





Ocean Observation System



COMPARISON AND VALIDATION OF Chl-*a* IN THE SURFACE WATERS ALONG THE OFF-KOCHI TRANSECT IN THE SOUTH EASTERN ARABIAN SEA USING OCM-3 DATA

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Satellite-based observations of ocean colour are indispensable for understanding the dynamics of ocean productivity, with Chlorophyll-*a* (Chl-*a*) serving as a crucial marker. This research endeavors to validate Chl-*a* data obtained from the Indian EOS-06 mission Oceansat-3 OCM-3 sensor by comparing it with ground truth measurements collected from 34 stations across Kochi and Calicut over a three-month period during November 2023 to January 2024. These stations were systematically positioned at various depths, ranging from 10m to 40m, to capture a comprehensive profile of Chl-*a* distribution. The study employs OCM-3 Chl-*a* satellite data (referred to as L2C data Geophysical product), sourced from the ISRO-NRSC Bhoonidhi portal and processed using SeaDAS software. In-situ measurements unveiled a spectrum of chlorophyll-*a* concentrations ranging from 0.38 to 2.47 mg/m³, while corresponding values derived from OCM-3 satellite data ranged from 0.48 to 3.06 mg/m³. A comparative analysis of Chl-*a* concentrations from both in-situ and OCM-3 datasets, conducted across 20 concurrent and synchronous satellite pass samples, yielded an R² value of 0.838, indicative of a significant correlation. Despite the promising alignment between the datasets, the study underscores the necessity for further refinement of OCM-3 chlorophyll retrieval algorithms, particularly in the South Eastern Arabian Sea region. It advocates for additional testing using extensive in-situ datasets in this locale to strengthen the accuracy of regional algorithms, thereby enhancing the efficacy of chlorophyll measurements for monitoring ocean health in this area.

Keywords: Chlorophyll-*a*, Bhoonidhi, SeaDAS, Ocean Color Monitor-3, Validation, South Eastern Arabian Sea



HIGH RESOLUTION GLOBAL OCEAN REANALYSIS EVALUATION FOR THE INDIAN OCEAN

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The Indian Ocean plays a crucial role in the global climate. Understanding its dynamics is essential for climate predictions, disaster preparedness, and resources management. The primary objective of this study is to provide a comprehensive evaluation of the spatiotemporal features of the Indian Ocean by comparing broadly utilised highresolution ocean reanalysis products, such as GLORYS12V1 and Global Ocean Ensemble Reanalysis, against both in situ and satellite data. The study will concentrate on key oceanographic parameters such as temperature, salinity, sea surface temperature (SST), sea surface salinity (SSS), and ocean current. In situ observations from buoys, satellites, and Conductivity Temperature Depth (CTD) profiles from experimental campaign will serve as the reference data. All reanalysis products exhibit a noticeable warm sea surface temperature (SST) bias, especially in the tropics. Furthermore, in the equatorial region, surface currents are shown to be overestimated. Understanding and quantifying the biases in reanalysis products can aid in refining them, leading to a more reliable and accurate representation of the ocean state and improved predictions.

Keywords: Inter-comparisons, Ocean reanalysis, Independent observations, Indian ocean



VALIDATION OF SATELLITE RETRIEVED CHLOROPHYLL-a DATA FROM OCEAN COLOUR MONITORING-3 SENSOR USING IN-SITU DATA OVER SOUTHWEST BAY OF BENGAL (TAMILNADU COAST)

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The accurate monitoring of ocean color plays a crucial role in understanding the dynamic nature of marine ecosystems and their response to environmental changes. The Ocean Color Monitoring-3 (OCM-3) satellite, equipped with advanced remote sensing capabilities, provides valuable insights into the optical properties of the oceans. In this study, we present a comprehensive analysis of the correlation between ground truth data and OCM-3 satellite remote sensing data, aiming to improve the accuracy of ocean color monitoring.

Over a period of one-year, extensive ground truth data was collected using in-situ measurements and sampling campaigns in specific regions of interest. Simultaneously, the OCM-3 satellite acquired high-resolution remote sensing data, capturing the spectral signatures of ocean color across the study area.

The collected ground truth data and corresponding OCM-3 satellite remote sensing data were subjected to a rigorous comparative analysis. Chlorophyll-a concentration was validated using in-situ data and satellite derived data. Spatial variation for physiochemical parameters such as SST, SSS, Ph, Dissolved Oxygen, were evaluated along with nutrients analysis such as nitrite, nitrate, ammonia, silicate and inorganic phosphate to assess the agreement and correlation between the two datasets. Statistical techniques including regression analysis and correlation coefficients were employed to quantify the relationship and identify any systematic biases or discrepancies.

Preliminary results indicate a significant correlation between the ground truth data and OCM-3 satellite remote sensing data, validating the satellite's capability for accurate ocean color monitoring. The findings highlight the potential of OCM-3 as a reliable tool for assessing variations in oceanic optical properties on a broader scale. Furthermore, the study demonstrates the value of integrating ground truth data with satellite observations, providing a comprehensive understanding of the observed oceanic processes.

This research contributes to the advancement of ocean color monitoring techniques by establishing a robust framework for combining ground truth measurements with satellite remote sensing data. The integration of these datasets enhances the accuracy of ocean color monitoring, allowing for improved characterization and assessment of marine ecosystems, water quality, and environmental changes. The results of this study have implications for a wide range of applications, including fisheries management, ecosystem modeling, and climate change studies.

Keywords: Ocean color monitoring, OCM-3 satellite, remote sensing, ground truth data, correlation analysis, optical properties, environmental changes.



HOW COULD CYCLONE MICHAUNG INDUCE TRANSIENT UPWELLING ALONG THE SOUTHWEST COAST OF INDIA

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This study investigates the effects of the severe tropical cyclone Michaung on the physical and biological changes in the South Eastern Arabian Sea (SEAS). Indian Coastal Monitoring Buoy (ICMB) environmental buoy data from the nearshore region in Kochi is used to collect real-time changes in ocean temperature, salinity, and dissolved oxygen. Multi-satellite data products comprising Sea Surface Temperature (SST), surface winds, and Ekman pumping are derived from European Reanalysis – 5 (ERA5) daily surface wind data to examine the evolution and life cycle of the storm. Copernicus Ocean Globcolor interpolated Chlorophyll-a (Chl-a), a daily dataset, is used to study the biological response to the cyclone. Transient upwelling was observed in the SEAS during the cyclone passage, which was unusual during this time of year. As the storm moved through its track, its effects were noticed in the nearshore waters in the Kochi coastal region, which the buoy detected. The satellite data-derived daily averaged winds, Ekman pumping, and chlorophyll concentration all supported the transient upwelling seen in the area. The wind stress curl strengthening and the changing wind pattern almost parallel to the coast initiated this process, suggesting that the cyclone induced these changes. The current study suggests that the slow-moving Michaung and intensity of the cyclone brought in cold, high-saline waters into the SEAS through wind-induced Ekman pumping, which uplifted the biological activity in the region.

Keywords: Transient coastal upwelling, Cyclone, Ekman pumping, Southwest coast of India



THE PIVOTAL ROLE OF OBSERVATIONAL DATA IN OCEAN WAVE MODELING STUDIES

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In this study, in situ and remote sensed observational data are extensively used to assess the performance of the global WAVEWATCH III model (WWIII) for the Atlantic and Pacific Oceans. Accuracy of any wave model critically depends on the accuracy of wind forcing and hence the NCMRWF wind input to WWIII is validated using available WAVEWATCH III. The assessment showed that NCMRWF winds are reliable for the global ocean with a correlation coefficient of 0.91 (0.89), and scatter index of 0.22 (0.22) for the Atlantic (Pacific) Ocean. We simulate wave conditions using WWIII for the period from January 2018 to December 2018. Collocation of NDBC buoy data, and altimeter data from Jason-3 satellite was done with a 25 km spatial and 30-minute temporal window in the Atlantic and Pacific Oceans. Preceding model validation, buoy data containing significant errors were filtered out to ensure data accuracy, consequently enhancing statistical confidence. Employing various statistical methodologies, we assess the model's accuracy in capturing observed wave patterns. Statistical metrics such as bias of 0.01 (0.05), root mean square error of 0.13 (0.33), correlation coefficient of 0.94 (0.92), and scatter index of 0.07 (0.12) for the Atlantic (Pacific) Ocean confirmed the accuracy of our WWIII configuration in simulating wave parameters. The integration of Jason-3 satellite data facilitated spatial validation, utilizing remote-sensed observational data for this purpose. Spatial comparisons, coupled with validations with buoy observations provided comprehensive insights into the model output quality. Utilization of observational data in wave modeling, as demonstrated in this study, not only refines model accuracy but also enhances the reliability of wave forecasts, consequently improving the safety of marine operations and supporting effective coastal management strategies. This research underscores the vital role of observational data in advancing our understanding and predictive capabilities of oceanic wave behavior, ultimately benefiting various marine-related applications.

Keywords: WAVEWATCH III, NDBC buoy data, satellite data, validation, wave prediction



Aerosol and Air Quality



UNUSUAL FOG EVENT OVER KERALA AND ITS ASSOCIATION WITH CYCLONIC ACTIVITY AND TRANSPORT OF PARTICULATE MATTER: A CASE STUDY

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Significant variations in atmospheric parameters are evident during the progression of cyclones in tropical regions. This study investigates the unusual occurrence of fog over Kerala during the development of the Mandous cyclone in the month of December 2022 in the Bay of Bengal (BoB). It also examines the fluctuations in atmospheric particulate matter loading and other meteorological factors. Prior to the Mandous cyclone's landfall, a notable surge in aerosol concentration was detected over Kerala. Shifting wind patterns during cyclone genesis in the BoB facilitated the long-distance transport of aerosols from diverse parts of India to Kerala region. While numerous studies have documented increased aerosol levels during cyclone formation, such trends specifically over Kerala remain unreported. Coinciding with this heightened aerosol burden, an abnormal fog persisted over Kerala for several days. Hysplit back trajectory analysis highlights the influx of PM_{2.5} to Kerala from multiple South Asian locales. The Indo-Gangetic Plain (IGP) region acts as the primary source of transported aerosols. Notably, the average PM_{2.5} mass concentration over Kerala experienced a significant increase during this period. The Vytila station reported a PM_{2.5} mass concentration of 121 µg/m³ and an Air Quality Index (AQI) of 301 on December 8th, 2022, just prior to the landfall of the cyclone. A shallow planetary boundary layer and low ventilation coefficient were observed during the fog event. Analysis indicates a pronounced rise in atmospheric aerosol loading and moisture transport to Kerala during the study period, coinciding with Mandous cyclone formation. Consequently, these conditions culminated in the observed abnormal fog events over the Kerala region on December 10th, 2022.

Keywords: Atmospheric Aerosols, Cyclone, Particulate Matter, Fog



CHANGES IN SURFACE OZONE AND PM DURING LOCKDOWN PERIOD OVER KANNUR AND ITS VALIDATION USING MODEL SIMULATIONS

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This research work describes the variations of surface O₃, NO, NO₂, CO, SO₂, NH₃, VOC's, PM10, PM2.5 and meteorological parameters at the time of country wide pre-lockdown, lockdown and triple-lockdown days in 2020 at Kannur, Kerala using ground-based analyzers. From pre-lockdown days to triple-lockdown days, surface O₃ concentration was found to increase in this VOC limited environment. NO and NO₂ concentrations were decreased and the concentrations of PM10 and PM2.5 were observed to decline significantly. The concentration of CO, VOCs, SO₂ and NH₃ were found to decrease significantly from pre-lockdown days to triple-lockdown days. Inorder to find the chemistry behind the changes in concentration of trace gases, Community Multi-Scale Air Quality (CMAQ) model was applied to evaluate the air quality in these periods. Both the simulations and observations showed a decline in the PM2.5 concentrations and an enhancement in the O₃ concentrations during the lockdown and triple lockdown periods compared with that in the pre-lock down period. Integrated process rate (IPR) analysis was employed to isolate the contributions of the individual atmospheric processes. The results revealed that the vertical transport from the upper layers dominated the surface O₃ formation, comprising 89.4%, 83.1%, and 88.9% of the O₃ sources during the pre-lockdown, lock down, and triple lockdown periods, respectively. Photochemistry contributed negatively to the O₃ concentrations at the surfacelayer. Compared with the Pre-lockdown period, the O₃ enhancement during the lock period was primarily attributable to the lower negative contribution of photochemistry and the lower O₃ removal rate by horizontal transport. During the Triple lockdown period, a slower consumption of O₃ by gas-phase chemistry and a stronger vertical import from the upper layers to the surface accounted for the increase in O₃. The decreases in the PM2.5 concentrations during the lock down and triple lockdown periods were primarily explained by the weaker PM2.5 production from emission and aerosol processes. The increased vertical transport rate of PM2.5 from the surface layer to the upper layers was also a reason for the decrease in the PM2.5 during the lock down periods.

Keywords: CMAQ, COVID-19 lockdown, O (3), PM (2.5)



TRACKING LONG-TERM NO₂ POLLUTION TRENDS: FROM GLOBAL TO CITY-SCALE INSIGHTS SHAPED BY ENVIRONMENTAL REGULATIONS

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Air pollution presents a formidable global challenge, exerting profound impacts on climate, human well-being and the world economy. Notably, atmospheric Nitrogen Dioxide (NO₂), predominantly of anthropogenic origin, arises from diverse sources, including vehicular and industrial emissions. This study investigates the changes in global atmospheric NO₂ through analysis of satellite and ground-based data, focusing on the period from 2002 to 2019.

Elevated NO₂ levels ($> 8 \times 10^{15}$ molec. /cm²) are identified in regions such as the USA, Europe, India, China, the Middle East (MDE), South Africa (SA), Central Africa (CA) and selected regions in Brazil. Seasonal variability is evident, with peak concentrations in winter and troughs in summer, largely influenced by meteorological conditions and biomass burning. While NO_x emissions from road transport dominate the USA and Europe, various industrial activities drive elevated NO₂ levels in East China (EC), the Indo-Gangetic Plain (IGP) and SA. Noteworthy is the substantial decline ($\sim -0.1 \times 10^{15}$ molec. /cm²/year) in NO₂ observed in the USA and Europe during the study period. In contrast, significant positive trends ($\sim 0.06\text{--}0.1 \times 10^{15}$ molec. /cm²/year) are noted in the MDE, EC, SA, CA and IGP. An additional analysis of NO₂ pollution in 3000 global cities reveals a declining trend in most cities in the USA and Western Europe (WE) at -0.1×10^{15} molec. /cm²/year. Conversely, cities in India, China, Africa, Southeast Asia, MDE, and South America exhibit positive trends in NO₂, ranging from 0.04 to 0.1×10^{15} molec. /cm²/year.

Stringent vehicular regulations in developed countries (North America and Europe) have driven significant reductions in NO₂ emissions from road transport, resulting in a downward trend. This study analyzes recent global NO₂ pollution trends across various nations and cities, highlighting the divergent patterns observed between developed and developing regions. It further proposes potential strategies for developing nations to mitigate air pollution.

Keywords: NO₂, Air Pollution, Anthropogenic Activities, Road Transport, Vehicular Norms



IDENTIFICATION OF AIR POLLUTION HOTSPOTS IN KERALA: A DECadal ANALYSIS OF SPATIOTEMPORAL VARIATIONS IN AMBIENT POLLUTION LEVELS

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Air pollution poses a significant global environmental health threat, necessitating critical assessments of spatiotemporal variations to identify and prioritize pollution hotspots. This study presents a comprehensive analysis of ambient air pollution in Kerala, focusing on Respirable Suspended Particulate Matter (RSPM), Nitrogen Oxides (NOx), and Sulfur Dioxide (SO₂). Utilizing Hovmuller diagrams and data collected from monitoring stations over a decade, the study reveals distinct seasonal patterns. Winter months (December-February) witness elevated RSPM concentrations, particularly in hotspot regions. Statistical analysis confirms significant seasonal variations, emphasizing the need for targeted interventions. Notably, Filatex Veli, Kadappakkada, Nagampadom, Ernakulam district, Nallalam, Kozhikode city, and Kannur emerge as prominent air pollution hotspots. These findings underscore the importance of tailored regulatory measures and interventions to mitigate pollution-related health risks in Kerala, especially in identified hotspot regions.

Keywords: Air pollution, Kerala, Hovmuller diagram, NOx, RSPM, SO₂



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