

Book of Abstracts



International Symposium **MECOS 4**

Marine Ecosystems
Challenges and Opportunities

4-6 November 2025
ICAR-CMFRI, Kochi



BOBP

Organised by

The Marine Biological Association of India, Kochi

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FOREWORD

It gives me great pleasure to present the Abstract Book of the Fourth International Symposium on Marine Ecosystems - Challenges & Opportunities (MECOS4), organised by the Marine Biological Association of India (MBAI) jointly with the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi. This flagship symposium brings together a global community of scientists, researchers, policy makers and stakeholders committed to understanding, conserving and sustainably managing our oceans. The oceans continue to sustain life and livelihoods while facing unprecedented pressures from human activities and climate change. As we move deeper into the UN Decade of Ocean Science for Sustainable Development (2021–2030), the need for interdisciplinary research, technological innovation and science–policy integration has never been more urgent. MECOS4 reflects this collective aspiration by bringing to the forefront, novel findings, evolving concepts and transformative solutions that can guide sustainable ocean stewardship. The symposium provides a vibrant platform for the exchange of ideas, innovations and insights across diverse themes encompassing marine biodiversity, ecosystem processes, fisheries, mariculture, biotechnology, pollution, climate change and ocean governance.

This Abstract Book compiles the essence of 501 scientific contributions from researchers representing institutions across India and abroad. The breadth of topics underscores the diversity and dynamism of marine sciences today, ranging from fundamental ecological understanding to applied innovations in mariculture, climate resilience, pollution mitigation and blue economy pathways. I extend my sincere appreciation to all contributors for sharing their valuable research findings and to the members of the Organising and Scientific Committees for their unwavering efforts in shaping MECOS4. The Editorial Team deserves special appreciation for their meticulous efforts in compiling, reviewing and organising the abstracts into this comprehensive volume. I also gratefully acknowledge the support of our collaborating institutions for their continued encouragement in advancing marine ecosystem research and management.

It is my earnest hope that this compilation will inspire further collaboration, stimulate meaningful dialogue and strengthen our shared commitment toward healthy, productive and resilient oceans for future generations.

Grinson George
Convener, MECOS4 &
Director, ICAR-CMFRI



Sessions at a glance

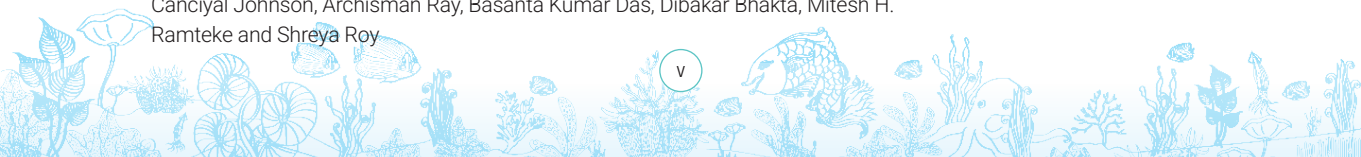
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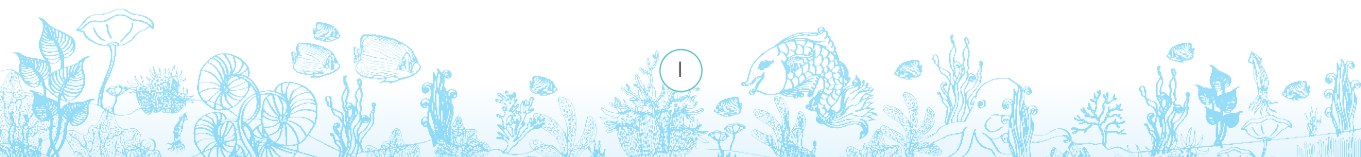


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Theme 1

Ecosystems and Biodiversity Conservation

Oral Presentations



Analysis of the impact of metal pollution on faunal biodiversity in Vembanad Lake using environmental DNA analysis

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The increasing concentrations of heavy metals in the environment represent a significant global concern, primarily resulting from the rapid expansion of industrial and urban sectors. Aquatic systems, along with their sediments, serve as critical sinks for these pollutants, receiving contributions from soil runoff, stormwater, groundwater, adjacent wetlands, meandering channels and in certain instances, direct industrial discharges. In their ionic or nanoparticulate forms, heavy metals can permeate living organisms, leading to bioaccumulation and severe health implications. Consequently, contamination by heavy metals has the potential to disrupt the biodiversity of the affected ecosystems. Vembanad Lake has been the subject of extensive research regarding metal contamination since the onset of industrialisation. Notably, the concentrations of metals such as zinc and cadmium in Vembanad Lake have frequently exceeded continental shale reference values, with an average contamination factor (CF) indicating moderate to considerable levels of contamination over the past four decades. However, owing to the vast expanse of these open-water systems and the inherent limitations of traditional sampling methods, a significant knowledge gap persists in understanding how these pollutants influence biodiversity dynamics within aquatic ecosystems. To address this gap, the present study seeks to correlate significant variations in biodiversity across selected stations in Vembanad Lake with corresponding metal concentrations, utilising environmental DNA (eDNA) analysis as an innovative and robust methodology. The metal concentrations at each station were assessed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), while biodiversity variations were evaluated through eDNA nanopore sequencing of collected sediment samples. Phylum-level diversity analysis demonstrated a notable relationship between metal concentrations and the biodiversity status at each sampling station, with molluscan diversity emerging as a primary indicator of metal pollution levels. This study underscores the potential of eDNA-based biodiversity assessments as a reliable, efficient and cost-effective tool for guiding evidence-based conservation strategies.

Keywords

Aquatic systems, Heavy metals, ICP-OES, Nanopore sequencing, Phylum-level diversity



Standing stock and composition of macrobenthos from three seamounts in the Southeastern Arabian Sea

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Seamounts are distinct underwater elevations rising over 1000 m above the surrounding seafloor. They are recognised as highly diverse marine environments and attract research interest due to their unique biodiversity and ecological significance. Unlike relatively flat seafloor areas, seamounts rise prominently from the ocean bed and interact dynamically with water flow. Their complex topography and hydrographic settings make them vital for benthic communities. In this study, the standing stock and composition of macrobenthos were examined from three Indian Ocean seamounts (designated S8, S9, and S12). Seamounts S8 and S9 are located on the eastern Laccadive Plateau and adjacent Laccadive Basin, whereas S12 lies near the southwestern continental slope of India. Sampling was conducted during the 178th cruise of RV Sindhu Sankalp (25 November-06 December 2024). Sediment samples were collected using a Van Veen grab (0.4 m²), and macro-benthic fauna were quantitatively analysed for abundance and biomass, with organisms identified to major taxonomic groups. Results revealed distinct variation in standing stock among seamounts. Mean macro-benthic abundance was highest at S12 (1852±462 ind. m⁻²), followed by S8 (400±390 ind. m⁻²) and S9 (108.0555±181.704 ind. m⁻²). Polychaetes dominated at S12 (54%) and S8 (65%), while crustaceans were most abundant at S9 (53%). Biomass followed a similar trend, with the highest at S12 (3.1691±0.3658 g. m⁻²), followed by S8 (0.7471±0.6526 g. m⁻²) and S9 (0.1357±0.1866 g. m⁻²). Polychaetes contributed most to total biomass accounting for 72% at S12, 70% at S8, and 42% at S9. The observed variations in standing stock appear to be influenced by depth, substrate type, and prevailing hydrographic conditions. Despite increasing global focus on seamount ecology, studies from the Arabian Sea remain scarce. This study provides the first baseline information on the standing stock composition of macrobenthos across selected seamounts in the Southeastern Arabian Sea.

Keywords

Abundance, Benthic communities, Biomass, Hydrographic conditions, Polychaetes, Taxonomic groups



Artificial reefs as a community-driven tool for sustainable coastal fisheries management - A proprietary approach

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Over the past several decades, concerted efforts have been made to improve fisheries management and strengthen coastal livelihoods through a range of regulatory and control measures. However, growing competition and escalating market demands have continued to exert considerable pressure on coastal communities. Consequently, many traditional mechanisms of control and self-regulation within coastal communities have weakened over time, gradually fading under the influence of advanced technological interventions, scattered settlements, and diminishing livelihood opportunities. Initially, the concept of artificial reefs and their introduction to suitable sites, along with the adoption of appropriate fishing practices, faced significant challenges, ranging from harsh environmental conditions to the need for major behavioural and operational changes. However, as reef development efforts progressed over the years and positive results were shared across different stakeholder groups, a broad sense of acceptance and satisfaction gradually emerged. Currently, proposals for establishing artificial reefs originate from the respective coastal villages. Expert teams are then deployed to conduct primary and secondary stakeholder consultations, through which suitable sites are identified and finalised by mutual agreement. Subsequently, the deployments are executed under the supervision of an Artificial Reef Sub-Committee (ARSC) constituted for the purpose. Members of this committee are chosen from among active and young traditional fishers, who receive training to maintain a fishing log register. The register records details such as fishing dates, site management, cleanliness, and other relevant observations, which are periodically submitted to the fisher panchayat and subsequently to officials of the Department of Fisheries. Local names for reef sites and seasonal fishing calendars are updated accordingly, and in some villages, fisher youth are trained in scuba diving to monitor reef development and report on its condition. In addition, CSR funds are utilised to support the regular upkeep and maintenance of the reefs.

Keywords

ARSC, Coastal livelihood, Proprietary management, Traditional fishers



Coral nursery development for the economic and environmental benefit of small islands: A case study advancing the blue economy in Lakshadweep Archipelago, India

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This study investigated the ecological and socio-economic potential of coral nurseries in the Lakshadweep Archipelago, focusing on growth performance, survival rates and associated biodiversity. Over two years, 10 iron-frame nurseries were deployed in Kavaratti Lagoon, hosting fragments of *Acropora* spp. and non-acroporid corals on concrete substrates. Monitoring revealed significantly higher growth and survival rates for acroporid species, with *Acropora muricata* achieving 31.1 ± 0.4 cm annual linear extension, followed by *A. hyacinthus* (21.7 ± 1.5 cm) and *A. gemmifera* (17.5 ± 2.8 cm). Among non-acroporids, *Pocillopora damicornis* showed the highest volumetric expansion (481.9 ± 68.4 cm³). Overall survival exceeded 80%, surpassing global averages. Fish surveys recorded 21 species across 10 families, including abundant damselfishes (*Chromis viridis*, *Dascyllus aruanus*), indicating functional habitat recovery and a thriving reef ecosystem. Eco-tourism initiatives, including snorkelling trails and glass-bottom boat tours, attracted more than 2,300 visitors annually, generating seasonal revenues of ₹8–10 lakh and direct community income of ₹2 lakh. School-based marine clubs engaged over 500 students, fostering ocean literacy and long-term stewardship. These outcomes demonstrate that coral transplantation is not only an effective ecological restoration tool but also a viable blue economy strategy, enhancing reef resilience while providing sustainable livelihoods for island communities. The Lakshadweep model offers a replicable framework for scaling coral restoration across the Indian Ocean, supporting climate adaptation, disaster risk reduction, and sustainable coastal development.

Keywords

Coral transplantation, Damselfishes, Ecological restoration, Livelihoods, Reef resilience

Prioritising fishing gears for marking: A VGMFG-based risk assessment along the Kerala Coast, India

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It is estimated that annually about 8–12 million t of plastic enter the oceans, of which approximately 10% originates from Abandoned, Lost, or otherwise Discarded Fishing Gear (ALDFG). This is a significant environmental challenge both globally and in India. Marking fishing gear, which enables tracking and retrieval, is one of the strategies identified to reduce the occurrence and impacts of ALDFG. Despite its recognised importance in mitigating plastic pollution from fisheries, the adoption of gear marking practices across different fisheries has been very limited. The Food and Agriculture Organization (FAO) has developed Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) framework, and since then, studies in various countries have explored its implementation. However, in India, there have been only limited documented attempts to understand and implement fishing gear marking. The present study reports the first attempt to develop a methodological approach based on the VGMFG framework along the Kerala Coast. In line with the VGMFG principles, a survey was conducted to develop a risk matrix to prioritise fishing gears for marking interventions. A structured survey form was designed, pre-tested, and used to collect information on gear loss and related factors from fishers operating in both estuarine and marine waters of central Kerala. A total of 76 fishers were interviewed, and the results indicated that significant gear losses occur predominantly in the gillnet and ring seine sectors. The main causes of gear loss reported were underwater obstacles, excessive catch weight, unfavourable weather conditions, strong currents and in some cases, interactions with dolphins. Analysis using a scoring matrix developed in accordance with the VGMFG guidelines revealed that urgent interventions for gear marking are required for gillnets and ring seines along the Kerala Coast. The findings are discussed in the context of potential implications for scaling up and implementing gear marking programs in India. Recommendations for policy interventions and institutional support to facilitate adoption, ensure compliance, and contribute to national efforts to reduce ALDFGs and marine plastic pollution are discussed.

Keywords

ALDFG, Gear loss, Gillnets, Estuarine waters, Marine plastic pollution, Ring seine



A multi-index approach to identify key determinants of ecosystem health in the Vembanad Estuary

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This study was conducted to determine the key factors influencing the ecosystem health of the Vembanad Estuary, a Ramsar site located at 9°00'-10°40' N latitude and 76°00'-77°30' E longitude. For the study, the estuary was partitioned into low, medium, and high saline zones based on a salinity gradient. Six sampling stations were designated: Munambam and Njarackal (high saline); Chembakkara and Arookutty (medium saline); and Vaikkom and Kuthiathode (low saline). Water, fish, plankton and benthic samples were collected from each station. The data were used to derive several key variables and indices, including primary productivity, Trophic State Index (TSI), and composite indices for fish, water quality, plankton and benthos. These indices comprised multiple sub-indices; for example, the fish index incorporated fish diversity, the number of exotic species, and the number of vulnerable fishes. Scores were assigned to each sub-index based on existing literature and then aggregated to calculate an ecosystem health index score for each zone. The aggregated dataset was subjected to a Random forest analysis to determine the relative importance of each factor in influencing ecosystem health. The results indicated that primary productivity was the most significant factor, with an IncNodepurity score of 3.9. This was followed by the fish index (3.197) and the water quality index (2.37). In contrast, the analysis showed that trophic status was the least influential factor, with a score of 0.712. The study concludes that primary productivity is a critical determinant of the Vembanad Estuary's ecosystem health. Monitoring primary productivity, therefore, serves as a vital indicator of the ecosystem's resilience and its capacity to sustain itself and adapt to environmental changes.

Keywords

Fish index, IncNodepurity score, Ramsar site, Random forest, Primary productivity, Water quality index



Impacts of molluscan fishery decline on ecosystem services of the Coringa Estuary and Kakinada Bay, east coast of India

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Molluscs comprising gastropods (such as conchs, whelks and snails) and bivalves (such as clams, oysters and mussels) are essential to the resilience and smooth operation of coastal-marine ecosystems. Beyond their rich biological diversity, molluscs play vital ecological roles and contribute significantly to food security, climate regulation, and the socioeconomic well-being of coastal communities. The decline or loss of molluscan biodiversity can therefore have profound ecological and economic impacts, disrupting ecosystem functions and affecting multiple interconnected sectors. This study examined the ecological and carbon storage contributions in Kakinada Bay and the Coringa Estuary along the east coast of India. Studies revealed that the dominant species include *Magallana bilineata*, *Meretrix casta*, and *Tegillarca granosa*. *Perna viridis* and *Pinctada fucata*. Research indicates that the carbon sequestration ratios (as a percentage of total shell mass) for the following species are around 33.68% for clams, 13.64% for oysters, and 13.64% for windowpane oysters. The molluscs' carbon storage is 1.5-2.3 t of CO₂-equivalents per hectare annually, with their shells containing 12-15% carbon by dry weight. Since the output of molluscan shells in Kakinada Bay has decreased from about 6000 t in 1973 to approximately 1064 t in 2013, the projected capacity to sequester carbon has decreased from approximately 9 to 13.8 t CO₂-eq per year to only 1.6 to 2.45 t CO₂-eq per year, which is comparable to a reduction of about 80%. The effects of long-term environmental changes and overexploitation are reflected in the exponential drop in Kakinada Bay's molluscan shell production from roughly 6000 t in 1973 to 1064 t in 2013. The decline of molluscan fisheries not only reduces carbon storage but also weakens water filtration, sediment stabilisation, and nutrient cycling. These losses result in a decline in molluscan biodiversity, which affects fish and bird food supplies, diminishes the availability of shell for the cement and lime industries, and undermines the bay's ability to sustain local livelihoods and coastal ecosystem services. This study highlights the urgent need for a spatial management and conservation plan for sustainable molluscan fisheries for the molluscan carbon services in India's blue carbon strategies.

Keywords

Blue carbon storage, Carbon sequestration, Conservation, Shellfish farming, Spatial management



Beach litter characterisation and source contributions along the coasts of Karnataka and Goa, South India

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Marine litter poses a serious threat to estuaries, mangroves, coral reefs and coastal ecosystems. Marine debris affects a wide range of marine mammals, birds, turtles, and fish globally through entanglement and ingestion. United Nations Environment Programme/Intergovernmental Oceanographic Commission (UNEP/IOC) defines marine litter as any manufactured or solid waste that enters the marine environment through land, river or sea. For effective management, decision-makers need to go beyond quantitative assessments to understand the composition and sources of beach litter. Therefore, this study was conducted across 52 beaches in five coastal districts spanning the states of Karnataka and Goa, during 2023. Litter categorisation followed standard protocols, with additional groupings based on earlier studies carried out in these beaches to distinguish fishery-related and land-based items. Based on the primary utility of the beach by local communities, the beaches were classified into three categories: Fishing, Tourism and Mixed (Fishing and Tourism). Coastal population density was collected from secondary data sources and beach width was measured following the UNEP methodology. A highly significant difference ($p < 0.001$) in population density was evident between districts in Karnataka and Goa, with the highest value recorded in Dakshina Kannada (1643.55 individuals km^{-2}), followed by South Goa (967.33 individuals km^{-2}). A significant difference in litter density (nos. m^{-2}) was observed for the fishing-based F1 group ($p < 0.002$) and land-based L1 group ($p < 0.01$). Among the two fishing-based groups, F1 contributed the highest proportion of litter in both Karnataka (44% by number; 52% by weight) and Goa (16% by number; 18% by weight). Similarly, among the nine land-based groups, L1 accounted for the larger share of litter items in Karnataka (43% by number; 18% by weight), and Goa (75% by number; 29% by weight). The L1 group as classified under UNEP codes [PL 02, 03, 04(2), 06, 07, 08, 10, 12, 24(2)] comprised litter types commonly observed during beach surveys. While the fishing-based F1 group [PL16, 18, 19, 22] comprised items such as sandbags, nylon or monofilament lines, ropes, net pieces and fibreglass board fragments. In total, 32 litter groups were identified as per the UNEP classification, with plastics dominating both the land-based and fishing-based categories. The findings highlight the need for effective local management interventions, such as waste segregation at source; improved community awareness, combined with establishment of waste collection and processing centres, to significantly reduce beach litter along the coasts of Karnataka and Goa.

Keywords

Beach survey, Coastal ecosystems, Fishing, Marine litter, Population density, Tourism, UNEP methodology

Fishing gears, biodiversity patterns and conservation challenges in the Hooghly-Matlah estuarine fisheries

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The Hooghly-Matlah estuarine system, situated in the western section of the Indian Sundarbans, supports a diverse artisanal fishery that sustains thousands of households in the estuarine and coastal areas. A comprehensive monitoring program, spanning from 2020 to 2024, was implemented across 10 landing centres to assess the relationships among fishing gear, biodiversity, and conservation challenges. More than 25 types of gears were documented, with stationary bag nets (*behundi jal*), gill nets (*phash jal*), and cast nets (*jhaki jal*) being the most common, together representing about 70% of the total landings. The seasonal migratory bag net fishery, carried out by mobile fisher groups along the salinity gradient from Sagar Island to Nabadwip, plays a crucial role in the exploitation of estuarine and nearshore stocks, particularly clupeids, catfishes, and penaeid shrimps. Fish diversity comprised 234 species of finfish, spanning 82 families. Silurids dominated the fish diversity with 33 species, followed by both cyprinids and perciforms, each with 29 species, carangids with 25, and so on. Fine-meshed bag nets and stake nets accounted for 30-35% of juveniles and sub-adults, indicating a notable level of recruitment fishing pressure. Amongst the ten sampling locations, the sea mouth area at Fraserganj was found to be the most species-diverse, harbouring the most significant number of brackishwater and marine migratory species. The extensive use of non-selective and migratory fishing gear, along with habitat alterations and ongoing fishing activities, poses significant threats to the biodiversity of estuarine ecosystems and the sustainability of their resources. The establishment of mesh size regulations, restrictions on migratory gear use during breeding periods, and the promotion of sustainable gear through cooperative management are essential for conserving fish biodiversity and maintaining ecosystem health in the Hooghly–Matlah Estuary

Keywords

Artisanal fishery, Biodiversity, Conservation management, Ecosystem health, Migratory bag nets



Ecological assessment of fish community structure in the lower estuarine stretch of the River Ganga, West Bengal

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The lower estuarine stretch (Hooghly Estuary) of the river Ganga represents one of India's most productive estuarine ecosystems, supporting rich multispecies fisheries. The present study was conducted over eight years (2017-2024) and aimed to assess the spatial and temporal variations in ichthyofaunal diversity across three representative zones: Godakhali (upper estuarine), Diamond Harbour (mid-estuarine), and Fraserganj (lower estuarine), covering gradients from freshwater to marine influence. A total of 67 finfish taxa belonging to 55 genera, 39 families, and 19 orders were recorded. Among these, 45% were euryhaline, 47% brackishwater, and 8% freshwater species, reflecting the mixohaline nature of the system. The family Engraulidae dominated at Fraserganj and Diamond Harbour, while Clupeidae was prominent at Godakhali. Diversity indices indicated that Diamond Harbour supported a well-balanced fish assemblage (Shannon Index: 1.974 and Evenness: 0.823), whereas Godakhali exhibited comparatively lower richness and evenness. Canonical Correspondence Analysis (CCA) revealed that key environmental variables, viz., depth, salinity, total nitrogen, dissolved oxygen, and silicates, strongly influenced species distribution across sites. Seasonal analyses indicated that winter months exhibited higher dominance by few species, while monsoon and pre-monsoon periods displayed more even community structures. The observed variations are attributed to hydrological shifts, nutrient dynamics, and anthropogenic influences along the estuarine continuum. The study underscores the Hooghly Estuary's ecological significance as a critical habitat for estuarine and diadromous fishes. It points out that long-term monitoring and sustainable management strategies are required to conserve its biodiversity under changing climatic and anthropogenic pressures

Keywords

Anthropogenic pressures, Ecosystem management, Environmental gradients, Estuarine ecology, Hooghly Estuary



Functional role of the striated surgeonfish *Ctenochaetus striatus* in the reefs of south Andaman

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Ctenochaetus striatus is one of the most abundant surgeonfishes on Indo-Pacific coral reefs. Yet, the functional role of these species has been debated for at least six decades. While some studies point to the role of algal removal, other studies focus on its role in the sediment cycle. Underwater surveys, direct behavioural observations, food and feeding analysis and anatomical studies were used to understand the functional role of *C. striatus*. Underwater surveys were conducted monthly across six study stations over a period of two years. Data on feeding behaviour were recorded using PVC slats during snorkelling observations on the reef. Fish specimens were collected using cast nets (10–20 mm mesh size), scoop nets, and hand picking. The guts were then dissected to examine and determine the food composition and feeding biology of the species. The morphological and ecological data were used for further analysis. It was found that *C. striatus* was more abundant in the reef flat and reef edge, and the highest feeding rate was observed between 10:00 and 14:00 hrs. *C. striatus* preferred algae-covered rocks with high sediment load and sandy patches during feeding, indicating a preference for sediments. Sand grains were the most common component (56.7%) in the gut, followed by turf algae (29.4%) and foraminifera (11%). *Enteromorpha clathrata* was the most dominant algal species (17%) in the gut. Food items like sponge spicules, ostracods and benthic copepods were also found in the gut, indicating the importance of the scraping action during feeding. While the trophic level (2.14) indicated herbivory/detritivory, behavioural observations in the wild and gut content analyses clearly showed that the species feeds more on detritus than on turf algae. Scraping was the most used mode of feeding, and it was often fed in heterospecific shoals which included other surgeonfishes, rabbitfishes and parrotfishes. The long teeth (0.35 cm), hard knob-like structures in the upper palate, and the presence of a gizzard and short-spaced gill rakers aided in detritivory. The current study presents evidence of high predominance of detritivory in this species from the Andaman Islands

Keywords

Acanthuridae, Detritivory, Functional ecology, Lined bristle-tooth, Turf algae



Solution from the blue: *Ectopseudomonas oleovorans* strain SKM9 from marine plastic drives cutinase-mediated poly (ϵ -caprolactone) biodegradation

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Polycaprolactone (PCL), an aliphatic polyester, is a promising biodegradable plastic widely used in various commercial applications, either alone or blended with other biopolymers. Although designed to be biodegradable PCL has emerged as a contributor to plastic pollution when released into the environment. Understanding its biodegradation is crucial for developing sustainable strategies to mitigate plastic accumulation. This study reports the ability of *Ectopseudomonas oleovorans* strain SKM9 to produce cutinase, which is capable of degrading PCL. The bacterium was isolated from marine plastic, and its identity was confirmed by 16S rRNA sequencing. Cutinases (EC 3.1.1.74), produced by bacteria, are serine esterases that can hydrolyse ester bonds in natural polyesters and synthetic polymers such as PCL. Thin films of PCL were prepared by solution casting, and bacterial degradation was evaluated in basal medium under shake-flask conditions for one month. Incubation with *E. oleovorans* SKM9 resulted in a 22.03% weight loss of the PCL films, confirming enzymatic degradation. The structural and chemical changes in degraded films were analysed using Fourier-transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) which revealed significant alterations consistent with cutinase-mediated hydrolysis. Cutinase activity was assessed using a 96-well microplate assay with p-nitrophenyl butyrate (pNPB) as a model substrate. The crude enzyme was partially purified by ammonium sulfate precipitation followed by dialysis, and its molecular weight (around 25kDa) and purity were confirmed by SDS-PAGE analysis. The purified enzyme exhibited a specific activity of 461 U mg⁻¹ and remained stable at 30-40°C and pH 8-10. Thus, this work unveils the ability of *E. oleovorans* SKM9 to produce cutinase and degrade PCL at mesophilic temperatures, underscoring its potential for sustainable plastic waste management.

Keywords

Ester bonds, FTIR, Microplate assay, Polycaprolactone, SEM, Serine esterases



Fostering compliance with global turtle conservation and sustainable fishing: The Government of India's initiative under Pradhan Mantri Matsya Sampada Yojana

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Marine turtles are integral to the health and balance of marine ecosystems. The olive ridley turtle (*Lepidochelys olivacea*), widely recognised for its extraordinary long migrations, inimitable breeding patterns, unique nesting behaviours and significant ecological contributions, predominantly inhabits the circumtropical regions of the Indian and Pacific Oceans. The present study was conducted to evaluate perceptions surrounding the conservation of the olive ridley turtle, involving fishermen who operate single-net stern shrimp trawlers along the Amalapuram Coast in Andhra Pradesh. The olive ridley is known to nest at four key sites in the Amalapuram region. These sites are closely monitored by the forest department in collaboration with local NGOs and fishermen. The findings revealed that 95% of the fishermen expressed profound spiritual respect for the olive ridley turtle. In cases of accidental or incidental capture, live turtles are promptly released back into the ocean. In contrast, deceased turtles are respectfully prayed over and disposed of according to spiritual customs, based on the belief that these turtles represent the *kurma avatar*, the turtle incarnation of the Hindu God Vishnu. However, fishermen appear to misunderstand the broader ecological significance of turtles. 100% of boat owners were familiar with turtle excluder devices (TEDs), and they opined that their use in shrimp trawlers might lead to a reduction in shrimp catch. The boat owners expressed their willingness to implement turtle excluder devices (TEDs) in their trawlers, provided the devices are supplied free of cost or with adequate subsidies. The US ban on wild-caught shrimp due to the lack of TEDs in trawlers has negatively impacted the shrimp market. Fishermen's major concerns include inconsistent TED adoption across vessels, the cost of procurement, limited awareness of the Wildlife Protection Act, lack of understanding about TEDs' benefits for turtle escape, potential loss of shrimp catch, and the absence of surveillance. It is essential to raise awareness about turtle conservation, the legal protections afforded to these species, and the benefits of TEDs in advancing responsible and sustainable fishing practices. In alignment with these goals, the Department of Fisheries, Ministry of Fisheries, Animal Husbandry, and Dairying, Government of India, has implemented a scheme to provide TEDs to 32,953 motorised mechanical boats under the *Pradhan Mantri Matsya Sampada Yojana*. This initiative aims to align fishing practices with international standards, fostering marine biodiversity conservation while ensuring compliance with US import requirements for wild-caught shrimp exports.

Keywords

Biodiversity, Olive ridley turtles, Sustainability, TEDs, UN specifications



Assessing India's grouper diversity and fishery: Status, threats and future directions

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Groupers (Family Epinephelidae) are ecologically significant, yet highly vulnerable marine fishes, valued globally for their economic and trophic roles. In India, grouper landings have shown a marked upward trend over the last several decades, averaging approximately 37,970 t annually between 2009 and 2018, with peaks reaching 53,924 t in 2017 and 51,433 t in 2018. This rise in catch raises concerns about potential overexploitation, given the biological traits of groupers, such as slow growth and long lifespans. During 2020-2023, grouper landings climbed further to approximately 50,388 t, indicating continued upward pressure. In 2023, grouper fisheries accounted for 1.95% of India's total marine fish landings, totalling 69,099 t. The data shows a consistent upward trajectory in grouper landings in India over the last three decades. From modest levels in the 1990s (~13,000 t), catches rose to around 20,000 t in the early 2000s and surged further in the following decade, hitting a high of roughly 54,000 t in 2017. The period from 2011 onward marks the most pronounced increase, with recent years (2020–2023) sustaining landings above 50,000 t annually. The increase in landings was especially from Gujarat, Karnataka, and Kerala on the west coast, and from the southeast coast of Tamil Nadu and Andhra Pradesh. Of the 52 species recorded from Indian waters, 39 were reassessed by IUCN in 2014 and grouped into Least Concern, Vulnerable, Data Deficient and Vulnerable categories. Of these, 79% fall in Least Concern (LC), 7% fall in Data Deficient (DD) and Vulnerable (VU) categories, while 5% fall in the Near Threatened (NT) category. *E. lanceolatus*, which is protected by the WLPA (1972), falls in the DD category. Regional conservation measures have to be strengthened to sustain some resources, like *Epinephelus diacanthus*, which have been moved from Vulnerable status to LC. Conservation assessments reveal that many species remain either Data Deficient or at risk, with a significant portion of spawning aggregation populations declining or disappearing, highlighting the urgent need for targeted management. The present study re-evaluates the conservation status of Indian grouper species, examines current fishery patterns, and recommends region-specific management strategies to ensure sustainable exploitation and biodiversity protection.

Keywords

Biodiversity protection, Epinephelidae, Spawning aggregation, Sustainable exploitation



Marine shrimp diversity and biogeography of India and conservation challenges

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Biodiversity, species richness, endemism and conservation are central themes in the ongoing global discussion on the biodiversity crisis. In India, compiling a comprehensive inventory of marine shrimps is a unique challenge, owing to the nation's vast and varied geography, which spans three distinct oceanic boundaries and encompasses two major island territories. To address this, data have been meticulously gathered from diverse sources, including exploratory surveys, expedition reports, published research and authoritative taxonomic platforms such as DecaNet, WoRMS, GBIF and INDOBIS. The outcome is a detailed biogeographic inventory of India's marine shrimp fauna, totalling 471 species and subspecies (159 penaeids, six stenopodids, and 306 carideans). This list represents a revision of the previous checklist published in 2012, incorporating an additional 139 species, including all new species and records from the past 13 years. Taxonomic changes at the family, genus, and species levels have also been incorporated. Of the 471 species, 49 are endemic to the region. The Lakshadweep Archipelago, with 102 species, and the Andaman and Nicobar Islands, with 211 species, are identified as the most biodiverse regions within the Indian EEZ. Other equally important regions with high species richness are the Gulf of Mannar on the southeast coast (61 species) and the Gulf of Kachchh (39 species) on the northwest coast. Pelagic shrimps constitute 12.5% of the marine shrimp fauna in the Indian Seas, with some species reported from abyssopelagic depths (>5000 m). This robust database provides an essential resource for future studies, supporting nuanced biodiversity characterisation and informing conservation planning for India's rich marine life.

Keywords

Exploratory surveys, Expedition reports, Comprehensive inventory, Database, Distribution, EEZ



Mass stranding of *Spiochaetopcerus* sp. along the Konkan Coast triggered by southwest monsoon and cyclone Biparjoy: Ecological observations and implications

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In June 2023, a large-scale stranding of calcareous tube shells, identified as *Spiochaetopterus* sp. (commonly known as cellophane tubeworms, Chaetopteridae), was observed along the beaches of Sindhudurg District, Maharashtra. This rare event coincided with the onset of the southwest monsoon. It was intensified by the impact of Cyclone Biparjoy, which, despite making landfall in Gujarat, significantly altered hydrodynamic conditions across the western Indian coast. The affected beaches viz., Shiroda, Devbag, Tarkarli, Malvan, Dandi, Wairi, Padavane, Achara, and Vengurla, are situated near the estuarine outflows of rivers such as the Kali, Mandavi, Achara and Devgad. These estuarine and intertidal zones provide suitable habitats for *Spiochaetopterus* colonies, which commonly occur on marine sandy substrates beyond low tide line, such as seagrasses, macroalgae, mangrove roots, driftwood, rocky shores, coral patches, fishing vessel hulls and other anthropogenic structures. Field assessments indicated variable biomass densities, with the highest recorded at Wairi ($443 \pm 54.2 \text{ g m}^{-2}$) and the lowest at Padavane ($59 \pm 16.0 \text{ g m}^{-2}$). The combined effects of increased wave energy, estuarine flushing, and onshore currents resulted in the detachment and subsequent deposition of *Spiochaetopcerus* colonies along the shore. These processes were further intensified by Cyclone Biparjoy, which generated strong turbulence and flooding, leading to the widespread dislodgement of biofouled materials. The stranded matter was frequently found intermingled with plastic debris, underscoring the dual challenges of ecological disturbance and coastal pollution. This stranding event highlights the ecological vulnerability of intertidal and benthic communities to climate-driven oceanographic changes and emphasises the potential of *Spiochaetopcerus* as a bioindicator species for monitoring coastal ecosystem shifts.

Keywords

Cellophane tubeworms, hydrodynamic conditions, Plastic debris, Sindhudurg



Copepods: Are they the same in the coastal and oceanic oxygen minimum zones?

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Although copepods are the most abundant metazoans in the ocean, data on their ecological characteristics in the Oxygen Minimum Zone (OMZ) of the Eastern Arabian Sea (EAS) are limited. This study introduces the influence of oxygen deficiency on the composition and eco-physiological features of copepods in the EAS. Using a multiple plankton net, stratum-wise vertical sampling of meso-zooplankton was conducted within the coastal and oceanic OMZs during the Southwest Monsoon (SWM) and the Northeast Monsoon (NEM). The findings provide the first evidence that oxygen-deficient conditions significantly impact both composition and physiological status of copepods. During the SWM, both OMZs were dominated by OMZ-adapted calanoids (Lucicutiidae, Metridinidae, Eucalanidae, Scolecitrichidae, Paracalanidae, Calanidae and Heterorhabdidae) with species composition showing over 50% similarity. A two-fold reduction in total copepod abundance was observed in the more intense oceanic OMZ compared to the coastal OMZ. The oceanic OMZ exhibited a more diverse and species-rich copepod community, but also featured an elevated proportion of copepod carcasses and a reduced number of immature stages relative to the coastal OMZ. The results demonstrate a clear physiological and ecological stress response as seen in the reduced abundance, higher mortality rates and lower proportion of immature stages in the more intense oceanic OMZ. Furthermore, the similarity of community composition between coastal and oceanic regions during the SWM highlights the critical role of upwelling in extending OMZ conditions into nearshore ecosystems.

Keywords

Abundance, Community composition, Diversity, Ecophysiology, Meso-zooplankton, Upwelling, Vertical distribution



Occurrence of gravid and neonatal elasmobranchs in the Gulf of Mannar and Palk Bay: Habitat and seasonal implications

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The Gulf of Mannar (GoM) and Palk Bay (PB), situated along the southeast coast of India, represent highly productive and biodiverse ecosystems characterised by a mosaic of habitats, including coral reefs, extensive seagrass meadows, mangroves, sandy flats, and muddy bottoms. These ecoregions serve as critical habitats for various life stages of elasmobranchs, particularly vulnerable and rare batoid species. The region experiences three broad seasons governed by the monsoonal cycle: Pre-monsoon (June–September), Monsoon (October–January), and Post-monsoon (February–May). A month-wise analysis conducted from January 2016 to June 2024 of elasmobranch diversity along Pamban, an island where both ecoregions converge, revealed a notable occurrence of pregnant individuals and neonates, with clear seasonal trends in the seagrass beds, coral reef and mangroves. Observations during fish landing surveys indicated that neonatal elasmobranchs were encountered across all seasons, at least for six species. However, landings peaked notably during the pre-monsoon season, particularly for other rays and ETP species belonging to the genera *Urogymnus*, *Aetomylaeus*, and *Sphyrna*, among others. Nearly 20% of the species occurrences were recorded during both the monsoon and post-monsoon seasons. Prominent species exhibiting both pregnant and neonatal occurrences include *Neotrygon indica*, *Pastinachus ater*, *P. gracilicaudus*, *Maculabatis gerrardi*, *M. bineeshi*, *Taeniurops meyeri*, *Urogymnus asperimus*, *U. granulatus*, *Rhinoptera javanica*, *R. jayakari*, *Gymnura poecilura*, *Himantura imbricata*, *H. walga*, *Glaucostegus granulatus*, *Acroteriobatus variegatus*, *Chiloscyllium griseum*, *Sphyrna lewini*, *Mobula mobular*, *M. kuhli*, *M. thurstoni*, *M. eregoodoo*, *M. birostris*, among others. The presence of these early life stages, especially in trawl bycatch, indicates probable use of inshore sandy and muddy bottoms as pupping and nursery grounds. This spatial and temporal clustering of neonates and pregnant females strongly suggests that parts of the trawling grounds within the GoM and PB function as seasonal birthing areas for multiple species. From a conservation and fisheries management perspective, these findings underscore the urgent need for targeted interventions. Recommended measures include seasonal fishing restrictions during peak pupping periods (primarily during the pre-monsoon), avoiding fishing in the nursery grounds and sensitisation and training of fishers to identify and safeguard neonatal elasmobranchs during fishing operations.

Keywords

Conservation awareness, Critical habitats, k-selected species, Northeast monsoon, Pupping ground

Dinoflagellate (Myzozoa: Dinophyceae) diversity along the Mumbai and Raigad coasts of Maharashtra

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Dinoflagellates are ecologically significant phytoplankton that play a vital role in marine food webs, and their distribution is strongly influenced by environmental conditions and anthropogenic pressures. This study examined dinoflagellate diversity and water quality dynamics at three coastal sites viz., Versova and Ferry Wharf in Mumbai, and Karanja in Raigad from January to June 2025. A total of 21 dinoflagellate species belonging to 11 genera, 9 families, and 5 orders under the class Dinophyceae were identified, with *Tripos furca* being the most dominant across all sites. Versova exhibited the highest species richness with 16 species, followed by Karanja with 12 species, and Ferry Wharf with 11 species. Among the physicochemical parameters, dissolved oxygen (DO) and temperature were the key drivers of dinoflagellate abundance. Diversity indices, including Shannon, Simpson, Brillouin, and Pielou's Evenness, indicated that Versova had the highest diversity, while Ferry Wharf recorded the lowest. Karanja showed the highest evenness, suggesting a more balanced community structure. Toxic and bloom-forming species such as *Alexandrium catenella* and *Cochlodinium* sp. were also recorded, raising ecological concerns. The findings indicate that site-specific conditions, pollution at Ferry Wharf, lower disturbance at Versova, and a stable estuarine ecosystem at Karanja, shape dinoflagellate communities. This study underscores the need for regular biodiversity monitoring to detect harmful algal blooms (HABs) and implement effective management strategies for sustainable management of coastal ecosystems

Keywords

Dinoflagellate, Diversity, Harmful algal blooms, Physicochemical parameters, Sustainable management

A Ridge-to-Reef framework for biodiversity, culture and climate adaptation: A holistic approach to conserving Minicoy Atoll, Lakshadweep, India

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Minicoy Atoll which is a part of the Lakshadweep Archipelago in the Arabian Sea, represents a fragile and complex island ecosystem with rich marine biodiversity. This includes vibrant coral reefs, mangrove forests, diverse fish, crustaceans, and echinoderms. These interconnected ecosystems provide essential habitats and resources that sustain ecological balance and support the traditional livelihoods of indigenous community. The island's cultural heritage is deeply intertwined with its natural environment, reflecting generations of sustainable practices, traditional knowledge, and strong spiritual ties to both marine and terrestrial ecosystems. Despite its ecological and cultural importance, Minicoy faces threats from marine debris, indiscriminate bait fishing, and mangrove deforestation, which harm coastal habitats and ecosystem functions. The ecosystem is worsened by climatic change impacts like sea-level rise, warming seas, and extreme weather events. These climate stressors contribute to coral bleaching, mangrove degradation, and shoreline erosion, which collectively weaken the resilience of natural ecosystems and the local communities depending on them. To address these challenges, this study promotes a Ridge-to-Reef (R2R) management framework tailored specifically for Minicoy Atoll. The R2R approach integrates watershed management, mangrove conservation, coral reef protection, and the preservation of cultural heritage. It recognises the critical interdependence of terrestrial and marine ecosystems, advocating for holistic planning to reduce sedimentation, pollution, and habitat loss. Key components include community-based resource management, promotion of sustainable fishing practices, systematic monitoring of marine debris, and climate adaptation measures such as mangrove restoration and coral reef rehabilitation. By combining scientific research, traditional ecological knowledge, and inclusive governance, the R2R framework aims to enhance ecosystem health, conserve biodiversity, and improve the socio-economic wellbeing of Minicoy's residents. Implementing this integrated strategy will strengthen the atoll's resilience to climate change, support sustainable development, and protect the unique cultural identity tied to its natural environment. The study's findings will guide policy formulation, conservation initiatives, and long-term resource management, ensuring the preservation of Minicoy's invaluable natural and cultural heritage for future generations.

Keywords

Climatic change impacts, Ecological balance, Ecosystem health, Marine biodiversity



Theme 1

Ecosystems and Biodiversity Conservation

Poster Presentations



Geospatial modelling of mangrove ecosystem dynamics and blue carbon potential along the Mumbai metropolitan region

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Mangrove ecosystems form an indispensable component of tropical marine environments, providing multiple ecosystem services such as shoreline stabilisation, storm surge protection, nursery grounds for fisheries, and long-term carbon sequestration. Along the Mumbai coast, these intertidal forests play a pivotal role in sustaining biodiversity and fisheries-based livelihoods while acting as significant blue carbon sinks. However, the rapid pace of urbanisation, coastal reclamation, and industrial development has resulted in extensive degradation and fragmentation of mangrove habitats, posing a serious challenge to their ecological integrity and climate regulation potential. In this context, the present study applies a geospatial modelling framework to examine mangrove cover dynamics and to identify both vulnerable and regenerative zones across the Mumbai Metropolitan Region. Multi-temporal satellite data, combined with environmental parameters, were analysed using QGIS-based simulation approaches incorporating Artificial Neural Network (ANN) and Cellular Automata (CA) models to project future distribution scenarios. The results highlight critical hotspots of degradation in proximity to infrastructure corridors, while also delineating areas suitable for restoration and conservation interventions. These findings demonstrate both challenges of safeguarding mangroves in a rapidly urbanising coastal setting and the opportunities for ecosystem-based management through data-driven planning. Protecting blue carbon hotspots is particularly significant for enhancing coastal resilience and contributing to India's climate action commitments under the Paris Agreement. By situating mangroves within the broader theme of marine ecosystem sustainability, this work emphasises the dual role of these habitats in mitigating anthropogenic pressures and offering nature-based solutions for climate adaptation. The study provides a replicable model for integrating remote sensing, spatial modelling, and conservation planning to address the pressing challenges facing marine ecosystems while unlocking opportunities for resilience-building in tropical coastal regions.

Keywords

Blue carbon, Climate action, Coastal resilience, Nature-based solutions, Sustainability



Satellite-derived Chlorophyll-a, phytoplankton size classes and their linkages to fisheries off Kerala Coast

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Marine phytoplankton plays a crucial role in the oceanic food web and global carbon cycle. In addition to various taxonomic groups, phytoplankton are categorised based on their size as microphytoplankton ($>20\ \mu\text{m}$), nanophytoplankton ($<20\ \mu\text{m}$ and $>2\ \mu\text{m}$), and picophytoplankton ($<2\ \mu\text{m}$ and $>0.2\ \mu\text{m}$). These phytoplankton size classes (PSC) differ in their own specific ecology, nutrient uptake, and energy transfer efficiency. Among them, microphytoplankton (MP) are considered the major contributors to fishery productivity and the key drivers of the oceanic carbon cycle. Chlorophyll-a (Chl-a), the principal pigment of phytoplankton, is widely used as an index of phytoplankton biomass. The distinct spectral signature of Chl-a enables its detection and monitoring using satellite remote sensing. Ocean colour satellites have been widely used for the retrieval of Chl-a, and with recent advancements in bio-optical algorithms and abundance-based models, synoptic-scale estimation of phytoplankton size class (PSC) is regularly being carried out. In the present study, we validated satellite-derived Chl-a and PSC products from MODIS-Aqua, ESA-OC-CCI, and Sentinel-3 OLCI with in situ data collected over selected dates over a period of 5 years (2018-2023) in the coastal waters off Kochi, southwest coast of India. Three widely used abundance-based models were used for PSC estimation. Following the validation, the monthly Chl-a and PSC were estimated, and their relation to marine fisheries landing data was examined. This study provides valuable insights into the role of PSC in supporting regional fisheries and contributes to a better understanding of ecosystem responses to environmental changes

Keywords

Abundance-based models, Bio-optical algorithms, Carbon cycle, Productivity, Remote sensing



A pan-India assessment of beach litter load and cleanliness status along the Indian coast

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Beach litter, a major component of marine debris, continues to be a significant environmental concern that threatens the coastal ecosystems and human health. In India, urbanisation, improper waste management, and lack of awareness have exacerbated the issue. A nationwide rapid survey on beach litter status from 248 beaches along various maritime states and union territories of Andaman and Lakshadweep Island has been conducted along the Indian coast. The abundance of beach litter was estimated following the standard methods. The analysis showed wide fluctuations in litter abundance and cleanliness status across various states and union territories. The number of beaches surveyed was the highest in Kerala (50), followed by Tamil Nadu (48), and the lowest was in Lakshadweep (3). The mean beach litter abundance was a maximum of $140.1 \pm 37.6 \text{ g m}^{-2}$ in Kerala state, followed by $128.6 \pm 47.01 \text{ g m}^{-2}$ in Karnataka state. West Bengal state reported the least of $0.163 \pm 0.04 \text{ g m}^{-2}$. Among all the beaches, the Ullal beach of Karnataka reported the highest abundance of 1687.8 g m^{-2} followed by Perumathura beach of Kerala 1382.7 g m^{-2} . The maximum number of extremely dirty ($> 100 \text{ g m}^{-2}$) and dirty ($51\text{--}100 \text{ g m}^{-2}$) beaches were reported at Andhra Pradesh, which indicated the lack of cleaning measures. Kerala (32%) and Karnataka (32.4%) also reported relatively high percentages of very dirty beaches, whereas all the beaches of West Bengal were very clean ($< 1 \text{ g m}^{-2}$). The relative percentage of very clean beaches ($< 1 \text{ g m}^{-2}$) was higher in states like Gujarat (41.6%) and Goa (80%). Similarly, the dominance of clean beaches ($1\text{--}10 \text{ g m}^{-2}$) was noticed in states like Tamil Nadu and the Andaman and Nicobar Islands. In all the beaches surveyed, plastic was the major constituent. In general, the mean total litter abundance along the Indian coast was $72.56 \pm 11.09 \text{ g m}^{-2}$, which is comparatively higher than the previous estimates made in 2014. The findings from this study underscore the urgent need for region-specific waste management interventions, stakeholder awareness, and policy enforcement aligned with global marine pollution reduction goals.

Keywords

Cleanliness, Litter abundance, Marine debris, Rapid survey, Waste management

Perceptions and practices of fishermen on marine debris: Insights from the Tamil Nadu Coast

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Marine litter, particularly plastics, is one of the most pressing environmental concerns globally, with estimates indicating that plastics constitute 50–80% of marine litter found on beaches across the four European regional seas. The impacts of marine debris are multifaceted, affecting biodiversity, ecosystem health, fisheries and coastal livelihoods. It is widely recognised that understanding the causes and stakeholder perceptions of marine litter is essential to framing effective management and policy interventions. Against this backdrop, the present study assessed fishermen's perceptions and practices related to marine debris along the Tamil Nadu Coast, India, with a view to identifying potential entry points for intervention. An online questionnaire survey was conducted using Google Forms, and 308 fishermen representing different stretches of the Tamil Nadu coastline participated. The responses revealed that 100% of trawl fishermen encounter debris during fishing operations, underscoring the ubiquity of the problem. Regarding gear management, 89% of respondents reported taking measures to retrieve damaged or lost nets, while 11% admitted leaving them in the sea, reflecting both positive practices and persistent gaps in awareness and operational feasibility. The average quantity of debris caught per fishing trip varied, with 41.6% reporting less than 1 kg, 39.7% between 1–5 kg, and 18.7% more than 5 kg. Notably, an overwhelming 92.22% of respondents believed that debris adversely affects marine life, with only a small proportion expressing uncertainty (6.22%) or denial (1.56%). These findings indicate a general awareness among fishers regarding the ecological impacts of marine litter, while also revealing behavioural gaps that call for targeted policy interventions, educational initiatives, and infrastructural support to promote responsible fishing practices. The study suggests that interventions focusing on gear retrieval, waste disposal infrastructure at landing centres and fisher-led monitoring programs could provide effective strategies for marine debris management.

Keywords

Ecosystem health, Coastal livelihoods, Gear retrieval, Marine litter, Pollution, Policy interventions



Hydroxyapatite from molluscan shell waste as a sustainable biosorbent for heavy metal removal in aquatic environments

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Molluscan shells, central to marine biology for their structural diversity and ecological roles, are increasingly recognised as renewable reservoirs of biominerals with wide-ranging environmental applications. Building on this paradigm, the present study explores the potential of the terrestrial invasive snail *Achatina fulica*, whose calcium carbonate-rich shells share conserved biomineralisation pathways with marine molluscs, as a resource for producing hydroxyapatite (HAP) for aquatic pollution remediation. Shells of *A. fulica* were processed via wet precipitation to synthesise crystalline HAP, which was characterised and tested for its adsorption capacity against heavy metals commonly found in aquatic environments. The synthesised HAP demonstrated high removal efficiencies for lead (Pb), copper (Cu), manganese (Mn), and zinc (Zn), highlighting its strong affinity for polyvalent metal ions and confirming its suitability as a low-cost biosorbent. These findings extend the ecological and biotechnological relevance of molluscan shell waste, showing that even terrestrial invasive species can be valorised within the broader framework of marine environmental management. By situating this work in the context of shell recycling practices already advancing in marine aquaculture, the study underscores the cross-ecosystem potential of molluscan biominerals as sustainable materials for mitigating heavy metal contamination. In doing so, it bridges terrestrial pest management with marine bioremediation strategies, positioning HAP derived from *A. fulica* shells as a valuable tool for protecting aquatic ecosystems from metal pollution. This integrated perspective demonstrates how molluscan biology, across both terrestrial and marine domains, can inform innovative approaches to resource utilisation, waste reduction, and environmental stewardship, thereby strengthening the role of biomineral research in addressing critical challenges in marine biology and environmental sustainability

Keywords

Achatina fulica, Heavy metal removal, Hydroxyapatite, Snail shell, Wastewater treatment



AI-Powered prediction of harmful algal blooms (HAB) by integrating traditional fishermen knowledge and remote sensing

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Harmful algal blooms (HABs) pose a persistent ecological risk to coastal and aquatic ecosystems with detrimental effects on their water quality, fishery resources and the livelihoods of fishers. Precise monitoring and early warning on the occurrence, spatial and temporal variation of HAB remains a bottleneck challenge; the integration of Artificial Intelligence (AI) with both remote sensing data coupled with Traditional Ecological Knowledge (TEK) offers a new possibility for its localised forecasting. This study attempted to forecast and nowcast the occurrence, proliferation and aftermath of harmful algal blooms in Vembanad and Ashtamudi backwaters, Kerala. TEK was systematically collected from fishermen through questionnaires about observations of indicators such as water discolouration, odour, unusual fish mortality, net fouling, and tidal cues. These inputs were encoded as in situ spatial and temporal features that complement the scientific datasets assessed from satellite-based observations from the Space Applications Centre (SAC) and the Indian National Centre for Ocean Information Services (INCOIS). SAC's atmospheric correction algorithms for ocean colour sensors enhance chlorophyll-a and water quality retrievals, whereas INCOIS services such as Algal Bloom Information Service (ABIS) and previous bloom records provide validated reference. In addition, Google Earth Engine's prebuilt algorithms (Sentinel-2 and Sentinel-3) for water quality indices, chlorophyll-a proxies, and turbidity estimation are employed to streamline data processing without extensive coding. Early-warning dashboard was produced using machine learning models that are derived using a combination of TEK indications and satellite-derived data. Administrators, fishers and aquafarmers will have access to obtain georeferenced risk maps and alerts if these models are integrated into a basic decision-support system so as to avoid livelihood losses. In the long run, a reliable and community-focused tool for fisheries management and ecosystem sustainability will be developed by coupling remote sensing data with indigenous knowledge that is validated for accuracy by comparing with the post-bloom events

Keywords

Artificial Intelligence, Chlorophyll-a, Remote sensing, Traditional ecological knowledge



A machine learning framework to map mangrove cover using multi-sensor satellite data: A case report from Ernakulam District, Kerala

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Mangroves are vital coastal ecosystems that provide natural shoreline protection, act as important carbon sinks, and sustain biodiversity, yet they remain increasingly vulnerable to human pressures and climate variability. Reliable, long-term monitoring of mangrove distribution is therefore essential for understanding mangrove degradation patterns to develop impact-specific management actions. This study develops a machine learning (ML)-based standardised framework for mangrove mapping in the coastal regions. Here, we evaluated both annual and decadal changes in mangrove cover, complemented by spatial analyses, to better understand short-term variability alongside long-term trends (25-year period from 2000–2025), in the Ernakulam District of Kerala. Post-monsoon median composites derived from multi-sensor satellite datasets, including Landsat, LISS-3/4, and Sentinel-2, were processed to ensure low cloud interference and temporal consistency. Multiple ML classifiers, including Random Forest, Gradient Boosting, Artificial Neural Networks, XGBoost, and CatBoost, were employed for classification, with independent field datasets used for model training and accuracy validation. Classification performance was assessed using a suite of accuracy indicators, including confusion matrix, overall accuracy, Kappa coefficient, user's accuracy, specificity, and sensitivity. Among the evaluated classifiers, XGBoost and CatBoost outperformed others, achieving Kappa coefficients of 0.925 and 0.908, respectively, demonstrating strong capability to handle multi-sensor imagery for reliable mangrove mapping. The framework enabled the identification of short-term fluctuations, decadal trends, and spatial patterns of mangrove cover, revealing both degradation hotspots and localised regeneration zones. These findings highlight the vulnerability of certain stretches of the Ernakulam coast, clearly pointing to the need for continuous monitoring, targeted habitat restoration and ecosystem management. Overall, this study details a harmonised ML framework for consistent mangrove monitoring and demonstrates its effectiveness in precise mangrove mapping using multiple sensors, at multiple time scales. Our work offers a scalable methodology that can be extended to other coastal regions of the Indian Ocean. The outcomes contribute directly to marine spatial management, supporting evidence-based policies to safeguard threatened mangrove ecosystems

Keywords

Carbon sink, Coastal management, Mangrove ecosystems, Multiple ML classifiers, Remote sensing



An innovative small-scale fishing gear for *Ehirava fluviatilis* in estuarine ecosystems: Design, efficiency and sustainability insights

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Estuaries are dynamic transitional ecosystems that play a crucial role in sustaining biodiversity, fisheries, and local livelihoods. *Ehirava fluviatilis* (Malabar sprat), a small pelagic fish species, primarily distributed in the ecosystems of southern India and Sri Lanka, locally known as *soochi kozhuva*, belongs to the category of small pelagic fish (SPF) and inhabits both estuarine and freshwater systems across the Indo-Sri Lankan region. This species forms an important fishery in the Vembanad estuarine ecosystem. Despite its ecological and socio-economic value, targeted fishing practices employed for this species remain under-documented. This study systematically documented the design, operation, and catch characteristics of a locally developed small-scale seine net used by fishers to harvest *E. fluviatilis* in Vembanad Lake during 2024–25. The gear, which can be classified as a seine net, as per the ISSCFG, is a small-scale gear, with a horizontal length of 58.7 ± 3.0 m, a width of 8.5 ± 2.0 m, and mostly fabricated using PA mesh of size of 8 mm. Across 78 operations, the average catch ranged from 7 to 135 kg, with peak catches reported in May. The study showed that the gear performed well in estuarine conditions and effectively captured the target species with minimal bycatch (10–15%), primarily consisting of *Metapenaeus monoceros*, *Leiognathus bindus* and *Ambassis* sp. The size of *E. fluviatilis* captured by the gear ranged from 23 to 48 mm, with larger individuals noticed in the month of January, aligning with the post-monsoon season in Vembanad Lake. The findings of the study, which include the design details and operational parameters of the gear, including the catch details, were considered for suggestions to improve catchability, addressing sustainability concerns and need for design improvements is discussed.

Keywords

Gear design, Malabar sprat, Seine net, Small pelagic fish, Vembanad Lake

Marine litter and microplastic pollution dynamics in coral reef and beach ecosystems of Lakshadweep: Ecological risk assessment and implications for biodiversity conservation

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Marine litter, particularly in remote island ecosystems, presents complex challenges due to its heterogeneity, persistence and extensive ecological footprint. Among its constituents, microplastics represent the most pervasive and insidious fraction, capable of penetrating multiple environmental compartments and biological systems, which ultimately lead to lethal impacts. This study presents a comprehensive ecosystem-scale assessment of marine litter across beach environments and a multi-compartmental evaluation of microplastic contamination spanning beach sediments, benthic sediments, and surface waters in Kavaratti and Andrott islands of the Lakshadweep Archipelago. Litter characterisation revealed that plastic materials constituted the dominant fraction in both islands, followed by glass, metal, rubber, and textile-based debris. Macroplastics, primarily single-use plastics, derelict fishing gear, and packaging waste, were concentrated along shoreline transects, indicating both terrestrial leakage and marine-based inputs. Microplastics were ubiquitous across all compartments, with the highest concentrations in beach sediments, followed by surface waters and sediments. Fibres were the predominant microplastic morphotype, and μ -FTIR analysis indicated a higher abundance of PE, PP, and PET, reflecting synthetic textile sources and fishing-related debris. A multi-index ecological risk framework was adopted using the Polymer Hazard Index, Microplastic Contamination Index, Marine Litter Hazard Index, Clean Coast Index, and Integrated Ecological Risk Index, which together revealed localised hotspots of moderate to high ecological risk, particularly in beach ecosystems of Kavaratti and the reef zones of Andrott, highlighting the urgent need for targeted mitigation and habitat protection. This study not only provides baseline risk zonation for vulnerable habitats but also proposes a science-driven conservation framework linking polymer-specific hazard mapping with island-scale management strategies and policy recommendations for biodiversity resilience and marine spatial planning.

Keywords

Ecological footprint, Hazard mapping, Macroplastics, Sediment, Shoreline transects

Towards sustainable deep-sea shrimp trawling: A baseline study for square mesh code end adoption

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Trawl is the major gear in marine fisheries worldwide, with shrimp trawls contributing significantly to India's marine fish production. Kerala operates a large trawl fleet, with Kollam being a key centre for deep-sea shrimp landings. Based on the field surveys conducted between November and July 2025 at Sakthikulangara Harbour, we examined the fishery targeting three commercially important deep-sea shrimps viz., *Heterocarpus chani*, *Heterocarpus woodmasoni*, and *Aristeus alcocki*, with *H. woodmasoni* being the most dominant (84.3%). On an average seven-day fishing trip, the targeted catch comprised 68%, while 32% was bycatch, including non-targeted species, trash fish, and discards. A total of 24 species from 24 families were identified in the bycatch, dominated by Synagropidae (38%), Pandalidae (19%), Myctophidae (17%), Platycephalidae (10%), Nemipteridae (6%), Gempylidae (2%), and others (8%). Size analysis showed *H. woodmasoni* individuals (90–120 mm TL) were above first maturity but below optimum exploitation length, while *H. chani* females matured at 81 mm TL, with most samples around 120 mm. *A. alcocki* individuals (12–18 cm TL) were largely above the minimum legal size (13 cm TL), indicating sustainable harvest levels for this species. Currently, the fishery employs 25 mm diamond mesh cod ends in demersal trawls (*Pullan vala*), which retain many juveniles and undersized individuals, contributing to bycatch. Adoption of square mesh cod ends can improve selectivity, reduce juvenile retention, and ensure shrimps are harvested above minimum legal size. The results of the study are discussed considering the ecological sustainability and long-term viability of the deep-sea shrimp trawl fishery of Kerala

Keywords

Bycatch, Demersal trawl, Juvenile retention, Minimum legal size, Selectivity, Trawl fishing



Monsoonal and depth-resolved variability of particulate organic carbon in the Southwest Bay of Bengal

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Particulate organic carbon (POC) is a vital component of the global carbon cycle, linking surface ocean productivity to deep-ocean sequestration through the biological carbon pump. However, its variability in the Bay of Bengal remains poorly constrained due to strong monsoonal forcing and freshwater influence. In this study, we investigate monsoonal (pre- and post-monsoon) and depth-resolved distributions of POC along the southwest Bay of Bengal, based on in situ observations collected during February 2024 (post-monsoon) and July-August 2024 (pre-monsoon) from four coastal transects (Nagapattinam, Pazhayar, Mahabalipuram, and Chennai). POC concentrations were consistently higher during the pre-monsoon (128-404 mg C m⁻³) than the post-monsoon (62-182 mg C m⁻³), reflecting enhanced phytoplankton productivity under stratified conditions. Depth profiles revealed maxima at the surface and Deep Chlorophyll Maximum (DCM), with sharp declines toward 100 m driven by remineralisation processes. Regional differences were evident, with Pazhayar and Chennai showing elevated POC influenced by freshwater and nutrient inputs, while Mahabalipuram exhibited lower, more oligotrophic conditions. These results demonstrate that POC dynamics in the southwest Bay of Bengal are primarily regulated by monsoon-driven stratification, freshwater inflow, and biological activity, with implications for coastal carbon export, sequestration, and regional carbon budgets. This study provides new insights into the role of monsoon-influenced marginal seas in regulating the marine carbon cycle

Keywords

Carbon cycle, Chlorophyll, Coastal transects, Ocean productivity, Phytoplankton, Sequestration



Ecology of picoplankton in the Southeastern Arabian Sea and the Gulf of Mannar

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This study examines the spatial variability in the biomass and abundance of picoplankton in Southeastern Arabian Sea and the Gulf of Mannar during the Southwest Monsoon (SWM). Sampling was carried out at both nearshore (30 m) and offshore (100 m) stations to assess changes in picoplankton community structure across different environmental gradients. Results indicated that the nearshore stations along the southeastern Arabian Sea (Kollam, Alappuzha, and Kochi) recorded the highest picophytoplankton biomass and abundance. These areas were characterised by elevated concentrations of nitrate and silicate, attributed to freshwater input and coastal upwelling. Enhanced chlorophyll-*a* concentration in these regions also suggested a shift toward the dominance of larger micro- and nanoplankton. Among the picoplankton groups, *Synechococcus* was the predominant one along all sampled stations, while picoeukaryotes exhibited higher relative abundance in nutrient-rich nearshore waters, reflecting their ecological preference for productive environments. In contrast, heterotrophic bacterial abundance lacked a consistent spatial pattern, indicating their distribution is more strongly influenced by localised environmental conditions rather than regional hydrographic trends. Vertically, the highest proportion of picophytoplankton was observed in the upper layers, characterised by greater sunlight and nutrient availability, whereas heterotrophic bacteria were more abundant in the bottom layers, particularly along the southeast coast, indicating their dependence on organic matter accumulating at deeper depths. Principal Component Analysis (PCA) underscored nitrate and silicate as the key environmental variables influencing autotrophic picoplankton distribution, as evidenced by their strong positive correlation in the ordination space.

Keywords

Abundance, Biomass, Chlorophyll-*a*, Nutrients, Productivity, Spatial variability, *Synechococcus*



Detection of microplastics in bottled water and its toxicity evaluation using Zebrafish

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Microplastics (MPs) have emerged as pervasive environmental contaminants in both freshwater and marine ecosystems. Alarming evidence has confirmed their presence not only in aquatic habitats but also in food, air, and drinking water, raising serious concerns about their potential impacts on the health of all living organisms. Despite increasing awareness, research on microplastic toxicity remains limited. In 2019, the World Health Organization (WHO) reported the presence of microplastics in drinking water, highlighting the need for the development of simple detection techniques from water. This study aimed to screen for the presence of MPs in commercially available bottled water and to highlight the toxicological risks posed by plastic debris using a zebrafish model system. In this study, Nile red (NR) stain was used to detect the presence of microplastics in bottled water. Thirty bottles from 10 different brands stored in three conditions were analysed. Microplastics were observed in all samples, with fragments (80%) and fibres (20%) being the predominant forms. FTIR analysis identified polyethylene, polystyrene (PS), polypropylene (PP), and polyamide (PA), with polyethylene (PE) and polystyrene (PS) being the most abundant. To evaluate their potential health effects, fluorescently tagged PE and PS particles were considered for further study in zebrafish (*Danio rerio*) embryos. Significant morphological defects were observed in a dose-dependent manner, including morphological deformities and abnormal organ development. Particle accumulation was observed in organs such as the gills, stomach, notochord, and embryo sac. The results of this study highlight the potential risk of MPs to human health and emphasise the need for more focused and detailed research on the adverse effects of MP exposure on living beings

Keywords

Environmental contaminants, Human health, Packaged water, Particle accumulation, Toxicological risks



Heavy metal contamination in fishes from Indian Sundarbans: Potential health risks

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Sundarbans, the largest mangrove delta on the planet earth is famous for its marine and estuarine fish resources. Due to negative pressures like intense industrialisation, urbanisation and increase of anthropogenic activities in recent times, this ecosystem is getting contaminated with toxic heavy metal which is a significant concern for human health and natural ecosystems. Our recent study indicates the presence of heavy metals in commercially important fish and crustaceans (shellfish and crab) collected from Indian Sundarbans and hence consuming the fish caught from the area may not be risk-free. The average of metal concentrations (mg kg⁻¹) in muscle of the studied species were found to be: Fe (71.62) > Zn (10.80) > Cr (5.32) > Mn (1.95) > Ni (1.62) > Cu (1.46) > As (1.37) > Pb (0.11) > Co (0.05) > Cd (0.01). Study revealed that at least two metals, chromium and arsenic in some of the fish species exceeded toxicity threshold limit. Tannery industry is the major source of Cr pollution and discharge from megacity Kolkata might have increased the Cr accumulation. Correlation analysis revealed that fish body size had little impact on the accumulation of most trace elements. Assessment of non-carcinogenic health hazard by target hazard quotient (THQ) indicated no concern from consumption of these fish. However, hazard index (HI) in individual fish species is greater than 1 indicating consumption of the studied fish species in excess and on a regular basis could pose a number of non-carcinogenic risks. The target cancer risk (TR) values suggested carcinogenic risk from arsenic (As). Taken together it can be concluded that there is potential human health risk in consuming fish from these areas and hence regular monitoring, identification of contamination sources and treatment are crucial to reduce any potential health risks to the local population and other consumers, as the Sundarbans is a major fish producing area in the state of West Bengal, India

Keywords

Carcinogenic risk, Crustaceans, Health risk, Mangrove ecosystem, Tannery industry, Trace metals



Evidence on Artificial reef habitats serving as recruitment grounds of rare and ornamental communities developing over maturing artificial reefs

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ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) has been into restoring vulnerable habitats and assisting the coastal states in the siting and deployment, and monitoring of artificial reefs for the last three decades, predominantly for the state of Tamil Nadu. Artificial reef surfaces can act as a platform for rare marine fauna, especially when natural habitats are degraded or lacking. By adding complex, stable, hard-bottom substrates and structures to otherwise featureless sea beds, by creating new complex shelter, ecological niches that attract and foster diverse marine life, including species that are locally uncommon or at the edges of their geographic ranges, as beneficial in movement as ocean conditions change, and acting as conservation corridors. The ongoing studies on the habitats developed, throws light on the very rare fauna like the black lip pearl oyster, pen shells, giant clam, damsels, zancids, angels, clown fishes, butterfly fishes, cardinals, gobiids, wrasses, blennies, surgeon fishes, trigger fishes, box fishes, Chromis, eels, dragonets, parrotfish, sea horses, squirrel fishes, idols, rays, pipe fishes, anemones, corals, camel shrimps, pistol shrimps, sea cucumbers, sea lilies, sea urchins, starfishes, ear shells, Pontonine shrimps, Galatheid lobster, lobsters, carideans, barnacles, sponges, gastropods, cephalopods, bamboo sharks and white spotted grouper, thriving and multiplying very fast. The zooplankton and settlement samples over the reef surfaces indicated the larval settlements and recruitments of several reef-associated fauna. The live samples collected were maintained for further development studies and to understand the larval cycles and feed relations in the niche. The study captured a few brood-sized numbers to understand the larval characters and further developments into the colony settlements. The fecundity, larval sizes, and feed performances were studied. These recruits and their role in developing habitats are better understood and help us in the assessment of the health of the newly developed Artificial reefs

Keywords

Conservation corridors, Ecological niche, Larval settlements, Natural marine nurseries, Recruitment



Spatial dynamics and decline of seagrass meadows in the Lakshadweep Archipelago, Northwestern Indian Ocean

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Seagrass meadows in the Lakshadweep Archipelago are vital for fisheries support, nursery habitat provision, and blue carbon storage, yet their long-term trends and drivers of change remain poorly documented. This study integrates multi-temporal satellite data (Landsat series processed on Google Earth Engine) with targeted field surveys to assess seagrass cover, species composition, and sediment characteristics across multiple lagoons. Findings reveal a measurable net decline in meadow extent, particularly in Kalpeni, where formerly continuous *Thalassia*-dominated beds have contracted and fragmented. Drivers of decline include increasing thermal stress, episodic bleaching, sediment mobilisation, turbidity, and localised anthropogenic pressures such as coastal modifications and nutrient inputs, alongside natural lagoon dynamics and grazing by sea turtles. Sediment analyses further indicate reduced organic carbon stocks in areas of meadow loss, signalling a decline in blue carbon. Complementary diversity and distribution studies (2018–2024) provide species-level insights and highlight spatial shifts across atolls. These results emphasise the urgent need for coordinated lagoon-scale monitoring, protective zoning of priority meadows, and community-based restoration integrated within coastal management frameworks. We propose a practical monitoring approach combining remote sensing with periodic in situ assessments to detect change, guide interventions, and evaluate restoration success in the Lakshadweep Islands.

Keywords

Blue carbon, Diversity, Distribution, Restoration, Seagrass mapping, Sediment characteristics



Spatial variability of surface microplastics off Karnataka, Eastern Arabian Sea, in relation to morphotypes, size classes and polymer composition

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Microplastics are widely recognised as a persistent and pervasive pollutant in marine ecosystems, yet information from Indian waters is still scarce. The Arabian Sea, particularly the Karnataka coast, supports intensive fisheries, aquaculture, textile industries, and port operations, all of which contribute to plastic leakage. Establishing a comprehensive baseline of microplastic pollution in this region is crucial for understanding sources, ecological risks, and future management. In this study, surface and near-surface seawater samples were collected during 2023–2024 at two depths (5 and 10 m) from multiple stations along the Karnataka coast. Water samples were filtered, and microplastics were identified under a stereomicroscope. Particles were categorised into morphotypes (fibres, fragments, foams) and size classes (<1 mm, 1–2 mm, >2 mm). To determine the polymer composition, selected particles were analysed by Fourier Transform Infrared (FTIR) spectroscopy. Abundance was standardised as numbers per cubic metre. Across the samples, total microplastic counts ranged from 48 to 328 per sample, with concentrations of 1.27–5.77 items m⁻³. Fragments were the most abundant morphotype, followed by fibres and foams. Most of the particles were smaller than 1 mm, highlighting the prevalence of secondary microplastics and their potential bioavailability to plankton species. FTIR analysis revealed polyethylene (PE) as the dominant polymer, followed by polypropylene (PP) and polystyrene (PS). Polyurethanes (PU) and polyethylene terephthalate (PET) contributed only marginally. Subsurface variation between 5 m and 10 m was evident but not uniform, with some stations peaking at 10 m while others showed higher counts at 5 m, indicating local hydrodynamic influences and source heterogeneity. This study provides the first systematic dataset on surface microplastic pollution along the Karnataka coast. The findings confirm significant contamination, dominated by fibres and buoyant polymers, and emphasise the need for sustained monitoring, improved waste management, and source-specific mitigation strategies in the Arabian Sea.

Keywords

Buoyant polymers, Environmental monitoring, Morphotypes, Near-surface seawater, Polymer identification



Utilisation of biochar made from *Eichhornia crassipes* as a sorbent for removing oil from water

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Oil spills and invasive water hyacinth infestations are among the major challenges faced by aquatic ecosystems worldwide. To address these issues, we developed a method to utilise biochar derived from water hyacinth for oil spill absorption. Water hyacinth was collected from the Vembanad Estuary and air-dried. The dried stalks were then converted into biochar by pyrolysis at 400–500°C for two different durations: 5 and 10 min. The biochar was evaluated for its oil sorption capacity by adding 0.1 g of biochar to a mixture containing 25 ml of distilled water and 1 g of spent engine oil, and incubating for two different durations (0 min and 30 min). After the sorption process, the biochar was collected, weighed, and oven-dried at 100°C for 24 h to remove moisture. The dried samples were then reweighed to determine the amount of oil absorbed. The residual oil in the mixture was extracted using hexane and subsequently analysed spectrophotometrically to quantify the unabsorbed fraction. UV–Vis spectrophotometric analysis was performed for various concentrations of spent engine oil, and a calibration curve was generated using absorbance data to estimate unknown concentrations (g l^{-1}). The absorbance values obtained were then used to calculate oil concentrations before and after adsorption with biochar, allowing the determination of the material's adsorption capacity. Results indicated that biochar produced with 5 min of heating exhibited the lowest sorption efficiency (47.56%) at 0 min contact time, whereas biochar prepared with 10 min of charring showed the highest efficiency (63.44%) under the same conditions.

Keywords

Adsorption capacity, Oil sorption, Pyrolysis, Sorption efficiency, Water hyacinth



Source diagnostics and ecotoxicological risks of sedimentary pesticides and heavy metal contamination in the uninhabited island ecosystem of the Lakshadweep Archipelago

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Uninhabited island ecosystems are increasingly vulnerable to diffuse pollution sources, with pesticide residues emerging as critical contaminants due to their persistence, bioaccumulation potential, and capacity to induce ecotoxicological stress in pristine environments. This study investigates the occurrence, source diagnostics, and ecological risks of pesticide and heavy metal contamination in the sediment of Suheli Par, an uninhabited tropical island ecosystem of the Lakshadweep Archipelago, integrating with multivariate statistical analyses and risk modelling approaches. A total of 55 pesticides spanning organochlorines, organophosphates, synthetic pyrethroids, and triazines were quantified using gas chromatography–tandem mass spectrometry (GC–MS/MS) following USEPA protocols. Concurrently, associated toxic heavy metals (As, V, Pb, Cd, Ni, Mn, Co, Cu, and Cr) were analysed via inductively coupled plasma–mass spectrometry (ICP–MS) to explore co-contamination patterns and potential shared pathways of transport. Diuron was found to be the dominant pesticide with the highest concentration, and the DDT derivatives were found to have a higher detection frequency. Regarding heavy metals, lead (Pb) and cadmium (Cd) were found to occur in higher concentrations. Diagnostic ratios and compositional fingerprints confirmed historic pesticide residues, indicating minimal recent local application. Ecotoxicological risk was assessed using Risk Quotient and Sediment Quality Guidelines, revealing that certain organochlorines and triazines exceeded threshold effect levels, posing chronic toxic risks to benthic invertebrates and higher trophic levels. The co-occurrence of As and V with high pesticide loads suggests a synergistic risk potential, likely linked to agrochemical formulations and marine deposition processes. This study underscores the need for transboundary pollution control measures and long-term biomonitoring in ecologically sensitive, uninhabited island systems, where even minimal anthropogenic influence can disrupt baseline ecological integrity

Keywords

Bioaccumulation, Ecotoxicological risk, Heavy metals, Pesticide residues, Transboundary pollution



Environment monitoring of trace metals and pesticides in the Kole wetlands of Kerala during the post-monsoon season

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The Kole wetlands, spanning Malappuram and Thrissur districts in Kerala and part of the ecologically significant Vembanad-Kole wetland system, were examined for heavy metal contamination in surface sediments during the pre-monsoon (February 2024), summer monsoon (June 2024), and post-monsoon (August 2023) seasons. This study focused on the concentration of eight heavy metals viz., Mn, Fe, Ni, Cu, As, Hg, Cd, Pb and the concentration of pesticides in sediments to discuss their potential to affect human beings. Samples were collected from six sites using a Van Veen grab sampler. For metal analysis, sediment samples were digested with a mixture of HF, HNO₃, and HCl, and metal concentrations were quantified using Inductively Coupled Plasma Emission Spectroscopy (ICP-MS). Pesticide samples were analysed by GC-MS. Most of the metals (Ni, Cu, As, Cd, Pb) showed the highest values in Parichakam. For copper, cadmium, and manganese, the concentration ranged from 0.74 to 88.36 (average: 20.04923 ± 20.65643) mg kg⁻¹, 0.01 to 0.45 (average: 0.092885 ± 0.105655) mg kg⁻¹, 10.86 to 311.49 (aveg: 85.70 ± 78.44) mg kg⁻¹, respectively. For mercury, the minimum concentration (0.002 mg kg⁻¹) was noted in Pullu with the maximum concentration (0.98 mg kg⁻¹) in Puzhakkal (aveg: 0.156385 ± 0.222883) mg kg⁻¹. Mercury can be contributed by human activities such as incineration of electronic waste and excessive use of mercury-containing fertilizers and pesticides. For lead, the concentration ranged from 3.53 to 83.81 (aveg: 15.90385 ± 18.32682) mg kg⁻¹, with the lowest in Parichakam. Lead can be contributed by land runoff as well as the application of pesticides. Protective measures are necessary to address the rising levels of toxic metals such as As, Cu, Hg, Cd, and Pb. Continuous monitoring and pollution source control, especially from agriculture and industry, are essential to protect the ecological integrity of the Kole wetlands. Out of the 56 pesticides targeted, only 19 pesticides were detected. The Hazard Quotient (HQ) approach was used to assess the environmental risk posed by pesticides in the sediment samples. HQ values ranged from 0 to 104.27, indicating a wide variation in risk levels, from negligible risk (HQ < 1) to high ecological threats (HQ > 100).

Keywords

Ecological integrity, Environmental risk, GC-MS, Hazard quotient, Heavy metals, ICP-MS



Microplastic contamination in the gut of commercial fishes from the Southeast Bay of Bengal: Evaluation, characterisation and risk assessment

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Food safety and livelihoods that depend on fisheries are increasingly at risk due to microplastic (MP) pollution, which has become a serious environmental hazard in marine environments. The current study examined the prevalence, traits, and possible dangers of microplastics in marine fish that are significant to the marine economy. The Kasimedu region yielded 200 fish specimens that were examined for microplastic ingestion. These specimens included moustached thryssa (*Thryssa mystax*), Dussumier's ponyfish (*Leiognathus dussumieri*), ribbon fish (*Trichiurus lepturus*), Delagoa threadfin bream (*Nemipterus bleekeri*), and Belanger's croaker (*Johnius belangerii*). To characterise MPs by size, shape, colour, and polymer composition, standardised procedures involving digestion and microscopic/FTIR spectroscopy were used. The findings showed that MPs were present in 87.5% of fish samples, with abundances varying from (1.9±1.1 particles per individual) in *T. mystax* to (2.4±1.2 particles per individual) in *L. dussumieri*, (1.9±1.4 particles per individual) in *T. lepturus* (1.8±0.8 particles per individual) in *N. bleekeri*, and (1.3±0.4 particles per individual) in *J. belangerii*. The most common shapes were fibers (69.89%), followed by foam (10.75%) and fragments (10.03%). The most prevalent colours were black (47.33%) and blue (20.66%). MPs of 1mm (35.33%) dominated the size distribution, indicating their potential for trophic transfer and bioavailability. The following primary polymers were identified by polymer analysis: Phenol formaldehyde resin, Epoxy resins, Paraffinic compounds, Chloro-sulfonated polyethylene, Polypropylene, Polyester, and Polystyrene. Risk estimation based on polymer hazard index (PHI) revealed possible ecological and health risks following the consumption of high-risk polymers. Commercially vital species like *T. mystax* had relatively higher MP loads with hazard level IV polymer, phenol formaldehyde (PF) and *J. belangerii* with the most hazardous polymer with the highest-level V epoxy resin (EP), highlighting seafood safety implications. In summary, the polymer composition and particle size strongly indicate that the principal sources of microplastics are abandoned fishing gear, synthetic clothing, packing trash, coastal urban runoff, and aquaculture practices. These results highlight the pressing necessity of policy action, sustainable waste management, and enhanced monitoring to abate microplastic pollution and its downstream risks in marine food webs.

Keywords

Abandoned fishing gear, Particle size, Polymer hazard index, Risk assessment, Trophic transfer

Seasonal hydrographic forcing and its influence on phytoplankton community dynamics in the Eastern Arabian Sea

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Phytoplankton, the dominant photosynthetic microalgae, contribute nearly half of global marine primary production and underpin pelagic food webs with their dynamics closely tied to hydrographic variability, regulating ecosystem productivity, nutrient cycling, and trophic dynamics. In the Southeastern Arabian Sea (SEAS), monsoon-driven processes such as upwelling, riverine discharge, and stratification drive strong spatiotemporal variability in phytoplankton biomass, composition, and distribution. The present study provides a comparative assessment of phytoplankton community structure, quantified through chlorophyll-*a* biomass, cell abundance, and species composition, under two climatically contrasting monsoonal regimes: the Southwest monsoon (SWM) and the Northeast monsoon (NEM). During SWM, intense coastal upwelling injected cooler ($< 26^{\circ}\text{C}$), nutrient-enriched subsurface waters into the euphotic zone, resulting in elevated chlorophyll-*a* concentrations and enhanced cell abundances. Diatoms dominated overwhelmingly, with *Proboscia alata*, *Asterionellopsis glacialis*, and *Chaetoceros* sp. serving as key bloom-forming taxa, indicative of *r*-strategist success under high-nutrient, turbulent conditions. In contrast, the NEM was characterized by warmer ($> 29^{\circ}\text{C}$), stratified, and oligotrophic surface waters that limited nutrient replenishment, leading to reduced chlorophyll-*a* biomass and a community shift toward dinoflagellate dominance. Conspicuous blooms of the mixotrophic dinoflagellate *Noctiluca scintillans* (29.7×10^3 cells l^{-1}) were observed during NEM at the Kollam transect, underscoring the trophic plasticity and bloom potential of this species in nutrient-depleted environments. Such shifts highlight the ecological significance of mixotrophy in sustaining productivity during resource-limited conditions. Spatial heterogeneity was also evident along the SEAS. Southern transects (Kollam and Cochin) consistently exhibited higher chlorophyll-*a* concentrations and phytoplankton abundances, driven by stronger upwelling intensity and enhanced nutrient supply. Conversely, northern transects (Beyport and Mangalore) displayed comparatively weaker upwelling signals, reduced nutrient enrichment, and lower phytoplankton productivity, reflecting a north-south gradient in monsoonal forcing. Collectively, these findings emphasise the critical role of monsoon-driven hydrographic variability in regulating phytoplankton community structure, productivity, and functional composition in the SEAS. As climate change is expected to alter the intensity, periodicity, and spatial extent of monsoon winds and coastal upwelling, intensive monitoring of phytoplankton community is essential to assess potential repercussions on regional biogeochemical cycling, fisheries productivity, and ecosystem resilience.

Keywords

Chlorophyll-*a*, Coastal upwelling, Monsoon, Nutrient cycling, Primary production, Trophic dynamics

Abundance and characteristics of microplastics in beach sediments of the Thiruvananthapuram Coast, South India

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Plastic particles smaller than 5 mm (microplastics) have emerged as a global environmental concern due to their deleterious impacts on ecosystems and potential risks to human health. A study was conducted to evaluate the abundance, distribution, and physical and chemical characteristics of microplastics in the beach sediments along the Thiruvananthapuram Coast. Sediment samples from 15 beaches were collected and analysed following standard protocols. The morphology of microplastics was assessed under a compound microscope and sorted based on their shape, colour, and size. Fourier Transform Infrared Spectroscopy (FTIR) was used for polymer identification. The maximum abundance of microplastics was observed in the sediments of fishing beaches like Puthenthope and Pozhiyoor, with a mean of 59.67 ± 4.18 nos. kg^{-1} and 50 ± 2 nos. kg^{-1} , respectively. In general, fishing and recreational beaches exhibited comparatively higher levels of microplastics, indicating the anthropogenic influence. Microplastic constituents observed included fibre, fragment, filament, and film, with fibres and fragments being the dominant constituents. All beaches except Vizhinjam exhibited the dominance of transparent microplastics, followed by blue at 10 beaches. Microplastics $< 500 \mu\text{m}$ were prevalent at most beaches, and most of them were identified as polyethylene. The presence of these polymers confirms fishing, domestic, and tourism-related sources as contributors of microplastics. Significant variation was noticed in the abundance of fibres and fragments across each site ($p < 0.001$). This study underscores the need for effective waste management, public awareness, and regular beach cleaning activities to safeguard ecosystem health and biodiversity.

Keywords

Beach sediment, Biodiversity, Ecosystem health, Morphology, Polyethylene



Bioaccumulation of heavy metals in commercially important marine fish species from Kerala's coastal waters: A monsoon-centric assessment with histopathological validation

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Heavy metal contamination in coastal marine ecosystems poses significant ecological and public health risks through bioaccumulation in commercially important fish species. This study investigated the spatial, seasonal, and tissue-specific distribution of seven heavy metals (Chromium, Manganese, Nickel, Copper, Zinc, Cadmium, and Lead) in three economically important fish species: mackerel (*Rastrelliger kanagurta*), oil sardine (*Sardinella longiceps*), and Japanese threadfin bream (*Nemipterus japonicus*), collected from Fort Kochi and Chavara coastal waters in Kerala, India. Fish samples were collected during pre-monsoon (Phase I) and post-monsoon (Phase II) periods, with five tissues (gill, liver, kidney, muscle, and gonad) analysed using acid digestion and instrumental analysis. Histopathological examination was conducted to assess tissue-level alterations. Statistical analysis employed one-way ANOVA and Pearson correlation analysis to determine the significance of variations across sites, seasons, and tissues. Results revealed significant interspecies variation in heavy metal accumulation, with *N. japonicus* exhibiting the highest total metal burden ($437.50 \text{ mg kg}^{-1}$), followed by *S. longiceps* ($408.08 \text{ mg kg}^{-1}$) and *R. kanagurta* (95.95 mg kg^{-1}). Zinc was the most dominant element across all species and locations, while lead showed consistently the lowest concentrations. Liver and kidney tissues demonstrated the highest metal accumulation due to their detoxification roles. Seasonal analysis indicated significantly higher metal concentrations during post-monsoon periods, reflecting monsoon-driven hydrological changes affecting metal bioavailability. ANOVA results confirmed highly significant differences ($p < 0.01$) in elemental concentrations among species for all examined metals. Histopathological examination revealed extensive tissue damage, including epithelial lifting, vacuolar degeneration, cytoplasmic vacuolation, and reproductive tissue alterations, indicating chronic metal exposure stress. These findings highlight alarming contamination levels in Kerala's coastal waters and emphasise the urgent need for strategic environmental management and continuous biomonitoring to protect marine ecosystems and public health.

Keywords

Detoxification, Ecotoxicology, Histopathology, Public health, Seasonal analysis



Interlinking canals, the major pathway of litter to the main lake: A case study in Vembanad Lake ecosystem, Kerala, India

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The pervasive global issue of plastic litter pollution is a major human interventional threat to the longevity and fertility of our lake and estuarine ecosystems that the current century is facing. Through land runoff, industrial, agricultural, and domestic wastes enter water bodies and discharge into estuaries. Approximately 80% of marine litter is derived from terrestrial sources, ultimately reaching the lakes through the interlinking pathways. But surprisingly, much less research has been dedicated to investigating the fate and impacts of plastic litter contributing to estuarine systems through these interlinking canals or pathways. The study aimed to assess the sources, abundance, and distribution of plastic litter through the interlinking canals to Vembanad Lake, the largest lake in Kerala and the longest in India, with international significance designated under the Ramsar Convention. As Vembanad Lake ecosystem comprises a large number of tributaries and streams flowing to it, owing to the practical difficulty in assessing the entire network, a representative number of canals situated in Vypin Island was selected for the study. Vypin is one among the cluster of islands that form part of Kochi, sprawls across 27 km of land, and is one of the most densely populated islands; the anthropogenic effect in the area always stands high. The land has several numbers of canals (Thodu) connecting to Vembanad Lake, which can form a corridor for plastic litter pollution to the lake. An attempt was made here by assessing the contribution of litter through selecting 8 such canals, namely Pukkad canal, Njarackal canal, Aniyal canal, Kuzhuppilly canal, Vastheri Cherai canal, Karuthala canal, Pallippuram and Moothakunnam-kottuvallikkad canal originating from Vypin Island and discharging to Vembanad Lake. The overall average abundance of micro, meso, and macro plastics obtained from the canal sediment was 91.04 ± 13.88 nos. m^{-2} (varied from 12 to 313 nos. m^{-2}); 53.26 ± 5.24 nos. m^{-2} (varied from 0 to 104); and 2.26 ± 0.22 nos. m^{-2} respectively. However, no significant variation was observed in the abundance of litter between the interlinking canal and the corresponding main lake, as the area observed was near Munambam-Azhikode Estuary, where the tidal influence permits the 'to and fro' movement of the material beneath.

Keywords

Abundance, Anthropogenic effect, Corridor, Plastic litter, Streams, Terrestrial sources



Assessing microplastic pollution in Potential Fishing Zones of the Eastern Arabian Sea

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Pollution has emerged as one of the most critical environmental challenges, with the marine environment acting as a major sink for these pollutants. Among various types, plastic pollution is a major concern as it persists in the environment for extended periods and gradually degrades to form smaller plastics known as microplastics (MPs), less than five mm in size. Ingestion of MPs by organisms can lead to bioaccumulation and trophic transfer, posing risks to fisheries and human health through seafood consumption, thereby raising concern over seafood safety and public health. The study aims to examine the occurrence and distribution of MPs in the water column from both Potential Fishing Zones (PFZs) and non-PFZ regions off the Mangalore-Udupi coast for three months (November 2024-January 2025). Thirteen samples were collected from surface, middle and bottom depths with sampling locations guided by PFZ advisories from INCOIS and non-PFZ sites serving as control sites. The highest concentrations were observed in November 2024 (23 ± 2.92 particles l^{-1}), likely linked to post-monsoonal runoff, while the lowest levels occurred in January 2025 (7.3 ± 1.14) particles l^{-1}). Fibres dominated across all samples (>70%), followed by fibre bundles, fragments and minor occurrences of foam, with likely sources including fishing nets, packaging materials and synthetic textiles. The 100-3000 μm size fraction was most prevalent, pointing to secondary MPs generated through fragmentation. Transparent particles dominated in November and December, whereas blue particles were more common in January. The dominance of fibrous MPs in PFZs suggests a potential exposure risk for commercially important fish species, heightening the likelihood of human ingestion through seafood. These findings underscore the urgent need for source-tracking and risk assessment studies to safeguard marine ecosystems, fisheries, and public health.

Keywords

Bioaccumulation, Emerging contaminant, Marine pollution, Seafood safety, Trophic transfer



Comparison of microplastics pollution from urban and rural sources of the Old Brahmaputra River along the Mymensingh City Corporation of Bangladesh

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The Old Brahmaputra River (OBR) is branched off from the Jamuna River in the Jamalpur District of Bangladesh and flows through six districts southeasterly, including the divisional headquarters and the City Corporation of Mymensingh. It runs for approximately 200 km before meeting the Meghna River at Bhairab Bazar in Kishoreganj, Bangladesh. The population and housing census (in 2022) shows that there are around 5,76,722 households in Mymensingh, and there are garment dyeing and plastic manufacturing industries; and municipal activities on the urban side of the OBR. In contrast, the rural side of the OBR along Mymensingh City Corporation is dominated by agricultural activities and a relatively thin distribution of households. During the present study, a comparative analysis of microplastic (MP) contaminants in water and sediment of the OBR originating from the urban and rural sources was carried out. Water and sediment samples were collected from six sampling locations of the OBR along the Mymensingh City Corporation; from upstream to downstream, these stations are: Silver Castle, Joynul Abedin Park, Thana Ghat, Boddho Bhumi, BAU Botanical Garden, and Kashiar Char. The highest number of MPs in the water was 20.1 particle l⁻¹ in the urban side of Thana Ghat, whereas for sediment samples, the highest was also in the urban side of Joinul Abedin Park, which was 1077.5 particles kg⁻¹. For both water and sediment samples, the highest proportion of MPs were in the 10 to 300 µm size range. Opaque-coloured MPs were predominant in the water (57.89%), and yellow-coloured MPs were more common in the sediment (56.04%) samples. The most significant percentage of MPs in both water and sediment samples were fragment-shaped. This study shows that urban areas contribute significantly to the MP pollution of the OBR due to intense anthropogenic activities and emphasises improved waste management and sustainable practices to mitigate the plastic contamination to protect the aquatic ecosystem of the OBR.

Keywords

Anthropogenic activities, Downstream sources, Sediment samples, Upstream sources, Waste management



Occurrence of microplastics in commonly consumed pelagic fish species from the Thiruvananthapuram Coast, South India

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Concerns over food safety and ecological risk have been raised by research conducted worldwide and along Indian coasts that have shown microplastics in various realms of marine ecosystems. A study was conducted to investigate the presence of microplastics in the muscle and gut tissue of two common marine pelagic edible fishes (oil sardine and mackerel) along the Thiruvananthapuram Coast to assess the extent of plastic pollution in the marine ecosystem and the risk it poses to marine life, including human beings. Microplastics were estimated using standard protocols involving chemical digestion, extraction and sorting. The confirmation of plastics was done by polymer identification by FTIR and micro-Raman spectroscopy. A total of 25 mackerel specimens were examined for microplastic contamination, out of which 92% were detected with microplastics either in the muscle or gut tissues. Among the microplastics observed, both in the muscle tissue and gut, the majority were fibres (86% and 81.5 %), followed by filaments (12% and 10.5%) and fragments (4% and 7.8%). The majority of microplastics observed were blue (43.28%), followed by red (25.37%), transparent (17.91%), black (5.97%), brown (2.98%), and yellow and white (1.49%). 41% of fibres were in the length range of 500µm -1mm, 75% of the fragments were in the range 50-100 µm, and 57.14% of filaments were in the range 1- 2mm. Among 30 sardine specimens examined, 73.3% were detected with microplastics either in the muscle or gut tissue. Among the microplastics obtained in the muscle tissue, the majority were filaments (48%), followed by fibre (32%) and fragments (20%). In the gut tissue, the majority of the microplastics observed were fibres (50%), followed by filaments (34.61%) and fragments (15.38%). 52% of the microplastics observed were blue, followed by transparent (24%), red (12%), black (8%), and green (4%). 60% of the fibres were in the length range of 100-500 µm, 66.6% of fragments were smaller than 50 µm in length, and 47.6% of the filaments were in the range 500 µm-1 mm. Polyethylene was the dominant polymer in both sardine (78.5%) and mackerel (61.5%). Among these, Low-Density Polyethylene (LDPE) was the major constituent. In mackerel, Poly Vinyl Chloride (PVC) was also noticed. In sardine, Polypropylene (14.2%) constituted the second major constituent, followed by Polyethylene Terephthalate (7.14%). The results may also help to guide and formulate environmental regulations and comprehensive policies to mitigate plastic pollution in the marine environment.

Keywords

Chemical digestion, Ecological risk, Edible fish, Environmental regulation, Fibres



Assessment of microplastics in the gut of *Sardinella longiceps* and *Rastrelliger kanagurta*: Implications for marine pollution

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Microplastics, defined as plastic particles smaller than 5 mm, have become a major environmental contaminant in marine ecosystems. Due to their small size and widespread presence, they are readily ingested by a variety of aquatic organisms. Globally, an estimated 1.2–2.4 million t of plastic waste enter the ocean annually via rivers, contributing to increasing levels of microplastic pollution in both coastal and offshore waters. Ingestion of microplastics has been documented in numerous marine species, including amphipods, barnacles, mussels, decapods, and fish, leading to adverse biological effects such as reduced feeding, impaired digestion, energy depletion, physical damage to the digestive tract, reduced reproductive output, and raising concerns about their transfer through food webs. The present study aimed to investigate the presence, quantity, and type of microplastics in the gastrointestinal tracts of two commercially and ecologically significant pelagic fish species, *Sardinella longiceps* and *Rastrelliger kanagurta*. Using stereomicroscopic examination combined with Raman spectroscopy, microplastics such as polyethylene and polypropylene were identified. In *S. longiceps*, a blue-coloured plastic fragment was detected and confirmed as polypropylene. Analysis of *R. kanagurta* specimens revealed the presence of both polyethylene and polypropylene fragments. Polypropylene and polyethylene are common polymers widely used in packaging materials and fishing gear, suggesting that local anthropogenic activities may contribute significantly to marine plastic pollution in the region. The detection of microplastics in both species indicates that the marine environment in the region is becoming increasingly contaminated by plastic pollution, with implications for consumers, as these species are widely consumed and form important links in the marine food web. As filter-feeding and small pelagic fish, sardines and mackerels serve as key dietary components for larger predators, and the presence of microplastics suggests a potential pathway for trophic transfer of plastic contaminants.

Keywords

Anthropogenic activities, Environmental contaminant, Gastro-intestinal tract, Marine ecosystems, Trophic transfer



Ingestion of marine plastic litter by the longnose lancetfish *Alepisaurus ferox* Lowe, 1833, off Northwest Coast of India

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Ingestion of marine plastic litter (MPL) by marine organisms has become a major threat to the marine ecosystem. Lancet fishes are the large oceanic predatory fishes of the genus *Alepisaurus* belonging to the family Alepisauridae widely distributed in the Pacific, Atlantic, and Indian Oceans. Lancet fish acts as an indicator of marine litter, due to the presence of a large mouth comprised of frightening fang-like teeth making them voracious and carnivorous feeders. Lancet fishes are caught as a bycatch in longline fishery, as they are commercially less important due to their gelatinous muscle. But they are common prey for commercially harvested fish for human consumption. Hence, plastic debris ingested by lancet fish affects species on most trophic levels. The present study was undertaken to determine the frequency of occurrence and to quantify the amount and type of plastic marine debris ingested by longnose lancet fish, *Alepisaurus ferox*, occurring along the northwest coast of India. A total of 120 samples were collected during 56 trips from the survey vessel MFV *Mastya Vrushi*, monofilament tuna longliner attached to the Fishery Survey of India. The samples were collected for the period of 10 years from 2013 to 2023. The survey vessel was operational in the area between latitude 18°N and 23°N. The total length of the specimens ranged between 89.0 to 136 cm, weighed between 1.02 to 2.80 kg. The Index of Relative Importance method was followed for gut content studies. Gut content analysis revealed that plastic was present in the gut of the lancet fish along with other gut contents such as digested fish, molluscs and digested matter. The retrieved plastic was categorised such as type, shape, malleability, and colour. It was observed that around 70% of the fishes (*A. ferox*) contained plastic marine debris. Correlation analysis indicated no relation between the length of the fish and the amount of marine plastic debris ingested by the fish.

Keywords

Alepisaurus ferox, Gut content analysis, Lancet fish, Plastic marine debris, Predatory fish



Seasonal distribution of organochlorine pesticides with special emphasis on DDT metabolites in the Periyar River, Kerala

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The Periyar River, a major lifeline of central Kerala, is subjected to intense anthropogenic pressures from industries and agriculture, making it a sink for persistent organic pollutants. This study assessed the seasonal distribution of organochlorine pesticides (OCPs), with special focus on dichlorodiphenyltrichloroethane (DDT) and its metabolites, in sediment samples collected during the monsoon and post-monsoon seasons across five stations influenced by industrial activity. Gas chromatography–mass spectrometry (GC–MS) analysis revealed the occurrence of several OCPs, including hexachlorocyclohexane (HCH) isomers, aldrin, dieldrin, endosulfan, and notably, DDT and its breakdown products (DDD and DDE). Among these, DDE was the most frequently detected metabolite, indicating long-term degradation and historical usage rather than recent DDT inputs. Spatial variation showed elevated residues at industrially impacted stations (CMRL, FACT, TCC, and IRE), while temporal variation suggested higher concentrations during the post-monsoon period, likely due to reduced dilution and sediment accumulation. The predominance of DDE over parent DDT underscores the persistence and ecological risk posed by legacy pesticide contamination in the Periyar River ecosystem. These findings highlight the urgent need for continuous monitoring and stringent management measures to mitigate pesticide contamination in tropical river systems.

Keywords

Anthropogenic pressures, GC-MS, Sediment contamination, Spatial variation, Temporal variation



Habitat heterogeneity and lunar cycles shape brachyuran crab communities in tropical mudflats of the Gulf of Khambhat, Gujarat, India

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Brachyuran crabs are ecologically significant members of intertidal communities, contributing to sediment bioturbation, nutrient cycling, and the overall functioning of coastal ecosystems. Their diversity, distribution, and activity rhythms are valuable indicators of ecosystem health, yet remain insufficiently documented across many tropical mudflat systems. This study investigated the diversity, spatial zonation, and lunar-driven burrowing behaviour of brachyuran crabs inhabiting the Kamboi mudflats along the Gulf of Khambhat, Gujarat, India. From January 2021 to October 2022, systematic transect–quadrat sampling and manual collection were carried out to assess crab diversity and distribution patterns. Time-lapse observations spanning two complete lunar cycles were conducted to quantify variation in burrow density, burrow opening diameter, and activity duration of dominant species. A total of ten brachyuran species representing nine genera and seven families were recorded, with *Austruca sindensis*, *Ilyoplax sayajiraoi*, and *Dotilla blanfordi* being the most abundant. Clear spatial segregation was observed, where *A. sindensis* dominated silty upper intertidal zones, *I. sayajiraoi* occupied muddy middle zones, and *D. blanfordi* inhabited sandy lower zones. Burrowing activity showed strong lunar periodicity, with peak densities during full moon phases coinciding with higher nocturnal luminosity and spring tides, and the lowest densities during new moon phases. Hourly observations further revealed a progressive increase in burrowing activity from high tide to low tide. These findings demonstrate how habitat heterogeneity, tidal cycles, and lunar illumination collectively govern the spatio-temporal activity of brachyuran crabs, providing crucial baseline data for their conservation and management of intertidal ecosystems.

Keywords

Conservation, Distribution, Diversity, Intertidal communities, Sediment bioturbation, Spatial zonation



Mangroves as natural bioremediators: Heavy metal accumulation in Batapady ecosystem, Southwest coast of India

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The Batapady mangrove ecosystem, located along the southwest coast of India, represents a small but ecologically important habitat exposed to anthropogenic inputs. Mangroves are known to act as natural sinks for pollutants, particularly heavy metals, yet site-specific data remain limited. This study was undertaken to evaluate the capacity of mangrove plants to accumulate heavy metals and their potential role in bioremediation. Monthly sampling was carried out across five stations from October 2023 to June 2024. Water, root, and leaf samples were collected and analyzed for zinc (Zn), copper (Cu), manganese (Mn), iron (Fe), cadmium (Cd), and lead (Pb) using Atomic Absorption Spectrophotometry. Physico-chemical parameters of water were measured in parallel, and phytoplankton and zooplankton samples were examined to assess links between environmental quality and ecosystem responses. The results revealed that roots accumulated significantly higher concentrations of metals than leaves. Fe (up to $215.62 \mu\text{g g}^{-1}$) and Mn (up to $23.15 \mu\text{g g}^{-1}$) recorded maximum values, followed by Zn ($11.25 \mu\text{g g}^{-1}$) and Cu ($3.48 \mu\text{g g}^{-1}$), while Cd ($0.15 \mu\text{g g}^{-1}$) and Pb ($0.23 \mu\text{g g}^{-1}$) were detected at comparatively lower levels. Leaves exhibited restricted translocation, confirming root sequestration as the dominant pathway. Seasonal fluctuations in waterborne metals corresponded to changes in rainfall and salinity. Correlation analysis indicated significant relationships between water quality parameters and tissue accumulation. Plankton diversity also reflected seasonal shifts, suggesting ecosystem-level responses to pollution stress. The findings highlight that mangroves of Batapady function as effective natural bioaccumulators, reducing the bioavailability of heavy metals and acting as ecological buffers against coastal pollution. This establishes their value both as bioindicators of contamination and as natural bioremediators that can be integrated into conservation and management strategies for sensitive coastal ecosystems.

Keywords

Batapady mangroves, Bioaccumulation, Bioavailability, Phytoremediation, Water quality



Sedimentary blue carbon stock and mangrove cover dynamics of Matsyafed Mangrove Park, Ernakulam District, Kerala

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Mangrove ecosystems are highly productive coastal habitats that play a crucial role in global climate regulation by sequestering and storing significant amounts of blue carbon. These ecosystems act as long-term carbon sinks, particularly through their sediments, making them vital for mitigating the impacts of climate change. The present study focused on the estimation of sedimentary blue carbon stock and the assessment of temporal changes in mangrove cover at the Matsyafed Mangrove Park, located in Malippuram, Kochi, Kerala. For the quantification of sedimentary carbon, a core sample was extracted to a depth of 1 m and systematically sub-sampled at regular intervals. Laboratory analyses were performed to determine organic carbon concentration and bulk density. These values were then used to calculate the total amount of blue carbon stored within the mangrove sediments. Such measurements provide reliable field-based estimates of carbon stock and offer a baseline for future monitoring. Simultaneously, spatial and temporal variations in mangrove cover were examined using geospatial techniques over 15 years. High-resolution satellite imagery for the years 2010, 2015, 2020 and 2025 was obtained from Google Earth Pro and processed in QGIS software. Mangrove extents were digitised, and the area estimates were generated through the attribute table in QGIS. The analysis revealed both expansion and reduction of mangrove patches during the study period, reflecting dynamic changes influenced by natural and anthropogenic pressures. The integration of carbon stock estimation with geospatial mapping provides a comprehensive understanding of the ecological function and carbon storage potential of mangroves. The findings of this study emphasise the importance of mangrove ecosystems as critical blue carbon reservoirs and highlight their role in climate adaptation and mitigation strategies. Moreover, the results can inform targeted conservation planning, restoration initiatives, and policy interventions aimed at protecting these vulnerable coastal ecosystems.

Keywords

Anthropogenic pressures, Climate adaptation, Geospatial mapping, Mangrove ecosystems, Policy interventions



MSC ELSA-3 shipwreck: Impact on water quality along the coastal waters of Kerala

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Following the maritime incident involving the container vessel MSC ELSA-3, which occurred on 24 May 2025, approximately 14.6 nautical miles off the Alappuzha coast, Kerala, a study was promptly undertaken to assess the potential environmental impacts, with a particular focus on coastal water quality and the associated risks to marine and estuarine ecosystems. Seawater samples were collected from 10 selected stations covering the coastlines of Ernakulam, Alappuzha, Kollam, and Thiruvananthapuram immediately following the incident, to capture short-term variations, which were further carried out every week. The water quality parameters such as pH, salinity (ppt), turbidity (NTU), dissolved oxygen (DO), Total ammoniacal nitrogen (TAN), Phosphate-P, Silicate- Si, Nitrite-N, Nitrate-N, Chlorophyll, and total alkalinity were assessed following standard procedures. Simultaneously, phytoplankton abundance (nos. l⁻¹) was also estimated from all the sampling locations as per standard protocols. pH, salinity, dissolved oxygen, nitrite-N, nitrate-N, chlorophyll, and total alkalinity were within the normal range during the sampling period. High values of turbidity (>90 NTU) were recorded during the initial sampling period after the incident during May 2025 at several locations, viz, Chappakadavu, Purakkad, Valiyazheekal, Azheekal. Elevated concentrations of Ammonia (TAN) (>0.3 mg l⁻¹) were observed during late May, particularly at Purakkad, Valiyazheekal and Azheekal, which later became normal (<0.1 mg l⁻¹ at most sites) by mid-June. Dissolved oxygen (DO) was within the safe range (4–8 mg l⁻¹). A temporary drop in DO was observed at Purakkad (2.61 mg l⁻¹) and Edava (4.46 mg l⁻¹) during the initial periods, but conditions improved during the subsequent samplings. The phytoplankton community was dominated by diatoms, primarily *Asterionella japonica*, *Odontella mobiliensis*, and *Biddulphia mobiliensis*, which are typically observed during this season. Continuous monitoring of water quality parameters following the MSC ELSA-3 shipwreck indicated that no significant deterioration in the coastal water quality of Kerala could be attributed to the incident. The observed variations in turbidity, TAN and occasional dips in DO, were consistent with natural seasonal fluctuations, indicating that the changes in water quality were more likely influenced by environmental processes than by pollution arising from the shipwreck.

Keywords

Dissolved oxygen, Environmental impacts, Phytoplankton abundance, Water quality parameters

Weathering and abrasion of fishing gear materials: An overlooked source of microplastic pollution

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Weathering and abrasion-induced degradation of fishing gear materials is a significant concern in both environmental and operational contexts. These processes cause a decline in the mechanical properties of fishing nets, affecting their longevity, strength, and finally leading to the breakage of nets. These materials are often made from synthetic polymers, and the physical fragmentation of these net materials into smaller particles adds to marine microplastic pollution. Further, these damaged nets pose risks to marine ecosystems through entanglement of marine life, leading to ghost fishing. The present study aims to assess the degradation of the mechanical properties of commonly used fishing net material due to weathering and abrasion. Degradation due to weathering was analysed for polyethylene twine (0.5 mm diameter) through outdoor exposure studies for a period of one year. Reduction in mechanical properties was analysed at monthly intervals. Breaking strength values decreased exponentially with the progressing weathering, and a 50% loss in values was observed after 270 days of exposure. At the end of the 360-day exposure period, the samples retained only 30.45% of their initial break load and 19.56% of their original elongation at break, indicating substantial degradation over time. The surface degradation of weathered samples was characterised by the presence of numerous cracks and grooves. Abrasion-induced degradation was further examined using an abrasion testing machine under controlled wear conditions, following the prescribed standard testing procedures. The abraded twines showed a loss in breaking strength of 14.2% after 450 h of abrasion. The findings of this study have important implications for both the functional lifespan of fishing gear and its environmental footprint. Future research should focus on developing more durable, eco-friendly, and biodegradable materials that can enhance performance while minimising environmental impacts.

Keywords

Degradation, Ghost fishing, Mechanical properties, Physical fragmentation, Synthetic polymers

Assessment of marine litter along Kerala beaches following the maritime incident involving the container vessel MSC ELSA-3

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The recent shipwreck incident involving the container vessel MSC ELSA-3 off the Kerala coast on 26 May 2025 has raised serious concerns regarding marine litter generation and coastal pollution. To assess the extent of marine litter pollution, surveys were conducted along the Kerala coast, covering the stretch from Chellanam (Ernakulam) to South Veli (Trivandrum), following the standard UNEP protocol using the quadrant sampling method. A total of 11 beaches were monitored, namely Chellanam, Purakkadu, Valiya Azheekkal, Valiya Azheekkal Mouth, Vellanathuruth, Marathadi, Thirumullavaram, Kollam, Pozhikkara, Edava and South Veli. The survey was conducted over a one-month period (May–June 2025) with weekly sampling, followed by fortnightly surveys during the subsequent months (July–August 2025) to monitor the persistence and spatial spread of marine litter. The survey recorded the presence of broken containers, their sealing materials such as thermocol, along with various plastic items, plastic nurdles, cotton bales and other debris being washed ashore, posing a major threat to the marine ecosystem. No visible oil slicks, sheens, or tar balls, nor a specific odour, were observed at any of the sampling locations. However, large quantities of plastic nurdles and bags containing nurdles (LDPE and HDPE) were observed along beaches and nearshore waters in Kollam and Thiruvananthapuram districts, except for Alappuzha. While not inherently toxic, nurdles pose a significant threat due to their small size, buoyancy, and resemblance to fish eggs, making them easily ingested by fish, seabirds, and other marine life. The average size of the nurdles ranged from 3–5 mm. Recognising the risk, INCOIS deployed its Oil/Nurdle Spill Trajectory System, which uses advanced ocean circulation models to predict dispersal patterns. The system indicated a drift towards the southern coast of Thiruvananthapuram. By mid-June, nurdles and nurdle bags (HDPE and polypropylene) had washed ashore at Dhanushkodi in Tamil Nadu and along the northern coastline of Sri Lanka, following initial reports near Kanyakumari. This highlights the widespread dispersal of debris from the Arabian Sea into the Bay of Bengal. Additional findings included cotton balls washed ashore at Pozhikkara, Valiyazheekkal and Thirumullavaram on 26 May 2025, with disintegrated cotton strands floating in adjacent waters. Damaged or empty containers were also found lodged in rocky seabed and coastal areas off Thirumullavaram during the initial sampling days. The area is ecologically sensitive, known for seaweed beds, patchy coral reefs, and reef-associated fish populations, making the prolonged presence of debris a serious concern.

Keywords

Cotton bales, Debris, Empty containers, Marine litter pollution, Plastic nurdles



Seasonal dynamics of sediment characteristics and macrobenthic response to anthropogenic activities at selected stations of Cochin Estuary, Kerala

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The Cochin Estuary is a monsoon-driven system characterised by pronounced seasonal variability in flushing; low during the pre-monsoon, high during the monsoon, and moderate in the post-monsoon period. During phases of low freshwater discharge, the residence time of water increases, resulting in the accumulation of pollutants, the development of eutrophication-like conditions, loss of biodiversity and an overall decline in water quality. To assess these variations, a seasonal investigation was carried out during 2022 and 2023 across 11 stations influenced by anthropogenic activities such as industrial effluents, domestic sewage, tourism-related discharges, port operations, and harbour activities. The study revealed that industrial waste exerted considerable stress on the ecosystem, causing localised damage to benthic communities. The observed reduction in diversity and abundance of benthic organisms was closely associated with sediment characteristics. Polychaetes emerged as the dominant benthic group across all seasons, serving as effective indicators of organic enrichment and sediment stability. Variations in benthic composition were further influenced by tidal dynamics, monsoonal fluctuations, land runoff and the mixing of industrial effluents with estuarine waters. The sediment oxidation-reduction potential (ORP) remained negative across all stations, indicating a reducing environment, particularly pronounced during the monsoon season. The organic carbon content of sediments at Cheranelloor, an upstream station within the industrial belt, reached a peak of 4.79% in 2022, likely reflecting elevated external organic inputs from surrounding anthropogenic activities. Clear seasonal patterns were observed in the benthic communities during the study period. Filter feeders, particularly bivalves, were more abundant during the monsoon season, while polychaetes predominated during the pre-monsoon period. Microplastics were also detected at selected stations, where abundance of benthic organisms was high.

Keywords

Anthropogenic activities, Benthic communities, Organic carbon, Oxidation-reduction potential, Polychaete



Between sustainability and survival: Challenges, attitudes and perceptions of fishermen navigating a Marine National Park (MNP) in Andaman and Nicobar Islands, Bay of Bengal

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This study examines fishers' perceptions and awareness of the Mahatma Gandhi Marine National Park (MGMNP) located in South Andaman, Bay of Bengal. A total of 120 fishers were surveyed across three landing sites located close to the MNP such as Wandoor (60%), Guptapara (31%), and Manjery (9%), to assess their awareness, attitudes, and experiences regarding the ecological and socio-economic impacts of Marine Protected Areas (MPAs), including No-Take Zones (NTZs). Most respondents operate motorised boats, with hook-and-line fishing (92%) targeting reef species such as groupers and snappers. The findings reveal that 98% of fishers avoid fishing within NTZs, while 76% perceive MPA regulations as effectively enforced. However, despite compliance, 58% report reduced access to traditional fishing grounds, limited participation in decision-making, and minimal perceived benefits from MPAs. Awareness and adherence were significantly influenced by education, generational involvement, and income. Notably, 87% of respondents expressed a desire for direct involvement in MPA management, while 42% favouring active participation and 45% supporting consultative roles. While centralised governance is broadly accepted, a strong preference (87%) emerged for inclusive and participatory approaches that integrate local knowledge and foster collaborative management. These findings underscore the need for adaptive governance frameworks to balance ecological conservation with community well-being. The insights generated here provide practical recommendations for enhancing co-management and promoting sustainable resource use within Marine National Parks.

Keywords

Co-management, Fisher perceptions, MPAs, No-Take Zones, Sustainable fisheries

An ecosystem-centric framework to prioritise fisheries management options for deep-sea fishes

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The deep-sea fishes beyond the 200 m depth contours of the continental shelf area of the Indian EEZ are largely unexploited at present. However, with the gradual development of interest in offshore fishing among fishers, several offshore species of fish are emerging as bycatch in multi-day trawl fisheries. With market acceptability for such fish increasing, these resources will be further tapped, thereby increasing fishing pressure on the preferred groups. Hence, resources likely to face progressive levels of fishing mortality need to be identified and evaluated for suitable reference points and harvest controls. The finfish catch from trawl hauls in the 200-1000 m depths from the exploratory trawl surveys on board FORV *Sagar Sampada* in the Southeastern Arabian Sea, along the continental slope of the Indian EEZ, were grouped into various categories and evaluated using a ranking criterion and specific attributes. An ecosystem-based fisheries management (EBFM) approach is critical to the develop deep-sea fisheries sector in India, where it can help to prioritise species management goals and possible options to achieve these.

Keywords

Bycatch, Continental slope, EBFM, EEZ, Fishing pressure, Harvest strategies, Sustainability



The tragedy of the commons in Thoothukudy trawler fisheries: A system dynamics model addressing juvenile fish catch for economics and ecological sustainability

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This paper investigates the “tragedy of the commons” in Thoothukudy’s trawler fisheries, where nearly 270 mechanised vessels operate with high capital investments of about ₹1 crore per unit. The short-term drive to recover operating and capital costs has fostered unsustainable practices, including the large-scale harvest of juvenile fish, illegal mesh size, and encroachment into restricted waters. Estimates suggest juveniles account for about 27% of total trawl landings, amounting to nearly half a ton per trip. This undermines stock recovery, accelerates biodiversity loss, and contributes to the destruction of coral reef habitats within the Gulf of Mannar biosphere reserve. Economically, resource depletion has led to declining catches, forcing fishers to increase effort, move to new fishing grounds, or even encroach into Sri Lankan waters where trawling is banned. This not only escalates cross-border tensions but also exacerbates operational pressures as diesel, labour, and maintenance costs continue to rise while fish prices remain largely stagnant. Profit-sharing arrangements, typically 65:35 between owners and labourers after deducting auction commissions and fuel, leave crews highly vulnerable, with many comparing trawling to gambling, hoping at least one trip will cover their expenses. The sharp decline in species diversity, now limited to only 8-10 commercially valuable varieties, further underscores the ecological crisis. Using a system dynamics framework, this study models the reinforcing feedback loop in which high investments drive increased fishing effort, leading to juvenile catch and biodiversity loss, which in turn reduces catch per trip and heightens economic pressures, fuelling further overfishing. A balancing loop, wherein low catches force idle vessels, is also identified. The paper proposes a three-pronged strategy: (i) community-based awareness and behavioural change campaigns, (ii) auction management ensuring minimum prices for legal-size fish, and (iii) enforcement of regulatory measures against destructive trawling. Integrating ecological conservation with economic incentives is argued as essential to safeguard both sustainability of Thoothukudy’s marine resources and the livelihoods dependent on them.

Keywords

Biodiversity loss, Destructive trawling, Economic sustainability, Juvenile fish catch, Legal-size fish



Technological modifications in fishing methods along the Palk Bay coast and their predictable consequences

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Palk Bay (9° 55' to 10° 45' N; 78° 58' to 79° 55' E), located on India's southeast coast, stretching from Point Calimere in the north to Dhanushkodi in the south, is home to coral reefs, mangroves, and seagrass ecosystems, besides several lagoons, estuaries, salt marshes, and wetlands. The shallow depth and nutrient-rich bottom of Palk Bay support rich diversity in this ecosystem. This diverse and productive ecosystem is, however, highly susceptible to human activities. The major fishing in Palk Bay is trawling, which began in the middle of the twentieth century. The shrimp fishery in this region has been growing steadily since 1980, with the tremendous development of the trawl fleet along the Palk Bay coast. Nowadays, the trawl nets are modified as species/resource-specific trawls such as shrimp trawls, fish trawls, chank trawls, crab trawls, and cephalopod trawls. The trawl landings include a multitude of commercial and non-commercial flora and fauna. The increasing demand for non-commercial fauna in the poultry industry as feedstock is promoting the catch of these fauna. The gill net fishery is also predominant in this region. Large gill nets are operated to catch fish, especially spawners, to cater to the demand from hatcheries. Fishing using Fish aggregating devices (FADs) is also practiced to catch cephalopods and capture of a large number of spawners by this practice will lead to the depletion of stocks. Seine nets of different sizes are also operated to catch shoaling fish like sardine, mackerel, and seer fish. Unregulated operation of these nets in the spawning and nursery grounds, which abound in the Palk Bay region, can cause imbalances in the ecosystem. The seasonal mechanised/trawl ban alone will not help to conserve the biodiversity; area-specific moratoriums, especially in demarcated nursery and spawning grounds, would help to sustain the biodiversity for optimum exploitation of the fish stocks in the Palk Bay region in the long run.

Keywords

Conservation, FADs, Gill net, Nursery, Spawning ground, Trawl net



Role of mangrove ecosystems in trapping, retaining and reducing plastic pollution in coastal and estuarine environments

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Plastic pollution in marine environments is a growing environmental concern, with millions of tons of plastic waste entering the oceans each year. This pollution originates from various sources, such as industrial discharge, poor waste management, river runoff, and littering along coastlines. Once in the water, plastics can float for long distances, break down into microplastics, and harm marine organisms through ingestion, entanglement, and habitat disturbance. A significant portion of this debris accumulates near coastlines, where it poses a persistent threat to coastal ecosystems. Mangrove forests, found along tropical and subtropical coastlines, play a vital role in reducing the impact of plastic pollution. Their dense and intricate root systems, including prop roots and pneumatophores, act as natural barriers that trap floating plastic debris before it can spread further into marine environments. These roots catch a variety of waste materials, such as plastic bags, bottles, packaging, and fishing gear, effectively preventing them from drifting into the open ocean. As a result, mangroves serve as natural filters that reduce the flow of plastic pollution from land to sea. In addition to filtering debris, mangroves provide numerous ecological benefits. They stabilise shorelines, reduce coastal erosion, and offer important habitats for fish, crustaceans, and other marine life. By trapping plastic waste, they also create localised areas where debris can be more easily collected and removed, supporting community-based clean-up efforts. To maintain the beneficial role of mangroves, it is essential to implement conservation strategies and reduce plastic pollution at its source. This includes promoting sustainable waste management, reducing single-use plastics, conducting regular clean-up activities, and raising public awareness about the importance of mangrove ecosystems. Protection and restoration of mangrove forests should be prioritised to ensure they continue to function as effective buffers against marine pollution. In conclusion, plastic pollution presents a major challenge to marine ecosystems, but mangrove forests act as natural defenses by capturing and containing plastic waste. Their unique root systems play a critical role in blocking the flow of debris into the ocean, making them essential in reducing the environmental impact of coastal pollution. Protecting and rehabilitating mangrove areas is a crucial step toward maintaining ocean health, supporting biodiversity, and building more resilient coastal ecosystems.

Keywords

Coastal erosion, Marine pollution, Ocean health, Plastic debris, Waste management



Mapping the deep-sea diet: A comprehensive review on trophic ecology and feeding guilds of deep-sea fishes

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Deep-sea ecosystems represent one of the least explored frontiers of marine biodiversity, despite their crucial role in global ecological functioning and fisheries sustainability. Understanding the trophic ecology and feeding habits of deep-sea fishes is vital for unravelling ecosystem dynamics, energy flow, and the resilience of these fragile environments. This review aims to provide a comprehensive synthesis of the existing literature on the trophodynamics of deep-sea fishes from Indian waters. The study evaluates feeding habits, prey composition, and ecological roles of different deep-sea ichthyofauna. The findings also modulated a guild-based categorisation of deep-sea fishes in Indian waters, grouping them according to trophic strategies. The outcome of the study helps in understanding food web structure, ecological interactions, and resource partitioning in deep-sea ecosystems. This review forms a crucial database on deep-sea trophic ecology, supporting evidence-based conservation and management strategies for deep-sea fisheries in India.

Keywords

Energy flow, Marine biodiversity, Prey composition, Shrimps, Trophodynamics



Molecular characterisation of deep-sea echinoderms from the seamounts of Southeastern Arabian Sea

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Seamounts and plateaus represent prevalent bathymetric features of the seafloor and are known to support a high diversity of benthic organisms. Echinoderms serve as predominant invertebrates within the benthic fauna, particularly in deep-sea environments, where they contribute significantly to marine ecological processes, including nutrient cycling, sediment bioturbation, and habitat structuring. Nevertheless, the inaccessibility and depth of the seamount environment have resulted in limited taxonomic knowledge regarding deep sea echinoderms. This study reports the molecular diversity of echinoderms obtained from seamounts and plateaus in the Southeastern Arabian Sea, Indian Ocean. Specimen collection was conducted aboard R.V. Sindhu Sankalp during Cruise SSK-178, utilizing Naturalist dredges, Van Veen grabs, and Agassiz trawls at three seamount locations: TED8 (1330 m), TED12 (426 m), TED9 (760 m); and one plateau, TED Pt6 (1402 m). Echinoderm specimens were primarily classified based on morphological characteristics, while phylogenetic identification was established through molecular sequencing of the nuclear 18S rRNA and mitochondrial 16S rRNA genes. A total of twelve individuals were analysed, yielding seven sequences from 18S rRNA and five sequences from 16S rRNA, encompassing four classes namely Asteroidea (n=2), Ophiuroidea (n=6), Holothuroidea (n=3), and Echinoidea (n=1). The generated DNA sequences have been submitted to the NCBI GenBank databases, including three novel entries namely *Amphigymnas woodmasoni*, *Stereocidaris indica*, and *Amphiura lorioli* which lacked prior molecular records. This study underscores the presence of diverse echinoderm species in the seamount environment and aims to enhance the molecular database with DNA sequences from deep-sea organisms, whose representation remains quite limited. The current investigation is designed to facilitate molecular identification and to elucidate genetic relationships, thereby supporting future biodiversity assessments and environmental research within seamount ecosystems.

Keywords

Biodiversity, Genetic relationships, Mitochondrial 16S rRNA, Nuclear 18S rRNA

Diversity and distribution of economically important seaweeds in Lakshadweep

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The Lakshadweep Archipelago, comprising twelve atolls in the Arabian Sea, is entirely coral-derived and supports diverse marine resources of ecological and economic importance. Among these, seaweeds (marine macroalgae) are globally valued for their bioactive compounds and wide applications as food, fodder, fertiliser, pharmaceuticals, and as industrial raw materials for agar, algin, and carrageenan. Despite their potential, the distribution and abundance of economically important seaweeds in Lakshadweep remain poorly studied, with limited baseline information on spatial patterns and resource variability. The present study assessed the taxonomy, abundance, and distribution of macroalgal resources across ten inhabited and two uninhabited islands of the Archipelago. Field sampling was undertaken using SCUBA and snorkelling along stratified transects across lagoonal, reef-flat, and outer-reef zones up to 30 m depth. An updated checklist was prepared by compiling published records and revised nomenclature. Earlier studies reported 77 economically important seaweed species from Lakshadweep reefs, including 34 species of Rhodophyta, 29 Chlorophyta, and 14 Ochrophyta. In contrast, the present survey documented 45 species, comprising 17 Rhodophyta, 16 Chlorophyta, and 10 Ochrophyta. Genera of major commercial significance include *Gracilaria* and *Gelidiella* (agarophytes), *Sargassum* and *Turbinaria* (alginophytes), and *Hypnea* (carrageenophytes). Spatial variability in species richness was observed across geomorphological zones, highlighting the site-specific potential for future resource development. The study provides baseline data on economically important seaweeds of Lakshadweep and underscores the need for sustainable management in the face of anthropogenic and climate-related pressures. These findings support conservation-linked utilisation strategies and community-based mariculture initiatives to strengthen island livelihoods and contribute to blue economy pathways.

Keywords

Blue economy, Economic importance, Livelihoods, Macroalgal resources, Species richness



Diversity and ornamental potential of brackishwater fishes in Muttukadu backwaters, Tamil Nadu

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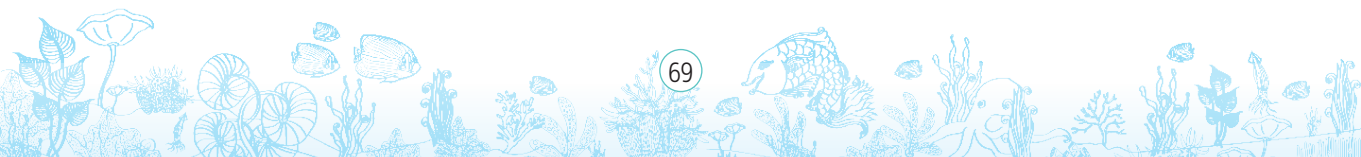
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Brackishwater ecosystems sustain rich biodiversity with significant ecological and commercial importance, yet ornamental aquaculture from these habitats remains largely underexplored. Muttukadu backwaters in Tamil Nadu support diverse food and ornamental fishes. A 12-month survey recorded 59 species spanning 11 orders and 33 families. Gobiiformes emerged as the most represented order with 22 species, followed by Perciformes with 16 species, while Gobiidae was the richest family with 19 species. The dataset revealed that 57.6% have ornamental value either exclusively or in combination as food fish. Seasonal variation was evident, with the lowest species richness recorded in December (19 species) and the highest in March (34 species), corresponding to salinity fluctuations associated with the northeast monsoon. The most abundant species, the goby *Mugilogobius tigrinus* (133 individuals), was among several promising candidates for the ornamental fish trade. Other potential species included gobies (*Mangarinus waterousi*, *Yongeichthys* sp.), ambassids (*Ambassis dussumieri*), puffers (*Chelonodon kappa*, *Arothron hispidus*, *A. immaculatus*), pipefishes (*Ichthyocampus carce*), scats (*Scatophagus argus*), silver moony (*Monodactylus argenteus*), siganids (*Siganus javus*, *S. vermiculatus*), and *pistol shrimps* (*Alpheus* sp.). Their colouration, adaptability, and market appeal highlight the aquaculture potential of this ecosystem. Muttukadu backwaters harbour substantial fish and crustacean diversity with high ornamental potential. Establishing captive breeding programs for target species could reduce pressure on wild stocks, generate economic opportunities, and promote sustainable utilisation of brackishwater biodiversity.

Keywords

Biodiversity, Conservation, Crustacean diversity, Gobies, Ornamental fishes



Beyond Netrani: Expanding the hard coral diversity map of Karnataka

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Coral reefs are among the most productive and biodiverse marine ecosystems on earth, offering vital ecological and socio-economic services such as shoreline protection, fisheries support, and tourism opportunities. In Indian waters, coral reefs cover approximately 2,383.87 km², with the highest diversity found in the Andaman and Nicobar Islands, followed by the Gulf of Mannar, Lakshadweep, and the Gulf of Kachchh. In contrast, the central west coast of India hosts only scattered and historically under-documented coral formations. Along the Karnataka coast, coral occurrence was previously known primarily from Netrani Reef, where 12 species had been recorded. To update and expand this baseline, exploratory surveys were carried out between 2014 and 2024 across four coastal and offshore habitats namely Netrani Island and its vicinity, Mulki Rocks, Devagad Island, and St. Mary's Islands in the eastern Arabian Sea. SCUBA-based underwater line transect surveys (depth range: 3–38 m) were conducted to document conspicuous coral species. At Devagad, species records were compiled from surveys conducted between 2014 and 2016. Identification was based on high-resolution underwater photography and reference literature. A total of 35 hard coral species (27 zooxanthellate and 8 azooxanthellate), belonging to 23 genera and 11 families, were documented representing a substantial increase over previous records. The family Merulinidae was the most dominant, followed by *Dendrophylliidae* and *Pocilloporidae*. The most abundant species included *Porites lutea*, *Turbinaria mesenterina*, and *Pseudosiderastrea tayamai*. Diversity analysis revealed pronounced site-specific variations. Netrani Island exhibited the highest species richness ($S=31$) but relatively low evenness ($J = 0.51$), indicating dominance by a few abundant taxa. Mulki Rocks, though species-poor ($S = 6$), showed the highest evenness ($J=0.936$), suggesting balanced population abundances. St. Mary's Islands supported minimal coral diversity ($S=3$) but high evenness ($J=0.961$), likely reflecting ecological constraints. Devagad Island showed moderate richness ($S=8$). These findings demonstrate that Karnataka's coral assemblages extend well beyond Netrani Reef, encompassing multiple coastal habitats with distinct community structures. The observed spatial variations in diversity and evenness likely result from differences in habitat complexity, substrate type, hydrodynamic conditions, and levels of disturbance. This updated inventory provides an essential baseline for long-term ecological monitoring, impact assessments, and conservation planning for coral reef ecosystems along the Karnataka coast.

Keywords

Coral assemblages, Devagad Reef, Mulki rocks, Netrani Reef, St. Mary's Island, Zooxanthellate



Spatio-temporal variation of macrofaunal communities in multi-species mangrove plantation site at Luni, Gulf of Kachchh, Gujarat

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The spatio-temporal variation of macrofaunal communities in the multi-species plantation site at Luni, along with associated physico-chemical parameters, was studied over one year covering three distinct seasons. The study area was divided into two zones namely the seaward low-tide area and the shoreward mangrove fringe. At the mangrove site, water temperature ranged from $21\pm0.29^{\circ}\text{C}$ to $22\pm0.23^{\circ}\text{C}$, pH from 7.9 ± 0.10 to 8.0 ± 0.10 , and salinity from 36 ± 0.34 psu to 37 ± 0.66 psu. Physical parameters such as turbidity, total suspended solids (TSS), and total dissolved solids (TDS) showed more pronounced fluctuations at the seaward site compared to the mangrove area. Among the dissolved nutrients, phosphate concentration was relatively higher at the mangrove site, ranging from 0.69 ± 0.14 mg l^{-1} to 2.0 ± 0.22 mg l^{-1} . The macrobenthic fauna consisted primarily of three groups namely molluscs, crustaceans, and fishes. At the shoreward mangrove site, crustaceans were dominant, contributing 44.97% of the total fauna, followed by molluscs at 40.6%. Conversely, at the seaward site, molluscs formed the major component (57.9%), while crustaceans accounted for 31.6% during the study period. During the monsoon and post-monsoon seasons, *Boleophthalmus dussumieri* and *Scopimera crabricauda* were the most abundant species at the mangrove site, whereas *Macrophthalmus sulcatus* dominated the seaward area during the monsoon. The Shannon–Wiener diversity index ranged from 2.62 to 2.75 and the Margalef richness index from 3.49 to 4.24 at the shoreward site. At the seaward site, Shannon-Wiener values ranged from 1.89 to 2.39 and Margalef from 2.50 to 3.56. Overall, the results indicate that species richness and diversity were higher at the seaward site compared to the mangrove plantation area, reflecting differences in environmental conditions and habitat characteristics across the two zones.

Keywords

Diversity, Nutrients, Macrobenthic fauna, Physico-chemical parameters, Species richness



Integrative taxonomy and molecular insights into the bandfishes (Family Cepolidae) from Indian waters

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The family Cepolidae, commonly known as bandfishes or deep-sea snakefishes, is characterised by an elongated, compressed, and tapering body. These fishes are distributed across tropical and subtropical waters, typically at depths ranging from 80 to 550 m. Despite their wide distribution, Cepolidae remains an overlooked and poorly studied group due to their lack of economic value and their common occurrence as bycatch in deep-sea fisheries. Globally, the family comprises 46 valid species under three genera. In Indian waters, five species have been reported, belonging to the genera *Acanthocepola*, *Cepola* and *Owstonia*. This study explores the diversity of bandfishes along the Indian coast through an integrative approach combining morphological and molecular method. Morphometric measurements and meristic characters were recorded for 4 species under two genera from major landing centres along the southwest and southeast coasts of India during the period of October 2024 to May 2025. The species documented are *Acanthocepola indica*, *A. limbata*, *Acanthocepola* sp, and *Owstonia whiteheadi*. The molecular analysis based on mitochondrial COI gene revealed that the 4 species are genetically discrete from each other and clustered into 4 groups. Our findings underscore the underexplored and poorly documented status of the family Cepolidae in Indian waters. Further systematic and molecular investigations may not only reveal additional species, enhancing the ichthyofaunal diversity of the region, but also provide crucial insights into their reproductive biology, developmental stages, and life history strategies essential for understanding their ecological roles and adaptations to deep-sea environments.

Keywords

Bycatch, COI gene, Deep-sea fisheries, Ichthyofaunal diversity, Snakefishes



Unveiling cryptic diversity in the mud spiny lobster (*Panulirus polyphagus*): A molecular framework for conservation and regional fisheries management in the Indo-Pacific

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The mud spiny lobster *Panulirus polyphagus* is an ecologically and commercially important crustacean, yet its population structure across the Indo-Pacific remains poorly understood. In this study, complete mitochondrial genomes from geographically diverse specimens were sequenced and compared to uncover cryptic diversity within the species. Genome sizes ranged from 15.6 to 15.7 kb and showed conserved pan-crustacean gene arrangements. Analysis of protein-coding genes indicated strong purifying selection, while phylogenetic reconstructions consistently identified multiple well-supported lineages associated with different oceanic regions. Notably, three distinct evolutionary groups were identified, with the greatest genetic divergence observed between populations from the Bay of Bengal and the Arabian Sea. Divergence dating suggests that lineage diversification mainly occurred during the Miocene-Pliocene, aligning with major geological and oceanographic events. Recognising these hidden genetic stocks emphasises the need for region-specific fisheries management, as traditional stock assessments may underestimate true biodiversity. These findings offer a molecular framework for the sustainable use and conservation of *P. polyphagus*, a species under intense harvesting pressure in Indian waters.

Keywords

Divergence dating, Miocene-Pliocene, Mitogenomics, Phylogenomics, Protein-coding genes



Mitochondrial marker-based analysis of indigenous Indian Ocean cuttlefish species resolves taxonomic ambiguities and provides novel systematic insights

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Cuttlefishes are one of the commercially important marine species, distributed worldwide, playing a critical role in fisheries and marine ecosystems. Despite their importance, the systematics of cuttlefishes have undergone numerous revisions, and taxonomic ambiguities persist, particularly for species inhabiting Indian waters, which remain relatively understudied. This study aims to clarify the systematics and phylogenetic relationships of cuttlefish species from Indian waters using mitochondrial markers 16S rRNA and Cytochrome C Oxidase subunit I (COI). A total of 80 specimens, representing 11 species, were collected and analysed. We generated 61 novel COI and 52 novel 16S rRNA sequences, which were concatenated for Bayesian phylogenetic analysis to infer evolutionary relationships. The analyses revealed significant genetic variation within *Acanthosepion aculeatum* and *Sepiella inermis*, suggesting potential cryptic diversity. For the first time, *Sepia prabahari* was genetically characterised, showing a close affinity to the genus *Acanthosepion*, indicating the need for a revision at the generic level. Additionally, *Sepia vecchioni* emerged as a robust sister taxon to the clade containing *Rhombosepion prashadi* and *R. omani*, highlighting the necessity for a comprehensive taxonomic reassessment within this genus. Overall, this study provides novel molecular insights that contribute to resolving taxonomic ambiguities of cuttlefishes in Indian waters. These findings have important implications for the management and conservation of these commercially important marine resources.

Keywords

Conservation, DNA barcoding, Evolutionary relationships, Taxonomy, Phylogeny



Discovery and genomic characterisation of PhVJ1.1: A novel lytic bacteriophage specific to *Serratia rubidaea*

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This study reports the discovery and comprehensive characterisation of a novel lytic bacteriophage, PhVJ1.1, which specifically targets *Serratia rubidaea* strain VJ1.1 (GenBank accession no. MZ489222). Both the host bacterium and its lytic phage were isolated from seawater samples collected from a tidal pool in Vypin, Kerala, South India. The bacteriophage was purified through three successive rounds of single-plaque isolation and high-titre stocks were prepared via ultracentrifugation. In soft agar overlay assays, PhVJ1.1 formed clear, small, pointed plaques approximately 0.5 mm in diameter on its bacterial host. Host range analysis confirmed specificity of the phage for *S. rubidaea*. Temperature and pH stability assays demonstrated that the phage remained active up to 65°C and within a pH range of 3 to 11. One-step growth curve analysis revealed a burst size of 10 PFU per cell and a latent period of 122 min, while the adsorption constant was determined to be 1.38×10^{-8} ml min⁻¹. Transmission electron microscopy (TEM) showed an icosahedral capsid measuring 90.65±8 nm in diameter with a tail length of 109±2 nm. Genomic DNA extracted from high-titre phage preparations was sequenced using the Illumina NovaSeq platform with a 2×150 bp paired-end configuration. Low-quality reads were filtered using Q30 (Phred score) as a cutoff, and adapter sequences were removed with Cutadapt (v3.7). The processed reads were assembled de novo using SPAdes, and Open Reading Frames were predicted with Prodigal (v2.6.3). PhVJ1.1 revealed a 262 kbp genome with an average GC content of 42.52% and 287 ORFs. Predicted protein sequences were annotated employing the DIAMOND BLASTp (v2.1.6) algorithm. The complete genome of PhVJ1.1 has been deposited in the NCBI GenBank database. Phylogenetic analysis based on the terminase large subunit and major capsid protein gene sequences indicated PhVJ1.1 is genetically distinct, potentially representing a new evolutionary group of bacteriophages infecting *S. rubidaea*.

Keywords

Genome annotation, Illumina NovaSeq, Phylogenetic analysis, Transmission electron microscopy

Functional characterisation of common gastropod species based on feeding guild and pattern of distribution in a rocky intertidal area

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Different species often exhibit functional similarities that contribute to the effective functioning of ecosystems, particularly herbivorous gastropods in seaweed-dominated habitats. This study was conducted along a rocky intertidal coast characterised by diverse assemblages of gastropods and seaweeds. The primary focus was on the quantitative and qualitative assessment of the functional feeding guilds of gastropods and their distribution patterns. Structural characterisation of the feeding organ (radula) was performed using scanning electron microscopy (SEM), along with gut content analysis of selected gastropod species. Based on functional feeding guilds, herbivorous gastropods showed significantly higher abundance (88.3%) compared to carnivorous species (11.7%) in the study area. Among herbivores, taenioglossan individuals were the most dominant (72.6%), followed by rhipidoglossans (8%) and docoglossans (7.7%). The most common and abundant taenioglossan species included *Clypeomorus batillariaeformis*, *Littoraria undulata*, and *Planaxis sulcatus*. The rhipidoglossan group was represented by *Turbo intercostalis*, *Trochus radiatus*, and *Nerita albicilla*, while the docoglossan category included *Cellana radiata*. Carnivorous stenoglossans (11.7%) comprised *Anachis terpsichore*, *Tenguella granulata*, *Tenguella ceylonica*, and *Semiricinula tissoti*. Zonal distribution analysis revealed that rhipidoglossans were most abundant in the eulittoral zone, taenioglossans occurred in both eulittoral and littoral zones, and docoglossans were predominant in the littoral zone. Increasing community stability and greater availability of trophic resources and refuge appeared to promote habitat specialisation among gastropods, leading to their concentration within specific intertidal zones. Overall, the functional traits of these species reflect their ecological roles more effectively than individual taxonomic identity, enhancing our understanding and predictability of ecosystem functioning within seaweed-dominated intertidal environments.

Keywords

Abundance, Distribution, Gastropods, Feeding guild, Rocky area



Genetic diversity assessment of wild and hatchery populations of pearlspot *Etroplus suratensis*, using novel microsatellite markers

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Pearlspot (*Etroplus suratensis*), a candidate commercial species of peninsular India, is widely bred in backyard hatcheries raising concerns about inbreeding and genetic erosion. To evaluate genetic variability, fifteen newly developed polymorphic microsatellite markers were applied to wild and hatchery populations. A total of 278 individuals were sampled, including wild stocks from Vembanad, Ashtamudi, and Kavvayi ($n=60$), and hatchery stocks from RGCA, Vallarpadam ($n=53$), and RARS, Kumarakom ($n=45$). DNA was extracted from fin clips and muscle tissues, amplified by PCR, and genotyped for diversity parameters. All loci were polymorphic ($PIC > 0.5$), with primer ES_11 showing the highest PIC (0.908). Wild populations showed a broader allelic range (7–20 alleles) compared to hatchery samples (6–17 alleles). Observed heterozygosity was considerably high in the wild population (0.85–0.95) compared to the hatchery (0.80–0.9), while expected heterozygosity (H_e) ranged from 0.79–0.93 and 0.68–0.91 in the wild and hatchery populations, respectively. Although wild populations displayed higher genetic diversity, stocks from RARS also shown values comparable to wild stocks. Pairwise F_{ST} values calculated between wild and hatchery populations of pearlspot indicated very low genetic differentiation. The highest F_{ST} observed was 0.027 between Kasargod and RARS samples. Inbreeding coefficients (F_{IS}) were observed to be negative in both groups, and Hardy-Weinberg Equilibrium tests showed no significant deviations, suggesting random mating and minimal genetic drift in both groups. The study demonstrates substantial genetic variation in both wild and hatchery populations, indicating that backyard hatchery stocks have not yet suffered significant genetic erosion. These findings provide a baseline for broodstock management and underscore the importance of integrating molecular tools into conservation and aquaculture practices.

Keywords

Conservation, Genetic erosion, Hatchery populations, Heterozygosity, Inbreeding



Elucidating environmental drivers and zooplankton community responses in a tropical microtidal estuary on the east coast of India

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The present study provides a comprehensive assessment of zooplankton community dynamics in relation to environmental drivers in a tropical microtidal estuary, the Rushikulya (RE), Odisha. Of the 21 measured water variables, 11 variables (temperature, pH, transparency, DO, turbidity, alkalinity, CO₃²⁻, HCO₃⁻, PO₄³⁻, TP and SiO₄⁴⁻) exhibited significant seasonal variations ($p \leq 0.05$). The mean values of trophic index viz., TRIX (5.04 ± 0.72) and TRBIX (0.17 ± 0.08) reflected that the RE has a moderate degree of eutrophication with 'good' water quality and 'biomass saturated'. A total of 69 taxa of zooplankton (59 taxa-copepoda) were recorded, belonging to 12 taxonomic groups, with copepoda contributing 40% of the total zooplankton population. Zooplankton density peaked during the pre-monsoon ($2,295 \pm 2,236$ ind. m^{-3}) and was lowest in the post-monsoon season (716 ± 492 ind. m^{-3}). Permutational MANOVA depicted a significant variation in zooplankton compositions between seasons ($F=3.563$; $p=0.002$), and insignificant between stations ($F=1.067$; $p=0.38$). Among copepods, cyclopoida (17 taxa) were the most dominant (19.33%). Copepod species *Paracalanus parvus*, *Bestiolina similis*, *Acrocalanus gibber*, *A. gracilis*, *Psudodiaptomus aurivilli*, *Acartia spinicauda*, *Oithona brevicornis*, *O. nana*, *Longipedia weberii*, *Microsetella norvegica* and *Euterpina acutifrons* exhibited their perennial existence, indicating their euryhaline tolerance and broad thermal adaptability. Functional feeding guild analysis showed that herbivorous and carnivorous copepods predominated, contributing 35–58% and 27–61% of the total copepod population, respectively, while detritivores and omnivores formed minor fractions (1–4%). ANOVA indicated significant seasonal variation in omnivore ($F=7.346$, $p=0.006$) and detritivore feeding guilds ($F=5.951$, $p=0.013$). Multivariate dispersion index was comparatively higher ($\beta > 1$) in the lower estuary, suggesting low predictability in zooplankton compositions. The calculated value of α -diversity ($d'=2.62$ – 4.59 and $H'=2.07$ – 2.73) denoted 'good' zooplankton diversity. The species-environment relationship showed that functional feeding guilds, including herbivore copepods (*P. parvus*, *B. similis*, *P. serricaudatus*, *Lebidocera minuta*, *Oncaea venusta*), were positively associated with salinity, TN, EC, transparency, and TP. Detritivores (*Clytemnestra rostrata*, *E. acutifrons*, *M. norvegica*, *Microsetella rosea*) were strongly inclined to water depth. The omnivores (*Acartia spinicauda*, *A. erythraea*, *A. danae*, *Centropages dorsispinatus*) correlated positively with pH, alkalinity and DO. The present findings highlight that zooplankton community structure and functional responses in the RE are primarily governed by seasonal hydrographic variability and nutrient dynamics, reflecting a merely eutrophic yet ecologically balanced estuarine system.

Keywords

Community structure, Diversity, Environmental variables, Estuary, Trophic index

Eutrophication and phytoplankton community dynamics in Wong Canal, Songkhla Province, Thailand

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Wong Canal is a tributary of Songkhla Lake, Thailand influenced by human activities that impact nutrient concentrations, leading to eutrophication. This study aimed to analyse water quality and nutrient concentration to assess the eutrophication status and examine their relationship with the phytoplankton community in Wong Canal. The study was conducted from December 2021 to October 2022 at 13 sampling stations. The results indicated that temperature, pH, salinity, and dissolved oxygen reached their highest levels in August. In contrast, nutrient concentrations (total ammonia nitrogen, nitrite, nitrate, dissolved inorganic nitrogen, orthophosphate, and total phosphorus) were the highest in December, April, and June. This increase was attributed to nutrient runoffs from surrounding communities during the monsoon season. Chlorophyll-a concentrations were highest in October. The assessment using the UNTRIX (Unscaled Trophic Status Index) classified the Wong Canal predominantly as eutrophic across both temporal and spatial scales. Spatial similarity analysis grouped the sampling stations into two distinct clusters i.e., upstream and downstream based on water quality and phytoplankton community composition. Correlation analysis between phytoplankton and environmental parameters revealed that salinity, dissolved oxygen, pH, nutrient concentrations, and chlorophyll-a significantly influenced the spatial distribution of phytoplankton in the Wong Canal. These findings highlight the impact of human activities on water quality in Wong Canal. Therefore, effective wastewater management and nutrient load regulation are crucial for sustaining the ecological balance of the aquatic ecosystem in the long term.

Keywords

Chlorophyll-a, Correlation analysis, Eutrophication, Wastewater management, Water quality



Spatial variation in the diversity of surgeonfishes (Family: Acanthuridae) across seven atolls of the Lakshadweep Archipelago

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Ichthyological investigations in the Lakshadweep Archipelago have significantly advanced our knowledge of reef fish diversity, particularly among surgeonfishes (family Acanthuridae). Studies in the last century documented 603 fish species, including 19 surgeonfishes, and subsequent studies expanded the list to 21 species. Recent documentation has led to the addition of new species, increasing the regional species inventory to 23. The present study, carried out across seven atolls of the Lakshadweep Archipelago as part of a biodiversity assessment, recorded 31 species belonging to the family Acanthuridae. Atoll-specific variation in species richness was evident, with Bangaram reefs supporting the highest number (25 species), followed by Minicoy and Kavaratti (24 species each), Agatti (23 species), while the reefs of Androth Island exhibited comparatively low diversity (9 species). The study also provides a checklist of the surgeonfishes present in the Lakshadweep Archipelago. The combined records, spanning from early baseline surveys to the present study, highlight both the taxonomic expansion and spatial variation in the diversity of Acanthuridae species across the Lakshadweep reefs. This dataset serves as an updated reference for ichthyofaunal inventories, enriching our understanding of reef fish diversity patterns and providing a valuable foundation for future ecological and taxonomic studies.

Keywords

Biodiversity assessment, Ichthyofaunal diversity, Reef fishes, Species richness



Marine ichthyofauna of the Andaman and Nicobar Islands: Diversity, distribution patterns and conservation imperatives in deep-sea environments

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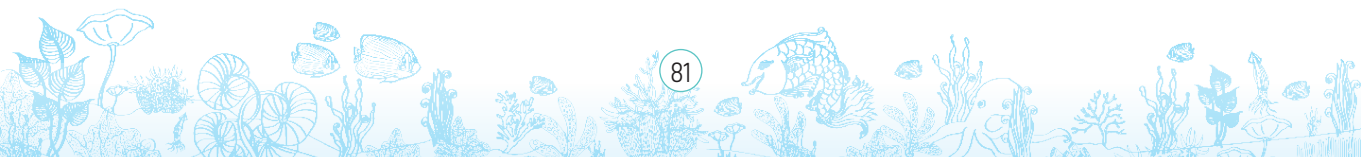
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The Andaman and Nicobar Islands form an Indian archipelago comprising 836 islands, islets, and rocky outcrops extending over 800 km in the southeastern Bay of Bengal. Despite their exceptional richness in harvestable marine resources, the region's fisheries sector remains critically underexploited. This paper aims to provide a comprehensive overview of the diversity, distribution, and conservation status of deep-sea fishes around the archipelago. The study aimed to integrate historical and contemporary research findings to elucidate patterns in species richness, depth-specific community structure, and taxonomic composition, underscoring the ecological importance of these deep-water environments. This study consolidates published literature from peer-reviewed journals, taxonomic databases, and technical reports over the past thirty years to provide a comprehensive evaluation of deep-sea fish diversity, distribution patterns, and conservation status in the Andaman and Nicobar Islands. A systematic literature search was undertaken across several databases, including Google Scholar, FishBase, and regional taxonomic archives, focusing on publications reporting fish species from depths exceeding one hundred meters around the archipelago. The results emphasises the critical need for systematic surveys and long-term monitoring programs, highlighting important knowledge gaps in the ecology, life history characteristics, and population dynamics of deep-sea ichthyofauna. As repositories of deep-sea biodiversity, the Andaman and Nicobar seamounts call for strengthened conservation strategies, sustainable fisheries management, and greater investment in deep-sea ichthyological research to ensure the long-term preservation of these unique marine ecosystems.

Keywords

Biodiversity conservation, Ichthyofauna, Marine ecosystems, Taxonomic diversity



Interannual shifts and seasonal blooms in dominant jellyfish species and their impact on coastal fisheries along the Kerala coast, India

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Jellyfish exhibit a wide distribution throughout various coastal and pelagic regions and the proliferation of jellyfish populations in coastal seas has become a regular occurrence in recent years, that affects ecosystem services. A study was carried out to investigate the seasonal and inter-annual variations in jellyfish abundance along southwest coast of India, from 2021 to 2025 and their impact on local fisheries. Data collected directly from ring seine and trawl operations revealed a significant difference in abundance of species during the study period. The period 2021 to 2023 was characterised by the abundance of *Chrysaora caliparea*, *Lychnorhiza malayensis*, and *Netrostoma coerulescens*. This was followed by a significant ecological shift in 2024 with a massive bloom of jellyfish *Cyanea nozakii*, with individuals weighing six to ten kilograms on average dominating the blooms. In 2025, there was a notable increase in the biomass of *Aequorea* sp., with smaller individuals weighing five to twenty-two grams in weight, and 80 to 110 nos. kg⁻¹. Usually, the jellyfish were most abundant during the post-monsoon period; however, the catch data of 2025 showed a notable shift, with blooms appearing during the southwest monsoon period itself, dominated by *C. caliparea* and *L. malayensis*. These jellyfish blooms consistently led to extensive net clogging and gear damage, causing substantial economic losses for the fishing community. This study highlights a clear shift in species dominance, the emergence of jellyfish bloom during monsoon and their economic impact on fisheries. These findings suggest a growing threat to fishery sustainability and necessitate the development of adaptive management strategies for this region.

Keywords

Ecosystem services, Fisheries impact, Jellyfish bloom, Pelagic regions, Seasonal variation



Crustacean macrofaunal assemblages in mangrove ecosystems

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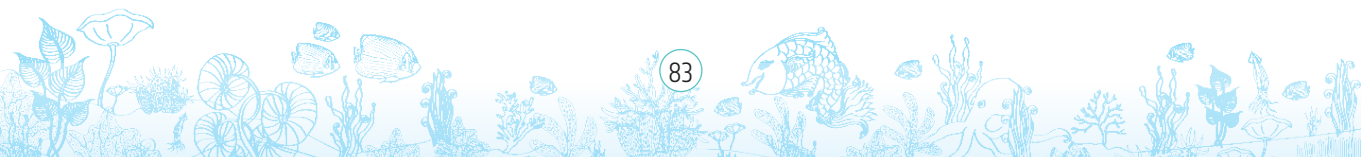
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Mangrove forests are the only types of forests on earth where land, freshwater, and saltwater coexist. In addition to providing resources to human populations, mangroves support various environmental functions. Macrofauna are significant players in nutrient cycling in the mangrove ecosystem and serve as a vital food source for larger organisms. As they evaluate the ecological effects of mangroves, macrofauna are valuable biological markers. Various types of crabs make up the majority of the macrofauna in mangrove habitats, and their diversity is rich. Macrofauna plays a crucial role in the mangrove ecosystem. As a major food source for larger creatures and a crucial link between primary detritus at the base of the food chain and consumers at higher trophic levels, macrofauna play a significant role in nutrient cycling. The coastline of Gujarat, which accounts for around 21% of India's coastline, is the longest in the country, spanning roughly 2,300 km. The Gulf of Kachchh, the Saurashtra coast of the Arabian Sea, and the Gulf of Khambhat are the three primary regions that make up Gujarat's coastal areas. The present research highlights the impact of mangroves on crustacean macrofauna in the Gulf of Khambhat, Bhavnagar District, Gujarat, India. Bhavnagar District is situated between 20° 45' to 22° 15' north latitudes and east longitude of 70° 13' to 71° 45'. Three field excursions were performed in the Bhavnagar coastal area in November and December 2024, and in January and February 2025. Two mangrove areas, Ghogha and Newport, were selected for sampling, and a non-mangrove area, Koliyak, was also selected. Densities of crustaceans were higher in December than in January. The crabs collected during field sampling were manually gathered, stored in labeled bottles, transported to the laboratory, and preserved in 10% formaldehyde solution for subsequent analyses. This study provides new insights and opens avenues for the conservation of coastal macrofauna in the Gulf of Khambhat.

Keywords

Bhavnagar, Diversity, Ecosystem, Impact, Nutrient cycling, Trophic level



Diversity and distribution of emperor fishes (Family: Lethrinidae) in South Andaman

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Emperor fishes (Family: Lethrinidae) are indispensable constituents of coral reef ecosystems and represent significant fish resources in the Andaman and Nicobar Islands. Regardless of their ecological and economic importance, limited baseline data exists regarding their diversity and distribution in this region. A comprehensive study was conducted from January to April 2025 to record the distribution patterns, species composition, and feeding ecology of emperor fishes landed at the Junglighat Landing Centre and local markets in South Andaman. The assessment was executed employing systematic sampling, morphological analysis, and gut content analysis. Species identification was performed using photographic documentation and standardised taxonomic keys. Gut content analysis was performed on *Lethrinus rubrioperculatus* and *Lethrinus conchyliatus* to determine their feeding preferences. Additionally, data on the fishing gears used to capture these species were documented, providing insights into the relationship between gear type and species occurrence. The study recorded 19 species from five genera in the family Lethrinidae, representing 86% of the known species in the Andaman and Nicobar Islands. The dominant genus among the five was *Lethrinus* (15 species), followed by *Gymnocranius* (3 species) and one species each of *Gnathodentex*, *Monotaxis*, and *Wattsia*. *Lethrinus rubrioperculatus*, *Lethrinus lentjan*, and *Lethrinus conchyliatus* were the most abundant species recorded daily. Gut content analysis of both species revealed their predominantly carnivorous feeding habit, primarily on fish and crustaceans. In *L. conchyliatus*, notable intraspecific colour variations were observed. Overall, the findings establish a comprehensive reference for the species diversity, feeding ecology, and fisheries interactions of emperor fishes, serving as an integral foundation for baseline data of the family Lethrinidae.

Keywords

Coral reef ecosystem, Feeding ecology, Fisheries interactions, Emperor fishes, Species diversity



Anthropogenic impacts on oyster populations and benthic diversity losses in the Vellar Estuary, southern India

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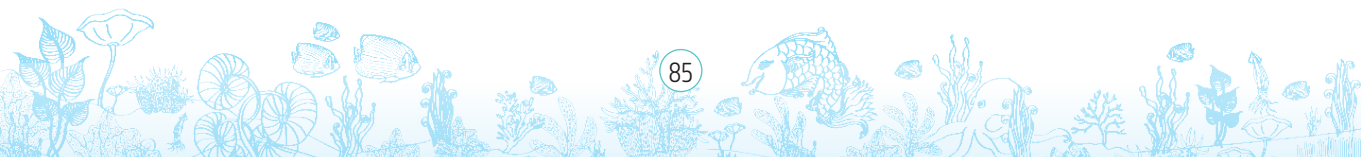
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Coastal and estuarine ecosystems are facing severe threats from climate change and increasing anthropogenic pressures. Oyster reefs, which play a crucial role in supporting biodiversity and providing essential ecosystem services, are undergoing rapid degradation due to overexploitation, habitat destruction, pollution, and the spread of invasive species. This study reports the indiscriminate exploitation of oyster fisheries in Indian estuarine and brackish water systems, highlighting the consequent loss of associated biodiversity. Observations from the Vellar Estuary revealed ongoing reef degradation, resulting in significant habitat deterioration and eventual collapse. A total of 6,846 individuals representing 58 benthic species were recorded from these impacted sites. Additionally, surveys among fishermen highlighted declining fish and oyster catches, corroborated by observations of fish caught in nets and underwater photographic evidence. Oyster reefs, formed by shell accretion on hard substrates, provide essential services including water filtration, habitat provision, shoreline stabilisation, and coastal protection. Globally, these habitats have declined by nearly 85%, with grave ecological and fisheries consequences. Our findings underscore the urgent need for conservation and sustainable management to safeguard oyster reefs, their associated fauna, and the commercially valuable fish that depend on them. Recommendations for achieving sustainable management are also provided.

Keywords

Climate change, Coastal protection, Diversity loss, Fisheries resources, Oyster reefs, Shoreline stabilisation



Insights into the reproductive biology of *Chromis viridis*

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The blue-green chromis (*Chromis viridis*), a reef-associated damselfish of the family Pomacentridae, is among the most widely traded species in the global marine ornamental industry and is also known as a baitfish in Lakshadweep for tuna catch. Its popularity is due to the vibrant colouration and adaptability to captive conditions, which make it a favoured choice among aquarists. However, the trade is predominantly reliant on wild harvest, which leads to collection pressure on the coral reef ecosystem. The threat extends beyond the long-term viability of natural populations, as it may also disrupt reef community dynamics due to the crucial role of this species in maintaining trophic balance. To promote sustainable alternatives, establishing aquaculture-based production is essential, which in turn requires a comprehensive understanding of reproductive biology. In this context, the present study was undertaken to elucidate the reproductive biology of *C. viridis* populations inhabiting reef environments around Agatti Island, Lakshadweep. The specific objectives were: (i) to characterise the gonadal developmental stages in males and females, (ii) to examine temporal variation in gonadal maturity and spawning activity, (iii) to estimate gonadosomatic index (GSI) and batch fecundity, and (iv) to analyse the fluctuations in sex ratios. Histological and macroscopic examinations classified the testes and ovaries into five stages: immature, maturing, mature, ripe, and spent. Monthly monitoring of gonadal maturity stages revealed breeding activity spans over several months, suggesting an extended spawning season. GSI values corroborated this trend, ranging from 0.017 to 9.2 in males and 0.51 to 13.16 in females. Batch fecundity estimates ranged between 1,903 and 32,925 eggs, with a mean of $8,323 \pm 6,290$ eggs, showing a strong positive correlation with ovary weight. Sex ratio analysis indicated significant deviations from 1:1 sex ratio during multiple months. Collectively, the findings highlight the reproductive plasticity, extended spawning potential, and high fecundity of *C. viridis*, traits that enhance its suitability for marine ornamental aquaculture.

Keywords

Maturity, Reproductive plasticity, Spawning season, Trophic balance, Wild harvest



Tracing Indo-West Pacific connectivity of *Penaeus semisulcatus* De Haan, 1844 through mitogenome sequencing

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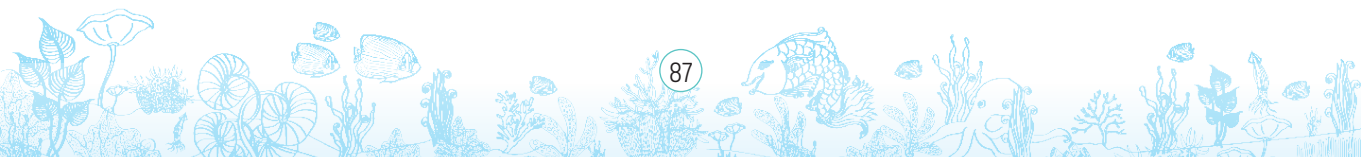
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The green tiger shrimp *Penaeus semisulcatus* is an ecologically and economically significant crustacean with a patchy distribution along the Indian coast, supporting a monospecific fishery along the southeastern region. Two distinct morphotypes, possessing banded and non-banded antennae have been reported, likely representing separate species. While the banded morphotype is widely distributed throughout the Indo-West Pacific, the non-banded form appears restricted to the Persian Gulf. This study presents the first complete mitochondrial genome (mitogenome) of the banded morphotype from Indian waters, helping bridge a key genomic knowledge gap for this species in the Indo-West Pacific. The assembled mitogenome is 16,004 bp in length and comprises 13 protein-coding genes (PCGs), 2 rRNA genes, 22 tRNA genes, and a control region, and displays the typical pan-crustacean gene content and arrangement. Comparative analyses revealed substantial genetic divergence, with K2P distances of 16.6% between the two morphotypes and 6.9% between Indian and Pacific lineages. Phylogenetic reconstruction supported the polyphyletic nature of *Penaeus sensu stricto* and recovered both morphotypes as a strongly supported clade. These findings enhance our understanding of the genetic diversity and evolutionary history of *P. semisulcatus*, providing an essential genomic resource for further comparative studies. The availability of the mitogenome will aid in resolving taxonomic uncertainties, guiding sustainable fisheries management, and informing conservation strategies for this commercially important species.

Keywords

Genetic diversity, Green tiger shrimp, Morphotypes, Phylogeny, Taxonomic resolution



Diversity and characterisation of culturable extremely halophilic archaea from two saltpans in Tamil Nadu, South India

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Halophiles are found distributed all over the world in hypersaline environments, with many found in natural hypersaline brines in arid, coastal, and even deep-sea locations. Haloarchaea are normally found in solar salterns and hypersaline lakes. Here, we discuss about the diversity of culturable extremely halophilic archaea from two solar salterns viz., Manakudy and Thoothukudy located in Tamil Nadu, South India. Halophilic archaea are recognised as valuable sources of novel natural products, enzymes, carotenoid pigments, catalysts, chemicals, biosurfactants, and other biomolecules. The objective of the study was isolation, characterisation and diversity analysis of potentially important haloarchaea from saltpan ecosystems. For the screening of haloarchaea, brine and sediment samples were collected from the saltpans, and the isolates were cultured in an archaeal-specific medium. The isolates were characterised and identified through phenotypic, biochemical and molecular approaches. The 16S rRNA gene sequences of the strains were submitted to the NCBI GenBank. Comparison and visualisation of biodiversity pattern were also carried out using the statistical software PRIMER v6. A total of 48 haloarchaeal isolates were obtained and comprehensively characterised to assess their phenotypic and genotypic traits accompanied by an analysis of their diversity. Both Mankudy and Thoothukudy saltpans harboured distinct and diverse haloarchaeal species. This study provides essential baseline data on haloarchaeal diversity in Indian saltpan ecosystems, contributing to our understanding of their taxonomy, ecological roles, and biotechnological potential.

Keywords

Biotechnological potential, Ecological role, Haloarchaea, Taxonomy



Composition of benthic fauna in Korapuzha Estuary, India, with an emphasis on its seasonal dynamics

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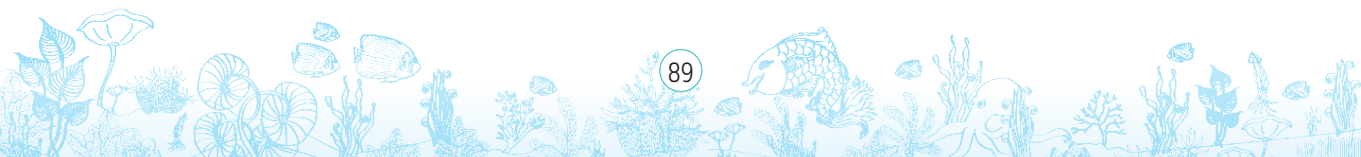
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The present study evaluated the spatiotemporal distribution of benthos in Korapuzha Estuary, India, during 2022-2024. During the study, a total of 54 species, comprising zoobenthos (81%) and phytobenthos (19%), were recorded. Based on organism size, the community comprised macrobenthos (69%), microbenthos (18%), and meiobenthos (13%). About 36 species were included in the macrobenthic taxa, and the major contributors were bivalves (22%), crabs (17%), shrimps (11%), fishes (8%), and polychaetes (5%). The dominant microbenthos were diatoms (10%), comprising nine species, and green algae, *Chlorella* sp. (1%). The dominant meiobenthic fauna were copepods, amphipods (43% each), and nematodes (14%). A significant seasonal variation was observed. During 2023, a total of 190 benthic organisms were recorded, with pre-monsoon showing the highest abundance (125 organisms), followed by post-monsoon (57 organisms), and the monsoon season (8 organisms). Spatial patterns revealed that site S3 was consistently productive during pre- and post-monsoon periods, while sites S1, S4, S5, S8 and S11 showed a complete absence of benthos during monsoon. During 2022, a total of 342 organisms were observed with pre-monsoon peaks (202 organisms) and monsoon lows (11 organisms). Gastropods (11 species) and diatoms (9 species) were the most diverse taxa, while squilla, *Chlorella* sp., and nematodes were rare (1 species each). The study found the highest benthic abundance in pre-monsoon months (Feb-May), with drastic declines during monsoon (Jun-Sep) and partial recovery in post-monsoon (Oct-Jan). Monsoon conditions drastically reduced benthic abundance, likely due to salinity fluctuations, with recovery during the post-monsoon period. These findings highlight the estuary's rich benthic biodiversity and its seasonal changes. The study underscores the need for long-term monitoring to understand climate-driven impacts on estuarine benthic ecosystems and their role in maintaining aquatic productivity.

Keywords

Benthos, Biodiversity, Community composition, Estuary, Microbenthos



Enzyme expression profiles of bacteria associated with Ophiuroidea and Asteroidea from seamounts of the Arabian Sea

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Host-microbe interactions within deep marine ecosystems represent a significant frontier in biological research, primarily due to our limited comprehension of their microbiome composition, interaction dynamics, and potential biotechnological and economic applications. In the present study, we report the enzyme expression profiles of 300 bacterial strains isolated from brittle stars collected from the summits of three seamounts (S8: 1330 m, S12: 426 m, S3: 554 m) and a plateau (Pt6: 1402 m) located in the Arabian Sea. Morphological analysis grouped these isolates into 103 distinct morphotypes, with 57% Gram-positive and 43% Gram-negative bacteria. These bacterial isolates exhibited varying expression levels of enzymes Aminopeptidase, β -Glucosidase, phosphatase, lipase, tyrosinase, and laminarinase. The isolates with the highest enzyme expression levels were identified by 16S rRNA Sanger sequencing, with the order *Stutzerimonas* most prominent (7 strains), followed by *Staphylococcus* (2 strains), *Halomonas* (1 strain), and *Brachybacterium* (1 strain). Notably, *Halomonas piezotolerans*, isolated from a brittle star, exhibited the highest expression profiles for all assessed enzymes. *Stutzerimonas nitritolerans*, recognised as an emerging opportunistic pathogen, yet possessing potential for bioremediation and denitrification, was also identified among the isolates. Furthermore, *Staphylococcus edaphicus*, initially discovered in Antarctic soil and known for its tolerance to cold and oligotrophic environments, is another significant isolate. Overall, the current study provides a comprehensive collection of brittle star-associated bacteria from deep-sea environments, with potential applications in bioremediation, biotransformation, and biomedical research.

Keywords

Biomedical research, Bioremediation Conservation, Denitrification, Expression profiles



Association patterns of the Jellyfish *Catostylus perezii* with marine crustaceans and fishes along the Gujarat Coast, India

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Jellyfish are ecologically important gelatinous zooplankton, functioning as active predators and mobile substrates that host diverse symbiotic communities. The class Scyphozoa (Phylum Cnidaria) includes over 842 known species, with at least 34 reported from Indian waters. Despite advances in jellyfish taxonomy, distribution, and fisheries research, studies on their ecological associations and symbiotic interactions with marine fauna remain limited in India. This study investigated the association of the Rhizostome jellyfish *Catostylus perezii* with other fauna along the Gujarat coast (November 2022–April 2025) by analysing 922 medusae *i. e.*, 631 from Okha and 291 from Jakhau. The jellyfish were reported to be associated with other marine fauna by 17.11 and 15.46% in Okha and Jakhau, respectively. In Okha, the jellyfish had dominant associations with crabs (60%), followed by shrimp (35%) and fish (5%), whereas in Jakhau, 58% of jellyfish were associated with fish, 40% with shrimp and 2% with crabs. The association of jellyfish with other fauna was correlated with their body size. We found a strong positive correlation between jellyfish body size and symbiont density, emphasizing the role of size in structuring associations. In Okha, symbiotic associations were frequent (43.40%) in medium-sized medusae with bell diameters of 15.1–20.0 cm. Similarly, the highest association (34.55%) was observed in medium-sized medusae with oral arm lengths of 10.1–15.0 cm. In Jakhau, associations occurred exclusively on medusae with 10.1–15.0 cm bell diameter, and 74.36% of associations occurred in jellyfish with oral arm lengths of 5.1–10.0 cm. These findings reveal pronounced regional variability in host–symbiont dynamics, with medium-sized medusae serving as key habitat providers in Okha, while smaller individuals dominate in Jakhau. Spatial variation in association patterns is likely driven by environmental conditions, prey availability, and fishing activity. This study provides new insights into symbiotic associations among jellyfish, crustaceans and fishes in the Northern Arabian Sea.

Keywords

Arabian Sea, Crustacean associations, Fisheries research, Gelatinous zooplankton, symbiotic associations



Free-living nematode assemblage as indicators of ecosystem health: A case study from selected mangrove ecosystems in Kerala, using molecular tools

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Free-living nematodes are widely recognised as reliable bioindicators of ecosystem health due to their high diversity, abundance, and sensitivity to environmental changes. Mangrove ecosystems, vital for coastal biodiversity, carbon sequestration, and livelihood support, are increasingly threatened by human activities. This study evaluated the potential of nematode assemblages to assess ecosystem quality in selected mangrove habitats along the Kerala coast (Kollam, Kochi, and Kannur) using an integrative approach combining morphological and molecular tools. The objectives were to (i) document nematode species diversity, (ii) standardise ecological indices such as Shannon diversity and maturity index for health assessment, (iii) relate community structure to environmental variables and pollutants, and (iv) generate molecular barcodes (18S rRNA, 28S rRNA, COI) to strengthen taxonomy and build a reference database. Sediment samples for meiofauna, physicochemical, and pollutant analyses were collected from the three regions representing varying levels of anthropogenic pressures during monsoon and non-monsoon seasons. The findings revealed distinct regional patterns in nematode assemblages along the Kerala coast. The Kannur region showed the highest diversity (37 species), including *Perspiria heterospicula* sp. nov. identified as a potential bioindicator of pristine conditions. Kollam exhibited moderate diversity (15 species), dominated by *Ptycholaimellus* spp., indicative of organic enrichment. In contrast, Kochi, under intense anthropogenic pressure, recorded the lowest diversity (12 species), with a dominance of opportunistic taxa, signalling habitat degradation. Among the 80 species identified, 15 represented new records for the Indian EEZ, and seven were new to science. Environmental correlations indicated that sediment texture was a key determinant, with clay-dominated sediments in Kochi supporting 67% fewer species than the silt-rich sediments of Kannur. This study represents the first systematic baseline of nematode diversity across Kerala's mangrove ecosystems and highlights their effectiveness as sensitive indicators of ecological health. The integration of morphological and molecular approaches provides a standardised framework for monitoring mangrove condition, facilitating regional comparisons and informing conservation policy. The key deliverables, including a DNA barcode library, a taxonomic handbook with pictorial keys, and a set of identified indicator taxa, will serve as valuable resources for future taxonomic research and ecosystem management in India and beyond.

Keywords

Anthropogenic pressures, Bioindicators, Integrated taxonomy, Meiofauna, Organic enrichment



Integrating planktonic biodiversity conservation into sustainable economic development strategies

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Planktonic biodiversity underpins the productivity and stability of marine and freshwater ecosystems, sustaining global biogeochemical cycles and higher trophic levels. However, increasing anthropogenic pressures have resulted in an unnoticed yet significant loss of phytoplankton, bacterioplankton, and zooplankton diversity, with cascading impacts on ecosystem services and economic sectors that depend on aquatic health. This study explores a sustainable subseabed sand-filtration technique as a practical approach to integrating biodiversity conservation into industrial seawater use. The method relies on the passive flow of seawater through natural sand columns beneath the seabed, allowing the collection of plankton-free water for industrial applications such as power plant cooling, desalination, ballast water management, and coastal aquaculture. The technique effectively prevents the impingement and entrainment of microscopic organisms in seawater intake systems, eliminating the need for chemical disinfection and reducing biofouling. It also minimises operational costs associated with traditional physical, chemical, and biological treatment processes. By avoiding the capture of planktonic organisms, this approach supports both ecological integrity and industrial efficiency. Integrating planktonic biodiversity conservation into sustainable economic development strategies can harmonise ecological health with industrial growth. The findings highlight the potential of nature-based and low-impact technologies to protect keystone planktonic communities, enhance ecosystem resilience, and reduce the ecological footprint of coastal industries. Collaborative policy frameworks are essential to scale such innovations globally and ensure that economic progress is achieved in synergy with biodiversity conservation.

Keywords

Eco-friendly technology, Plankton biodiversity, Subseabed intake system



Establishment of continuous neural cell line from the brain tissue of the whiptail silver biddy *Gerres filamentosus* (Cuvier, 1892)

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Primary cell cultures and cell lines are indispensable tools for applications such as virus isolation, propagation and toxicological studies. Whiptail silver biddy *Gerres filamentosus*, is one of the important minor commercial fish species that contribute to local fisheries. In the present study, a novel continuous neuronal cell line was developed from the brain tissue of *G. filamentosus* using the explant culture method. The cell line was subcultured 65 times over a period of 14 months, and the optimum conditions for the maximum growth of the cells were observed in Leibovitz L-15 medium supplemented with 14% fetal bovine serum (FBS), containing 0.4% NaCl at 28°C, designated as GFb (*Gerres filamentosus* brain). The GFb cell line was cryopreserved in LN2 at different passages, and a viability rate of $\geq 85\%$ was observed after thawing. Amplification and sequence analysis of the COI gene by PCR confirmed the origin of the cell line from *G. filamentosus*. The presence of only brightly stained nuclei, without pinpoint or filamentous fluorescence, after Hoechst 33258 staining confirmed that the cells were free of mycoplasma contamination. Immunophenotyping using epithelial and neuronal antibodies (NeuN, GFAP and MAP2) confirmed that the established brain cell line possesses neuronal properties. Further, 3D GFbs (GFb spheroids) were successfully generated in agarose-coated 6-well plates, enabling the utilisation of these cell lines in a more suitable *in vitro* model. In conclusion, this is the first study to establish a continuous cell line from the brain tissue of the *G. filamentosus* and to generate their subsequent 3D spheroids. The cells reacted positively with neuronal antibodies NeuN, GFAP and MAP2 during characterisation, demonstrating an excellent *in vitro* platform for systematic screening of emerging aquatic neurotoxicants, as well as for assessing the toxicity of heavy metals and microplastics *in vitro*.

Keywords

Mycoplasma contamination, Neuronal antibodies, Spheroids, Toxicological studies



Exploring the diversity of deepwater bycatch fauna in the southeastern Arabian Sea

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This study investigated the composition and biodiversity of deepwater bycatch fauna in the southeastern Arabian Sea, based on samples collected from commercial shrimp trawlers operating out of Sakthikulangara Fishing Harbour, Kollam, between November 2023 and May 2025. A total of 35 kg of bycatch yielded 1171 individuals, dominated by teleost fish (88.6%), followed by elasmobranchs (4.1%), crustaceans (5.6%), and cephalopods (0.5%). Taxonomic analysis identified 60 species, spanning 81 genera, 74 families, and 30 orders, including significant representation from Myctophidae and *Synagrops japonicus*, which together accounted for over 50% of the total catch. Crustacean diversity was dominated by *Puerulus sewelli* and *Homolax megalops*, while *Eridacnis radcliffei* emerged as the most frequent elasmobranch species. The presence of both commercially valuable and low-value species, including juveniles, highlights the ecological impact of non-selective trawling practices. This underscores the urgent need for sustainable management practices and gear selectivity to mitigate biodiversity loss in deepwater ecosystems.

Keywords

Biodiversity loss, Bycatch fauna, Ecological impact, Low-value species, Non-selective trawling



Ecological strategies of three sea urchin species: Growth patterns, recruitment and diet composition in the Gulf of Mannar

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The length–weight relationships, condition factor, and gut content composition of three echinoids: *Lovenia elongata*, *Temnopleurus toreumaticus*, and *Salmacis virgulata*, were studied from the Gulf of Mannar coral reef ecosystem. A total of 330 specimens were analysed across pre- and post-monsoon seasons, revealing species-specific growth patterns with negative allometric tendencies ($b < 3$). Sea urchin specimens were collected from landing centres in the Gulf of Mannar as bycatch from crab nets during pre- and post-monsoon seasons and measured for test diameter and weight to derive length-weight relationships and condition factor. Size-class distributions were examined to assess seasonal recruitment. At the same time, gut contents were analysed using Frequency of Occurrence (FO%), Numerical Method (N%), and Index of Preponderance (IOP%) to quantify dietary composition. The relationships obtained were $W=0.216L^{1.126}$ ($R^2=0.265$) for *L. elongata*, $W=0.003L^{2.204}$ ($R^2=0.639$) for *T. toreumaticus*, and $W=0.008L^{1.980}$ ($R^2=0.310$) for *S. virgulata*. Seasonal regressions indicated stronger length–weight coupling during the pre-monsoon than post-monsoon, reflecting spawning recovery and shifts in energy allocation. Condition factor (K) declined with increasing test diameter, with the lowest values observed during monsoon months. Size-frequency distributions revealed contrasting recruitment dynamics among the species. *L. elongata* showed a unimodal distribution, with larger mean diameters in the pre-monsoon (≈ 61.5 mm) that shifted to smaller classes during post-monsoon (≈ 52.3 mm), indicating recruitment of younger cohorts. In contrast, *T. toreumaticus* and *S. virgulata* maintained broader, overlapping size distributions, suggesting more continuous recruitment and weaker seasonal structuring. Gut-content analysis highlighted dietary partitioning. *L. elongata* functioned mainly as a detritivore (43.9% N%; IOP=46.0). *T. toreumaticus* was algivorous, dominated by seaweed (42.4% N%; IOP=43.7). *S. virgulata* exhibited an omnivorous strategy, consuming seagrass (38.5% N%; IOP=39.9), detritus (33.7%), and seaweed (23.0%), with molluscan shell and crustacean fragments as minor components ($<3\%$). The results indicate that the three echinoids exhibit distinct growth strategies, seasonal condition variability, and recruitment dynamics shaped by monsoon cycles. Dietary partitioning, with *L. elongata* as a detritivore, *T. toreumaticus* as an algivore, and *S. virgulata* as an omnivore, reduces interspecific competition and reflects adaptive resource use. Collectively, these patterns highlight niche differentiation as a key mechanism promoting coexistence and ecological stability within the Gulf of Mannar reef ecosystem.

Keywords

Algivore, Bycatch, Detritivore, Gut content analysis, Omnivore, Recruitment dynamics

Deciphering the invader, *Mytella strigata* in Indian backwaters

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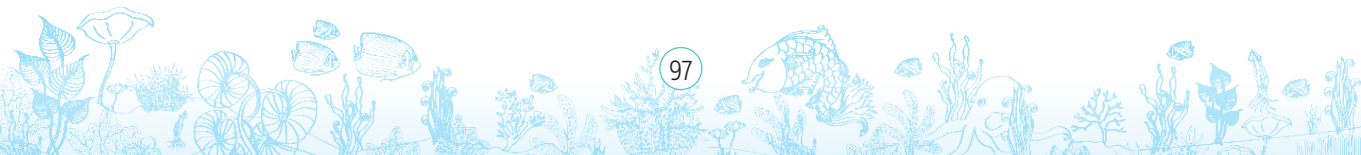
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Mytella strigata, an invasive exotic mussel, has been increasingly establishing itself in the Indian backwaters, raising concerns over the population of indigenous mussels since 2019. Once established, they are often impossible to eradicate, as they transcend jurisdictional boundaries; therefore, prevention is critical. With their fine byssus thread, they can firmly attach to the substratum where they fall. Unique characteristics such as broader adaptability, tolerance to extreme salinity, and higher fecundity lead to cascading ecological effects. The present study clarifies the distribution status and density variation of *M. strigata* in relation to seasonal changes in the Ashtamudi backwater, a Ramsar site of importance in India. Salinity variation, reflected in seasonal fluctuations, showed a significant decrease in abundance. The average distribution of the species across three locations in Ashtamudi was 2,278 ind. m⁻² during the monsoon season and 2,544 ind. m⁻² during the pre-monsoon season. The mussel exhibits a mean abundance of 2,516 ind $\pm$ 6.16 m², forming a dense mat in the mid-estuarine region, with a salinity of 26 ppt during pre-monsoon and 2175 ind $\pm$ 10.14 m² in 13 ppt during monsoon. A seasonal rise in abundance during the pre-monsoon period may result from environmental factors that were stable at that time. However, annual stock diversity data indicate that the population of *M. strigata* has declined due to overexploitation, as it is harvested as an alternative to the native mussel, *P. viridis*, and the yellow clam, both of which support fishermen's livelihoods. Although the species is invasive, it is now recognised as an edible mussel rich in essential nutrients, including a higher protein content, making it an affordable protein source. When *P. viridis* yields `510 per kg, *Mytella* fetches a price of `280 per kg. *M. strigata* exerts competitive pressure on native species and consequently alters the biodiversity of the backwater ecosystem. To prevent their spread, systematic physical inspection and removal can be effectively achieved only through the collaborative participation of fishermen. Such cooperative efforts are vital to safeguard the backwater from the harmful impact of the invasive species.

Keywords

Ashtamudi, Biodiversity, Competitive pressure, Invasive mussel, Seasonal variation



Comparative study of trawl bycatch from the Eastern Arabian Sea, landed in central Kerala on the southwest coast of India

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This study aimed to compare the species composition of trawl bycatch landed at Cochin and Munambam fisheries harbours, and assess the abundance of juveniles of various species in the landed bycatch. Bycatch samples were collected from the landings by trawlers operating from two major fishing harbours in Central Kerala viz., Cochin (CFH) (9°56'20.4"N; 76°15'47.4"E), and Munambam (MFH) (10°10'58.0"N; 76°10'15.0"E) of Ernakulum District, according to a pre-fixed sampling schedule during the period from November 2023 to April 2024. Overall, 93 species of finfish and shellfish were recorded in the trawl bycatch landed at CFH and MFH during November 2023-March 2024. Of this, 85% was constituted by finfishes, while crustaceans formed 11% and molluscs 4%. Diversity analysis indicated higher species richness, evenness, and diversity at CFH. Differences in species diversity and evenness indicated a low overlap of the fishing grounds targeted by boats operating from the two centres. The presence of juveniles was observed in 36 of the 93 species observed, with the percentage in the samples hovering between 30 and 35%; more than 80% of this was accounted for by finfish. Qualitative and quantitative studies on the bycatch of non-selective gears, such as trawls, are crucial for long-term fishery monitoring to develop strategies that minimise fishing impacts on stocks and improve resource sustainability. Education and awareness campaigns are vital to empower fishermen with the knowledge and skills necessary to adopt bycatch mitigation measures. By fostering a culture of responsible fishing practices and environmental stewardship, stakeholders can work towards a more sustainable and equitable future for both marine ecosystems and coastal communities.

Keywords

Diversity, Evenness, Juvenile percentage, Species composition, Sustainability



New record of three rockskipper blennies (*Praealticus bilineatus*, *Praealticus tanegasimae* and *Istiblennius muelleri*) from Indian waters

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The present study documents new records of three species of rockskipper blennies: *Praealticus bilineatus* (Peters, 1868), *Praealticus tanegasimae* (Jordan & Starks, 1906) and *Istiblennius muelleri* (Klunzinger, 1879) from Andaman coasts, thereby extending their known geographical distribution into the Indian waters. Specimens were collected from intertidal rock pools and adjacent rocky shores of Burmanallah, South Andaman, in February, March and April 2023. The species were identified based on their morphological traits. Additionally, molecular phylogenetic analysis was performed using mitochondrial COI gene sequences generated through universal FishF1/FishR1 primers and standard Sanger sequencing protocols. Complementing morphological identification, mitochondrial COI gene sequences were analysed phylogenetically, confirming species distinctiveness and evolutionary relationships. The first COI barcode sequences for *Istiblennius muelleri* (Klunzinger, 1879) and *Praealticus bilineatus* (Peters, 1868) are reported and are being submitted to GenBank to enhance molecular reference databases. These studies contribute to the growing knowledge of the diversity and phylogenetic relationships of blennioid fishes in India.

Keywords

Andaman Islands, Blenniidae, COI barcoding, New distribution records



Marine plastisphere-associated agarolytic bacteria: Characterisation and enzyme analysis

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Marine environments host numerous microbes capable of degrading agar as a carbon and energy source. Agarolytic bacteria possess enzyme agarase that catalyse the hydrolysis of agar, which is classified as α -agarases and β -agarases based on their cleavage patterns. This study focuses on agar-degrading bacteria isolated from the marine plastisphere off Kochi, highlighting plastisphere as a novel niche for enzyme-producing microbes. Phenotypic, biochemical, and molecular analyses identified three agarolytic bacterial species, viz., *Aquimarina litoralis*, *Persicobacter diffuens* and *Microbulbifer elongatus*. Molecular identity of the strains were confirmed by 16S rDNA sequencing and the sequences were submitted in NCBI GenBank with the accession numbers, PX472820, PX472821 and PX472822 respectively. The agarolytic patterns, agarolytic index, and agarase enzyme from the three bacterial strains were evaluated. Each of the agarolytic isolates exhibited varying degrees and patterns of agar degradation, ranging from surface softening of the agar to pit formation and progressive liquefaction. The distinct agarolysis patterns produced by different strains were visually assessed, documented, and recorded for comparative analysis. Agarase activity of the crude enzyme was measured spectrophotometrically by 3,5-dinitrosalicylic acid (DNS) method by measuring the reducing sugar equivalents released under standard assay conditions, using d-Galactose as the standard. Results of the study indicated that agarolytic bacteria from the marine plastisphere represent valuable sources of agarases with significant potential for industrial applications.

Keywords

16S rDNA sequencing, Agarase, Agarolytic index, Enzyme activity



Meroplankton with special reference to ichthyoplankton, in the Southeastern Arabian Sea and the Gulf of Mannar

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This study presents the seasonal and spatial variations in the distribution and abundance of meroplankton with a focus on ichthyoplankton in the Southeastern Arabian Sea (SEAS) and the Gulf of Mannar. During the southwest monsoon [SWM (June-September)], coastal upwelling leads to enhanced biological productivity and increased zooplankton biomass and abundance in the nearshore waters. In contrast, the northeast monsoon [NEM (November-February)] was characterised by the intrusion of warm, low-salinity Bay of Bengal water, which resulted in a decline in overall productivity and zooplankton abundance in the nearshore areas compared to the SWM. A detailed analysis of the meroplankton community revealed that they contributed 2-10% of the total zooplankton abundance. Ichthyoplankton (fish eggs and larvae) constituted a major component of the meroplankton, contributing 33-92% of the total meroplankton abundance throughout the study period. During the SWM, average ichthyoplankton abundance was higher and comparable in the nearshore (29 ± 12 ind. m^{-3}) and offshore (28 ± 22 ind. m^{-3}), but it declined during the NEM (8 ± 6 ind. m^{-3}). Similarly, the nearshore during SWM was characterised by a high abundance of benthos larvae (decapods, polychaetes and gastropods) and hydromedusae, while the offshore region was dominated by euphausiid larva. Eleven fish larval families were identified. Engraulidae, Clupeidae, Carangidae and Mullidae were most prominent in nearshore waters, and their spawning coincided with the high food availability associated with coastal upwelling. Offshore, larvae of Scombridae, Sciaenidae and Sparidae were dominant, linked to oceanic spawning and larval drift. During the NEM, nearshore locations were dominated by Engraulidae, Clupeidae and Carangidae, likely due to extended spawning periods and a preference for low-salinity coastal waters. Overall, these patterns show the importance of monsoon-driven processes in influencing the spawning strategies, larval dispersal and habitat preferences of various zooplankton taxa, which is essential for sustaining fisheries productivity.

Keywords

Biological productivity, Coastal upwelling, Habitat preferences, Larval drift, Zooplankton taxa



Diversity and enzyme expression profile of cultivable gut bacteria in skipjack and yellowfin tuna

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The gut microbiome of marine fish, along with its implications for host health and overall well-being, as well as its influence on the sustainability of the surrounding ecosystem, represents an emerging area of research that remains inadequately documented. This study involved the isolation of bacteria from the gastrointestinal tracts of skipjack and yellowfin tuna. In total, 129 bacterial strains were isolated across five different media, comprising 72 isolates from skipjack tuna and 57 from yellowfin tuna. Morphological analysis categorised these isolates into 96 distinct morphotypes. Gram-positive bacteria constituted 51.16% of the isolates, while Gram-negative bacteria represented 48.83%. Enzymatic screening was performed to assess six ecologically and metabolically significant enzymes: tyrosinase, laminarinase, aminopeptidase, lipase, phosphatase, and β -glucosidase. The bacterial isolates exhibiting multiple enzymatic activities were sequenced, demonstrating a high diversity within the gut microbiomes of both skipjack and yellowfin tuna. This diversity included the bacterial species *Proteus cibi*, *Bacillus tequilensis*, *Bacillus mexicanus*, *Enterococcus faecalis*, *Lactiplantibacillus argentoratensis*, *Levilactobacillus brevis*, *Vreelandella piezotolerance*, *Providencia rustigianii*, and *Psychrobacter maritimus*. These findings contribute to a deeper understanding of host-microbiome interactions in pelagic fish and significantly advance the field of marine microbial biotechnology.

Keywords

Host health, Marine microbial biotechnology, Microbiome, Morphological analysis, Pelagic fish



Biodiversity inventory of faunal assemblages at Sewell Rise and Andaman Accretionary Prism (AAP) in the Andaman Sea with insights into deep-sea habitat complexity

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Deep-sea ecosystems host unique and highly adapted biological communities shaped by extreme physicochemical conditions. This study aimed to advance understanding of deep-sea biodiversity in the Andaman Sea by compiling a comprehensive inventory of faunal assemblages. The present work addresses the objective of documenting these assemblages and provides essential baseline data for future ecological and conservation assessments. Field investigations were carried out at Sewell Rise and the Andaman Accretionary Prism (AAP) in the Andaman Sea during Geological Survey of India cruises SR-039 and SR-046 aboard *R.V. Samudra Ratnakar*. Samples were collected using grab samplers, and recovered deep-sea fauna were preserved and subsequently identified in the laboratory. A total of 20 taxa were identified, representing diverse phyla, including Cnidaria, Echinodermata, Arthropoda, Brachiopoda, Foraminifera, and Porifera (Hexactinellida). Cnidarians were particularly diverse, comprising octocorals (*Acanthogorgia* sp., *Chrysogorgia* sp., *Calyptrophora* sp., *Corallium* sp.), scleractinians (*Enallopsammia rostrata*), hydrocorals (*Stylaster* sp.), and antipatharians (*Leiopathes* sp., *Stylopathes* sp.). glass sponges (*Euplectella* sp., *Farrea* sp., *Aphrocallistes beatrix*) and echinoderms, including cushion stars (*Ceramaster* sp.) and *Pillsburiaster* sp., were recorded, along with arthropods such as squat lobsters and deep-sea shrimps (*Heterocarpus* sp.). Additional findings included the xenophyophore *Reticulammina* sp., brachiopods (lamp shells), and the distinctively metallic-hued golden coral. Morphological descriptions were prepared based on in situ imagery and preserved specimens, with diagnostic characters such as colony architecture, skeletal composition, and surface ornamentation documented for each taxon. Several species, including *Leiopathes* sp. and *Stylopathes* sp., are known for their exceptional longevity and habitat-forming capacity, highlighting the ecological significance of this assemblage. The prevalence of suspension feeding corals and sponges indicates a community structure influenced by strong bottom currents and particulate organic matter input. This inventory constitutes a vital reference for monitoring temporal changes, evaluating anthropogenic impacts, and informing conservation strategies in deep sea habitats of the Andaman Sea. In light of growing interest in deep sea resource exploitation, including polymetallic nodule mining, such baseline biodiversity data are critical for robust environmental impact assessments and sustainable management planning.

Keywords

Arthropoda, Brachiopoda, Cnidaria, Deepsea fauna, Echinodermata

Local hands, lasting impacts: Whale shark conservation campaign outcomes along the Kerala Coast

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Whale sharks (*Rhincodon typus*) faced threats along the Kerala coast, primarily as bycatch in fishing, leading to intentional killing for use in the poultry feed industry. Initial findings from the Traditional Ecological Knowledge surveys conducted by the Wildlife Trust of India along the coast revealed significant knowledge gaps within fishing communities concerning whale shark identification, ecological importance, and legal status. WTI initiated a project in 2017 to reduce both intentional and unintentional killing of whale sharks through the rescue and release of entangled individuals, and the sensitisation of coastal communities. Sensitisation programs were conducted for fishers, focusing on the ecological significance, safe release techniques, and legal status of the whale shark. Events were also held to foster long-term stewardship among students. Visual communication tools, such as life-size inflatables, were deployed to enhance outreach. Capacity-building training programs were organised for practising vets along the coast to improve their response to marine megafauna stranding. Before the project intervention, 90% of fishers (n=150) were unaware of the Wildlife (Protection) Act and believed that killing would not harm the whale shark population. With 203 sensitisation events between 2017 and 2025, 92,827 fishers and 77,266 youths across nine coastal districts were sensitised. Reinforced by 23 signage and seven wall graffiti, these campaigns have potentially changed the attitude of fishers. As evidenced by over 50 whale shark rescues by fishers, with ₹11 lakhs in compensation for net damage. This conservation initiative underscores the role of multi-stakeholder engagement and community stewardship. By addressing knowledge gaps, fostering positive attitudes, and promoting responsible practices within coastal communities, the project has contributed to the conservation of whale sharks along the Kerala Coast.

Keywords

Awareness, Community stewardship, Marine megafauna, Protected species, Rescue



Burrow architecture of the horned ghost crab *Ocypode ceratophthalmus* (Pallas, 1772) from the sandy shores of Kanhangad coastal region, Kerala

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Burrowing behaviour is common among crabs and serves multiple purposes, including protection from environmental changes, predators, and other challenges they face. Burrows are essential for reproductive activities like mating and brood care. The Ghost Crab, *Ocypode Ceratophthalmus*, is semi-terrestrial and is found on tropical and subtropical sandy beaches, where it occupies conspicuous burrows. Adult crabs are nocturnal, so they spend their daytime inside the burrows. In this study, the burrow morphology of the brachyuran crab *Ocypode Ceratophthalmus* was examined from Meenapis, Kanhangad coastal region of Kerala state, India. Burrows were randomly selected. The entire burrow casts were used for different shape analyses, identification and measurements. The temperature and pH of the sediments and seawater were also measured. About eight different burrow shapes were excavated from the study area. The shapes observed include J-shape, J with branch, Y-shape, Y with double opening, U-shape, spiral, single tube, and bulb, with single tube burrows being the most abundant. Burrow opening diameter, depth, total length, branch lengths, burrow inclination angles, and branch inclination angles were all calculated. Crabs exiting the burrows were photographed, and their carapace width, length, and sex were recorded. Carapace width showed a positive correlation with burrow opening diameter. A significant decrease of 4-5°C in temperature was observed inside the burrows compared to the atmospheric temperature. From this study, we observed different types of burrows created by the species. Besides their common functions, each burrow appears to serve specific purposes. Both adults and juveniles actively participate in constructing these burrows.

Keywords

Brood care, Burrow cast, Mating, Nocturnal, Protection



A plankton baseline model for interpretable and open-world biodiversity monitoring

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Plankton are microscopic organisms that are fundamental to aquatic ecosystems, sustaining marine food webs and driving nutrient and carbon cycles. Their ecological and climate significance make accurate biodiversity monitoring essential. Yet, despite decades of research, large-scale and fine-grained assessment of plankton diversity remains unresolved. Manual identification is laborious and expert-dependent, while automated approaches, though promising, face critical gaps. Convolutional neural networks, transfer learning, and, more recently, vision-language models have shown strong performance on benchmark datasets. However, most remain heavily label-dependent, struggle with domain shifts, and, crucially, offer limited interpretability: their predictions do not reliably align with the diagnostic traits used by taxonomists, reducing trust and usability. Modern imaging platforms now generate millions of high-resolution plankton images. Still, this wealth of data remains underutilised due to annotation bottlenecks and the absence of models that combine scalability, open-world recognition, and morphological explainability. To address this, we introduce the Plankton Foundation Model (PFM), a vision transformer pretrained on extensive unlabeled plankton image collections. PFM learns morphology-aware representations without labels by leveraging domain-specific augmentations and morphometric losses that enforce shape invariance and boundary consistency. This enables three capabilities: (i) few-shot species identification with minimal labelled data, (ii) open-world novelty discovery, clustering unseen morphotypes and (iii) interpretable predictions, grounded in morphological cues. A vision-language module further explains outputs in taxonomically meaningful terms, such as body outline and appendages. Across diverse datasets, PFM surpasses ImageNet-pretrained and CNN-based baselines in few-shot and cross-domain scenarios. By coupling imagery with morphology-aware intelligence, PFM paves the way for scalable, interpretable, and expert-in-the-loop plankton monitoring, advancing biodiversity assessment, fisheries management, and climate research.

Keywords

Explainable AI, Image-based species identification, Marine taxonomy, Self-supervised learning



Spatial diversity of culturable bacterial communities associated with selected coral reef ecosystems in Southern India

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Coral reef ecosystems along the southern Indian coast were surveyed to assess the spatial diversity of culturable bacterial communities. Six reef locations were studied viz., Kalpeni, Androth, Amini, Minicoy, and Kavaratti in the Laccadive Sea (southwest coast), as well as Thoothukudi and Palk Bay on the southeast coast, using Line Intercept Transect (LIT) surveys across five stations per site. Bacteriological samples were collected from stony corals (healthy, diseased, and bleached), soft corals, coralline algae, seawater, and sediments. From a total of 1,343 isolates, 1,058 were characterised using phenotypic and biochemical traits, Amplified rDNA Restriction (ARDRA) profiling, as well as 16S rRNA gene sequencing. A total of 61 bacterial species representing 16 genera were identified. Species richness was highest at Kalpeni, while genus-level diversity peaked at Amini. The genus *Vibrio* (~50%) was dominant, with *V. alginolyticus* most prevalent, followed by *V. parahaemolyticus*, *V. neocaledonicus*, *V. azureus*, and *V. diabolus*. Among non-*Vibrio* taxa, *Shewanella* algae, *Bacillus* spp., *Micrococcus* spp. and *Photobacterium rosenbergii* were frequently recorded. Overall, Gammaproteobacteria were predominant, followed by Bacilli, Actinobacteria, and Sphingobacteria, while at the phylum level, Proteobacteria dominated with lower representation of Firmicutes, Actinobacteria and Bacteroidetes. These findings reveal distinct spatial variation in coral reef-associated culturable bacterial assemblages along southern India, providing baseline insights into their diversity and potential ecological roles

Keywords

ARDRA profiling, Laccadive Sea, LIT survey, Species richness, Stony corals, 16S rRNA gene sequencing



Fish biodiversity assessment using eDNA metabarcoding in the Kumarakom Wetlands, Vembanad Lake

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Environmental DNA (eDNA) metabarcoding is a sensitive, high-throughput, and non-invasive approach for monitoring aquatic biodiversity, offering significant advantages over traditional survey methods. In this study, eDNA metabarcoding with MiFish primers was employed to assess fish diversity in the Vembanad–Kumarakom wetlands, a Ramsar-designated site in Kerala, India, renowned for its ecological complexity and habitat heterogeneity. Water samples collected from five locations were pooled into a composite sample representing the regional fish community and sequenced for the mitochondrial 12S rRNA gene. Reads with Phred scores above 30 were subjected to taxonomic assignment using BLASTn against the NCBI nucleotide database. The analysis revealed 14 fish taxa spanning freshwater and brackish environments, with varying levels of sequence similarity. High-confidence detections ($\geq 97\%$ similarity) comprised eight species ie., the euryhaline cichlids *Pseudetroplus maculatus* (100%) and *Eetroplus suratensis* (100%), reflecting the system's brackish character; *Leiognathus brevisrostris* (100%), indicative of marine connectivity; the freshwater carps *Labeo dussumieri* (100%) and *Systomus sarana sarana* (100%); *Dawkinsia tambraparniei* (98.16%); *Channa marulius* (98.13%); and *Monodactylus argenteus* (97.66%). Moderate-confidence detections (91–96%) included *Netuma thalassina* (96.40%), *Ehirava fluviatilis* (95.35%), *Schismorhynchus labialis* (93.43%), *Gerres erythrouros* (93.87%), and *Gerres cinereus* (91.32%). A low-similarity detection of *Synbranchus marmoratus* (88.32%) - a Neotropical species was absent from India and likely reflects gaps in reference databases and underscores the importance of regionally curated resources. *Dawkinsia tambraparniei* (98.16%), a species regarded as endemic to the Tamiraparani River system in the Western Ghats of Tamil Nadu, was detected, indicating possible range expansion, undocumented local occurrence, or database-related misassignments that require further validation. These results illustrate the effectiveness of eDNA metabarcoding in detecting diverse fish assemblages in complex wetland ecosystems. The study establishes a molecular baseline for biodiversity monitoring in the Vembanad wetlands and highlights the value of integrating eDNA with traditional survey methods to strengthen conservation strategies in ecosystems facing increasing anthropogenic pressures.

Keywords

Anthropogenic pressure, Biodiversity monitoring, Ecological complexity, Fish taxa

Fisheye: An android application for fish species identification integrating Google Gemini AI

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Fish species identification is essential for biodiversity monitoring, ecological research, and sustainable fisheries management. Traditional approaches often require domain expertise, extensive field guides, and manual verification, which can be time-consuming and inaccessible to non-specialists. To overcome these limitations, we developed FishEye, an Android-based mobile application that utilises the Google Gemini AI API (Application Programming Interface) to facilitate automated fish species recognition. The application allows users to either capture images with a mobile device camera or upload photographs from their gallery. These images are then analysed through advanced AI-based image recognition to generate species predictions with high accuracy. Cloud-based inference ensures computational efficiency, rapid processing, and seamless operation on mobile devices. The application is designed to benefit a wide range of users, including researchers, educators, students, fishing enthusiasts, and local communities. Future developments aim to expand the species database, incorporate offline prediction capabilities, and integrate an AI model custom-trained on Indian resources to ensure more accurate species identification.

Keywords

Biodiversity monitoring, Computational efficiency, Mobile application, Seamless operation



Feeding ecology of spotfin flathead *Grammoplites suppositus* (Troschel, 1840) from the Northeastern Arabian Sea

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Information on a species' dietary preferences is essential for understanding its ecological role, trophic level, and interactions within the marine food web. The current investigation examines the trophodynamics of the demersal predator *Grammoplites suppositus*, collected from the Northeastern Arabian Sea. The study reveals that the species feeds on a diverse range of prey items, including crustaceans, fish, cephalopods, and gastropod shells. Crustacea constitute the main important prey (MIP) in the diet, with *Acetes indicus* identified as the dominant prey species; while teleosts and cephalopods form secondary and occasional prey, respectively. Several deep-sea species like *Sergestes* sp., *Pontocaris affinis*, *Diaphus* sp., *Benthoosema pterotum*, *Champsodon nudivittis*, *Acropoma japonicum*, and *Bregmaceros maclellandi* were identified from the prey items of the species. The feeding intensity was higher during December to February, while a high vacuity index was observed during September to November. The Costello analysis proclaimed that *G. suppositus* is a specialist feeder on crustaceans. Size-wise, feeding preferences were higher in smaller groups than in larger groups. The present study provides the first comprehensive report on the feeding habits of the Spotfin flathead from the Northeastern Arabian Sea, which could aid in the sustainable management of the fish stock in the studied region

Keywords

Acetes indicus, Costello analysis, Deep-sea, Platycephalidae, Trophodynamics



AI-based identification vs. conventional taxonomy of deep-sea fishes: A comparative analysis of strengths, limitations and synergies

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The precise identification of deep-sea fishes is foundational for biodiversity monitoring, resource assessment, and setting conservation priorities. Conventional taxonomy is the basic method of fish identification; however, it faces significant challenges in the deep-sea due to limited habitat accessibility, high species diversity, frequent collection of damaged or incomplete specimens, time consumption, and insufficient taxonomic resources and expertise. These constraints have led to significant gaps in the accurate assessment of deep-sea fishery resources. Recent advances in Artificial Intelligence (AI) using Artificial Neural Networks (ANNs) offer a promising new tool for automating species identification using image data. This study critically evaluates the advantages and limitations of AI-based identification vs. the conventional taxonomic approach. AI models have demonstrated high accuracy in recognizing visually distinct species and automating large-scale image analysis, significantly reducing the time and cost needed for manual identification. Despite that, these models often stem from the identification of cryptic and rare species, poor image quality, and an incomplete training dataset. The present investigation reveals that rather than replacing conventional taxonomy, AI-based models serve as complementary tools for deep-sea species identification and biodiversity assessments. This integrative approach can accelerate taxonomic resolution and support data-driven conservation planning of deep-sea resources.

Keywords

Artificial Neural Networks, Biodiversity monitoring, Conventional taxonomy, Image analysis



From legislation to conservation action: Strengthening protection for endangered elasmobranchs in India

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The Wild Life (Protection) Amendment Act, 2022, effective from April 2023, marks a significant milestone in India's marine biodiversity conservation efforts. By aligning national legislation with global commitments under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the amended Act extends the highest legal protection to 18 species of elasmobranchs under Schedule I and safeguards an additional 8 species under Schedule II. This legal reinforcement addresses the growing threats of habitat loss and illegal trade, imposing stringent penalties to deter violations. However, the effectiveness of such legal measures depends heavily on stakeholder awareness and capacity. Fishery managers, enforcement agencies, coastal communities, and the general public must be equipped with the knowledge to identify protected species, understand their legal status, and comply with conservation regulations. Without this awareness, even the most robust laws risk underperformance in the field. Awareness creation remains crucial, and in this regard, questionnaires were developed to assess stakeholder understanding and evaluate the effectiveness of the amended legislation, with all findings systematically documented for reporting. Robust scientific research is equally critical to guide policy, monitor population trends, and evaluate the success of conservation measures. Studies on species distribution, biology, migration, and threats enable evidence-based management, and support adaptive strategies that align conservation goals with coastal livelihoods. Beyond awareness and research, effective protection requires strengthening monitoring and surveillance systems, enhancing inter-agency coordination, improving species identification skills, and ensuring effective implementation of legal provisions. Promoting sustainable fishing practices, engaging local communities in conservation incentives, and building capacity at grassroots and institutional levels will help transform legislation into tangible conservation outcomes for these ecologically vital predators.

Keywords

Awareness, Biodiversity, CITES, ETP species, Legislation



Taste variation in hilsa (*Tenualosa ilisha*): A comparative analysis between the Meghna and Tetulia river systems in Bangladesh

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Hilsa shad (*Tenualosa ilisha*) is one of the most important anadromous fishes (ascending rivers from the Bay of Bengal) that migrate into the Meghna and Tetulia River systems in Bangladesh. Hilsa is the national fish of this country and is famous for its taste and delicacies, especially among the vast majority of the Bengali population living in Bangladesh and the seven sister states of India. There is widespread consumer complaint across all ages about variations in the taste of hilsa fish captured from different river systems. However, information on differences in Hilsa taste across river systems in this region is scarce. An effort was made to closely examine the causes of differences in Hilsa taste between the Meghna and Tetulia River systems through nutritional profiling (amino acid and fatty acid analysis). The nutritional composition revealed that higher myristic and lauric acid contents were found in the Meghna *Hilsa*, whereas myristic, oleic, and lauric acid contents were higher in the Tetulia *Hilsa*. The taste active components, such as non-essential amino acids (glutamic acid>glutamine>aspartic acid>alanine>glycine) and essential amino acids (lysine>methionine>isoleucine>phenylalanine), were higher in hilsa fish of the Tetulia River estuary compared to those of the Meghna River estuary. Higher contents of taste-active components, such as amino acids, viz., glutamine, glutamic acid, alanine, aspartic acid, lysine, methionine, isoleucine, and fatty acids, viz., myristic acid, lauric acid, and oleic acid, along with higher n3:n6 fatty acids, are attributed to the superior taste of hilsa from the Tetulia. To support the reasons for better amino acid performance in *hilsa*, both plankton and hilsa fish samples were collected from the Meghna and Tetulia estuaries at the same time. Chlorophyta (green algae) was the dominant phytoplankton group in Meghna's hilsa gut (40%) compared to Tetulia (30%), whereas bacillariophyta (diatoms) were the dominant group in Tetulia's hilsa gut (60%) compared to Meghna's (25%). The study suggests conducting a thorough investigation to determine whether the hilsa stocks in the two river systems differ genetically.

Keywords

Non-essential amino acids, Fatty acids, Nutritional composition, Phytoplankton

Tracing fins through time: Elasmobranch diversity along Mumbai Coast, Maharashtra from 1801 to 2024

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This study examines elasmobranch diversity along the Mumbai Coast through two comparative checklists: a historical compilation from 1801-1974 and a more recent dataset from 1991-2024. Between 1928 and 1946, 13-41 species were recorded, belonging to 5-6 orders, 10-19 families, and 10-23 genera, primarily caught using indigenous gears such as bag nets, gill nets, hook-and-line, and shore seines. By 1974, a total of 56 species from 7 orders, 19 families, and 34 genera were documented, coinciding with the rise of multi-gear fisheries. The current study (1991–2024) recorded 62 species from 6 orders, 18 families, and 35 genera. A bibliographic review revealed 58 species in historical records, of which 13 appear to have disappeared in recent data, while 15 new species were recorded in the present study. Shifts in fishing practices, including boat types, gear diversity, and expanded fishing grounds, have significantly influenced species composition and diversity over time. Catch statistics for sharks, skates, and rays from five major gears indicate a declining trend from 1991 to 2024, with sharks dominating across all gears. The most dominant orders in the recent data were Carcharhiniformes (38.7%, 24 species) and Myliobatiformes (37.1%, 23 species). Similarly, in the historical data, Carcharhiniformes (37.9%, 22 species) and Myliobatiformes (32.8%, 19 species) were also predominant. The order Lamniformes was represented by only one species in the earlier records. Of the total 80 species evaluated from both time periods, 8.8%, 10.8%, and 22.5% of the 41 species assessed are listed as Critically Endangered, Endangered, and Vulnerable, respectively, under IUCN criteria. Notably, this study reports the first occurrence of *Urogymnus asperrimus* (Bloch & Schneider, 1801) in Mumbai waters. The findings underscore the urgent need for targeted conservation measures, particularly to identify and protect key habitats, such as mating and pupping grounds, that are critical to the survival of vulnerable elasmobranch populations.

Keywords

Arabian Sea, Biodiversity, Guitarfish, Rays, Sharks, Wedge fish



Food web characteristics and trophic interactions in Netravathi Gurupur estuarine ecosystem in the west coast of India

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Estuarine ecosystems are dynamic, and the food webs are more complex compared to other aquatic ecosystems, mainly due to the emigration of freshwater and marine species. An ecological model of Netravathi-Gurupur (NG) Estuary, on the Karnataka coast, was developed to evaluate the trophic structure through food web modelling. This is a tropical estuary with high biological production, contributing to active fishery. The estuarine food web developed with 28 functional groups is controlled by a bottom-up approach. The input parameters were collected from the fish catch assessment, sample surveys and published reports. The pedigree index for the NG Estuary is good (0.50), indicating a high level of confidence. The ecological impact of various fishing nets on the fishery showed that gill nets had a strong negative impact on the glassy perchlets (-0.340), while hook-and-line gear had a positive impact (0.013). The system network had six discrete trophic levels, with mean transfer efficiencies of 12.8% from primary producers and 14.4% from detritus. The trophic impact routine revealed that *Sillago sihama*, the dominant fish in the fishery, was positively impacted by shrimps (0.14) while negatively affected by crabs (-0.08). A high level of system throughput (22655.1 t km⁻² yr⁻¹) and low dimension of Finn's cycling index (1.70), Mean path length (2.30) and omnivory index (0.29) were observed, indicating that the NG estuarine ecosystem is in the developing stage.

Keywords

Energy flows, Ecosystem modelling, Pedigree index, Prey-predator interactions



Exceptional diversity and new records of flatfishes from the Saurashtra Coast (Gujarat, India) revealed through integrated morpho-radiographic analysis

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A comprehensive ichthyofaunal assessment targeting the order Pleuronectiformes was conducted along the Saurashtra coast, Gujarat, situated on the northwestern margin of India. This systematic study, carried out from April 2024 to March 2025, aimed to elucidate the region's flatfish diversity through a detailed taxonomic approach, combining detailed morpho-meristic analysis with radiographic imaging of osteological structures to resolve complex species identifications. The research documented a total of 27 species across six families and 19 genera. The family Bothidae was the most speciose (11 species, 40.7% of the assemblage), followed by Cynoglossidae (6 species, 22.2%). The families Psettodidae and Samaridae were represented by a single species each (3.7%). Ecological analysis revealed that the demersal guild dominated significantly (20 species, 74.1%), with bathydemersal and reef-associated species each comprising 11.1% (3 species each), and a single benthopelagic species (3.7%). Trophic-level estimation placed all species within a mid-range carnivorous niche (TrL 3.0–4.4), indicating a complex, predator-driven benthic food web. A critical component of this study was a conservation status assessment based on IUCN Red List criteria. The evaluation determined that the majority of the species (70.4%) are currently classified as Least Concern (LC). However, a substantial proportion (22.2%) was identified as Data Deficient (DD), underscoring a significant knowledge gap regarding their population trends and threats. Furthermore, a single species (3.7%) remains Not Evaluated (NE), and another 3.7% is listed as Vulnerable (VU), highlighting specific conservation priorities for regional management. The study yielded seven significant new distributional records, with six species from the families Bothidae and Cynoglossidae representing first records for Indian waters, and one species (*Arnoglossus maculophus*) newly reported for the western coast of India. Multivariate cluster analysis (Bray-Curtis similarity) identified strong seasonal groupings in species abundance, with the highest similarity (81%) observed between post-monsoon and summer assemblages. These findings not only significantly update the biogeographic understanding of flatfish in the northeastern Arabian Sea but also emphasise the critical need for continued research, particularly for Data Deficient species, to inform effective conservation and fisheries management strategies.

Keywords

Bottom trawling, Distribution, Range expansion, Seasonal availability, Speciose, Taxonomy



Unravelling the fish-based ecosystem services and benefits from the estuaries of Goa, southwest coast of India

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Estuaries are vital coastal ecosystems that serve as biodiversity hotspots and provide a wide array of ecosystem services benefiting humans both directly, through fish, water, raw materials, medicinal resources, plants, and recreation, and indirectly via regulating (climate regulation, carbon sequestration, water quality and quantity control, disturbance regulation) and supporting (biodiversity conservation, habitat provision, nursery and breeding grounds) services. Fish species, due to their ecological and economic significance, contribute to all four categories of ecosystem services: provisioning, regulating, supporting, and cultural types. This study presents a preliminary assessment of fish-based ecosystem services in five estuaries of Goa-Mandovi, Zuari, Terekhol, Chapora, and Sal-highlighting key services such as fishing, fish marketing, aquaculture, recreational fishing, island and mangrove tourism, carbon sequestration, biodiversity and habitat support, nursery and breeding grounds, and scientific research. However, these services face significant threats from illegal and destructive fishing, unregulated tourism, sedimentation, habitat degradation, and pollution. The annual mean fish productivity from the estuaries ranged from 7.3 to 35.5 t km⁻², with the highest yields from Zuari and the lowest values from Sal. The diversity of fish species ranged from 107 in Sal to 257 in Zuari. Mandovi and Zuari estuaries yielded the highest index for the supporting service, biodiversity (3.53 and 3.51). The preliminary estimates of these services yielded ₹114016 ha⁻¹, ₹111917 ha⁻¹, ₹109590 ha⁻¹, ₹105673 ha⁻¹, and ₹103991 ha⁻¹ for Terekhol, Sal, Chapora, Mandovi and Zuari estuaries, respectively. To ensure the long-term sustainability of these estuarine ecosystems, we propose an ecosystem service-based management framework that integrates conservation and responsible resource use.

Keywords

Estuarine management, Goa challenges, Hotspots, Payment for ecosystem service



Biodiversity hotspots in the deep: Comparing biological succession and ichthyofaunal diversity on artificial reefs and seamounts

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The deep-sea hosts complex habitats that act as biodiversity reservoirs, yet the processes governing ecological succession and fish community structure in these environments remain insufficiently understood. Seamounts are naturally occurring underwater mountains that serve as key centres of productivity and endemism and represent the most ecologically significant habitats for marine life and specialised taxa, reflecting their evolutionary and ecological uniqueness. Artificial reefs, deployed as tools for fisheries enhancement and habitat restoration, and natural seamounts, recognized as biological hotspots, provide structural complexity that supports diverse ichthyofaunal assemblages; artificial reefs predominantly facilitate colonization by opportunistic and generalist species. Understanding these distinctions is critical for assessing the ecological validity of artificial structures, guiding marine spatial planning, and ensuring that biodiversity conservation strategies integrate both natural and human-made habitats in the deep sea. Understanding the similarities and differences in biological succession and fish species diversity between these systems is essential for evaluating their ecological roles and conservation potential. This study examines and compares patterns of biological succession, trophic interactions, and species diversity between artificial reefs and seamount ecosystems. The review synthesises the available literature on the succession patterns and ichthyofaunal diversity associated with seamounts and artificial reefs, highlighting distinctions in the ecology and biology of fishes arising from natural versus artificial habitat origins. The comparative analysis provides insights into how artificial reefs may serve as a functional proxy model to seamount ecosystems in connection to ichthyofaunal diversity. The findings suggest that conserving and protecting natural seamounts is essential for understanding habitat complexity and biodiversity conservation, while also recognising the role of artificial habitats in mitigating pressure on natural ecosystems.

Keywords

Artificial habitats, Ecological complexity, Ichthyofauna, Natural ecosystems



Taxonomic insights into the hidden diversity of needlefishes (Family: Belonidae) from Indian waters

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The order Beloniformes includes 292 species worldwide, with 56 reported from Indian waters. Among them, the family Belonidae (Bonaparte, 1835) is represented globally by 47 species across 10 genera, with five genera and nine species found in India. Despite their ecological and fishery significance, the taxonomy of these fish has long remained unclear due to incomplete checklists and a lack of molecular evidence, which limits biodiversity assessment and conservation planning. In this study, we applied an integrative approach combining morphometric characters, otolith structure, and mitochondrial DNA markers (COI and 16S rRNA) to reassess Belonidae diversity from Indian waters. The results revealed greater diversity than previously recognised and clarified long-standing ambiguities. *Ablennes hians* was redefined as a complex of three species, including two newly described taxa (*Ablennes joseberchmansis* and *A. gracalii*) that exhibit more than 6.5% genetic divergence. A new genus and species were also provisionally recognised from the Andaman region, characterised by 10-20.6% inter-genetic divergence and distinct body form, eye size, snout proportions, and fin positions. Within *Strongylura* three species; *S. incisa*, *S. leiura*, and *S. strongylura* were clearly distinguished. Similarly, *Tylosurus crocodilus* and *T. melanotus* were confirmed as distinct species in genus *Tylosurus*. In freshwater systems, diversity was re-evaluated in light of potential cryptic speciation within *Xenentodon cancila*, the only species currently recognised from India, highlighting the conservation importance of the Western Ghats, a global hotspot of endemism. Together, these findings reveal hidden diversity and resolve long-standing taxonomic uncertainties within Belonidae, establishing a stronger framework for biodiversity inventories. The study shows that many species once thought to be widespread are actually complexes of distinct, often range-restricted taxa. This is an important insight for conservation, as unrecognised diversity can mask the vulnerability of localised populations. This work highlights the critical role of integrative taxonomy in uncovering the biodiversity, guiding conservation priorities, and ensuring the sustainable management of fishery resources in Indian waters

Keywords

Biodiversity conservation, Cryptic diversity, Fisheries management, Integrative approach



Monsoon-driven dynamics of phytoplankton size classes and trophic status in a tropical coastal lagoon in India

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Tropical coastal lagoons regulated by monsoonal hydrology experience strong seasonal shifts in freshwater influx that reshape their trophic status and ecological balance. Understanding how Phytoplankton Size Classes (PSCs: Pico-, Nano-, and Micro-phytoplankton) respond to such variability is essential for assessing ecosystem functioning and biodiversity conservation. In this study, we examined the spatiotemporal dynamics of PSCs in relation to the Trophic Level Index (TLI) in Chilika Lagoon, India, using monthly data collected from 2018 to 2019 across a salinity gradient. PSCs were characterized through HPLC-aided pigment chemotaxonomy, allowing robust detection of pico- and nano-phytoplankton, often underestimated by traditional microscopy. The lagoon exhibited a trophic transition from eutrophic (TLI=4.61) in 2018 to mesotrophic (TLI=3.98) in 2019, largely driven by reduced nutrient concentrations and higher turbidity. Pico-phytoplankton consistently dominated (66-76%) across all seasons and sectors, even under eutrophic conditions, highlighting their adaptive advantage under fluctuating light and nutrient regimes. In contrast, micro-phytoplankton showed seasonal increases during the monsoon in 2019, likely linked to silicate enrichment and turbidity. Redundancy Analysis (RDA) revealed clear spatiotemporal linkages: pico-phytoplankton correlated with salinity, transparency, and nutrients, while micro-phytoplankton associated with turbidity and suspended matter. These findings suggest that pico-phytoplankton dominance during pre- and post-monsoon periods may sustain microbial food webs, whereas monsoon-driven increases in micro-phytoplankton contribute to a mixed trophic structure. Such monsoon-driven variability in size-structured phytoplankton communities has significant implications for ecosystem resilience, biodiversity conservation, and the long-term productivity of tropical coastal lagoons.

Keywords

Coastal lagoon, Microbial food chain, Spatiotemporal dynamics, Trophic level index



Biological traits and population characteristics of Japanese threadfin bream *Nemipterus japonicus* from the Coromandel Coast of Tamil Nadu, India

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The present study assessed the biology and stock status of *Nemipterus japonicus* along the Cuddalore Coast of Tamil Nadu, where it is one of the dominant species landed year-round. The species exhibited negative allometry, with length at first maturity estimated at 15.3 cm. Peak spawning occurred in November and January, as indicated by gonadosomatic index (GSI) values of 4.54 and 5.17, respectively. Fecundity ranged from 22,709 to 267,365 eggs, highlighting its high reproductive potential. Gut content analysis revealed a diet primarily composed of small fishes and crustaceans. Growth parameters, based on the von Bertalanffy growth equation, showed an asymptotic length (L_{∞}) of 30.45 cm and a growth coefficient (K) of 0.62. The exploitation rate ($E=0.39$) was below the maximum exploitation level ($E_{\max}=0.49$), indicating that the stock is slightly underexploited. The study emphasises the need for effective management measures to ensure sustainable utilisation and optimal exploitation of the resource.

Keywords

Exploitation rate, Growth parameters, Gut content analysis, Optimal exploitation



Molecular phylogeny and taxonomic delimitation of dragonets (Family: Callionymidae) from the South Indian coast

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Fishes of the family Callionymidae, are commonly known as dragonets. They exhibit high degree of phenotypic plasticity, sexual dimorphism and overlapping morphometrics, which is challenging, both for conventional and molecular studies. In this context, the present study aims to document the diversity of dragonets distributed along the southern peninsular coast of India. Morphometric measurements and meristic characters were recorded for 74 specimens of 7 species across 2 genera collected from major fish landing centres along the southwest and southeast coasts of India. The species identification was based on morphological characteristics, which were challenging because their morphometric and meristic features change with growth, often resulting in overlap. To overcome this challenge, molecular identification, using the COI gene, was employed for species delineation. The results revealed the presence of seven species of Callionymids along the southern coast; *Callionymus japonicus*, *C. filamentosus*, *C. margaretae*, *C. carebares*, *Callionymus* sp., *Synchiropus stellatus* and *Synchiropus lineolatus*. The generated COI gene sequences for the species were aligned using CLUSTALW, and a phylogenetic tree was subsequently constructed using the Maximum Likelihood (ML) method. This analysis resulted in the classification of these species into seven distinct, well-supported clades, thereby validating the taxonomic investigation. A detailed analysis is required to determine the complexity of species identification, which is essential for understanding the ecological roles and phylogenetic relationships among Callionymidae. Results of the present study provide new insights and implications for researchers regarding the conservation of the species in Indian waters.

Keywords

COI gene, Dragon nets, Peninsular India, Phenotypic plasticity, Sexual dimorphism



Fish neoplasia as sentinel indicators of marine ecosystem health: A case study from the southeast coast of India

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Marine ecosystems are threatened by anthropogenic stressors, including industrial effluents, agricultural runoff, heavy metals, hydrocarbons, and other persistent pollutants. Detecting the ecological impacts of such contaminants requires sensitive and reliable biomarkers. Fish neoplasia, characterised by abnormal proliferative growths in tissues and organs, has emerged as a valuable sentinel indicator of chronic environmental degradation. This study examines the occurrence and prevalence of neoplastic conditions in fish populations along the southeast coast of India, a region characterized by dense human settlements, industrial activity, and ecologically significant habitats. Field sampling and pathological screening were employed to identify tumour incidences in selected fish species, with findings correlated against physicochemical parameters of seawater and sediment contamination profiles. Results indicate a clear association between elevated pollutant levels and increased neoplasia prevalence, highlighting the role of fish tumours as early warning signals of marine ecosystem stress. These findings reinforce the importance of fish neoplasia as a bioindicator for long-term monitoring and management of coastal marine health, providing critical insights for policymakers, conservationists and environmental managers working to safeguard India's vulnerable coastal ecosystems.

Keywords

Anthropogenic stressors, Bioindicators, Environmental managers, Pollution monitoring



Ardea birds in the wetlands of Kachchh as indicators of ecosystem health and their ecological roles in semi-arid landscapes

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Kachchh and its seasonal and coastal wetlands function as essential carbon sinks and provide habitat for some of the richest bird populations in South Asia, particularly within the semi-arid landscapes of western India. These wetlands shape avifaunal community structures, making them important for sustaining wildlife and maintaining the ecological health and biodiversity of the region. This study investigates bird assemblages across twelve microhabitats within six wetland sites in Abdasa and Mandvi talukas of Kachchh District, Gujarat, surveyed over one year (January to December). The study aims to provide baseline data for future monitoring, conservation, and management planning for wetland bird diversity in Kachchh. It analyses how the presence, abundance, diversity, and distribution patterns of the *Ardea* genus vary across ecological conditions and microhabitats, revealing their role as indicators of ecosystem health and habitat quality. Data were collected using Buckland's Distance Sampling protocol, integrating fixed point count stations and line transects to ensure robust estimates of species abundance and detectability in the case of salt pans. A total of 317 individual birds were recorded, comprising four species of the *Ardea* genus. Species occurrence data of distinct microhabitats were quantitatively assessed using three diversity indices: the Shannon–Wiener diversity index (H'), Simpson's dominance index (D), and Pielou's evenness index (J'). All indices were computed using standardised formulae, and inter-habitat comparisons were statistically validated through one-way ANOVA. The findings revealed significant variation across microhabitats, with the highest diversity recorded in coastal wetlands ($H'=1.354$, $D=0.734$), suggesting a taxonomically cohesive assemblage of *Ardea* species. In contrast, SP2 exhibited the lowest diversity indices ($H'=0.693$, $D=0.5$). The results highlight the importance of conserving the coastal wetlands of Kachchh and support the use of flexible, microhabitat-inclusive methods to protect avifaunal diversity and improve wetland resilience in semi-arid coastal environments. This study also contributes to global conservation efforts in the Central Asian Flyway and offers important data for regional wetland management.

Keywords

Biodiversity, Coastal wetlands, Conservation, Microhabitats, Wetland management



The transcriptomic blueprint of an ecological invader: de Novo transcriptome assembly of *Mytella strigata*

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Mytella strigata, an invasive mussel native to South America, is emerging as a significant ecological and economic threat across tropical and subtropical estuarine systems, including the Indian coastline. Its rapid spread, facilitated by biofouling and ballast water transport, has led to severe bioinvasion events, adversely affecting native bivalves such as *Perna viridis*. To decode the molecular mechanisms underlying its invasiveness, we report the first comprehensive de novo transcriptome assembly of *M. strigata*. Using Illumina NovaSeq 6000 sequencing, over 254 million high-quality paired-end reads were generated and assembled using Trinity, resulting in 60,362 transcripts with an N50 of 1,578 bp. Quality assessments confirmed 98% completeness using BUSCO, validating the robustness of the assembly. Functional annotation using UniProt, KEGG, Reactome, InterPro, and eggNOG databases revealed a diverse array of genes associated with environmental adaptability, particularly in stress response, metabolic reprogramming, cellular signalling, immune regulation, and tissue remodelling. Importantly, pathway enrichment analysis uncovered the overrepresentation of cancer-related and apoptosis-regulating genes, suggesting that *M. strigata* may possess inherent transcriptomic traits that support both survival in fluctuating environments and potential resistance to physiological stress. The transcriptome also revealed molecular signatures of neoplasia-associated networks, echoing patterns seen in other bivalves known to harbour transmissible cancers. This study significantly enhances the omics resources for invasive molluscs and provides a foundational reference for understanding the adaptive plasticity and ecological dominance of *M. strigata*. It opens avenues for future research into stress biology, invasion genomics, and bivalve conservation. The insights gained can aid in developing targeted strategies to manage invasive populations and protect native biodiversity and fisheries in vulnerable marine ecosystems.

Keywords

Bioinvasion events, Echoing patterns, Functional annotation, Invasiveness, Neoplasia



Assessment of genetic variation in the invasive mussel *Mytella Strigata* (Hanley, 1843) using mitochondrial DNA markers

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Mytella strigata, a neotropical bivalve mussel, has become an invasive species along several parts of the Indian coastline. This study aimed (i) to estimate the genetic variation of *M. strigata* using mitochondrial DNA markers, and (ii) to assess its invasiveness risk. A total of 71 individuals were collected from six locations: Ashtamudi, Thevara Canal, and Vembanad (Kerala); Ennore Creek, Pulicat Lake, and Palayakkayal Estuary (Tamil Nadu). Genetic variation was evaluated using mitochondrial cytochrome b (Cyt b) and COI gene sequences. A total of 16 Cyt b haplotypes were identified, with moderate haplotype diversity ($Hd=0.609\pm0.067$) and low nucleotide diversity ($\pi=0.00202\pm0.00126$), indicating a recent demographic expansion from limited introduction sources. Haplotype network analysis revealed a partially star-like topology, with a central haplotype (H2) shared across all sites. Ennore Creek exhibited the highest haplotype and nucleotide diversity, suggesting longer establishment, secondary introductions, or environmentally driven local diversification. Despite low regional structuring, AMOVA and pairwise Φ_{ST} values showed significant intra-population variation (82.6%), with Vembanad showing the most significant differentiation. Neutrality tests and mismatch distribution curves further supported a model of recent population expansion. Risk assessment using AS-ISK, Harmonia+ and GISS tools consistently categorised *M. strigata* as a high-risk invasive species. Its broad environmental tolerance, high reproductive output, and competitive dominance pose significant threats to native biodiversity, aquaculture, and ecosystem functioning. Based on genetic and ecological evidence, Ennore Creek and Vembanad are identified as priority sites for monitoring and control. This study provides a crucial scientific basis for early detection, biosecurity planning, and region-specific invasive species management to mitigate the further spread and impact of *M. strigata* in Indian waters.

Keywords

Invasive species, Neutrality tests, Mismatch distribution curve, Population expansion, Risk assessment



Assessing habitat suitability of dominant phytoplankton in a tropical estuary through a GAM-based approach

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Phytoplankton, as primary producers in estuarine systems, are highly responsive to environmental changes and serve as valuable indicators of ecosystem health. This study employed a Generalised Additive Model (GAM) framework to examine how environmental drivers shape the distribution and abundance of four dominant phytoplankton taxa, *Asterionellopsis glacialis*, *Odontella sinensis*, *Pseudo-nitzschia pungens*, and *Skeletonema costatum*, in the Karanja Estuary along India's Northeastern Arabian Sea coast. Monthly data were collected from five sampling sites between January 2022 and March 2023, capturing seasonal and spatial variability. The GAMs explained 55-75% of the variation in species distribution and identified water temperature, salinity, chlorophyll-b concentrations, and nutrient levels as key predictors. Seasonal patterns revealed that *A. glacialis*, *P. pungens*, and *S. costatum* flourished under post-monsoon conditions, while *O. sinensis* dominated during the pre-monsoon period. Optimal growth occurred at water temperatures of 24-32°C for *O. sinensis*, *P. pungens*, and *S. costatum*. Chlorophyll-b concentrations between 1-20 mg m⁻³ favoured higher abundances of all four taxa. Salinity tolerance varied, with *P. pungens* and *S. costatum* exhibiting broad adaptability across 10-40‰. Nutrient preferences were species-specific: *P. pungens* thrived under nitrate levels of 0.1-1 mg l⁻¹, while *O. sinensis* showed a strong association with silicate concentrations of 1-10 mg l⁻¹. As several of these species indicate eutrophic conditions, their dynamics provide insights into nutrient enrichment and climate-linked stressors in estuarine systems. This first application of GAMs to Indian estuarine phytoplankton highlights their predictive potential for habitat suitability. It offers a robust framework for water quality assessment, climate resilience, and sustainable estuarine management.

Keywords

Climate resilience, Environmental variables, Habitat suitability, Model-based approach



Occurrence of red tide phenomena caused by *Noctiluca scintillans* in the inshore waters up to 30 m depth zone off Kochi, Kerala

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A phenomenal red tide of heterotrophic dinoflagellate *Noctiluca scintillans* with a cell density of 2.2×10^6 cells l^{-1} was observed off Kochi ($10^{\circ}02'18''$ N; $76^{\circ}02'29''$ E) on 14 August 2025. The red tide was observed approximately 20 km off Kochi, in waters about 30 m deep. The bloom manifested as striking red-orange patches, extending up to 2 km in length and width, drifting gradually toward the coast. The surface waters appeared vividly orange, resembling a painted expanse, with numerous tiny, floating orange particulates dispersed across the sea. This event formed part of a series of red tide occurrences reported along the Kerala coast since early August, including those at Chavakkad, Edakazhiyoor, Nattika, Fort Kochi, Thoppumpadi, Purakkad and Pozhikkara. The present observation is significant as it represents the first documented red tide at a depth of 30 m in the inshore waters off Kochi during August 2025. The bloom was caused by a symbiont-free variant of *Noctiluca scintillans*. This species is known to produce either green or red tides, depending on the presence of its photosynthetic endosymbiont *Pedinomonas noctilucae*. Within the bloom patches, a high abundance of gelatinous zooplankton, particularly scyphozoan and hydrozoan medusae such as *Obelia* sp., was also observed. Water quality analysis revealed lower dissolved oxygen levels (4.27 mg l^{-1}) at the bloom site compared to the non-bloom station (6.25 mg l^{-1}). In addition, elevated levels of key nutrients, specifically ammonia (284.85 μ g l^{-1}) and phosphate (63.04 μ g l^{-1}), were recorded relative to the non-affected area. The continuous monsoon runoff and river discharge along the Kochi coast likely led to eutrophic conditions that enhanced phytoplankton productivity, providing a rich food source for the heterotrophic *N. scintillans* and triggering the bloom. As a phagotrophic dinoflagellate, *N. scintillans* feeds on diatoms, bacteria, and other planktonic organisms. Intense blooms of this nature can cause substantial depletion of food resources, posing a threat to the sustenance of larval, juvenile and adult fish. Such events disrupt the marine food web and may adversely affect commercially important fisheries, including those of oil sardine and mackerel, highlighting the broader ecological and economic consequences of such events.

Keywords

Dinoflagellate, Eutrophic conditions, Food web, Monsoon runoff, *Pedinomonas noctilucae*, River influx



Monthly variability of mesozooplankton abundance and community structure during the pre-monsoon season of 2025 in the coastal waters of Kochi, Southeastern Arabian Sea

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Mesozooplankton form a vital component of coastal food webs, acting as key intermediaries between primary producers and higher trophic levels such as fish and marine mammals. In the coastal waters of Kochi, located along the southeast Arabian Sea, mesozooplankton community are strongly influenced by seasonal hydrography, freshwater inflow from backwaters, and monsoon-driven upwelling. To examine short-term variability in the mesozooplankton community in the coastal waters of Kochi, we studied monthly variations in abundance and community structure during the pre-monsoon (March-May, 2025) at four sampling locations extending from the coast to offshore. Mesozooplankton sampling was conducted using a WP2 net with a mesh size of 200 μm . Sampling of key hydrographic variables such as temperature, salinity, dissolved oxygen and chlorophyll-a was also carried out along with the zooplankton sampling. The results of the study revealed conspicuous spatiotemporal variation in the zooplankton abundance and community structure in the study region. Zooplankton abundance increased progressively from March (260-411 ind. m^{-3}) to April (959-1821 ind. m^{-3}) and subsequently declined during May (134-880 ind. m^{-3}). Holoplankton contributed 77-99% of the total zooplankton population, while the meroplankton contribution varied from 0.2-22%. Copepods dominated the holoplankton community (>60%) during all the sampling periods, followed by Cladocera and Chaetognatha. Among the meroplankton community, decapod, lamellibranch, and gastropod larvae dominated, though with varying abundances and degrees of predominance. The study found marked seasonal succession in zooplankton assemblages in the coastal waters of Kochi. There was a pronounced peak in April under favourable hydrographic conditions, followed by a transitional phase in May characterised by reduced meroplankton contribution and overall standing stock. Understanding the composition and temporal variability of zooplankton in coastal waters of Kochi is vital for predicting ecosystem responses to environmental change and ensuring the sustainability of fisheries that support coastal livelihoods.

Keywords

Chlorophyll-a, Copepods, Holoplankton, Meroplankton, Seasonal hydrography



Assessment of fish species diversity in the Thane Creek, Mumbai, Maharashtra

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Thane Creek is a prominent estuarine ecosystem located along the eastern part of Mumbai. This estuarine habitat serves as a nursery ground for many fish, crustaceans, and other intertidal marine animals, as the detritus from mangroves, comprising fallen leaves and branches, provides essential nutrients to these fauna. The present study aimed to document the diversity and distribution of finfishes and shellfishes in Thane Creek. Surveys were conducted at major jetties from April to October 2021 to record fish catches using various fishing gears in and around the creek. In addition, experimental fishing was conducted using gill nets and shore seines at five fixed sampling stations covering both the upper and lower zones of the creek to assess its overall fish diversity. A total of 49 fish species representing 29 families were recorded during the study. The highest fishing activity was observed during the pre-monsoon season (February-May), primarily during high tides, with fishing efforts often aligned with the lunar cycle. These findings provide valuable baseline information for the long-term monitoring of Thane Creek's ecological health and offer essential insights for its conservation and the sustainable management of fisheries resources.

Keywords

Conservation, High tides, Pre-monsoon season, Sustainable fisheries



Meiofaunal diversity in polychaete reefs: Insights from Gopalpur Coast, Southern Odisha

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Polychaete (*Sabellaria*) reefs are significant contributors to the diversity of benthic ecosystems, providing shelter to a wide range of taxa. The present study focuses on understanding meiofaunal diversity within polychaete reefs from the Gopalpur Coast, Odisha. The study was conducted during January and February 2025. Samples were collected at depths of 20-30 m, approximately 3-5 km offshore, with assistance from local fishermen. Meiofauna associated with the reef matrix were identified to major taxonomic groups using standard protocols. Twenty distinct groups of meiofauna were identified within the reefs. Foraminifera and nematodes were dominant groups in both samples, comprising 30 and 24.2%, respectively. Community diversity was higher in January compared to February, indicating potential seasonal variability in reef-associated assemblages. These findings align with global patterns of reef-associated meiofauna, wherein Foraminifera and Nematoda typically dominate due to their specialised adaptations to these complex biogenic structures. *Sabellaria* polychaete reefs function as ecosystem engineers, creating microhabitat complexity that supports substantially higher species richness than adjacent sedimentary environments. The identification of diverse meiobenthic communities highlights the ecological importance of these biogenic structures as biodiversity multipliers and their critical role in benthic productivity. Long-term, seasonally resolved monitoring is required to quantify temporal dynamics and inform evidence-based conservation strategies for polychaete reef habitats along the Bay of Bengal Coast, particularly given increasing anthropogenic pressures on coastal marine ecosystems.

Keywords

Biodiversity, Benthic ecology, Coastal ecosystems, Conservation, Polychaete reefs, *Sabellaria*



Characterisation of zooxanthellae communities through molecular and pigment analyses in Lakshadweep coral reefs: A baseline for understanding coral thermal tolerance

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Coral reefs in the Lakshadweep Archipelago are particularly vulnerable to climate-induced thermal stress, yet knowledge of the diversity and thermal tolerance of their endosymbiotic dinoflagellates (zooxanthellae; family Symbiodiniaceae) remains limited. This study provides the first comprehensive assessment of the zooxanthellae communities associated with two reef-building corals, *Acropora muricata* and *Dipsastraea pallida*, across four reef lagoons (Agatti, Kavaratti, Bangaram, and Perumal Par), with emphasis on molecular characterisation and pigment profiling. Molecular analyses revealed a predominance of *Durudinium trenchii*, *Symbiodinium* sp. subtype D1, and *Symbiodinium thermophilum*, taxa widely recognised for their elevated thermal tolerance and capacity to enhance coral resilience against heat stress, thereby reducing susceptibility to bleaching. Notably, *Symbiodinium* sp. subtype D1 (previously recorded in *Pteraeolidia ianthina*) was widely distributed across all lagoons except Agatti, where *S. thermophilum* was the dominant taxon. In addition, *D. trenchii* was particularly prevalent in the corals of Bangaram Lagoon. The coexistence of multiple *Symbiodiniaceae* lineages within single coral hosts highlights the potential flexibility and stability of host-symbiont associations across the archipelago, a feature that may confer adaptive advantages under fluctuating environmental conditions. Pigment profiling of zooxanthellae, conducted using reverse-phase high-performance liquid chromatography (HPLC), consistently detected major chlorophylls (chlorophyll-*a* and chlorophyll-*c*₂) along with diagnostic accessory pigments such as peridinin, diadinoxanthin, and β -carotene. The relatively elevated chlorophyll-*a* concentration across sites indicate photosynthetically competent and physiologically healthy symbiont populations within host corals. Collectively, the dominance of thermally tolerant symbiont taxa, coupled with a robust pigment profile, suggests that Lakshadweep corals may possess inherent adaptive mechanisms that mitigate the adverse effects of rising sea surface temperatures. This study, therefore, establishes critical baseline knowledge of coral-symbiont assemblages in the Lakshadweep lagoons, offering valuable insights into their ecological role in maintaining reef stability and resilience under accelerating climate change.

Keywords

Coral resilience, Host-symbiont assemblages, Molecular characterisation, Pigment profiling, Reef stability



Occurrence of successive dinoflagellate blooms causing red tides along the nearshore waters of Thrissur, Kerala

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In recent years, occurrences of intense algal blooms have become increasingly frequent along the southeastern Arabian Sea (SEAS). These red tide phenomena, resulting from dense algal proliferations, have emerged as a growing environmental concern due to their detrimental impacts on marine ecosystems and commercially important fisheries. Red tide events were recorded in the nearshore waters of Thrissur, central Kerala, particularly along the coasts of Chavakkad and Edakkazhiyur, between 5 and 11 August 2025. The present study investigated this event, focusing on the identification of the causative species and the assessment of associated hydrographic conditions. Surface water samples were collected from nearshore stations and analysed for phytoplankton composition, chlorophyll-*a* concentration, temperature, salinity, and nutrient levels. Microscopic examination revealed that the bloom was dominated by the heterotrophic dinoflagellate *Noctiluca scintillans*, which caused the characteristic brick-red discolouration of seawater, with a recorded cell density of 9×10^5 cells L^{-1} . This was followed by another bloom at the same locations, dominated by *Cochlodinium* sp., with a recorded cell density of 3.04×10^6 cells L^{-1} . Surface water temperature, pH, and salinity during the event ranged from 29.0–30.3°C, 7.6–7.7, and 33–34 PSU, respectively. The nutrient concentrations observed were: silicate (0.22 ± 0.09 mg L^{-1}), phosphate (0.04 ± 0.01 mg L^{-1}), nitrite-N (0.004 ± 0.001 mg L^{-1}), and nitrate-N (0.035 ± 0.01 mg L^{-1}). Elevated ammonia levels (0.22 ± 0.14 mg L^{-1}) suggested the degradation of *Noctiluca* cells and the subsequent proliferation of *Cochlodinium* sp. Gross primary productivity (0.01 mg C $\text{L}^{-1} \text{h}^{-1}$) and net primary productivity (0.032 mg C $\text{L}^{-1} \text{h}^{-1}$) indicated moderate levels of productivity, while dissolved oxygen remained within the normal range (4.5 – 5.1 mg L^{-1}). The occurrence of successive blooms was likely influenced by monsoonal runoff, which introduced oxygen and nutrient rich waters, thereby preventing hypoxic conditions despite the high cell densities. Although *Cochlodinium* sp. is recognised as a harmful algal bloom (HAB) species, no fish kill was reported by local fishermen during the event. The bloom extended northward up to Kuzhipilly, Ernakulam, but with reduced intensity. These observations emphasise the ecological significance of recurrent red tide events along the Kerala coast and highlight the necessity for continuous monitoring and the establishment of early warning systems to mitigate potential impacts on fisheries and coastal livelihoods.

Keywords

Cochlodinium sp., HAB, Hydrographic conditions, Monsoonal runoff, *Noctiluca scintillans*

Marine turtle conservation in Andhra Pradesh: Challenges and opportunities

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Marine turtles, among the most ancient and ecologically important migratory species, face numerous anthropogenic and natural threats. Of the five species reported from India, four namely the Olive ridley (*Lepidochelys olivacea*), Green (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*), and Hawksbill (*Eretmochelys imbricata*) occur along the Andhra Pradesh coast, with Olive ridley being the most abundant and dominant nesting species. Despite legal protection under the Indian Wildlife (Protection) Act, 1972 (Schedule I) and their inclusion in CITES Appendix I, turtles continue to experience high mortality rates due to various anthropogenic pressures, particularly fisheries interactions. Field surveys, stranding records, and fisher interviews conducted between June 2024 and May 2025 along the northern Andhra Pradesh coast revealed accidental entanglement in fishing nets and ghost gear, and opportunistic strandings, as major threats in foraging and migratory zones. These findings highlight the urgent need for multi-pronged conservation strategies, including stricter regulation of fishing practices, the adoption of bycatch reduction devices, the provision of artificial nesting sites, community beach patrols, eco-friendly tourism, and awareness programs involving local fishing communities. By implementing these measures and fostering collaborative management, Andhra Pradesh can position itself as a model for marine turtle conservation in the Bay of Bengal, ensuring the long-term survival of these ancient migrants while supporting sustainable coastal livelihoods.

Keywords

Coastal livelihoods, Fisheries interactions, Ghost gear, Nesting sites, Stranding



Diversity and community structure of microzooplankton community in diverse coastal water ecosystems of the Andamans

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Microzooplankton (MZP), which includes heterotrophic and mixotrophic plankton within the 20-200 μm size spectrum, constitutes a fundamental component of marine ecosystems. They act as key intermediaries in microbial food webs, mediating trophic linkages between phytoplankton and higher consumers. This assemblage is mainly composed of protozoans, including ciliates, heterotrophic dinoflagellates (HDs), and sarcodines, along with planktonic larvae, copepod nauplii, and, to a lesser extent, cladocerans and rotifers. In the present study, the spatio ecological dynamics of the MZP community were investigated in the coastal waters of Port Blair and Neil Island (Andaman Sea) during the fall intermonsoon (October 2024), with emphasis on their relationship to concurrent hydrographic and phytoplankton conditions. The two regions exhibited distinct contrasts in ecosystem characteristics: Port Blair waters were comparatively more productive, as reflected in elevated phytoplankton chlorophyll-*a* concentration, whereas the coastal waters surrounding Neil Island remained characteristically oligotrophic. This differential productivity was reflected in the MZP assemblage, with Port Blair waters supporting markedly higher abundance and biomass (carbon content) than Neil Island waters. Protozoans dominated the community structure in both regions, though with pronounced compositional divergence. Port Blair was characterised by the dominance of HDs (av. 98.8% of total MZP abundance), while ciliates contributed only marginally (av. 1.17%). In contrast, Neil Island waters supported a more balanced protozoan assemblage, where ciliates constituted the dominant group (av. 51.78%), followed closely by HDs (av. 48.22%). Metazoan contributions were negligible in both areas, accounting for only 3.4% of total MZP abundance at Neil Island and 0.4% at Port Blair. Overall, 46 protozoan taxa were identified across the two regions, of which ciliates comprised 28 species and HDs 18 species, reflecting a diverse but functionally skewed community structure. Estimates of MZP biovolume and carbon biomass further underscored the elevated trophic role of Port Blair waters, where larger-bodied ciliates, dinoflagellates, and copepod nauplii were more prevalent, indicating higher grazing potential and energy transfer efficiency. The prevalence of larger microphytoplankton, particularly diatoms, in Port Blair was likely stimulated by nutrient enrichment, especially nitrate inputs of terrestrial origin, creating favourable conditions for enhanced MZP growth and biomass accumulation. Conversely, the nutrient-poor environment of Neil Island constrained phytoplankton growth, thereby limiting MZP abundance and biomass. Collectively, these findings highlight the strong bottom-up control exerted by nutrient availability and phytoplankton community composition on the structuring of MZP communities in tropical island ecosystems.

Keywords

Biomass accumulation, Chlorophyll-*a*, Ciliates, Phytoplankton, Trophic linkages



Phytoplankton growth dynamics across contrasting seasonal regimes in a tropical monsoonal microtidal estuary

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The Cochin Estuary (CE), a monsoonal microtidal system situated along the southwest coast of India, represents a dynamic and biologically productive ecosystem shaped by the interaction of seasonally varying freshwater inflows and tidal intrusions from the Southeastern Arabian Sea. Substantial freshwater discharge from seven major rivers, coupled with tidal exchanges through two permanent inlets, modulates the estuarine hydro-biogeochemical regime. In this study, the ecological characteristics of phytoplankton were examined in relation to hydrographic variability along the estuarine axis, extending from Munambam in the north to Thanneermukkam in the south, during two contrasting hydroclimatic phases: pre-monsoon (PRM; April 2023) and monsoon (MN; June 2023). Marked seasonal contrasts in hydrography were evident. During the PRM, a pronounced longitudinal salinity gradient was observed, with polyhaline conditions near the inlets transitioning to oligohaline waters in the upstream reaches. Conversely, the MN period was characterised by extensive oligohaline conditions resulting from copious riverine discharge. Phytoplankton biomass, assessed via chlorophyll-*a* concentration, exhibited substantial spatiotemporal variability: moderate levels ($0.63\text{--}13.46\text{ mg m}^{-3}$) during the PRM contrasted with markedly higher concentrations ($0.26\text{--}40.43\text{ mg m}^{-3}$) during the MN. Size-fractionated chlorophyll *a* analysis indicated the persistent dominance of nanophytoplankton ($2\text{--}20\text{ }\mu\text{m}$; $>50\%$ of total biomass) across both seasons, followed by micro- and picophytoplankton. Taxonomic composition was strongly diatom-dominated ($>50\text{--}90\%$ of total abundance), irrespective of season. Widely distributed taxa such as *Skeletonema costatum*, *Thalassiosira* spp., and *Cylindrotheca closterium* exhibited a broad salinity spectrum, reflecting their high tolerance and adaptability to fluctuating estuarine conditions. In contrast, dinoflagellates were moderately represented during the PRM, particularly in inlet-proximal regions, while chlorophytes became more abundant during the MN under oligohaline, freshwater-dominated conditions. Nutrient concentrations remained enriched throughout the estuary in both seasons, underscoring its mesotrophic status. However, enhanced turbidity during the MN, largely associated with riverine sediment inputs, restricted light penetration and likely reduced phytoplankton growth efficiency despite nutrient repletion. Spatial analysis further revealed that the northern sector of the estuary, particularly the hydrodynamically constrained zone between the CE inlet and Munambam inlet, sustained consistently elevated phytoplankton biomass, with a pronounced peak during the PRM. Overall, these findings demonstrate the strong seasonal coupling between hydrography, nutrient availability, and phytoplankton community structure in the CE. They emphasise the contrasting ecological drivers: salinity gradients exert a dominant influence during the PRM, while turbidity emerges as a critical limiting factor modulating phytoplankton responses during monsoon-driven freshwater influx.

Keywords

Chlorophyll-*a*, Cochin Estuary, Diatoms, Hydroclimatic phases, Nutrients



Distribution of ichthyoplankton community in coastal waters of Kochi, southwest coast of India

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Globally, coastal ecosystems are among the most productive and biologically diverse regions of the marine environment, playing a central role in sustaining fisheries and supporting livelihoods. Over the past few decades, however, these critical habitats have experienced marked declines in tertiary productivity and fishing yields. This is primarily due to intensifying anthropogenic pressures such as pollution, overfishing, and habitat degradation, alongside natural stressors including climate variability and hydrological changes. Since ichthyoplankton communities respond rapidly to environmental fluctuations that influence spawning and recruitment patterns, they serve as effective indicators of habitat change. Therefore, a comprehensive understanding of ichthyoplankton distribution is crucial for evaluating habitat conditions and assessing the fishery potential of coastal waters. In the present study, spatio-temporal variations in ichthyoplankton abundance in the coastal waters of Kochi were evaluated. Sampling was carried out at five stations (S1, S2, S3, S4, and S5) extending from the inlet to offshore locations during pre-monsoon (February-May), monsoon (June-September), and post-monsoon (October-January) in 2021. Surface water and mesozooplankton samples were collected monthly at each station. Hydrographic parameters, including temperature, salinity, and chlorophyll-*a*, were analysed. The ichthyoplankton community were sorted from mesozooplankton samples and identified using standard taxonomic keys. The study revealed a clear seasonal pattern in ichthyoplankton distribution. Abundance was high in the pre-monsoon, followed by the post-monsoon, and low during the monsoon. Diversity at the family level also varied seasonally, with 18 families recorded in the pre-monsoon, 16 in the post-monsoon and 11 in the monsoon. Spatial variations in ichthyoplankton distribution were evident as well. Near-shore stations had higher ichthyoplankton abundance than offshore stations. Hydrographic variables such as temperature, salinity, and chlorophyll-*a* exerted a significant influence on the distribution and abundance of this ecologically important taxon in the coastal waters off Kochi, along the southwest coast of India.

Keywords

Coastal waters, Chlorophyll-*a*, Hydrographic variables, Mesozooplankton



Spatio-temporal distribution of fish eggs and larvae in the coastal waters of Kochi during the pre-monsoon period of 2025

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Spatio-temporal variation in fish egg and larval abundance provides critical insights into fish reproductive dynamics in coastal ecosystems. The present study assessed the spatio-temporal distribution of fish eggs and larvae across four sampling stations extending from the coast to offshore in the coastal waters of Kochi during the pre-monsoon season of 2025. Marked variation was evident in both fish egg and larval distribution, indicating the sequence of spawning and the subsequent hatching process in this region. Fish egg abundance peaked during February, with the highest density observed at the nearshore station (1.80 ind. m⁻³), indicating active spawning. A sharp decline in egg density was observed during March, accompanied by a rise in larval abundance (1.02 ind. m⁻³), suggesting successful hatching and transition to larval stages. By April, egg abundance increased in the offshore stations, coinciding with high larval abundance in the extreme coastal station, suggesting spatial segregation possibly influenced by hydrodynamic processes. In May, fish larvae were observed across all depths, with maximum abundance at the offshore station (3.68 ind. m⁻³), reflecting the continued occurrence of post-hatch stages in the coastal waters of Kochi. The findings indicate a clear spawning peak in February, followed by progressive hatching and subsequent offshore dispersal of larvae through April–May in the coastal waters off Kochi. Detailed species-level identification of fish eggs and larvae would provide more accurate insights into spawning dynamics, larval dispersal pathways, and the relative contributions of different fish taxa to the structure of this ecologically significant coastal ecosystem in the southeastern Arabian Sea.

Keywords

Egg density, Hydrodynamic processes, Larval dispersal, Southeastern Arabian Sea, Spawning



Spatio-temporal variability in fish and shellfish assemblages of Kayamkulam Estuary, Kerala

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Kayamkulam Estuary, extending across the Alappuzha and Kollam districts of Kerala, is a major backwater system connected to the Vembanad Estuary in the north and the Ashtamudi Estuary in the south. Covering 1652.33 ha (9°2'-9°16'N; 76°25'-76°32'E), the estuary opens into the Arabian Sea through the Kayamkulam barrage. The ecosystem is characterised by salinity gradient, rich mangrove vegetation, and productive fisheries. Seasonal sampling at seven stations during 2024-2025 recorded 54 fish species representing 36 families and 13 orders. Species richness was higher in the high saline zone (49 species) compared to the low saline zone (40 species). K-dominance analysis indicated a stable ecosystem in the high-salinity region, with 12 species accounting for 80% of fish diversity during the post-monsoon. Seine nets yielded the most diverse catches, comprising cichlids, clupeids, mullets, carangids, and shrimps. The estuary also supports crustaceans (*Metapeneaus monoceros*, *Peneaus indicus*, *P. monodon*, *Scylla serrata* and bivalves like *Villorita cyprinoides* and *Crassostrea madrasensis*). The findings highlight the ecological importance and fishery potential of Kayamkulam Estuary, emphasising the need for its conservation and sustainable management.

Keywords

Diversity indices, Fish diversity, Salinity gradient, Temporal changes



Spatiotemporal variations in the diversity and occurrence of Lutjanid fish species of the Gulf of Mannar, southeast coast of India

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In recent years, biodiversity studies have increasingly emphasised the importance of examining environmental patterns across different spatial and temporal scales. This research investigated the diversity of lutjanid fishes in the Gulf of Mannar, with fortnightly collections carried out between August 2023 and July 2024 at two major sites of Thoothukudi Fishing Harbour (TFH) and Pamban Fish Landing Centre (PFLC). Data were analysed using PRIMER v7 software. A total of 32 species belonging to six genera were documented, including two new distributional records *Lutjanus notatus* and *Paracaesio xanthurus*. PFLC exhibited the highest species richness, with 31 species, while TFH supported 27 species. Seasonal variations were evident, with maximum diversity observed during the Southwest monsoon and lower diversity during the Northeast monsoon. Overall, the results highlight a relatively healthy status of lutjanid fisheries at both sites, with stable catches and considerable species richness. The findings provide a critical baseline for future conservation planning and sustainable fisheries management in the Gulf of Mannar.

Keywords

Biodiversity, Snapper, Species richness, Stable catches, Sustainable fisheries



Diurnal dynamics of planktonic ciliate diversity in the Hooghly Estuary, West Bengal, India

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Planktonic ciliates are micro-heterotrophs that transfer energy from microbial to higher trophic levels of coastal-marine ecosystems. Studies on planktonic ciliates in Indian waters are limited, particularly those concerning the Indian Sundarbans. The objective of the study was to assess the day-night effect and tidal influence on the abundance of the ciliate community in the Hooghly Estuary. Twenty-four hours of continuous sampling were carried out at hourly intervals from 15:30 hrs on 10th to 14:30 hrs on 11th February 2024. During the study period, water depth ranged from 6.2 to 1.6 m, salinity from 14.7 to 7.7 ppt, temperature from 23.1 to 21°C, pH from 7.34 to 6.76, total dissolved solids (TDS) from 15752 to 10574 mg l⁻¹, and dissolved oxygen (DO) from 11.79 to 8.05 mg l⁻¹. Regression analysis showed that those parameters did not vary significantly over the sampling period. A total of 24 species under seven genera were recorded during the study. Among them, *Tintinnopsis parvula*, *T. rotundata*, and *T. lohmani* were dominant. Diversity indices did not vary significantly over the course of the study period. However, Shannon-Wiener, Simpson diversity, and Pielou's indices varied considerably with a change in water depth. The species richness, Shannon-Wiener, and Simpson diversity indices varied significantly with the water temperature, whereas Pielou's index varied considerably with changes in salinity and TDS. These results suggest a larger role in limiting ciliate diversity in a macro-tidal estuary. This study also showed that, high-resolution temporal sampling is required to understand the complex structural changes in a plankton community in response to estuarine ebb-flood tides.

Keywords

Distribution, Diversity, Indian Sundarbans, Macro-tidal estuary, Micro-heterotrophs, Tidal variation



Seaweed dominance and biomass accumulation on the coral reefs of the Mangadu Coast, Tamil Nadu

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This study investigated seasonal patterns of macroalgal dominance and accumulation on the coral reefs of Mangadu, with emphasis on their effects on reef health. Surveys showed extensive proliferation of green (Chlorophyta), brown (Phaeophyta), and red (Rhodophyta) algae, frequently overgrowing live corals and reef substrates. Overgrowth led to reduced light availability, hypoxic microzones at night, and direct competition through shading and physical contact, particularly from *Sargassum* and *Halimeda*. Clear seasonal trends were observed, with Chlorophyta dominating during the monsoon and Phaeophyta prevailing in the summer and pre-monsoon periods, with minimum contribution from Rhodophyta. Among individual taxa, *Caulerpa sedoides* and *Sargassum wightii* consistently emerged as dominant species across seasons. Biomass accumulation peaked during the post-monsoon, indicating favourable conditions for algal growth following nutrient enrichment and hydrological shifts. These findings demonstrate that macroalgal dominance is closely regulated by seasonal environmental variability, and that excessive algal proliferation significantly reduces coral resilience in the Mangadu reef ecosystem.

Keywords

Anthropogenic impact, Hypoxic microzones, Monsoon, Palk Bay, Reef health



Genomic insights into microbial communities and their role in fish and environmental health in estuarine ecosystems

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Estuarine systems are semi-enclosed coastal water bodies and are ecologically productive zones that support diverse microbial life, fish species, and aquatic organisms. Microbial communities in estuaries play a vital role in nutrient cycling, water quality, and fish health. Microbial genomics involves genomic tools such as metagenomics, 16S rRNA sequencing, and whole-genome sequencing to identify microbial species, understand their functions, and detect pathogens and beneficial microbes. Fish harbour complex microbiomes on their skin, gills, and gut and susceptible to unstable environmental impacts like pollution and pathogenic microbial infections. Genomic analysis helps in the early detection and monitoring of fish diseases. Certain microbial taxa act as bioindicators of environmental health, and the genomic data can reveal shifts in microbial communities, spread of antibiotic resistance genes (ARGs), heavy metal resistance genes (HRGs), etc. Sensitive and tolerant microbial taxa are identified, and microbial metrics are scored based on their deviation from reference or expected conditions in a healthy ecosystem. Scores are aggregated into a composite MC-IBI score. Higher scores indicate better ecological health, while lower scores suggest degradation. Integrating microbial genomics with fish and environmental health studies offers sustainable strategies to manage fish populations and estuarine ecosystems effectively.

Keywords

Bioindicators, Fish population, Microbiomes, Nutrient cycling, Productive zones



Feeding strategies, resource partitioning and seasonal variations in feeding patterns between three sympatric estuarine predators inhabiting a tropical estuary

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Tropical estuaries are highly dynamic ecosystems where seasonal fluctuations strongly influence prey availability, predator interactions, and fisheries productivity. Understanding the feeding ecology and resource use of estuarine predators is central to assessing ecosystem stability and fisheries sustainability in these complex and dynamic ecosystems. The present study examined diet composition, feeding strategies, trophic niche breadth, and seasonal resource partitioning among three sympatric, commercially important carnivorous fishes viz., *Daysciaena albida*, *Caranx sexfasciatus*, and *Ambassis ambassis*, in the Cochin Estuary, Southwest India. A total of 311 stomachs were analysed between June 2016 and May 2018, using frequency, number, volume, and Index of Relative Importance (%IRI), with seasonal variations assessed across monsoon, post-monsoon, and pre-monsoon periods. Niche breadth was estimated using Levin's and Hurlbert's indices, while dietary overlap was quantified using Pianka's index and tested against null models. Gut content analysis revealed seven prey categories, with shrimps forming the most dominant prey across species and seasons, followed by fish. Seasonal variability significantly influenced prey preferences, with reduced dietary diversity during the monsoon and broader prey utilisation during the pre-monsoon. Feeding strategy diagrams highlighted specialisation towards decapod crustaceans, while trophic niche breadth values ranged from intermediate to high (0.50-0.67). Pianka's index indicated high dietary overlap among species ($O=0.78-0.99$), with null model simulations revealing significant resource sharing during pre-monsoon and potential competition in other seasons. The findings underscore the strong influence of seasonal prey availability in structuring trophic interactions and reveal that sympatric carnivores cohabit through partial niche partitioning and dynamic overlap. These findings highlight the central role of shrimps and other crustaceans in sustaining estuarine predators and demonstrate how seasonal resource fluctuations and partial niche partitioning facilitate coexistence despite high overlap. Given their commercial importance and the pressure to exploit them, the study provides a baseline for ecosystem-based fisheries management. It underscores the need to safeguard estuarine prey resources to ensure both stock sustainability and ecosystem resilience.

Keywords

Dietary overlap, Monsoon, Niche breadth, Predator interactions, Stock sustainability



Diversity of commensal organisms in the Vellar Estuary, southeastern coast of India

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Commensalism is a type of species interaction where one organism benefits by gaining food, shelter, or protection, while the other is neither helped nor harmed. A regular exploratory survey was conducted from January 2022 to 2025 to investigate the cryptic biodiversity of the Vellar Estuary, located on the southeastern coast of India. This biodiverse ecosystem is characterised by heterogeneous habitats, including artificially established mangrove forests, fragmented seagrass beds and oyster reefs. This diverse environment provides essential feeding, spawning, and nursery grounds for a wide range of species. As part of this survey, approximately 150 windowpane oysters, *Placuna quadrangula*, were sampled, examined, and returned to their natural environment. The examination revealed new records of commensal organisms, such as shrimps, *Conchodytes placunae*, for the first time in Indian waters. Pea crab, *Arcotheres placunae* was recorded from a new host with a commensal association with the *P. quadrangula*. As a result, 75% of hosts were infected with crustaceans in their mantle cavity, comprising *C. placunae* (42%) and *A. placunae* (33%). Oysters often carried either both male and female specimens or single individuals, underscoring the rich commensal diversity of the estuary. Previously, both *C. placunae* and *A. placunae* were recorded only from the known host bivalve species *Placuna placenta*; this study provides the first report of their association with a new host, *P. quadrangula*, based on specimens collected from the Vellar Estuary. The identification of this commensal relationship underscores its role in ecological balance and species survival, warranting further research on ecosystem dynamics, interspecies interactions, and behaviour to better understand biodiversity and guide conservation efforts.

Keywords

Bivalves, Crabs, Interspecies interactions, Oyster reefs, Shrimps, Symbiotic relationships



Sea cucumbers of India: Ecological role, Red List status, and conservation challenges

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Sea cucumbers (Phylum: Echinodermata, Class: Holothuroidea) are key benthic components of tropical marine ecosystems. Often described as the “earthworms of the sea,” they play vital ecological roles as natural bioturbators by processing large volumes of sediment, recycling nutrients, and regulating carbonate balance. These functions maintain the health of coral reefs, seagrass beds, and soft-bottom habitats, supporting broader marine biodiversity. Their decline cascades into impacts on ecosystem functioning and resilience. Currently, 171 sea cucumber species have been reported from Indian waters, including 54 deep-sea forms. Many of these species are ecologically valuable and have been heavily exploited for the beche-de-mer trade. Therefore, the Government of India has protected all holothurians under Schedule I of the Wildlife (Protection) Act, 1972. While this blanket protection safeguards keystone species, it has also created indirect challenges for the independent researcher. Lengthy official procedures and restrictions on specimen collection led to fewer studies of the very important group. Even though illegal poaching and trade remain significant, no baseline data are available. It is challenging to track population recovery, understand species distributions, or assess the effectiveness of conservation actions. The present account provides a background on the diversity of the Indian sea cucumber, its ecological functions, its international conservation status, and national legal frameworks, and also outlines the research and conservation challenges based on published papers and personal observations. *Holothuria (Metriatyla) scabra* is the most frequently targeted species in Tamil Nadu, while *Actinopyga* spp. are commonly involved in reported wildlife poaching cases from Lakshadweep. A total of 72 sea cucumber species found in Indian waters have been globally assessed by the IUCN Red List, including 11 endemic species. Among these, four are categorised as Endangered, five as Vulnerable, 28 as Least Concern, and 35 as Data Deficient. Unlike Sri Lanka and Malaysia, India does not yet have a national Red Data Book. In addition, three sea cucumber species listed under CITES Appendix II are also distributed in Indian waters. In conclusion, the urgent need for non-destructive research methods such as underwater visual surveys, assessments of all Indian sea cucumber species in the IUCN Red List, and the establishment of long-term (≥ 10 years) monitoring programs in major reef regions, combined with community engagement and international collaboration, is critical. Such efforts will not only strengthen the conservation of sea cucumber species in India but also reaffirm the nation’s global commitment to safeguarding these keystone marine invertebrates.

Keywords

Beche-de-mer, Bioturbators, CITES, Ecosystem services, Holothuroidea, IUCN



Phylogenetic assessment and DNA barcoding of ichthyofauna in Southern India's Thamirabarani River using the 16s rRNA gene

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The ichthyofaunal diversity of the Thamirabarani River is under increasing anthropogenic pressure. This study aimed to establish a comprehensive DNA barcode reference library for the river's fish species to support conservation efforts. 16S ribosomal RNA (rRNA) gene sequences from 41 morphologically identified species, representing 10 orders, 13 families, and 25 genera, collected from six different locations, were analysed. The genetic data were used to validate species identification through an integrated approach: determining the nucleotide frequency of each base pair within the gene sequence, calculating the genetic distance between taxa to quantify evolutionary divergence, and building an evolutionary tree to visualise the relationships between species and confirm their classification. This study yielded nucleotide frequencies of 31.07% Adenine, 21.99% Thymine, 24.30% Cytosine, and 22.64% Guanine. The AT frequency was 53.06%, while the GC frequency was 46.94%, demonstrating the AT-enrichment characteristic of teleosts in this study. Gobiiformes showed the highest GC content among the fish population. Genetic divergence increased across taxonomic levels: interspecific (3.9%), intergeneric (3.96%), interfamilial (10.42%), and interordinal (13.33%). The overall mean distance was $0.1788 \pm SE 0.0177$. The Maximum Likelihood (ML) tree was generated using MEGA 11.0 software utilizing 41 16S rRNA nucleotide sequences and employing 1000 bootstrap replications. *C. chitala* was chosen as the outgroup for tree reconstruction. These analyses provide a robust molecular foundation for the conservation management of the Thamirabarani River's fish populations. The establishment of this molecular reference database provides a valuable tool for future biodiversity assessments and for implementing effective conservation strategies within this threatened ecosystem. The publicly accessible barcode data contributes a foundational resource for subsequent studies on the freshwater ichthyofauna of Southern India.

Keywords

Conservation, Molecular signature, Phylogenetic tree, Southern Western Ghats



Influence of pre-monsoon conditions on plankton community structure and diversity in coastal waters of Kozhikode, Kerala

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This study presents a comprehensive analysis of spatiotemporal plankton dynamics in the coastal waters of Kozhikode, Kerala, utilising a dataset from three stations collected between February and June 2025. A descriptive analysis of the total plankton abundance revealed a community heavily dominated by diatoms (97.7%), with *Odontella*, *Chaetoceros*, and *Coscinodiscus* emerging as the most abundant genera. The maximum plankton abundance observed during the study period was 4.96×10^8 cells l^{-1} . Genera such as *Ceratium*, *Protoperdinium*, and *Prorocentrum* micans, all recognised for their potential to form harmful algal blooms, were detected at sub-bloom abundances, particularly during the late pre-monsoon season. The diversity analysis revealed marked temporal variation, with relatively high diversity in February and March giving way to a pronounced decline during April and May, and reaching its lowest values in June. This reflected a transition from a more balanced community to one dominated by a few bloom-forming genera, indicating ecosystem stress. Notably, while diversity varied significantly across months, no consistent station-wise differences were detected, suggesting that seasonal forcing rather than local spatial factors exerted the stronger control. These results highlight the sensitivity of the plankton community to pre-monsoon environmental shifts, particularly the approach of the southwest monsoon, which introduces stressors such as reduced salinity and altered nutrient regimes. The findings affirm the role of plankton as a sensitive bioindicator of both seasonal climatic variability and susceptibility to bloom events in this region.

Keywords

Bioindicator, Climatic variability, Diatom dominance, Plankton dynamics



Smart fish passes: For sustaining biodiversity resilience in regulated river systems

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For thousands of years, migratory fish such as salmon, sturgeon, eels, hilsa, and mahseer have travelled upstream and downstream rivers, without any barriers, completing their lifecycles, bridging ecosystems and sustaining communities. Today, these journeys are increasingly being blocked by structures such as dams, barrages, and weirs and other such engineered structures. The barrier effect is further intensified by climate change hence the old traditional structure needs to be updated to meet the requirement of the changing climatic condition. A framework of climate-adaptive fish pass innovations that merge hydraulic design with ecosystem-based engineering becomes a necessity So that the fish bypass can emerge as critical conservation tools, integration with: Thermal Cooling Zones provide engineered cold-water refugia for temperature-sensitive species. Carbon Capture and Flow Regulation via algae bio-reactors and seagrass mats integrated into fish pass structures. Geoengineering Sensors & AI-Controlled Systems enabling real-time monitoring of various critical parameters can help in enhancing microhabitat complexity, biodiversity, and ecosystem resilience. Fish passes can evolve into multi-functional infrastructures that not only facilitate species migration but also deliver broader ecosystem services, including carbon sequestration, climate adaptation, and habitat enhancement.

Keywords

Carbon capture, Conservation, Ecosystem-based engineering, Migratory species



Dinoflagellate bloom dynamics: Abundance and dinocyst formation in Kumbalangi backwaters, Kerala

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The backwaters of Kumbalangi along the southwest coast of India, have been experiencing recurrent dinoflagellate blooms over the past several years. Bioluminescence, locally referred to as “*kavaru*”, were also observed during the bloom periods at night. To assess the environmental conditions associated with the bloom events, water and sediment samples were collected between 2023 and 2024. Water parameters, including temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), chlorophyll-a, pH, turbidity, salinity, total suspended solids (TSS), and nutrients (phosphate, nitrite, nitrate, ammonia, and silicate), were analysed using standard protocols. Sediment salinity, total organic carbon (TOC), and texture were also determined following established procedures. Principal Component Analysis (PCA) revealed that the phytoplankton community structure in the Kumbalangi backwaters was primarily influenced by salinity, dissolved inorganic nitrogen (DIN), and dissolved inorganic silicate (DiSi). A total of 107 phytoplankton species were recorded, comprising 67 diatom species, 19 dinoflagellate species, 10 Chlorophyceae species, and 11 Cyanophyceae species. Among the dinoflagellates, *Gonyaulax spinifera* was the predominant species, accounting for approximately 80% of the total dinoflagellate abundance, followed by *Protoperdinium pellucidum* (10%), *Protoperdinium leonis* (1%), and *Ceratium furca* (1%). The bloom events observed during March-April were attributed to the proliferation of *G. spinifera*. The abundance of *G. spinifera* peaked in March, reaching 97,000 cells l⁻¹, and exhibited a strong positive correlation with salinity. Diatom populations were comparatively higher during the monsoon season, likely driven by elevated dissolved silicate concentrations. This enhanced diatom productivity may have, in turn, supported the proliferation of the heterotrophic dinoflagellate *P. pellucidum*, which attained a peak density of 39,667 cells l⁻¹. Resting cysts of *G. spinifera* were observed during monsoon period, suggesting that the prevailing stressful environmental conditions, marked by reduced salinity, lower temperature, and diatom dominance may have triggered the formation of temporary dormant cysts as a survival mechanism. *Gonyaulax* cysts observed during the monsoon period completely disappeared during the subsequent bloom and post-bloom phases. As environmental conditions became favourable, characterised by increased salinity, higher temperature, and reduced competition from diatoms; the phytoplankton community shifted predominantly toward dinoflagellate dominance, leading to monospecific bloom events. This study highlights the link between phytoplankton abundance and environmental factors driving recurrent bloom events that influence water and sediment quality. Continuous ecosystem monitoring is vital to identify and predict the conditions triggering bloom initiation and persistence.

Keywords

Bioluminescence, *Gonyaulax spinifera*, Monospecific bloom, Physico-chemical parameters, Resting cysts



Prevalence of microsporidiosis in marine fishes of Indian coastal waters

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Microsporidiosis, caused by obligate intracellular parasites of the phylum Microsporidia, is emerging as a significant threat to marine fishes worldwide. In recent years, increasing reports from Indian coastal waters highlight the rising incidence of microsporidian infections in commercially and ecologically important fish species. These pathogens invade host tissues, particularly muscle and gonadal cells, leading to tissue degeneration, growth retardation, reduced fecundity, and in severe cases, mortality. Such infections not only compromise fish health and population stability but also pose serious challenges to fisheries productivity and sustainability. Environmental stressors, including pollution, eutrophication, and climate-driven changes in sea surface temperature, appear to exacerbate parasite prevalence and transmission dynamics. This study synthesises current knowledge on Microsporidiosis in marine fishes along the Indian coast, with emphasis on species affected, pathological manifestations, ecological implications, and potential socio-economic impacts on fisheries. The findings underscore the need for continuous monitoring, improved diagnostic tools, and integrated management strategies to mitigate the emerging risks posed by Microsporidiosis to marine biodiversity and coastal livelihoods.

Keywords

Biodiversity, Ecological implications, Fisheries, Host tissue, Parasitic diseases



Exploring seamount fish diversity in the deep Arabian Sea through eDNA metabarcoding

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Seamounts are underwater mountains that frequently support rich and diverse marine ecosystems; however, the potential for fisheries in the seamounts of the Arabian Sea remains inadequately understood. This knowledge deficit is largely attributable to restricted access to deep-sea environments and to the challenges of acquiring intact biological samples necessary for identification. The present study aims to elucidate fish diversity in the water column above seamount summits in the eastern Arabian Sea, utilising environmental DNA (eDNA) metabarcoding techniques. Water samples were collected aboard the vessel *Sindhu Sankalp* during cruises SSK#148 and SSK#178. The eDNA was isolated from filtered samples of 2-3 l of water collected at various depths, employing a commercially available kit and amplified via polymerase chain reaction (PCR) using specific primers that target the cytochrome c oxidase subunit I (COI) gene of fish. The resultant amplicons were aggregated according to depth classifications ie., epipelagic (0-200 m), mesopelagic (200-1000 m), and bathypelagic (>1000 m) for each sampling station before sequencing with Oxford Nanopore Technology. Long-read sequencing data were analysed using a customised in-house bioinformatics pipeline that integrates publicly available tools. Taxonomic classification of the Amplicon Sequence Variants (ASVs) was conducted using the standard fish mitochondrial genome database, MitoFish. The study identified two principal classes of fish, namely the Actinopterygii and Chondrichthyes, comprising 64 orders, 247 families, 655 genera, and 823 species. Fish diversity varied across sampling sites and depths, with the highest species richness recorded in the epipelagic zone and the lowest in the bathypelagic zone. This study demonstrates that eDNA serves as a viable approach for monitoring fish ecology, community composition, and distribution, as well as for detecting endangered, invasive, and commercially significant species. In contrast to traditional sampling methods, eDNA techniques are non-invasive and environmentally benign. The findings underscore the importance of eDNA metabarcoding for the conservation and management of marine fish populations. As biodiversity assessments gain prominence, eDNA metabarcoding is poised to play a pivotal role in facilitating the sustainable utilisation and conservation of marine resources.

Keywords

Bathypelagic zone, Bioinformatics, Community composition, Conservation, Non-invasive



Finfish diversity in the low-value bycatch (LVB) from trawling operations in the western Bay of Bengal along the north Tamil Nadu coast

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A study was conducted to assess the finfish composition in the low-value bycatch (LVB) in trawl landings at Chennai Fisheries Harbour from July 2005 to March 2012. Weekly collections of bycatch samples were brought to the laboratory, sorted, and identified up to the species level. The LVB contributed approximately 16% to the total trawl landings. Fishes formed 62.8% of the LVB, followed by crustaceans (30.6%), molluscs (4.9%), and others (such as echinoderms and sponges, 1.7%). A total of 16,686 finfish were segregated during the study, and classified into 244 finfish species, belonging to 36 orders, 87 families, and 164 genera. Based on the price of different species of fishes that were sold in the market for human consumption, the finfishes in the LVB were sorted into the following three categories: (i) Juveniles of commercially important fishes (C1); (ii) Small-sized adult fishes with low market price (C2); and (iii) fishes having no market value (C3). Among the LVB, C2 contributed 58.2%, and C1 and C3 contributed 25.6% and 16.2%, respectively. C1, C2 and C3 consisted of 89, 88 and 67 species, respectively. The top 10 Families in C1 were Mullidae, Engraulidae, Nemipteridae, Platycephalidae, Sciaenidae, Carangidae, Synodontidae, Dorosomatidae, Trichiuridae and Psettodidae. The top 10 Families in C2 were Leiognathidae, Engraulidae, Bothidae, Solidae, Pristigasteridae, Atherinidae, Tetraodontidae, Muraenesocidae, Ambassidae and Pinguipedidae. C3 comprised Apogonidae, Caesionidae, Callionymidae, Bregmacerotidae, Gobiidae, Scorpaenidae, Narkidae, Monacanthidae, Synanceiidae, and Tetraodontidae (toadfish, toby, and poisonous inedible puffers). The analysis indicated high biodiversity in the bycatch of bottom trawls in Chennai, which included a considerable quantum of juveniles of several commercially important species. Implementing minimum cod end mesh size and Minimum Legal Size (MLS) of capture are called for as remedial measures to lessen the negative impact of trawling activity in the region.

Keywords

Juveniles, Mesh size, Minimum legal size, Remedial measures, Trawl landings



Fishery and diversity of snappers (Family: Lutjanidae) along the Thoothukudi Coast, Tamil Nadu

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The diversity, fishery, and exploitation of snappers were studied at selected fish landing centres along the Thoothukudi coast (Tharuvaikulam, Therespuram, Tuticorin Fishing Harbour, and Amalinagar). The study, conducted from 2012 to 2023, aimed to understand the snapper fishery and the species composition of the family Lutjanidae. Fish in this family are targeted resources due to their high demand in the international seafood market. The maximum landings of snappers were recorded in 2015 (1,680.56 t), followed by 2016 (1,066 t) and 2023 (1,087.30t). The lowest landings occurred in 2021 (399.54 t). In total, twenty-two species belonging to the family *Lutjanidae* (snappers) were identified, representing four genera: *Lutjanus* (81%), *Pinjalo* (9%), *Aprion* (5%), and *Pristipomoides* (5%). Among these, the genus *Lutjanus* accounted for the vast majority of landings (99.2%), with *Pinjalo* (0.7%), *Pristipomoides* (0.04%), and *Aprion* (0.01%) accounting for much smaller proportions. The genus *Lutjanus* had the highest species richness, with about 18 species recorded from the Thoothukudi coast. Among the 22 identified species observed during the study period, *Lutjanus rivulatus* (22.31%) contributed the maximum landings, followed by *L. russelli* (19.14%), *L. decussatus* (13.05%), *L. quinquelineatus* (9.96%), *L. fulviflamma* (8.9%), *L. johnii* (5.3%), *L. kasmira* (5%), *L. argentimaculatus* (3.5%), *L. gibbus* (3.4%), *L. malabaricus* (2.6%), *L. lutjanus* (2%), and *L. fulvus* (1.3%). The lowest catches were recorded for *L. bengalensis*, *Pinjalo pinjalo*, *L. lemniscatus*, *L. vitta*, *P. lewisi*, *L. bohar*, *Pristipomoides typus*, *L. indicus*, and *L. sebae*. The maximum landings of snappers were recorded from the motorised sector using hook-and-line gear (37.78%), followed by gill nets (29.03%) and trawl nets (0.22%) along the Thoothukudi Coast. The mechanised sector recorded moderate landings, with hook and line accounting for 0.56%, followed by mechanised gill nets and trawl nets (0.17%). The minimum snapper landings were recorded in the non-motorised sector (0.78%). Findings on species composition and gear-specific occurrence provide valuable insights for formulating sustainable management strategies for snapper resources in the region.

Keywords

Gear-specific occurrence, Hook and line, Mechanised sector, Motorised sector, Species composition



Theme 2

Sustainable Fisheries and Mariculture(SFM)

Oral Presentations



Multi-stakeholder participatory trials for the potential commercial exploration of mesopelagic resources in the Indian EEZ

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India's Exclusive Economic Zone (EEZ) supports significant mesopelagic (200–1000 m depth zone) resources, with biomass surveys indicating promising potential for food, feed, and pharmaceutical needs. However, commercial exploitation has remained negligible due to data limitation on geographical abundance, technological limitations, inadequate sampling protocols, gear inefficiencies at greater depths, and uncertainties over ecological impacts. Demand for alternative marine protein sources and diversification of fisheries underscores the need to explore these resources using technically viable and environmentally responsible approaches. This study aimed to assess the commercial feasibility of harvesting mesopelagic resources in Indian waters through participatory, multi stakeholder exploratory trials, engaging fishers, boat owners, and industry partners. Conventional trawlers, typically restricted to operations up to ~200 m depth, were modified for deep water and mesopelagic operations up to 800-1000 m. Key interventions included reinforcing and lengthening steel winch wires and replacing conventional floats with high-strength Ethylene Vinyl Acetate (EVA) floats resistant to deformation under extreme pressures. Operations were scheduled at night to intercept diel vertical migrators, with precise documentation of GPS positions, trawling speeds, depths, and durations. Catches from 38 families and 20 orders were recorded, including families Alepocephalidae, Bathylupeiidae, Chaunacidae, Myctophidae, Nemichthyidae, Nettastomatidae and Ophidiidae. Length frequency analysis revealed wide ontogenetic ranges for dominant species, suggesting that the area functions as a growth and feeding ground. Substantial bycatch of gelatinous zooplankton (*Periphylla periphylla* and *Atolla wyvillei*) occasionally impaired gear performance. Post-harvest handling emerged as a bottleneck due to the delicate and perishable nature of many species; retrofitting vessels with insulated fish holds and ice slurry systems improved product quality. The trials demonstrated that with targeted modifications, existing trawler fleets can technically access mesopelagic resources, though challenges remain in fuel efficiency, catch rate, and market acceptance. Findings highlight the need for finding potential grounds of mesopelagic resource abundance, improved biomass estimation protocols, gear designs tuned to deep scattering layer dynamics, and integrated operational strategies to minimise ecological disturbance. These preliminary results establish a foundation for developing India's mesopelagic fisheries within a precautionary, science driven framework, offering prospects for enhancing food and nutritional security, generating new livelihood opportunities, and contributing to the nation's blue economy, provided technological, economic, and environmental considerations are jointly addressed

Keywords

Blue economy, Deep-sea trawling, Gear modification, Livelihood, Myctophid

Artisanal shark longline fishery of Minicoy Island, Lakshadweep: Insights into practices, catch dynamics and conservation needs

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The “Nanu” shark longline fishery of Minicoy Island, Lakshadweep, India, represents a traditional, small-scale, artisanal fishery that primarily targets reef-associated and pelagic shark species. Operations are conducted from fibre-reinforced plastic (FRP) boats ranging from 5.9 to 12.3 m in length overall (LOA), powered by either outboard or inboard engines. The fishing gear consists of a polypropylene mainline 25–50 m in length and 4 mm in thickness, rigged with 8–10 branch lines spaced at intervals of 1.5–10 m. Each branch line comprises a snatching clip, 1 m of 6 mm black nylon rope, a swivel, 1 m of 3 mm steel wire trace, and end with a slightly curved No. 0 “Eagle Eye” hook. Gear setting typically occurs in the evening (18.30–19.00 hrs), with retrieval in the following morning at approximately 07.00 hrs, yielding a soak time of 12–12.5 h. Rotten eel fish, locally prepared by burying freshly collected eel in sand to induce decomposition, serves as bait. The strong odour of the spoiled meat enhances olfactory attraction and improves catch efficiency. Fishing takes place throughout the year except during the southwest monsoon (May–August), when rough seas and strong currents make operations unsafe. The catch is dominated by four shark species: *Negaprion brevirostris* (lemon shark, 45%), *Triaenodon obesus* (whitetip reef shark, 20%), *Carcharhinus melanopterus* (Blacktip reef shark, 12%), and *Galeocerdo cuvier* (Tiger shark, 15%). Minor species include *Carcharhinus albimarginatus* (Silvertip shark), *C. amblyrhynchos* (Grey reef shark), *C. falciformis* (Silky shark), *C. limbatus* (Black tip shark), *C. longimanus* (Oceanic white tip shark) *Sphyrna mokarran* (Great hammerhead), *Nebrius ferrugineus* (Tawny nurse shark), *Alopias vulpinus* (Common thresher shark) and *Rhizoprionodon acutus* (Milk shark) which together contribute the remaining share of the catch. Post-harvest handling involves processing sharks into fresh and dried meat forms, with significant volumes transported to mainland India, particularly Kerala, for commercial markets. In addition, cleaned shark jaws are sold as souvenirs to tourists visiting Minicoy, providing supplementary household income. While the fishery sustains local livelihoods and draws upon long-standing traditional ecological knowledge, the high proportion of shark catch raises concerns regarding species sustainability. The “Nanu” fishery exemplifies a culturally embedded and economically valuable practice that requires careful monitoring, management, and balanced approaches to conservation and utilisation

Keywords

Artisanal fishery, Management, Pelagic shark, Reef-associated, Small-scale, Sustainability

Enhanced survey methodology for estimating marine fish landings - A relook at ICAR-CMFRI methodology

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The survey methodology for marine fish landings in India, led by ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), since 1959, underpins fisheries management and ecological research. It applies a two-stage stratified random sampling (SRS) design, with landing centres as primary units and fishing trips as secondary units, ensuring unbiased estimates of species, gear, and region-wise landings. Covering about 1,200 centres along India's 6,100 km coastline, the approach delivered robust national estimates, with 3.53 million t of landings reported in 2023. However, challenges arose in estimating multiple parameters, such as catch per unit effort (CPUE), within a single framework, while temporal variability was often overshadowed by spatial stratification. To address these limitations, alternative strategies were evaluated. Adaptive Cluster Sampling (ACS) intensified effort in high-catch areas, improving precision for patchy species like sardines, though it was computationally demanding. Model-assisted sampling integrated auxiliary data (e.g., satellite imagery, historical trends) with regression estimators, reducing variance but depending on data quality. Systematic sampling selected landing centres and trips at fixed intervals, ensuring even coverage but risking missed localised peaks. For surveys along the southwest coast in 2024, a hybrid approach was recommended, combining SRS with temporal post-stratification and model-assisted techniques. This improved precision for seasonal fisheries, reduced CPUE bias, and balanced feasibility with robustness, aligning with sustainable management goals

Keywords

Adaptive cluster sampling, CPUE, Marine fish landings, Systematic sampling, Stratified random sampling



Gear-based economic analysis of jellyfish fishery in Gujarat: Implications for sustainable management

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Global commercial jellyfish fisheries commenced in the 1970s, producing over 321,000 metric t between the years 1988 and 1999. Currently, 23 countries are engaged in edible jellyfish harvest, and China is leading in jellyfish fishery. In India, the jellyfish fishery was initiated by small-scale fishers during the 1980s, with an estimated export of 32 t in 1984-1985. Today, India has emerged as one of the major global contributors, exporting ~5,000-6,000 t annually. While jellyfish fisheries are reported along Andhra Pradesh, Tamil Nadu, and Kerala, continuous seasonal fisheries occur only along the Gujarat coast. The jellyfish landings in Gujarat increased significantly from 70 t in 2003 to 5,040 t in 2024. The Gulf of Kutch (Pindara Bay) and Jakhau creeks are the most important jellyfish fishery grounds in Gujarat. The jellyfish harvesting seasons are between the months of March-May and November-December. The increased jellyfish landings in Gujarat is driven by increased fleet size and adoption of new fishing gear. Traditionally, jellyfish were harvested by small boats using scoop nets; however, in recent years, they have increasingly been targeted by trawlers and encircling nets. Despite more than two decades of jellyfish fishing in Gujarat, the economic performance of this fishery remains undocumented. To address this gap, structured interviews were conducted with 30 jellyfish fishers in Okha and 20 in Jakhau between 2023 and 2025. Results indicated that approximately 270-300 small boats participate in the seasonal jellyfish fishery along the Gujarat coast. Jellyfish catch data from different fishing gears revealed that, on average, trawlers, surrounding nets, and scoop nets harvested about 1,500 kg day⁻¹, 1,200 kg day⁻¹, and 850 kg day⁻¹ of jellyfish, respectively. Operational expenditure data for each gear type were also recorded. This study represents the first systematic, gear-wise economic assessment of the jellyfish fishery, highlighting pathways to achieve maximum sustainable yields, safeguard fisher livelihoods, optimise resource use, and enhance the resilience of this emerging sector

Keywords

Economic efficiency, Fishing gear, Gujarat coast, Jellyfish fishery, Small-scale fisheries



From length to life status: LBB-based stock analysis of seven elasmobranchs in the Northwestern Bay of Bengal

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The Bay of Bengal (BoB) is among the most biologically productive marine regions, supporting a rich diversity of elasmobranchs, including sharks and rays. These apex predators are vital for regulating prey populations, maintaining ecological balance, and sustaining the structure of marine food webs. However, in recent decades, elasmobranch populations in Indian waters have experienced a noticeable decline, attributed to multiple anthropogenic and environmental pressures such as habitat degradation, climate change, marine pollution, illegal and unregulated fishing, and overexploitation for commercial trade. This decline not only threatens biodiversity but also undermines the ecological resilience and economic sustainability of coastal fisheries. In response to these growing concerns, the present study evaluated the stock status of seven commercially important elasmobranch species such as *Scoliodon laticaudus*, *Rhizoprionodon oligolinx*, *Chiloscyllium burmense*, *Iago omanensis*, *Brevitrygon walga*, *Glaucostegus granulatus*, and *Rhinobatos lionotus* along the West Bengal coast in the northwestern BoB. Length-frequency data were collected from commercial landings between 2021 and 2025. The stock assessment was conducted using the Length-based Bayesian Biomass (LBB) model, a robust and contemporary tool particularly suited for data-limited fisheries. Two key indicators, relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}) were estimated to determine the degree of exploitation and sustainability status of each species. The analysis revealed varying degrees of stock depletion and fishing pressure among the studied species, highlighting species-specific vulnerabilities. These findings provide critical, quantitative insights into the current exploitation patterns of elasmobranch fisheries in the region. The outcomes of this study hold significant utility for policymakers, fisheries managers, and conservation agencies, offering a strong scientific basis for developing targeted, evidence-based management interventions. Such strategies are essential for ensuring the long-term sustainability of elasmobranch populations, preserving ecosystem integrity, and supporting the livelihoods of coastal fishing communities dependent on these valuable marine resources

Keywords

Fisheries management, Fishing mortality, LBB model, Relative biomass, Stock assessment



Strengthening bycatch mitigation in trawl fisheries: Implementation of Turtle Excluder Device with square mesh trawl cod end

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Trawl fisheries in India face growing concerns over stock depletion and declining catches, driven by overfishing, non-selective gear, and environmental pressures. A major issue is bycatch, the unintentional capture of non-target species, including juveniles and endangered species such as sea turtles and seabirds. This not only threatens marine biodiversity but also undermines the sustainability of fisheries. To tackle this, the FAO's Code of Conduct for Responsible Fisheries (1995) urges the use of selective fishing gear and Bycatch Reduction Devices (BRDs), notably Turtle Excluder Devices (TEDs) and square mesh cod ends. TEDs are now essential in Indian trawl fisheries and improved designs ensure nearly 100% turtle exclusion without reducing shrimp catch or increasing fuel use, as confirmed by field trials on both coasts. Their adoption helps reduce turtle mortality and meets international conservation standards. However, TEDs alone cannot solve the issue of bycatch. Many juvenile fish and other small species still end up in the catch due to the use of fine mesh cod ends. Widespread adoption of square mesh cod ends could enable the escape of juveniles from over 100 species of finfish, crustaceans, and molluscs, potentially preventing millions of tonnes of unwanted bycatch each year and enhancing marine fish production. Despite their proven benefits, TEDs and square mesh cod ends are not yet mandatory in the Marine Fisheries Regulation Acts (MFRAs) of many states. Without urgent policy action, the future of Indian trawl fisheries remains at risk. Adoption of these devices ensure a practical and cost-effective pathway towards minimum legal size (MLS) in trawl landings, biodiversity-friendly fishing practices for sustainable fisheries

Keywords

Bycatch, BRDs, MLS, Square mesh cod end, TED, Trawl



Navigating the transition: Challenges in moving from traditional approaches to integrated stock assessments in tropical fisheries - A case study from India

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Fish stock assessments are crucial for understanding the health and sustainability of fish populations. They provide insights into the size, age, and productivity of fish stocks, enabling managers to make informed decisions on fishing regulations, harvest control rules, and quotas. In India, such assessments are regularly undertaken using either length-frequency-based methods or surplus production model-based approaches employing catch and catch per unit effort (CPUE) data. While these methods provide valuable outcomes, there is a need to improve the confidence and accuracy of assessment results through an integrated approach that combines diverse data sources, such as catch, abundance indices, size data, and life-history information, within a single modelling platform. In this paper, we address the challenges involved in translating data as required for an integrated stock assessment model such as Stock Synthesis. As an example, we use the Indian halibut stock from the south-east region of India to discuss the strategies used for collating data and information used for model assumptions, and demonstrate the process involved in building an integrated stock assessment model. The results were further compared with the outcomes from conventional length-based assessments to discuss the pros and cons while identifying what strategies might help in future-proofing model validation, model acceptance, and model usage for management advice. We believe that the outcomes of this study will lay out a guideline for building integrated stock assessments and recommendations on improving data collection mechanisms tailored for such needs

Keywords

CPUE, Fisheries management, Indian halibut, Multi-species, Sustainability





Bycatch composition and trends in the exploratory tuna longline fishery survey in the Indian Exclusive Economic Zone

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The present study examined the composition of bycatch, along with its spatio-temporal abundance and seasonal trends, in the exploratory tuna longline fishery conducted by the Fishery Survey of India (FSI) from 2009 to 2018. The analysis included both the targeted tuna catches and 31 identified bycatch species, comprising billfishes, pelagic sharks, rays, barracudas, dolphinfish, lancetfish, ribbonfish, scaled pomfrets, and others. Among these, sharks represented the dominant bycatch group in the Indian EEZ. The highest aggregate hooking rate recorded was 0.28% (number per 100 hooks), with a corresponding catch rate of 33.6 kg per 1000 hooks. Yellowfin tuna (YFT) was the dominant species across all three regions, contributing over 60% of the total catch (by number) in the Bay of Bengal and more than 40% in both the Arabian Sea and the Indian EEZ. Sharks were the second most important group, particularly in the Andaman and Nicobar (A&N) waters, where they accounted for 37.86% of the catch by number and 61.01% by weight. Billfishes (Sailfish, Marlins, and Swordfish) were more abundant in the Arabian Sea, while Rays contributed significantly in the A&N waters (25.22% of individuals caught). Other tunas, Skipjack, Dolphinfish, Barracudas and other species contributed less than 10% across all regions. This study provides comprehensive insights into species composition, relative abundance, and seasonal patterns of bycatch in the Indian EEZ, thereby contributing valuable information to support sustainable fishery management strategies

Keywords

Discards, Exploratory survey, Fishery management, Hooking rate, Seasonality



Stock status and precautionary harvest control rules for *Amphioctopus neglectus* (Cephalopoda: Octopodidae) in the Southeastern Arabian Sea

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The neglected ocellate octopus *Amphioctopus neglectus*, a commercially important cephalopod in the Indo-Pacific region has experienced rapid fishery expansion in the Southeast Arabian Sea (SEAS), driven by international demand. This study evaluates fishery and stock status of *A. neglectus* stock in SEAS using data collected during 2007-2023. Annual landings peaked at 9,366 t in 2022-23, with highest catch rates during the post-monsoon season. Dorsal mantle length (DML) ranged from 2.0 to 10.5 cm, with 27.4% of the landings below the minimum legal size (MLS) of 5 cm DML. Bayesian Schaefer surplus production model (BSM) analysis estimated the current stock biomass above B_{msy} ($B/B_{msy} = 1.39$), but the upper limit of F/F_{msy} (97.5 perc = 1.77) exceeded the confidence bound of 1.0 ($F/F_{msy} = 1.04$), with catch exceeding MSY by 75%. The L_{mean}/L_{opt} ratio was >1 indicating growth overfishing. The sex ratio was significantly male-biased, likely due to brooding-related behavioural traits, such as female seclusion, reducing their catchability. These findings suggest the fishery may be at or beyond its sustainable limit, however this skewed ratio may serve as a temporary demographic buffer under elevated fishing pressure. Precautionary harvest control rules are proposed based on L_{mean} , F/F_{msy} and B/B_{msy} , along with strict MLS enforcement and gear regulation, to reduce fishing pressure and to push the mean size of the fishery to be closer to L_{opt} for maximum economic benefits and long-term viability of this fishery in the SEAS

Keywords

Fishing pressure, Growth overfishing, Ocellate octopus, Stock assessment, Surplus production model



Developing sustainable mariculture and fisheries in the coral atolls of Lakshadweep

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The unique coral atoll ecosystem of Lakshadweep offers immense potential for developing sustainable fisheries and coastal aquaculture. In recent years, the Government has shown strong commitment to advancing the fisheries sector through initiatives that are both viable and beneficial for local communities. A study was conducted in Lakshadweep to assess potential development interventions in the fisheries sector. Using both primary and secondary data collected through structured tools, stakeholders from Kavaratti, Kadmath, Chetlat, Agatti, and Minicoy were engaged. The investigation evaluated the potential of the pristine marine environment as a model for developing resilient mariculture technologies and sustainable fisheries management practices. The study revealed that the region is suitable for culturing high-value species such as cobia, pompano, seabass, seaweeds, pearl oysters, mussels, and ornamental fishes, offering avenues for income diversification and reduced pressure on wild stocks. Emerging avenues like seaweed farming and cage-based ecotourism have shown promising results in multi-location trials across the islands. The ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), its Krishi Vigyan Kendra (KVK) in Kavaratti, and the Department of Fisheries jointly implemented these development interventions. Under this initiative, over 125 fishers, Self-Help Group (SHG) members, and other stakeholders actively participated in seaweed farming. Multi-location seaweed culture trials indicated that cultivation is feasible in select islands. Notably, 30 HDPE rafts were established in Kadmat as a seed bank, currently holding about 800 kg of *Gracilaria edulis* for use as seed material. Successful seaweed culture interventions in Kiltan, Chetlat, and Bitra islands have been previously documented. Building on these achievements, the Government of India has designated Lakshadweep as a Seaweed Cluster. Additionally, a modern ornamental fish hatchery with a capacity of 24,000 larvae per cycle is being established in Kavaratti, with 50 local fishers already trained. Sea cage farming of pompano and lobster has also been introduced and successfully integrated with eco-tourism. Key challenges identified include the need to modernise post-harvest practices, expand processing infrastructure, and strengthen marketing channels. The study recommends strategic branding, promotion, and digital marketing to enhance Lakshadweep's seafood industry. These insights offer actionable pathways to improve livelihoods in fisheries and mariculture, aligning with the broader blue economy agenda.

Keywords

Blue economy, Coastal aquaculture, Marine resource management, Policy interventions, Sustainable fisheries



Year-round induced spawning of giant trevally *Caranx ignobilis* in captivity

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The giant trevally *Caranx ignobilis* is a high potential mariculture species due to good market demand, faster growth and remarkable tolerance to a wide range of salinities. It is the largest species of the genus *Caranx*, reaching a maximum size of 1.7 m and 80 kg. Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) has achieved success in broodstock development, induced breeding and larval rearing of *C. ignobilis* for the first time in India. This study provides a detailed account of the successful year-round induced spawning of *C. ignobilis* under tropical hatchery conditions. Juveniles [total length (TL) - 11 to 18 cm; body weight (BW) - 12 to 58 g] were collected from Ashtamudi, Kollam, and stocked in open-water floating GI cages. The fish were fed with pellets and small trash fishes. When fish grew to sub-adult size, all the fish were tagged for individual monitoring. Gonadal maturation was assessed at regular intervals through biopsy of the broodfish, (TL 46.5 - 56 cm; BW 1.7 to 2.8 kg). Once the oocyte size reached 300 to 320 μ m, broodstocks (female: male 1: 2) were transported to the spawning facility and transferred to the recirculatory aquaculture system (RAS) of 10 t capacity. In the RAS tanks, broodstock was maintained under optimal water quality conditions (salinity 30-34 ppt; pH 7.9 $\pm$ 0.3, temperature 28 $\pm$ 1 $^{\circ}$ C, dissolved oxygen 5.8 $\pm$ 1.2 mg l $^{-1}$ and total ammonia-N<0.02 ppm. Spawning was induced in both female and male broodfish using a commercial-grade GnRH analogue. Spawning occurred 24 to 36 h after the hormone induction. In a period of one year a total of 23 spawnings were obtained from three sets of broodfish. The fecundity observed was 3.6 $\pm$ 1.45 lakhs per female with a fertilization rate of 79.6 $\pm$ 17.9%. Although year-round spawning were obtained for *C. ignobilis*, the peak spawning success was observed from February-May. The study confirms the feasibility of year-round induced spawning of *C. ignobilis* under hatchery conditions. Year-round spawning and successful larval rearing of *C. ignobilis* in captivity ensures continuous supply of seeds for farming and popularisation of the species as an ideal candidate for coastal mariculture in Indian waters

Keywords

Coastal mariculture, Fecundity, High-value finfish, Induced breeding, Larval rearing



Sustainable seed production of Indian pompano *Trachinotus mookalee*: An integrated approach

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The Indian pompano (*Trachinotus mookalee*), a high-value marine finfish, holds strong potential for commercial mariculture in tropical and subtropical regions. To meet rising demand and ensure consistent seed availability, this study proposes an integrated approach to sustainable seed production. Key components of the breeding cycle were optimised, including broodstock management in variable-capacity holding systems equipped with either recirculating aquaculture systems (RAS) or flow-through setups, tailored nutritional protocols using mixed seafood diets, and hormonal induction using human chorionic gonadotropin (hCG) and gonadotropin-releasing hormone analogues (GnRHa), delivered through both injection and implantation. Among the methods tested, GnRHa implantation, when combined with controlled environmental parameters, adequately sized broodstock holding systems, and a diet comprising squid, clam, and crab, resulted in the highest spawning success. Larval rearing strategies incorporated DHA-rich live feed transitions, early weaning onto artificial diets, and the exclusion of *Artemia* nauplii, which collectively improved survival as well as fry quality. Additionally, the implementation of biosecurity protocols and sustainable system-level practices minimised environmental impact and disease risks. This multi-faceted, eco-efficient protocol provides a reliable model for year-round seed production of Indian pompano and supports the long-term sustainability of marine aquaculture.

Keywords

Artificial diets, Breeding, Larval rearing, Spawning success, Sustainability



Pond culture of hilsa aimed at conserving and sustaining its fishery

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Clupeids are among the most preferred food fishes, with hilsa being a key representative of this group. Mature hilsa are rich in lipids (around 10%) and contain ω -3 and other polyunsaturated fatty acids (PUFAs). Hilsa fisheries have traditionally been vital in estuarine and coastal regions due to their high economic value. However, except for occasional bumper catches, the fishery has shown a declining trend in India, from 44,011 t in 2017 to 37,000 t in 2020-21. Recognising this concern, researchers from ICAR fisheries Research Institutes have launched a comprehensive project aimed at hilsa domestication. With the leads obtained, the second phase of the project (2020–2023) focused on captive culture, gonadal maturation, and breeding potential of hilsa. The participating institutes included ICAR-CIFRI, ICAR-CIBA, ICAR-CIFA and ICAR-CIFE. Ready-to-breed hilsa were collected from the Gadakhali stretch of the Hooghly River to develop captive broodstock. Fertilization was achieved through dry stripping, and the fertilized eggs were transported to the hatchery for incubation and post-larval rearing. The early larval stages were maintained in freshwater and gradually reared to fry and fingerlings. Grow-out culture was carried out at three locations: a fully freshwater system at Rahara (ICAR-CIFA), a low-salinity system at Kolaghat (1.2 ppt during summer), and brackishwater systems at Kakdwip (ICAR-CIBA). Stocking density was maintained at 2,000 nos. ha⁻¹, with adequate phytoplankton and zooplankton levels. Feeding was done using specially formulated feeds developed by ICAR-CIBA and ICAR-CIFA. Being a slow-growing species, hilsa reaches 150–200 g in the first year and up to 500 g in 1.5-2 years, consistent with the growth patterns observed in the present culture trials. At the Kolaghat site, the maximum size recorded was 689 g and 43.6 cm after 36 months of rearing. Gonadal development was monitored through histological sampling, while maturity assessment at Kakdwip was conducted using cannulation and a non-invasive ultrasonic method standardised by ICAR-CIFE. Anaesthetised fish were examined via ultrasonography (USG), then recovered and returned to their respective rearing systems. Breeding trials with mature captive broodstock were attempted; however, after fertilization, development was arrested within 3-4 h. Partial success was also achieved using cryopreserved milt with wild broodstock. These studies confirm that hilsa can be successfully reared in captivity using spawns from wild broodfish. Once captive breeding is achieved, hilsa culture can become viable, supporting stock restoration through ranching and conservation aquaculture while meeting market demand with cultured fish

Keywords

Breeding trials, Captive rearing, Conservation aquaculture, Cryopreserved milt, Hilsa fisheries



Evaluation of hatchery-produced Asian green mussel *Perna viridis* in field conditions and approaches for farming optimisation

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This study evaluated the field performance of hatchery-produced Asian green mussel *Perna viridis* seed in India. Mussel farming in the country that has traditionally relied on wild spat is often constrained by irregular spatfall, disease outbreaks and environmental stressors. To address these limitations, hatchery-reared seed produced by the Vizhinjam Regional Centre of ICAR-CMFRI was subjected to field trials at three sites in Kollam District, Kerala: Ashtamudi (S1), Neendakara (S2) and Vellimon (S3) under varying environmental conditions and stocking densities. The results demonstrated high growth and production potential of hatchery seed, with the trials conducted at Ashtamudi recording a maximum yield of 33.4 kg m⁻¹ at a stocking density of 2,000 seed m⁻¹ and a final shell length of 82.9 mm over 13 months. Lower stocking densities (1,000 m⁻¹) resulted in higher survival rates (up to 77%) compared to higher densities (29–37%). Growth rates at Neendakara (8.7 mm per month) and Vellimon (6.9 mm per month) culture trails were comparable to or exceeded previous records using wild-collected seed. Key factors influencing performance included protective netting, stocking density, water quality especially salinity and chlorophyll-a and site-specific management practices. The findings validate the feasibility of hatchery seed for year-round mussel farming and underscore the importance of predator control and density optimisation. These advancements support the sustainable scaling of mussel aquaculture in India, contributing to the development of blue economy development, rural livelihoods and national food security

Keywords

Field trial, Hatchery seed, Mussel aquaculture, Stocking density, Water quality



Comparative performance of *Penaeus indicus* in indoor and outdoor culture systems: Insights from heterotrophic, clear water and recirculatory aquaculture setups

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A growth trial was conducted to evaluate the performance of *Penaeus indicus* in indoor and outdoor rearing systems under three culture conditions: (i) microalgal and heterotrophic floc-based units, (ii) clear water systems, and (iii) a recirculatory aquaculture system (RAS) incorporating sand-based *in situ* biofiltration, with no water exchange throughout the trial. Post-larvae (PL12) of *P. indicus* were stocked at a density of 175 individuals m⁻³ and reared for 8 weeks. In outdoor systems, the highest average body weight (ABW) was obtained in heterotrophic units (1.53 g), followed by clear water (1.33 g) and sand-based RAS (1.00 g). Survival in outdoor systems was relatively high and uniform (72.9–74.3%), whereas indoor units exhibited lower and more variable survival, with clear water recording the highest (69.0%) and RAS the lowest (48.8%). Indoor units maintained slightly lower water temperatures (27–28 °C) compared to outdoor systems (28–29 °C). Light intensity was much lower in indoor systems (641 lux at noon, 102 lux at dawn, 36 lux at dusk) compared to outdoor units, which showed strong dawn–dusk variations (15,000 lux at noon, 300 lux at dawn, 100 lux at dusk). Water quality analysis revealed alkalinity levels of 140–160 ppm across systems, while both alkalinity and hardness were relatively lower (120–130 ppm) in RAS units. Microbiological analysis showed that heterotrophic floc-based systems supported the highest microbial proliferation (THB: 9.83 × 10² cfu ml⁻¹; TVC: 3.17 × 10² cfu ml⁻¹), particularly outdoors, whereas RAS maintained the lowest bacterial load (TVC: 0–0.17 × 10² cfu ml⁻¹; THB: 1.5–2.83 × 10² cfu ml⁻¹). Although RAS minimised water use, growth performance was compromised due to limited nutrient enrichment, as the same water was recycled throughout the trial. In contrast, outdoor heterotrophic systems supported superior growth performance, while clear water systems were more favourable for indoor conditions. Overall, the study underscores the importance of optimising nutrient dynamics in RAS and harnessing the high productivity of heterotrophic systems for enhancing the growth of Indian white shrimp, supporting the development of system-specific aquaculture strategies

Keywords

Sand-based *in situ* biofiltration, Microalgae, Microbial floc, Minerals, RAS, Water



Investigation of oocyte hydration as a reproductive indicator in captive broodstock of black seabream *Acanthopagrus berda* (Forsskal, 1775)

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This study investigates the morphological characteristics, temporal dynamics, and environmental associations of hydrated oocytes in a marine teleost species, with implications for reproductive timing and induced spawning success. Ovarian biopsy samples from wild populations (Karwar and Calicut) and captive broodstock revealed the presence of hydrated oocytes under both natural and captive conditions. Mature oocytes increased in diameter from 450–475 μm to 650–790 μm upon hydration. Hydrated oocytes exhibited a smooth zona radiata with distantly spaced pits and prominent surface folds, but underwent progressive degeneration, forming folded debris. The degenerated oocyte membranes showed an average thickness of $1.95 \pm 0.062 \mu\text{m}$, and ultrastructural analyses suggested cytoplasmic discharge through ruptured membranes. Temporal analysis of hydrated oocyte prevalence indicated peak reproductive activity between December and February. From August to November, ~70–75% of females lacked hydrated oocytes, while in February, the proportion of fish with numerous hydrated oocytes increased markedly (~0.35). Statistical analysis showed a significant monthly variation in the "Numerous" category (Kruskal-Wallis $\chi^2 = 14.40$, $p = 0.0445$). Hydrated oocyte presence was positively correlated with rising sea surface temperatures, particularly above 28.5°C. The highest abundance of numerous hydrated oocytes occurred in February and March, when temperatures reached 30.5°C. Lunar periodicity also influenced reproductive readiness. The Full Moon phase was associated with the highest proportion of fish containing numerous hydrated oocytes (mean ratio = 0.35), while the First Quarter showed the lowest (mean ratio = 0.70 in "Nil" category). Although statistical tests were not significant ($p > 0.05$), patterns strongly suggested synchronisation of spawning with lunar cycles. Induced spawning success aligned with these reproductive trends, peaking in December (0.55) and February (0.45), closely matching periods of high oocyte hydration. These findings emphasise the importance of environmental and lunar cues in regulating reproduction and optimising spawning induction in this species

Keywords

Lunar phase, Reproductive cycle, Spawning induction. Temperature, Ultrastructure



Mitigating nitrogen release from lobster sea cage farming through integrated seaweed cultivation

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Mariculture is a rapidly growing sector significantly contributing to the global seafood production while reducing pressure on wild fish stocks. The open sea farming has immense potential, but it also heightens the risk of nutrient runoffs that accelerate eutrophication and threatening marine ecosystems. The state of Gujarat having the longest coastline India has great potential for sea cage farming particularly for shellfish culture. In this context, our study focused on the cultivation of spiny lobster *Panulirus polyphagus*, along the Saurashtra coast, where 12,557.74 km² (52%) of the coastal area has been identified as suitable for sea cage farming. The present study was conducted with the objective of quantifying nitrogen release during lobster cage culture operations. From the experiments conducted, a standardised stocking density of 24 m⁻² individuals per cage was found optimal for lobster culture. The preconditioned lobsters were reared in galvanised iron (GI) cages with dimensions of 4 m in diameter and 2.5 m in depth, providing a surface area of 12.56 m². The lobsters were segregated into four different treatment groups according to their size, comprising T1 (60-80 g), T2 (81-100 g), T3 (101-120 g) and T4 (121-140 g). The experimental duration was 120 days. A survival rate of 80% was recorded, the specific growth rate of lobster varied from 0.43 to 0.92% per day. The lobsters in the size range of 60-100 g were found to be the ideal stocking size for open sea cage culture to attain maximum growth and survival. The nitrogen concentration in the body of stocked lobster was estimated before stocking and the subsequent nitrogen accumulation was estimated by collecting samples throughout the culture period. The lobsters were fed with fresh trash fish at 8 % body weight. Total release of nitrogen into the environment was estimated at approximately 80 kg of nitrogen during the experimental period. This nitrogen release into open waters can be effectively utilized by cultivating the seaweed *Kappaphycus alvarezii* up to a biomass yield of about 125 t. The study underscores the potential of seaweed farming as a sustainable approach to mitigate the environmental impacts of nutrient run-off from cage culture on marine ecosystems

Keywords

Cage culture, Eutrophication, Nutrient run-off, Spiny lobster aquaculture, Sustainable mariculture



Geospatial intelligence for spatial expansion of sustainable seaweed farming in Indian waters: A framework for the future

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Seaweed farming presents a transformative opportunity for enhancing coastal livelihoods, supporting marine biodiversity and advancing India's blue economy. Despite its potential, the sector lacks structured and evidence-based spatial strategies for sustainable expansion. This study proposes a geospatial framework that integrates remote sensing (RS), GIS, image processing and ground validation to identify and monitor potential seaweed farming zones. As a case study, natural seaweed beds along the northwest coast of India, specifically coastal villages of Gujarat and Maharashtra were assessed using satellite time-series analysis and field-based observations. Three vegetation indices NDVI, Floating Algae Index (FAI), and Seaweed Enhancing Index (SEI) were applied to five years of Landsat-8 data to detect changes in seaweed cover and abundance. Among these, SEI proved most effective in accurately delineating seaweed-rich zones. Rigorous field validation through grid-based biomass estimation and site-level surveys confirmed strong correlations between index values and actual seaweed presence, with Gujarat exhibiting the highest biomass density. The study establishes a standardised, scalable framework for remote sensing-based monitoring of seaweed habitats and offers pathways for expansion planning across diverse Indian coastal regions. It further highlights the potential of integrating advanced tools such as AI/ML models, high-resolution UAV imagery, and ecological forecasting to enhance predictive capacity. These innovations are critical for tracking long-term habitat shifts, informing mariculture zoning and adapting to climate change. This approach provides a science-based decision-support system for policymakers to promote sustainable seaweed farming, protect marine ecosystems and strengthen climate resilience in coastal India

Keywords

Blue economy, GIS, Remote sensing, Seaweed farming, Spatial planning



Induced maturation in Indian white shrimp *Penaeus indicus* through hormonal administration

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The study investigated the role of sex steroids on gonadal maturation, moulting, mating, and spawning in the Indian white shrimp *Penaeus indicus*. Captive-reared broodstock (males: 22.15 ± 2.15 g; females: 25.6 ± 4.06 g) were subjected to induced maturation through hormone administration following eyestalk ablation. Three treatments were tested: T1 (17β -estradiol + 17α -hydroxyprogesterone), T2 (17β -estradiol), and T3 (control: ablation only). Hormone administration ($1 \mu\text{g g}^{-1}$ body weight) was initiated on the fourth day after ablation, with booster doses on days 7 and 26. Brooders were stocked at 5 ind. m^{-3} and maintained in indoor maturation units for 42 days, fed a maturation diet of fresh krill, squid, and formulated pellets at 25% body weight. In T1, 85% of brooders showed onset of gonad development by day 2 and 100% by day 9, whereas T3 exhibited minimal progression. The combined treatment (T1) yielded the highest spawning success (42.9%), while sole administration of 17β -estradiol (T2) was less effective. Mating success declined from 100% to 28%, negatively associated with a rise in female moulting from 0 to 50%. Results indicate that 17β -estradiol combined with 17α -hydroxyprogesterone is more effective in enhancing final oocyte maturation and ovulation than estradiol alone. However, eyestalk ablation increased moulting frequency, which compromised mating success during induced maturation. Overall, the study highlights the potential of sex steroid manipulation to improve reproductive performance in *P. indicus* and underscores the need for developing non-invasive alternatives to eyestalk ablation for sustainable broodstock management

Keywords

Broodstock management, Gonad development, Indian white shrimp, Reproductive performance



Ontogenic expression pattern of key immune genes (tnf-a il-10, ifn-y, and tlr-21) in *Trachinotus blochii* larvae

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The larval stages of marine fish are critical periods for the establishment of immune competence, and high mortality during these phases in aquaculture highlights the need to understand immune system maturation. Identifying critical immune ontogeny can guide larval rearing protocols, feeding strategies, and prophylactic interventions, ultimately improving larval survival and disease resistance in hatchery systems. The silver pompano (*Trachinotus blochii*), a fast-growing and commercially valuable species, has limited molecular information on larval immunology. This study characterised the expression profiles of four key immune genes, viz. tumor necrosis factor-alpha (*tbtnf-a1*), interleukin-10 (*tbil-10*), interferon-gamma (*tbifn-y*), and toll-like receptor 21 (*tbtlr-21*) across defined developmental stages [eggs, and 5, 7, 16, 21 and 25 days post-hatching (dph)]. Additionally, expression of these genes between fertilized and unfertilized eggs were compared. Samples were collected from the national brood bank facility of silver pompano in ICAR-CMFRI, Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) preserved in TRIzol at -80°C, and processed for RNA extraction, cDNA synthesis, and quantitative real-time PCR using β -actin as the housekeeping control for normalisation. Distinct stage-specific expression patterns were observed. *tbtnf-a1* showed an early upregulation (eggs to 5 dph), a decline at 7 dph, and resurgence at later stages (16 to 25 dph). The *tbifn-y* peaked at 5 dph but was undetectable thereafter. The *tbil-10* expression progressively increased with ontogeny, except for a transient decline during metamorphosis (21 dph). The *tbil-10* expression regained back after the metamorphosis (25 dph), reflecting the establishment of regulatory mechanisms to maintain immune balance. The *tbtlr-21* expression peaked at the onset of exogenous feeding (5 dph) and then remained at significantly ($p > 0.05$) similar level. Notably, fertilized eggs exhibited significantly higher expression of *tbtnf-a1* (7-fold), *tbil-10* (6-fold), and *tbtlr-21* (6-fold) compared to unfertilized eggs, whereas the expression of *tbifn-y* was low in the fertilized eggs. These findings suggest that immune competence in *T. blochii* develops through a coordinated sequence of pro-inflammatory activation, microbial recognition, and subsequent regulatory control. The study provides the first molecular insights into immune gene ontogeny in *T. blochii*, offering a foundation for improving larval health management in aquaculture

Keywords

Ontogenic progression, qPCR analysis, Relative quantification, Silver pompano

Evaluating the potential of superworms (*Zophobas morio*) as a sustainable aquafeed ingredient: plastic degradation capability, proximate composition and implications for marine ecosystem health

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Plastic pollution is a mounting global concern with serious implications for marine ecosystems, biodiversity, and food security. Innovative biological solutions are urgently needed to mitigate plastic waste while supporting sustainable food systems. This study investigates the potential of superworms (*Zophobas morio*) as dual-function agents for plastic biodegradation and sustainable aquafeed production. Over a 35-day period, the capacity of *Z. morio* larvae to consume polystyrene (PS) and polyethylene (PE) was evaluated, with cabbage-fed larvae serving as a control. Key parameters assessed included larval growth, survival, plastic consumption rates, proximate composition, and fatty acid profiles. Larvae exhibited higher PS consumption compared to PE, although cabbage-fed controls achieved greater growth and survival rates. Remarkably, PS- and PE-fed larvae demonstrated significantly elevated crude protein (51.35 ± 0.006 and 53.64 ± 0.13 , respectively) and lipid content (26.53 ± 0.16 and 25.12 ± 0.03 , respectively) relative to cabbage-fed larvae (46.21 ± 0.12 and 23.83 ± 0.11), indicating enhanced nutrient density despite lower biomass yield. Essential fatty acid profiles remained consistent across all treatments, underscoring the nutritional stability of the larvae. Feeding trials with ornamental fish confirmed the palatability and nutritional adequacy of *Z. morio* biomass, supporting its viability as an alternative protein source in aquafeeds. These findings highlight the promise of *Z. morio* as a sustainable solution for reducing plastic pollution and advancing circular feed systems, with potential benefits for marine ecosystem health and resilient aquaculture development

Keywords

Bioconversion, Circular economy, Plastic pollution, Sustainability, Waste management



Characterization of *Trachinotus Blochii* (Lacepede, 1801) *mstnb* gene and construction of cognate CRISPR-Cas9 guide RNA expression vectors

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Skeletal muscle development is negatively regulated by myostatin b (*mstnb*) gene in finfishes. CRISPR-Cas9-mediated knockout of *mstnb* gene has been used to develop fish strains with increased muscle mass. *Trachinotus blochii* (silver pompano) is a high-value marine finfish of moderate size (~500 g) with strong aquaculture potential. Its suitability for culture and market demand make it a promising candidate for *mstnb* gene knockout using CRISPR/Cas9 gene editing to develop an improved, fleshy strain. Currently, a limited number of studies are available on the characterisation of *T. blochii* *mstnb* gene, and there is also a lack of CRISPR/Cas9-mediated *mstnb* knockout studies in *T. blochii*. The present study aimed to partially characterise the *mstnb* gene of *T. blochii* and develop CRISPR/Cas9-based guide RNA (gRNA) expression vectors to knockout its *mstnb* gene. The *T. blochii* *mstnb* sequence available in NCBI was used as a reference to design exon and intron-specific primers for PCR amplification and further sequencing. The obtained sequence was used to characterise the gene and to design two gRNAs targeting exon 1 using CRISPR metrics and clone into pT7-gRNA (Addgene #46759) and pSpCas9(BB)-2A-GFP (PX458) (Addgene #48138) gRNA expression vectors. The partially characterised *T. blochii* *mstnb* gene comprised three exons and two introns. Sequence analysis from multiple fish samples detected a few novel putative polymorphisms such as SNPs and a (CA)_n microsatellite. Predicted open reading frame of 1131 bp encodes a protein of 376 amino acids with conserved domains typical of the TGF- β family, which includes an N-terminal signal peptide, a propeptide region, a conserved RARR cleavage motif, and a C-terminal GF domain containing nine conserved cysteine residues. The secondary and 3D structure predictions confirmed the functional integrity of the protein. Phylogenetic analysis based on the *mstnb* sequence clustered *T. blochii* with closely related *Trachinotus* species and with other carangiformes species. The gRNA expression vectors constructed here were verified through restriction digestion and sequencing to confirm the presence of gRNA coding inserts. The novel sequence information generated in the present study adds to the available literature and can serve as a base for future studies to characterise a larger population to identify possible genetic markers. The gRNA expression vectors developed in the study will be useful for the development of CRISPR/Cas9-mediated *mstnb* knockout silver pompano to study *mstnb* function in this fish and to develop a silver pompano strain with increased muscle mass

Keywords

Expression vectors, Gene characterisation, Gene knockout, gRNA, Silver pompano



Development and characterisation of chitosan-silver nanoparticles for bioactive applications

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The growing challenge of antimicrobial resistance in aquaculture has intensified the need for sustainable alternatives to conventional antibiotics. In this study, chitosan-silver nanoparticles (Ch-AgNPs) were synthesized using 1% (w/v) chitosan and 0.1 M silver nitrate. Characterization through UV-Visible spectroscopy, particle size analysis, zeta potential measurements, X-ray diffraction, thermogravimetric analysis, and Fourier-transform infrared spectroscopy confirmed the successful formation, stability, and functional integrity of Ch-AgNPs. Antimicrobial potential was tested against *Vibrio harveyi*, *Vibrio alginolyticus*, and *Escherichia coli* using zone of inhibition, minimum inhibitory concentration, and minimum bactericidal concentration assays. The results revealed strong antimicrobial activity, with *Vibrio* species exhibiting greater sensitivity compared to *E. coli*. Beyond their antibacterial and antifungal effects, Ch-AgNPs also showed marked antibiofilm activity against *V. alginolyticus*, demonstrated by crystal violet staining, indicating their capacity to inhibit or disrupt biofilm formation. Importantly, the study underscored a synergistic effect between chitosan and silver, resulting in enhanced antimicrobial and antibiofilm efficacy compared to the individual components. These findings highlight the potential of Ch-AgNPs as natural, biocompatible, and effective antimicrobial agents, offering a promising strategy for sustainable disease management in aquaculture.

Keywords

Antibiofilm activity, Antimicrobial activity, Ch-AgNPs, *Escherichia coli*, *Vibrio alginolyticus*, *Vibrio harveyi*, Nanotechnology





Differential expression studies of defense-related protein-encoding genes in the tiger shrimp (*Penaeus monodon*) demonstrate their role in disease resistance

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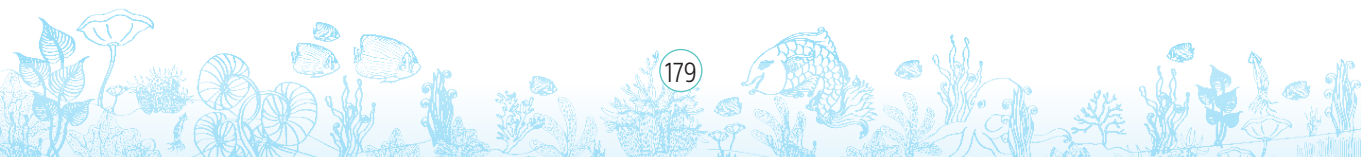
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The global demand for aquacultured shrimp makes it essential for food production and the economy of Asian countries. However, it faces setbacks from disease outbreaks. Traditionally, antibiotics have been used and continue to be majorly applied to control diseases, but their indiscriminate use has led to problems of antimicrobial resistance. Exploring alternative strategies is the need of the hour in aquaculture. A promising solution lies in investigating the role of defense proteins in enhancing the innate immune response of shrimp. The roles of defense proteins such as Akirin and Thrombospondin, along with the stress-response protein Heat shock protein 70 (HSP70), were investigated to gain insights into shrimp immune mechanisms against bacterial and viral pathogens. Akirin, Thrombospondin, and HSP70 encoding genes of the tiger shrimp *Penaeus monodon*, were identified, cloned, and expression analysis was performed. Differential expression of Akirin and Thrombospondin encoding genes was studied in response to immunostimulant administration and infection with *Vibrio harveyi* and white spot syndrome virus (WSSV). Likewise, the expression profile of HSP70 of *P. monodon* was studied in response to WSSV infection. Expression profiling demonstrated that defense proteins exhibit pathogen and tissue-dependent regulation. Akirin was consistently expressed in shrimp tissues, and significant upregulation was observed following *V. harveyi* and WSSV infection. Thrombospondin expression was most prominent in the gills and lymphoid organ following bacterial challenge. HSP70 expression was upregulated in response to WSSV infection in *P. monodon*. The study provides insights into how immunostimulation and pathogen challenge influence the transcriptional dynamics of defense-related proteins in shrimp, which can be used as an alternate strategy in shrimp aquaculture with the possibility of reducing antibiotic use

Keywords

Akirin, Defense proteins, HSP70, Immunostimulant, Shrimp farming, Thrombospondin



Molecular regulatory mechanisms of gonad inhibiting hormone (GIH) in ovarian maturation of *Penaeus indicus*

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Gonad Inhibiting Hormone (GIH), a neuropeptide belonging to the crustacean hyperglycemic hormone (CHH) family, plays a pivotal role in regulating reproduction in crustaceans by suppressing vitellogenesis and gonadal maturation. Understanding the regulatory mechanisms of GIH in penaeid shrimp reproduction has direct implications for broodstock management and improving reproductive efficiency in aquaculture. This study focused on the molecular characterisation, localisation and differential gene expression of GIH in *Penaeus indicus*. Sequence analysis of *P. indicus* GIH (Pi-GIH) revealed a conserved precursor structure, including a signal peptide and mature hormone domain, consistent with other CHH-family members. Phylogenetic analysis confirmed its close evolutionary relationship with known GIHs from other crustacean species. Immunohistochemical localisation studies using specific polyclonal antibody raised against Pi-GIH revealed specific expression in the X-organ and axon terminals of sinus gland in the eyestalk. Circulating levels of GIH were found to be highest during the immature phase of ovarian development. Temporal expression profiling further showed that GIH transcript levels decreased progressively with ovarian maturation. Moreover, significantly lower GIH transcript levels were observed in eyestalk-ablated and hormone-treated shrimp compared to intact controls, reinforcing its inhibitory role in reproduction. Our previous study demonstrated that RNA interference (RNAi) mediated silencing of GIH led to a significant reduction in GIH expression, accompanied by an upregulation of vitellogenin, thereby supporting the hormone's negative regulatory role in vitellogenesis. Preliminary protein–protein interaction studies have identified potential GIH interactors, and initial evidence suggests the presence of a putative GIH receptor in *P. indicus*. The results of the study highlight the central role of GIH in regulating shrimp reproduction. Future strategies combining anti-GIH antibodies, GIH-dsRNA, and receptor antagonists may offer viable alternatives to eyestalk ablation for inducing ovarian maturation in shrimp aquaculture

Keywords

Gene expression, Gonadal maturation, Immunohistochemistry, Penaeid shrimp, Reproduction, Vitellogenesis



Theme 2

Sustainable Fisheries and Mariculture(SFM)

Poster Presentations



Comparing and combining marine fish landings estimates: Challenges and way forward towards achieving composite estimates

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Comparisons of survey-based estimates in marine fisheries revealed new insights and challenges in 2024, particularly when reconciling discrepancies from methodological differences. The first instance involved Maharashtra's marine fish landings, where ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI)'s standard two-stage stratified random sampling (SRS) estimated 3.11 lakh t in 2024, a 47% increase from 2.11 lakh t in 2023. Alternative stratifications, such as district-level subpopulations or gear-specific groupings, produced varying results. For instance, emphasising mechanised crafts, which contributed 81% of landings, inflated estimates in high-intensity zones, while species-based groupings improved precision but added complexity. Such mismatches stemmed largely from differing stratification criteria, affecting effort and CPUE estimates. Post-stratification adjustments and variance decomposition were useful in reconciling these differences. The second instance compared sampling-based estimates with enumeration-derived ones. Enumeration, used by agencies monitoring exports, aimed at complete counting and offered detailed accuracy but was costly and prone to underreporting, as it focused mainly on processed products. In contrast, CMFRI's sampling design provided scalable national-level estimates with 5–20% error margins. Reconciliation was achieved by calibrating sampling results against partial enumeration at major centres. Integrated systems, such as aligning CMFRI with Marine Products Export Development Authority (MPEDA) data or using CMFRI estimates as national standards, reduced duplication and improved accuracy. These comparisons highlighted trade-offs between precision and feasibility, underscoring the need for adaptive designs in India's dynamic fisheries

Keywords

CPUE, Dynamic fisheries, Gear-specific groupings, Marine fish landings, Stratified random sampling



Tropical marine fish stock assessment: Complexity driven integrated modelling alternatives

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Marine fish stock dynamics link individual behaviours with population-level outcomes, making them central to ecological and fisheries research. At the micro scale, individual-based models explore processes like growth, reproduction, and migration, while population models summarise biomass, mortality, and recruitment. In data-limited situations, flexible modelling approaches are essential, whereas data-rich fisheries allow integrated frameworks. Biomass dynamic models, such as the Schaefer surplus production model, remain widely used. They treat stocks as single biomass units, estimating Maximum Sustainable Yield (MSY) and carrying capacity from catch and effort data. Catch-effort approaches use catch per unit effort (CPUE) as an abundance index, though results may be biased under hyperstability or unreported catches. Integrated frameworks like Stock Synthesis (SS) provide greater realism by incorporating age, length, and survey data, though they demand more computation. Optimisation tools such as Automatic Differentiation Model Builder (ADMB) and Template Model Builder (TMB) enhance efficiency, with TMB offering faster execution and stronger integration with R. Bayesian approaches further improve assessments by incorporating prior knowledge, though they require reparameterisation to speed up inference and improve convergence. Hybrid Bayesian models that combine individual-based growth processes with biomass dynamics offer a promising way to bridge biological realism and management goals, strengthening predictions under environmental variability.

Keywords

Bayesian approach, CPUE, MSY, Stock synthesis, Surplus production models



Evolving dynamics, implications and sustainable management of purse seine fisheries along the Karnataka coast

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Purse seine fisheries have profoundly transformed the marine fisheries sector along the Karnataka coast since their introduction in the late 1970s. Initially targeting small pelagic species such as oil sardine and Indian mackerel, the fishery gradually expanded in scale and geographic range. Over time, operations ventured into deeper waters, employing large-meshed nets (*kotibale*) to harvest large pelagics, and later adopted light fishing, a practice officially prohibited in 2016. Purse seine landings along the Karnataka coast from 1991 to 2024, ranging from 40,302 t in 1991 to 195,056 t in 2017, averaging 87,712 t annually. Their contribution to the total marine fish landings varied between 8.0% (2019) and 52.8% (1991) with decadal average of 38.8% (1991–2000), 30.4% (2001–2010), 22.3% (2011–2020), and 24.2% (2021–2024). Although their overall contribution has declined, gear productivity has increased substantially with technological advancements, as reflected in the rise of catch per unit effort (CPUE) from 1,449 kg unit⁻¹ in 1991–2000 to 1,644 kg unit⁻¹ in 2001–2010, 2,589 kg unit⁻¹ in 2011–2020, and 4,492 kg unit⁻¹ in 2021–2024. Across the study period, more than 70% of purse seine landings were consistently contributed by only three to four dominant species. During 1991–2000, the catch composition was led by mackerel (39.8%), followed by oil sardine (15.2%), scads (9.0%), and anchovies (8.2%). In 2001–2010, oil sardine became the predominant species (54.8%), with mackerel (23.5%), horse mackerel (3.8%), and other sardines (3.4%) forming the rest of the major share. The 2011–2020 period was dominated by oil sardine (42.1%) and mackerel (27.7%), along with other sardines (7.7%) and *Euthynnus affinis* (4.9%). In recent years (2021–2024), mackerel (35.4%), oil sardine (20.7%), scads (14.4%), and *Euthynnus affinis* (8.1%) have emerged as the principal contributors. Technological advancements have increased engine capacities from about 40 hp in the initial phase to over 350 hp in modern purse seines, enabling more efficient operations in deeper waters. The use of large-meshed, fast-sinking nets beyond 60 m depth has also helped reduce pressure on traditional fishing grounds. However, the continued use of light fishing, despite regulatory restrictions, targets long-lived species and disrupts spawning behaviour, raising concerns about recruitment overfishing, stock depletion, and user conflicts. This study highlights the evolving dynamics of purse seine fisheries and emphasises the urgent need for adaptive, science-based management to ensure sustainable marine resources and secure coastal livelihoods.

Keywords

Kotibale, Light fishing, Recruitment overfishing, Small pelagics, Sustainable management

Stock assessment of skipjack tuna (*Katsuwonus pelamis*) off Andhra Pradesh, India, using the Stock Assessment Continuum Tool

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Tuna fisheries contribute approximately 5% to the total marine fish landings in Andhra Pradesh, with skipjack tuna (*Katsuwonus pelamis*) constituting a significant portion, estimated at 20% of the state's total tuna catch. The species is primarily harvested using hook and line and gillnet operations along the coast. Despite its economic and ecological importance, the stock status of skipjack tuna in this region remains poorly defined, necessitating a robust assessment to inform sustainable management. This study employed the Stock Assessment Continuum (SAC) Tool to conduct the first integrated stock assessment for skipjack tuna in Andhra Pradesh. Moving beyond traditional length-based methods, the SAC framework within Stock Synthesis (SS) allows for the integration of multiple data types, including historical catch, life history parameters, and length composition data. This integrated approach is considered a global benchmark, as it leverages all available information to produce more reliable and defensible estimates of stock status. The model will be configured to reflect the regional fishery characteristics and available data. Key outputs will include estimates of spawning stock biomass, fishing mortality, and biological reference points. The results of this assessment are critical for evaluating the sustainability of current harvest levels and will provide a scientific basis for developing effective management strategies for the skipjack tuna fishery in the Northwestern Bay of Bengal, ensuring its long-term viability. This could be first step towards use of integrated assessment of fisheries resources in the region

Keywords

Data-limited fisheries, Integrated stock assessment, Northwestern Bay of Bengal, Sustainable harvest levels



Impact of minimum legal size (MLS) enforcement in marine fisheries of Kerala: A bioeconomic perspective

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The biological and economic impact of Minimum Legal Size (MLS) enforcement in the fishery along the coast of Kerala were assessed based on the data collected from major fish landing centres of Kerala during pre-MLS implementation period as well as post-MLS implementation period. The incidence of juvenile landings was higher along north and central Kerala region and lower along the southern Kerala coast. In the present study, the size-based indices like, mean Size of the fish in the fish landings, seasonal and annual changes in juvenile composition and stock indicators such as standing stock and spawning stock biomass besides the price structure in the landings of selected species, formed the basis to assess the impact of MLS implementation. The size composition analysis indicated significant decline in the juvenile component of 20% of the species studied and marginal improvement was observed in 37.1% of the species. No impact was noticed in 40% of the species and situation worsened in 3%. The annual mean length of the major species which contributed to growth overfishing has been also increased during 2017-2022 period compared to that of the preceding years. In order to examine the impact of MLS regulations on selected fish stocks, the changes in the stock status of the threadfin bream *Nemipterus randalli* was studied using length-based stock assessment methods, since it formed a major species targeted. It is one of the major species monitored for growth overfishing by mechanised trawlers and often penalised by the enforcement authorities for landing juveniles. The results indicated that, the spawning stock biomass of *N. randalli* increased by 30% and the standing stock biomass by 27%, during post-MLS implementation period compared to that of Pre-MLS implementation period. The recruitment numbers in the fishery improved by 64% and the total yield increased by 41%. The annual discounted economic loss due to juvenile fishing of some of the major species along the coast of Kerala, estimated using the bio-economic model developed, indicated substantial decrease in the same during the post-implementation period. The estimated economic loss incurred due to juvenile fishing of threadfin breams during 2017 was ₹221 crores, which decreased to ₹85 crores in 2018. There was significant decrease in the estimated economic loss due to juvenile fishing of other major targeted resources namely lizardfishes, groupers and squids in 2018 compared to that of the preceding years. There was also an increase in unit value realisation and increased profitability for the mechanised trawlers during the post-implementation period due to the reduction in the landings of low value juvenile fishes. Considering the positive biological as well as economic impact of MLS enforcement in Kerala, the MLS regulation can be one of the effective output control measures to prevent growth overfishing thereby sustaining the fishery of important marine fish resources along the region

Keywords

Growth overfishing, Kerala marine fisheries, Minimum legal size, Output control.



Fishery, exploitation patterns and utilisation of *Chicoreus ramosus* in the Gulf of Mannar, Southeast coast of India

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In the Gulf of Mannar, *Chicoreus ramosus* (Linnaeus, 1758) is a commercially important gastropod exploited primarily through gillnets and skin diving, with only a meagre quantity obtained from trawl. Annual landings from 2013 to 2023 showed substantial interannual variability. Gillnet catches increased from 83 t in 2013 to a peak of 302 t in 2021, before declining to 221 t in 2023. Skin diving catches initially decreased, but rose sharply after 2018, reaching a record 624 t in 2020, and then decreased to 184 t in 2023. Over the study period, skin diving contributed 56% of the total *C. ramosus* catch, while gillnets accounted for 44%. Within gastropod landings, *C. ramosus* comprised 61% by skin diving and 43% by gillnet. Overall, *C. ramosus* represented 26% of the total gastropod landings in the Gulf of Mannar. Monthly catch patterns indicated maximum landings from September to February, with peaks in November and December, coinciding with the highest catch rates. Skin diving recorded the highest catch rates (22.1 kg unit⁻¹ and 4.5 kg per person), followed by outboard gillnets (7.8 kg unit⁻¹). Size range in skin diving catches were 55–245 mm (mean: 174 mm) in shell length and 60–1600 g (mean: 684 g) in weight, while gillnet catches ranged from 75–243 mm (mean: 176 mm) and 65–1690 g (mean: 693 g). Length frequency analysis showed that 82% of the catch fell within the 150–205 mm size group, with the 171–185 mm group being most dominant (29%). In the Gulf of Mannar, the shells of *C. ramosus* are primarily used in handicraft production, while the meat is exported to international markets

Keywords

Chank, Catch rate, Gastropod, Gillnet, Handicraft production, Skin diving



Age validation of *Sepioteuthis lessoniana* using statolith

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Age estimation is essential for understanding the growth rates, longevity, and reproductive cycles, which are critical for assessing population dynamics and evaluating stock health for setting effective fisheries management limits. Hard-part ageing revealed *Sepioteuthis lessoniana* (lineage B) in the Gulf of Mannar (GOM) has a potential lifespan of up to seven months, based on the statolith increment counts. The present study aimed to validate the deposition of growth increments in the statoliths of *S. lessoniana* from the GOM, located along the southeast coast of India. Hatchery-reared individuals were cultured under controlled conditions, with a total of 162 squids monitored from hatching up to 100 days of age. Statoliths were extracted and examined to count the growth increments. A strong linear relationship ($R^2 = 0.998$) was observed between the number of statolith increments and the known age in days, supporting the hypothesis of "one increment = one day." Increment counts in 71% of individuals precisely matched their actual age, while 29% exhibited overestimations of 1–6 days, likely due to stress or environmental conditions during rearing. This study confirms the accuracy of daily increment deposition in statoliths of *S. lessoniana* and establishes statolith microstructure analysis as a dependable method for age estimation. It represents the first age validation study for *S. lessoniana* (lineage B) from the GOM and significantly contributes to cephalopod ageing research in Indian waters. These findings highlight the reliability of statoliths as accurate age markers, providing valuable understanding into the age and growth of squid populations

Keywords

Growth increments, Gulf of Mannar, Linear relationship, Microstructure analysis, Overestimation



Integrated analysis of length-weight relationship, condition factor, morphometrics, fecundity and molecular identification of the portunid crab *Monomia argentata* (A Milne-Edwards, 1861) from trawl landings off the southwest coast of India

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Monomia argentata, a portunid crab species, is distributed along the Indian coastline and in recent years, has been regularly recorded in the bycatch landings at major fish landing centres in Kerala. The species is primarily fished from the 60–80 m depth zone. Despite a few taxonomic studies, its biology remains largely undocumented. The present study provides insights into several biological parameters based on samples collected between 2022 and 2025. The allometric growth parameter 'b' for the carapace width (CW)–total weight (TW) relationship was estimated at 2.938 for males (17–45 mm CW), 2.601 for females (16–37 mm CW), and 2.653 for pooled sexes. For the carapace length (CL)–TW relationship, the b values were 2.930 in males (11–27 mm CL), 2.826 in females (11–23 mm CL), and 2.791 in the pooled sample. Growth in males tended toward isometric patterns for both CW–TW and CL–TW relationships, whereas females and pooled samples showed considerable deviation from isometric growth. Analysis of covariance revealed a statistically significant difference between sexes ($p \leq 0.01$). Morphometric relationships were also analysed: in males, between CW and CL and chelar propodus length (CPL) and height (CPH); in females, between CW and CL and abdominal width (AW) and length (AL). These allometric relationships were predominantly positive and highly significant ($p \leq 0.01$). The study analysed a total of 827 crabs (347 males and 480 females). The condition factor (K) values estimated in males and females (based on CW) were 1.2975 ± 0.3302 and 1.1874 ± 0.346 , respectively, and the estimated K values based on CL were 1.1077 ± 0.2891 and 1.088 ± 0.379 , respectively. Fecundity was assessed in 70 ovigerous females (25–38 mm CW), with egg counts ranging between 60,000 and 200,000. Molecular identification was performed using mitochondrial cytochrome oxidase subunit I (COI) gene barcoding. The resulting sequences were submitted to the NCBI GenBank database under accession numbers PX239475–PX239478. BLAST analysis confirmed that all sequences showed the highest similarity to *M. argentata*, validating the taxonomic identity of the specimens

Keywords

Biological parameters, Carapace, Isometric pattern, Morphometric relationships, Portunid crab

Biological insights for sustainable fisheries of Pharaoh cuttlefish (*Sepia pharaonis*) off Odisha Coast

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Cephalopods are increasingly recognised for their ecological significance and commercial value, with rising demand in both domestic and export markets. Among them, the pharaoh cuttlefish *Sepia pharaonis* represents a dominant resource in cephalopod landings along the Odisha coast of the Bay of Bengal. Despite its importance, limited information is available on its biology and stock status in this region, which is crucial for developing effective conservation and management strategies within the framework of sustainable fisheries. The present study provides a comprehensive account of the biology and stock status of *S. pharaonis* from Odisha waters. Biological observations revealed a mean length of 21.65 cm and a sex ratio of 1:0.30 (female:male). The length at 50% maturity (LM_{50}) was estimated at 12.2 cm, with 76% of individuals found mature, indicating active spawning during November–December. Stomach content analysis confirmed its role as a mid-trophic predator, with digested fish, shrimps, crabs, and molluscs forming the bulk of the diet. Growth and mortality parameters indicated that it is a fast-growing and short-lived species, with von Bertalanffy growth estimates of $L_{\infty} = 32.61$ cm and $K = 2.49 \text{ yr}^{-1}$. Natural mortality (M) was 3.45 yr^{-1} , fishing mortality (F) 3.22 yr^{-1} , and total mortality (Z) 6.67 yr^{-1} , resulting in an exploitation rate (E) of 0.48. These findings suggest that the stock is currently exploited at a moderate level, with no apparent signs of overfishing. Stock assessment using the Bayesian Surplus Production Model (BSM) confirmed sustainability, while Rapid Stock Assessment (RSA) indicated relatively high abundance in Odisha waters. The results underscore that *S. pharaonis* is presently in a healthy state, yet precautionary approaches are necessary to prevent overexploitation given the species' commercial importance and susceptibility to intensive fishing. A minimum legal size (MLS) of 11 cm DML is recommended to safeguard juvenile stocks, enhance recruitment, and sustain long-term yields. This study provides the first comprehensive baseline on the biology and stock status of *S. pharaonis* from Odisha, offering critical insights for sustainable fisheries management. The findings highlight the potential of this resource to strengthen food security, support fisher livelihoods, and promote sustainable cephalopod fisheries in the Bay of Bengal region

Keywords

Bay of Bengal, Overexploitation, Minimum legal size, Precautionary approaches, Rapid stock assessment



Stock health of the kiddi shrimp *Parapenaeopsis stylifera* on India's southwest coast: A length and catch-based evaluation

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Fisheries management is a vital requirement for commercial fisheries worldwide. Several methods and models are available for assessing the stock status of fishery resources. Determining the biological reference points of a fishery stock through multiple stock assessment methods is essential for informed decision-making. Here, we assess the stock of *Parapenaeopsis stylifera* from Kerala on the southwest coast of India by using both catch and length-based approaches. The fishery serves both domestic and international markets, contributing 35-40% of the total coastal penaeid shrimp landings of the state, second only to *Metapenaeus dobsoni*. The species has a short lifespan and a marine developmental lifecycle requiring regular evaluation to ascertain its stock status. The stock of the karikadi shrimp, as it is locally known in Kerala, was assessed using the Bayesian Schaefer Model (BSM) with catch and standardised effort data from 2009 to 2023 input into the model. Length frequency data from January 2021 to December 2023 period was used in the Length-Based Spawning Potential Ratio (LBSPR) model to estimate the spawning potential ratio (SPR). Both methods indicated that the fishery resource is sustainable and in good condition.

Keywords

Bayesian Schaefer Model, Kerala, LBSPR, Karikadi shrimp, Standardised effort



Bycatch trends and post-release survival in small-scale trap fisheries the Gulf of Mannar: Implications for sustainable management

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Gulf of Mannar (GoM) archipelago with 21 uninhabited coral islands that occur between Rameswaram and Tuticorin is known for coral reefs and associated biodiversity. Over 100,000 fishers living in numerous villages and hamlets along the Gulf of Mannar coast depend primarily on reef-associated fisheries for their livelihood, with traps serving as the main fishing gear. Trap fisheries, though considered selective, capture a wide range of non-target species whose survival after release is rarely quantified. In this study, we examined bycatch trends in trap fisheries by conducting on-board field experiments and assessed the post-release survival of incidentally captured fishes and evaluated strategies to enhance their survival. Catch rates, handling times, and factors influencing mortality were noted concurrently. Results revealed that immediate return of incidental catches to the water after removal from the trap, significantly enhanced survival when compared to delayed handling or prolonged air exposure. Species-specific differences in tolerance were evident, with certain fishes showing high resilience under rapid release conditions, while others were more vulnerable to stress, and the key factors influencing survival were handling duration and exposure to air. These findings demonstrate that simple operational measures can substantially increase post-release survival of incidental catch in trap fisheries. These strategies provide a practical, low-cost approach to reducing the ecological footprint of trap fishing without compromising target catch efficiency. Integrating such practices into fisheries management and policy frameworks can contribute to more sustainable and conservation-friendly trap fisheries

Keywords

Catch efficiency, Ecological footprint, Livelihood, Post-release survival, Reef-associated fishery



Biology of the Near Threatened coastal shark *Scoliodon laticaudus* from the Northeastern Arabian Sea

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Globally, one third of the elasmobranch species are facing the threat of extinction due to their vulnerability related to life history, over-exploitation, habitat alterations, and climate change. The spadenose shark *Scoliodon laticaudus* (Family: Carcharhinidae) is a small-bodied coastal shark known to occur in shallow coastal and inshore waters, with a restricted distribution in the northern Indian Ocean. It has been assessed as Near Threatened (NT) in the IUCN Red List, indicating its vulnerability to overfishing in the distribution range. Life history traits related to habitat are fundamental for evaluating the vulnerability and extinction risks of elasmobranch species at the regional level. *S. laticaudus* is a dominant coastal shark in the northern coasts of India, where northern Arabian Sea coastal states account for >80% of the estimated *S. laticaudus* landings. We investigated the reproductive biology and feeding ecology of *S. laticaudus*, based on samples from the fishery in the Northeastern Arabian Sea during 2014-2022. Specimens of 155-610 mm TL in the weight range of 16-1150 g were observed in the fishery, mostly as bycatch in trawl and gillnets operated in the coastal waters along the Gujarat and Maharashtra coasts. The dominant size class was 300-500 mm TL, forming ~73% of the sampled population. Adult males were observed from 260 mm TL, and females from 320 mm TL. It feeds on a variety of prey, dominated by teleosts and crustaceans. The present study provides additional information on the life history traits of *S. laticaudus* from the Arabian Sea to support the formulation of fishery management and conservation plans for this resource

Keywords

Conservation plans, Distribution range, Elasmobranchs, Extinction risks, Spadenose shark



Eco-biological characteristics of *Erythrocles* spp. fished in the south eastern Arabian Sea

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Ruby fishes (*Erythrocles* spp) belonging to family Emmelichthyidae are a significant component of the multispecies deep-sea trawl fishery landings. Considering its likely development as a significant fishery resource in the years to come, documenting the fishery development over time is important. An ecosystem approach in assessing the multi-species deep-sea trawl fisheries as well as identifying research priorities in management of specific fish stocks of interest is facilitated by knowledge of species-wise life history traits and regional fishery information on the concerned fish populations. *Erythrocles schlegelii* (Ricardson, 1846) commonly known as Japanese rubyfish is a seasonal, offshore fishery resource entering the domestic marine fish market chains of Kerala. Regular monthly sampling was done to collect information on size groups caught and landed at Munambam Fisheries Harbour. Biological aspects such as gonad development and diet composition were recorded along with relevant size-based life history traits. The size range of *E. schlegelii* caught was 310-490 mm. The size range recorded was 370–420 mm for females and 390–490 mm for males. The gonadal maturity scale was developed for male and female fishes using multiple indices like GSI, oocyte diameter and macroscopic staging of oocytes, as applicable. Size related effects on fecundity were noted. The absolute fecundity varied from 4381 to 260605 eggs in fishes with a total length range from 320-476 mm and body weight from 340-1220 g. Diet composition with mesopelagic fish varieties such as lantern fishes, *Bregmaceros* spp. and gapers as well as the inshore fishes such as anchovies and sardines were recorded. The fishery was evaluated using size-based indicators with respect to fisheries management needs for an emerging fishery resource

Keywords

Emerging fishery resource, Emmelichthyid, Fisheries management, Gonadal maturity, Life-history, Ruby fish



Reproductive traits and population characteristics of *Atule mate* (Cuvier, 1833) from the Gulf of Mannar: Implications for Minimum Legal Size

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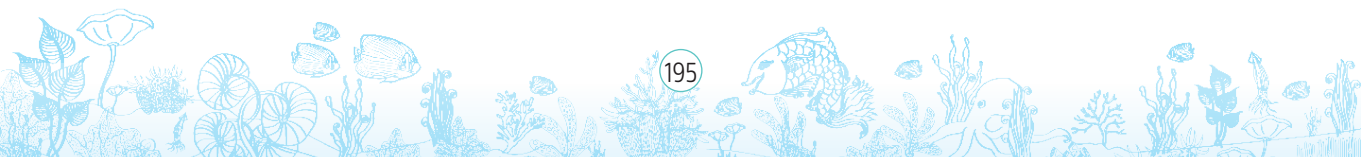
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The study examines the reproductive traits and population characteristics of *Atule mate* (Family: Carangidae), based on specimens collected from the major fish landing centres within the Gulf of Mannar Biosphere Reserve viz., Pamban fish landing centre (PFLC) and Thoothukudi Fisheries Harbour (TFH) between September 2023 to August 2024. The spawning period lasted for over six months, exhibiting two pronounced peaks during February and June. The length at first maturity ($L_{m_{50}}$) was estimated at 21.4 cm for males and 21.9 cm for females, with females predominating the commercial catch with a sex ratio of 1:1.27. The growth parameters were L_{∞} =33.60 cm, K =1.50 year⁻¹, and t_0 =-0.10 year. Mortality rates were Z =4.71 year⁻¹, M =2.29 year⁻¹ and F =2.42 year⁻¹, with an exploitation ratio of 0.51, suggesting that reducing fishing effort could help sustain stock levels. The length-weight relationship indicated positive allometric growth, with the fishery's size composition ranging between 11.5 and 32 cm in total length (TL). The Minimum Legal Size (MLS) corresponding to the size at which the species first attains maturity was set at 17.0 cm. Analysis of size composition showed that approximately 75.8% of the commercial catch falls below the $L_{m_{50}}$, while 25.2% of the catch is below the MLS. To promote the sustainable exploitation of the resource, it is essential to implement regulatory measures that limit the harvest of immature individuals and minimize fishing pressure on sub-adult stocks

Keywords

Exploitation ratio, Gulf of Mannar, MLS, Mortality rates, Size composition



Trophodynamics and reproductive timing of kawakawa *Euthynnus affinis* in the Eastern Arabian Sea

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Tunas are commercially important fishery resources of India, accounting to nearly 3.4% estimated marine fish landings of India. Coastal tunas account for >50% tuna landings. Little tunny *Euthynnus affinis* is the dominant species in fishery accounting to 34% of the tuna fishery of India exploited mainly by gillnets, lines and ring seines. This study investigated the trophodynamics and reproductive biology in the eastern Arabian Sea, to determine the spatial and temporal variation in the feeding reproductive changes in the north-eastern and south-eastern Arabian Sea. The composition of stomach contents shows it is an opportunistic feeder, with a diet dominated by fish, followed by crustaceans and molluscs. On both coasts, north and south eastern Arabian Sea, the species showed a preference for feeding on clupeids, although the species varied. Feeding intensity increased with an increase in the body size of fishes with a high prey-to-predator weight ratio. There were no changes in feeding preference between the sexes. Prey-specific abundance indicated a relatively specialized feeding pattern, with a high occurrence of species belonging to the order Clupeiformes. The timing of reproduction was examined using the gonadosomatic index and macroscopic assessment of the ovarian stage. These indices demonstrated that spawning-capable females were caught in June-July and that spawning ceased by August in the southern Arabian Sea. However, in the Northern Arabian Sea, mature females with spent ovaries were observed instead of spawning-capable females. The maturity level was dominated by immature and maturing ovaries. The sex ratio of *E. affinis* was estimated to be 1:0.8. The length at first maturity was estimated as 38-41 cm fork length (FL). The parameters estimated in this study are key information for stock assessments of the species and will contribute to the conservation, management and sustainable yield of *E. affinis* in eastern Arabian Sea

Keywords

Indian Ocean, Little tunny, Opportunistic feeder, Trophic ecology, Trophodynamics, Tuna fishery



Unveiling the health and growth patterns of pelagic reef fishes caught in troll lines in Gulf of Mannar: Evidence from length-weight relationships and condition factor

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The study evaluated the length–weight relationship (LWR) and the relative condition factor (Kn) of 12 economically important pelagic reef fishes captured through experimental troll line fishing at the Kombuthurai fish landing centre, located along the Gulf of Mannar. From January to December 2024, a total of 3,096 specimens were collected. The experimental troll line gear was operated at depths ranging from 5 to 30 m, with fishing sessions lasting between 4 and 7 h. Logarithmic transformations of the data were applied to establish the LWR, and linear regression analysis was conducted to estimate the parameters a and b for 12 fish species belonging to six families under 11 genera. Notably, this study documented a new maximum length (L_{max}) for the tuna species *Euthynnus affinis* (106 cm). The estimated growth coefficient (b) values for the 12 species varied significantly ($p < 0.005$), ranging from 2.5892 (*Epinephelus malabaricus*) to 3.228 (*Scomberomorus commerson*), indicating that most of the species exhibited allometric growth. Furthermore, almost all species, except *Decapterus russelli* (0.9544), displayed a relative condition factor (Kn) of one or greater, suggesting that the prevailing environmental conditions favoured fish growth. These findings provide valuable insights into ecological patterns, fish biology, fisheries dynamics, stock assessment and species-level management.

Keywords

Experimental troll line, Fish biometrics, Logarithmic transformation, Regression coefficient



Ensuring sustainability: Stock health and fisheries management of the Bengal whipray along the Odisha coast, Northwestern Bay of Bengal

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Brevitrygon imbricata, a small to medium-sized stingray of the family Dasyatidae, inhabits shallow coastal waters of the Indo-West Pacific, including the eastern Arabian Sea and Bay of Bengal. Despite its ecological and fishery importance, species-specific information on biology and stock status is scarce, constraining effective management. The present study assessed the population structure, reproductive biology, and stock status of *B. imbricata* along the Odisha coast, India. Fishery-dependent data were obtained from the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), MarineSTAT, NMFC-CMFRI database (2017–2024) while biological samples (disc width, total weight, sex, and maturity) were collected from 2021 onwards along the Odisha coast. Stock status was evaluated using three complementary approaches. The CMSY++ model, based on catch data, CPUE proxies, and life-history priors, estimated a carrying capacity (K) of 10,700 t and intrinsic rate of increase (r) of 0.395. The maximum sustainable yield (MSY) was estimated at 259 t, with key indicators from Markov Chain Monte Carlo simulations suggesting sustainable exploitation ($F/F_{MSY} = 0.567$; $B/B_{MSY} = 1.18$). Rapid Stock Assessment (RSA) categorised the stock as abundant, with a final year relative abundance of 79.4%. Length-based spawning potential ratio (LBSPR) analysis, incorporating estimated growth parameters ($L_{\infty} = 26.5$ cm, $K = 0.55 \text{ yr}^{-1}$, $M = 1.072 \text{ yr}^{-1}$ obtained from the ELEFAN GA bootstrap, TropFishR), revealed a current spawning potential ratio (SPR_{cur}) of 33% with the F/M estimated at 2.45, which is below the precautionary target reference point (SPR40%), suggesting reproductive stress. Biological investigations revealed clear sexual dimorphism, with females (18.7 ± 0.22 cm DW) attaining larger sizes than males (17.2 ± 0.21 cm Disc Width, DW). The size at 50% maturity (LM50%) was 18.11 cm DW, while LM95% was 20.15 cm DW. Litter size ranged from 1–4 pups per cycle, reflecting low fecundity and high vulnerability to fishing pressure. Overall, the findings indicate that *B. imbricata* along the Odisha coast is currently exploited within sustainable limits. However, reproductive constraints necessitate precautionary management. To maximize yield while ensuring long-term sustainability, it is recommended to increase the size at capture to above 20 cm DW through appropriate mesh size regulation and to maintain the relative exploitation (F/M) at 1.75. These measures will help sustain the spawning potential ratio at or above the target 40%, thereby balancing conservation concerns with fishery benefits

Keywords

Brevitrygon imbricata, Life-history parameters, Northeast coast, Population, Reproductive stress

Species-specific feeding diversity among elasmobranchs from the Eastern Arabian Sea off the southwest coast of India

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Elasmobranchs, including sharks, rays, and skates, play crucial ecological roles in marine ecosystems and are of significant commercial importance and conservation concern globally. This study investigated feeding diversity among elasmobranchs, using 208 samples that included 12 shark species, 5 ray species, and 1 skate species, landed at Cochin and Munambam Fisheries Harbours in Ernakulam District, Kerala, during January to March 2024 period. The stomach contents were analysed to identify preferred prey items, using the Index of Relative Importance for species-specific dietary preferences, and the interrelationship between the species based on their diet was found. The study also examined feeding intensity and diet contents, highlighting the importance of prey items such as pufferfish, *Acetes* spp., and squids. Notably, elasmobranchs exhibited characteristics of both apex predators, exerting top-down control on marine food webs. Additionally, the study revealed instances of avian predation by elasmobranchs, underscoring their opportunistic feeding behaviour and the diversity of their diet. The Primer software was used to assess species richness, species evenness, and the Shannon-Weiner index, providing a comprehensive understanding of dietary diversity among elasmobranch species. These quantitative metrics further enriched the analysis, providing insights into the distribution and equitability of prey consumption across different species, thus enhancing the comprehension of the trophic dynamics within the Arabian Sea ecosystem. The comparison of prey profiles among elasmobranchs highlights the potential for cohabitation in shared feeding grounds in the Arabian Sea. This finding underscores the importance of considering species interactions and competition dynamics in ecological studies and management strategies. The results also provide insights into the distribution patterns of elasmobranchs, which can support the formulation of fishery management strategies and conservation plans based on spatiotemporal distribution

Keywords

Gut Contents, Index of Relative Importance, Rays, Shannon-Weiner index, Sharks



Biology and life history insights of Bleeker's whipray *Pateobatis bleekeri* (Elasmobranchii: Dasyatidae) from the Arabian Sea

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This study provides the first comprehensive investigation into the reproductive biology and feeding ecology of Bleeker's whipray (*Pateobatis bleekeri*), a benthic medium-sized coastal elasmobranch distributed only in the northern Indian Ocean. Between 2006 and 2015, a total of 8,806 specimens were collected from the northwest coast of India as bycatch from shrimp trawl, dol (bag) nets, and gillnet fisheries operating in Maharashtra, and Gujarat waters, at depths of up to 40 meters. Specimens ranged in disc width (DW) from 22 to 124 cm and in total weight (TW) from 0.26 to 45.0 kg. Length–weight relationship (LWR) was established for both sexes, with no statistically significant difference observed between males and females. The derived LWR equation was $W=0.0894710 DW^{2.700457}$ ($r^2 = 0.957$), indicating the ray's disc width grows faster than weight. The estimated length at 50% maturity (Lm_{50}) was 60.0 cm disc width (DW) for females and 55.0 cm DW for males. Females exhibited a single functional ovary (left), and the species was found to undergo synchronous ovarian cycling and gestation. The year-round presence of pregnant females suggests a continuous, non-seasonal reproductive cycle though peaks in reproductive activity were observed between January and April, particularly during the pre-monsoon season. Litters typically consisted of a single embryo, with estimated birth sizes between 20.0 and 25.0 cm DW. The overall sex ratio (female: male=1.13:1) differed significantly from parity ($p<0.05$). Dietary analysis revealed a diverse and opportunistic feeding strategy, with teleost fishes constituting the major prey group (41.1% Index of Relative Importance, IRI), followed by stomatopods (29.2% IRI), crustaceans (26.9% IRI), and molluscs (0.2% IRI). Feeding habits varied with size, sex, maturity, and season, indicating ecological adaptability across life stages. This study provides critical data on the reproductive and trophic ecology of *P. bleekeri* in the eastern Arabian Sea, offering valuable insights for elasmobranch fisheries management, conservation planning, and population sustainability assessments in Indian waters.

Keywords

Batoids, Biology, Maturity, Management, Trophic ecology



Time-series variability in mean trophic level and fishing-balance index of marine fisheries of Gujarat, India

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Understanding trophic relationships and resource partitioning mechanisms is fundamental to marine ecosystem ecology and fisheries management. Investigating the long-term effects of fishing on the marine Mean Trophic Level (MTL) and Fishing Balance (FiB) Index is very important for understanding the status of marine ecosystems. The present study presents a time-series (1985-2024) variability in the MTL and FiB Index, which indicates fishing down the marine food web along the Gujarat coast of India. The regression analysis on the Mean Trophic Level (MTL) time series reveals a significant long-term decline (annual change of -0.00366). A linear regression model indicates a statistically significant negative slope ($p < 0.001$) and an R^2 value of 0.4085 , and the fitted model generated a constant term of 3.6430 . The regression analysis revealed a significant temporal pattern in the ecosystem dynamics. The linear model demonstrated a positive trend with an annual increase of 0.007067 , explaining approximately 34% of the temporal variability. These results establish a quantitative trophic framework for Arabian Sea fishery management, supporting conservative harvest limits for apex predators, nursery habitat conservation, and the inclusion of trophic metrics in population assessments to preserve ecosystem integrity and fishing productivity.

Keywords

Fishing down the food web, Marine ecology, MTL, Trophic ecology



Seasonal fishery of sand lance (*Bleekeria kallolepis*), an emerging non-conventional resource from the Gulf of Mannar

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Fish landings were monitored during 2024–25 at the Therkuvadi and Mandapam fish landing centres, where trawlers operating in the Gulf of Mannar regularly land their catch. In recent years, significant landings of the sand lance *Bleekeria kallolepis*, locally referred to as 'palli meen', have been reported at these two landing centres. The fish trawlers, measuring 20 to 25 m in overall length (OAL) and equipped with 240 hp engines, operate out of Therkuvadi and Mandapam, fishing at depths of up to 40 m and covering distances of 45 km from the shore. The catch per unit effort (CPUE) ranged from 200 to 1500 kg unit⁻¹, while the catch per hour (CPH) varied from 13 to 100 kg. The sand lance was not specifically targeted and was caught alongside carangids. Fishers indicated that carangids and lethrinids are abundant in the sand lance shoals, suggesting that these species may prey on the sand lance. Total length to total weight (TL-TW) relationship demonstrates negative allometric growth, with no significant differences observed between males and females; thus, the pooled length-weight relationship yielded 'a' and 'b' values of 0.0244 and 2.241, respectively. Current conditions indicate that the sand lances in the Gulf of Mannar are in good growing condition [condition factor (k) ~ 1], with males measuring between 102 and 138 mm and females ranging from 102 to 140 mm. The mean lengths for males and females are 128.85 and 128.82 mm, respectively. In terms of weight, males range from 4.47 to 9.94 g and females from 4.05 to 9.53 g, with mean weights of 6.80 and 6.62 g, respectively. The gonadosomatic index (GSI) for males ranged from 0.54 to 14.65, while for females, it ranged from 0.64 to 15.47, resulting in mean GSI values of 3.8 for males and 3.49 for females. The gastrosomatic index (GaSI) varied from 0.35 to 5.45 for males and from 0.28 to 10.06 for females, with mean GaSI values of 1.58 for males and 1.52 for females. Approximately 78% of males and 81% of females were found to be in a mature condition during the months of June to August. This study highlights the importance of updated information on morphometric relationships for the effective management of the fishery in this region.

Keywords

Gonadosomatic index, Gastrosomatic index, Gulf of Mannar, Length-weight relationship



Parental mouth brooding and larval survival: Insights into the reproductive biology of the spotted catfish *Arius maculatus* from south Kerala coast

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Aspects of the reproductive biology, parental care, and larval development of the marine catfish *Arius maculatus*, commonly known as the spotted catfish, caught from the south-west coast of Kerala was studied. Fish samples were collected monthly during November 2022 to January 2025, from the landing centres along this coast. The total length (TL) of the fish ranged from 300 to 374 mm and the total weight from 106 to 514 g. The male fish exhibited parental care in the form of mouth incubation. Fecundity varied from 29 to 41 eggs (gonad weight 7–31.8 g) with ova diameter ranging between 1.36 and 10.81 mm. The highest gonadosomatic Index (GSI) of 7.52 was observed in females during November, coinciding with the presence of mouth-brooding males carrying incubating eggs. During sample collection from Vizhinjam Landing Centre, where fishing operations are carried out during night hours and landings occur in the early morning, freshly caught, dead males were occasionally found with viable, ready-to-hatch eggs in their mouths. These live eggs were transferred to tanks in the hatchery, and within 48 h they successfully hatched as larvae (TL 20.1 mm) with prominent yolk sacs. The yolk sac sustained the larvae until 18 days post-hatch, after which they commenced feeding on small pieces of squid, cuttlefish, and mussels, and were gradually weaned onto formulated pellet feeds (300–500 μm) by 30–35 days, with subsequent increments to 600–800 μm , 1.2 mm, and 2 mm sizes. The larvae displayed rapid growth, high resilience, and could be reared for over two years, attaining a total length of 18.2 cm and a weight of 163 g in 18–24 months. The retrieval of viable eggs from the buccal cavity of freshly caught males and their successful rearing under captive conditions demonstrate a unique opportunity for conserving early life stages and exploring further developmental biology studies

Keywords

Fecundity, Gonadosomatic index, Larval development, Mouth-brooder, Parental care



Navigating sustainability: The role of mechanised tuna fisheries in Thengaipattinam's deep-sea fishing economy

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The mechanised tuna fisheries at Thengaipattinam Fishing Harbour in Kanyakumari, Tamil Nadu, are essential to the region's deep-sea fishing sector. These fisheries use mechanised gillnetters and longliners, each equipped with inboard engines (450-500 hp) and operated by 15-18 fishers. They target key tuna species such as *Thunnus albacares* (yellowfin), *Katsuwonus pelamis* (skipjack), *Thunnus alalunga*, among others, in offshore waters at depths of 200-250 m. Techniques include drift gillnets and hook-and-line fishing, with 12-15 gillnet hauls per trip and 1,000-3,000 hooks per line. Gillnets are non-selective, high-volume, and mechanised, whereas hook-and-line fishing is more selective, lower in volume, and likely artisanal. Trends show peak gillnet catches between 2018 and 2020, particularly for skipjack, while hook-and-line catch volumes fluctuate seasonally. Peak seasons are January to March and September to December, aligning with tuna migrations along India's southwest coast. Species composition differs by gear: hook-and-line catches are dominated by yellowfin (55.1%) and skipjack (41%), while gillnets mainly catch skipjack (62.49%) and yellowfin (19.74%). These mechanised fisheries significantly boost the regional economy through domestic and export markets, especially for high-value species like yellowfin and skipjack tuna. Thus, the Thengaipattinam tuna fishery is a vital part of Tamil Nadu's deep-sea fishing industry. Overall, these mechanised fisheries support the local economy and regional growth by targeting key tuna species, especially yellowfin and skipjack. Despite seasonal and compositional variations, their activities contribute substantially to domestic sales and international exports. Moving forward, adopting sustainable fishing practices and effective management will be crucial for preserving the ecological and economic future of these fisheries.

Keywords

Gillnetters, Longliners, Mechanised sector, Skipjack, Species composition Yellowfin



Unveiling the fishery dynamics, growth performance and stock status of the golden trevally (*Gnathanodon speciosus*) from the Gulf of Mannar

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The Golden trevally *Gnathanodon speciosus* (Forsskal, 1775), is a highly valuable commercial fish in the Gulf of Mannar. The trend and stock status of this species were studied from 2017 to 2021 using fish landings and size frequency data. Growth parameters were estimated using length-based methods. Ramanathapuram dominated the landings of golden trevally during 2012–2023, contributing 65.94% of the total catch, with peak landings in 2019 and 2020. Nagapattinam ranked second, contributing 19.17%, with peaks in 2018 and 2020. The catch was mainly exploited by single-day trawl (52.38%), followed by multiday trawl (15.64%) and gillnet (14.55%). The observed size range was 8.5–103.53 cm. Growth was allometric, with the length-weight relationship parameters estimated as 0.0267 (a) and 2.778 (b). The estimated asymptotic length (L_{∞}) was 103.53 cm, and the growth coefficient (K) was 0.11 yr⁻¹ with the growth performance index (Φ') as 3.072. The instantaneous total mortality rate (Z), estimated from the length-converted catch curve, was 0.38 yr⁻¹. The estimated annual total mortality, fishing mortality and natural mortality rates were 0.50, 0.20, and 0.30, respectively. Spawning peaks occurred during September–October and May–June period. The exploitation rate (E) was 0.40. Estimates of Relative Yield per Recruit and Biomass per Recruit were indicating that the stock of *G. speciosus* is underexploited. Sustaining *G. speciosus* in the Gulf of Mannar requires science-based management, including regulated fishing effort, protection of spawning periods and selective gear use. These findings provide guidance for fisheries management for this high-value species

Keywords

Allometric, Exploitation rate, Fishing effort, Mortality rates, Selective gear, Size frequency



Preliminary insights into non-conventional fisheries resources along the Indian coast: Prioritisation and early research outcomes

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The marine sector currently exploits 3.56 million t (mt) against an estimated potential of 5 mt, underscoring the need to diversify fisheries resources. Exploring new and non-conventional resources provides a viable pathway toward this diversification. However, significant knowledge gaps remain regarding their life history traits, value chains, and nutritional potential. These aspects lie beyond the scope of existing monitoring and assessment systems, demanding focused research and systematic evaluation. The increasing recognition of Non-Conventional Fisheries Resources (NCR) highlights their potential to contribute to sustainable fisheries, economic diversification, and nutritional security in India. Preliminary efforts have been undertaken to systematically define, prioritize, and assess NCR along the Indian coastline. A criteria-based framework was developed to prioritise NCR, enabling the identification of target species and the initiation of species-specific monitoring programs across different coastal regions. Concurrently, methodologies for data collection and analysis are being standardised, with initial assessments focusing on length composition, gear-wise contribution, spatial distribution, and depth ranges. Preliminary mapping of the abundance and distribution of selected NCR species has also been undertaken. To capture socio-economic perspectives, structured questionnaires have been designed to gather insights from fishers, alongside early explorations of trade dynamics and market drivers. In addition, methodological refinements are underway to improve the estimation of abundance and stock assessment of NCR. Collectively, these initial achievements provide a critical baseline for advancing the systematic study and sustainable utilization of NCR, paving the way for their integration into future fisheries management frameworks in India.

Keywords

Knowledge gaps, Resource diversification, Sustainable utilisation, Value chain



Seasonal size structure and reproductive dynamics of mud spiny lobster *Panulirus polyphagus* along the Maharashtra Coast

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The lobster fishery of Maharashtra forms an important component of the state's coastal fisheries, contributing significantly to local livelihoods and export earnings. The dominant species landed is the mud spiny lobster *Panulirus polyphagus* (>99%), followed by *Thenus unimaculatus* (<1%). Although lobster landings from Maharashtra are moderate compared to prawn and crab fisheries, their high commercial value makes them a priority resource. Present study examined the size structure, landing trend and biological aspects of the spiny lobster *P. polyphagus* along the Maharashtra coast during 2023-2024 period. The fishery is carried out primarily by trawls and gillnets with peak landings observed during the post-monsoon and winter months. The landings data indicates that lobsters are exploited over a broad size range, with smaller lobsters (<40 mm carapace length or CL) abundant during pre- and post-monsoon months, indicating recruitment pulses, whereas intermediate (40–80 mm CL) and larger size classes (>80 mm CL) were more dominant during winter and early summer, reflecting growth progression and maturation. Biological observations indicated a high proportion of mature females occur during April–June and October–December. These observations highlight seasonal reproductive activity, with peak spawning periods aligning with the monsoon cycle, thereby influencing the availability of recruits. The study underscores the need for adopting management measures such as Minimum Legal Size (MLS) and its enforcement, protection of breeding grounds, and seasonal fishing restrictions to ensure long-term sustainability. Strengthening monitoring programs and integrating biological and fishery data will further support evidence-based management of mud spiny lobster stocks along the Maharashtra coast.

Keywords

Lobster fishery, Management measures, Minimum Legal Size, Spawning periods



Quindecennial trend of cephalopod resources in the marine fisheries of Andhra Pradesh

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Cephalopods are an increasingly important component of Andhra Pradesh's marine fisheries, contributing significantly to both domestic supply and export earnings. Using CMFRI landing data (2010–2024), this study analyses the species composition, seasonal pattern, and gear-wise contribution of cephalopod catches along the state's coast. Annual landings showed considerable variability, with overall growth across the period. The fishery was dominated by cuttlefish, which consistently contributed the largest share, followed by squids, while octopus resources formed only a minor fraction. Gear-wise patterns underscored the overwhelming contribution of mechanised trawlers, which accounted for the bulk of cephalopod catches, especially cuttlefish, highlighting their trawl-centric exploitation. Squid landings, though smaller in magnitude, were captured not only by trawlers but also by ring seines and gillnets during peak seasons, pointing to the species' wider distribution and shoaling behaviour. Octopus catches remained minor and mostly incidental, but were observed in bottom-set gears in addition to trawl bycatches. The monthly distribution highlighted a marked seasonal pattern, with peaks generally coinciding with the post-monsoon and early winter months, reflecting both biological cycles and the dynamics of fishing effort. The quindecennial analysis suggests that while cephalopod resources remain stable in contribution, they are heavily dependent on trawl fisheries and subject to strong inter-annual fluctuations. Given their growing export demand and ecological importance, these resources may be approaching full exploitation. The study emphasises the importance of species-specific monitoring, sustainable trawl management, and adaptive seasonal closures to ensure the long-term sustainability of cephalopod fisheries in Andhra Pradesh.

Keywords

Cuttlefish, Fisheries trend, Gear contribution, Octopus, Squids, Sustainability





Nearshore dragnet fishery for *Metapenaeus dobsoni* by artisanal fishers: A case study from Andhra coast

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Nearshore shrimp dragnets have expanded along the Andhra Pradesh coast, targeting the commercially valuable *Metapenaeus dobsoni*. Operated by traditional fishers in nearshore waters, these gears represent a growing livelihood source but also raise ecological and management concerns. This study examined dragnet operations across coastal districts, documenting patterns of catch, seasonal variability, and biological characteristics of the target shrimp. Observations indicate that the fishery provides substantial economic benefits to local communities. The fishery is characterised with bycatch of juvenile finfish and non-target fauna, with potential impacts on benthic habitats due to the bottom-trawling nature of the gear. The findings underscore the need for appropriate management interventions, including gear modifications, seasonal regulation, and community engagement, to ensure long-term sustainability. This work provides baseline insights into an understudied artisanal fishery and its implications for coastal resource governance in Andhra Pradesh.

Keywords

Dragnet operation, Mini-trawl, Penaeid shrimp, Small-scale fisheries, Traditional fishers



Non-conventional crustacean fishery resources of Karnataka: A case study on stomatopods

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Stomatopods form an important non-conventional crustacean resource landed off Karnataka coast. They form around 16 % of crustacean resources contributed mainly in single-day shrimp trawlers. These are generally considered as low value, contributing 30-40% of trawl catches near the shore. *Miyakella nepa* is the major species among stomatopod resource landed along Karnataka coast. The study analysed the catch trend, fishing effort, and catch rate for stomatopod resources from 2007 to 2024, and also examined catch-based MSY plots for these resources. The average landings of stomatopods in single day trawlers is 8603 t per year with peak in 2015 and lowest in 2024. The peak landing was observed during January- March every year with average catch per unit effort (CPUE) of 15.3 kg h⁻¹. The average catch per unit effort for stomatopod fishery along Karantaka coast from single day trawlers was estimated at 16.5 kg h⁻¹. Around 93% of the total stomatopod catch is contributed by single day trawlers operating within 30 m depth. The estimated decrease in fishing efforts in terms of unit operations from 2007 and 2024 was 75.8 %. The stomatopod landings have decreased gradually over the years due to less demand and reduced market price for the produce. They form an important source for substitution in fish meal industries and poultry feed. High bycatch and discards of the resource signals the need of suitable management strategies for exploitation of the resource. Stomatopods exhibit high fecundity and short life span rendering them less vulnerable to the existing fishing pressure. Other non-conventional crustacean resources include crab species *Charybdis smithii* which is landed mainly in multi-day mechanised trawlers.

Keywords

Catch trend, CPUE, Fishing effort, *Miyakella nepa*, MSY, Peak landing, Trawl catch



Spawning calendar of the black clam *Villorita cyprinoides* (Gray, 1825) from Vembanad Lake

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The black clam *Villorita cyprinoides*, is the most important clam species in India contributing more than three-quarters of the clam landings in the country. Kerala leads in clam production in India with Vembanad Lake, along the west coast, contributing 55.5% to the estimated clam production of India. As an accessible protein source, clams regularly fished from Vembanad Lake are marketed locally and also exported. The fisheries for the clams thus provide a major livelihood means for local communities. The clam is harvested extensively from its natural beds with more than 6,000 fishermen involved in the fishery. The production of black clams declined from a peak of 75,592 t in 2006 to 45,570 t in 2024. In the present study, the maturity stages and spatfall of black clam in the Vembanad Lake was analysed for determining its annual spawning calendar. The spatfalls were observed twice in a year. The maturity stages were categorised as Indeterminate, Early maturing, Late maturing, Mature, Partially spent and Fully spent. The spawning period was determined as the month or season with the highest proportion of spawners and mature individuals.

Keywords

Clam landings, Livelihood, Maturity stages, Spatfall, Spawning season, *Villorita cyprinoides*



Fishery and reproductive biology of the three-spot swimming crab *Portunus sanguinolentus* (Herbst, 1783) along the Maharashtra coast

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Understanding the reproductive biology and spawning seasons of crustaceans is essential for assessing their vulnerability to external stressors such as climate change and fishing pressure. This knowledge forms a critical foundation for developing effective fisheries management strategies for these species. The three-spot swimming crab *Portunus sanguinolentus* (Herbst, 1783) supports a significant fishery along the Maharashtra Coast and it contributes about 1.2% to the total crustacean landings in the Northeastern Arabian sea of the Maharashtra Coast. The average annual catch of *P. sanguinolentus* during the 2015-2024 period was 315 t while the historical maximum landings recorded was 787 t in 2024. Nearly 68% of crab landing was contributed by trawl nets, followed by dol nets (17%) and gill nets (7%). Data collected during January 2023 to December 2024 excluding monsoon fishing ban period from the commercial landings were analysed to assess the fishery trends, size composition, reproductive biology and sex ratio. The size of male crabs varied between 73-174 mm (123.34 ± 3 mm) carapace width (CW); and for female 77-158 mm (113.2 ± 2.4 mm). Total weight (TW) of male and female ranged between 23 to 308 g. The male crabs mature earlier than the females and they do not have specific seasons or cyclic changes. The female to male ratio was not equal with females recorded in greater numbers in the landings. The percentage of berried female crabs was 37% with peaks in January, April and September. According to the gazetted notification dated 02nd November 2023, the minimum legal size (MLS) fixed for this species was 70 mm in CW. In the present study, landings of this species along the Maharashtra region was above MLS indicating the fishery was well managed in this region. The species can be harvested sustainably by imposing a seasonal ban on fishing during peak breeding season, regardless of the gear. The present study provided fundamental information on *P. sanguinolentus* resource along the Maharashtra which is helpful in developing suitable strategies for future management.

Keywords

Berried females, Breeding season, Carapace width, Crustacean landings, Sex ratio, Spawning season



Occurrence of Hawaiian flying squid *Nototodarus hawaiiensis* (Cephalopoda: Ommastrephidae) in the Arabian Sea

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Most of the world's commercial squid production comes from the flying squid family Ommastrephidae. The Arabian Sea, considered as one of the richest regions for oceanic squid, has long been thought to host only a single representative of the family Ommastrephidae, the Purpleback flying squid *Sthenoteuthis oualaniensis* (Lesson, 1830). Increased interest in nerito-oceanic cephalopod resources in the last decade has stimulated research on oceanic squid's populations and diversity in the Arabian Sea and reported two more Ommastrephidae squids from the Arabian Sea. The arrow squids (genus *Nototodarus* Pfeffer, 1912) are distributed widely in the Indian and Pacific oceans and are an important resource for jigging and trawl fisheries. This study is the first report on the occurrence of the Hawaiian flying squid *Nototodarus hawaiiensis* (Berry, 1912) in the Arabian Sea (India). These were collected from the Kollam Bank, off the southwest coast of India, at depths ranging from 192 to 593 m. The dorsal mantle length (DML) ranged from 130-155 mm and body weight (BW) from 93-146 g in males, while females measured 62-128 mm DML and 13-88 g BW. Age estimation based on statolith increment analysis indicated that males were 132–168 days old, with an average growth rate of 0.91 mm DML per day. Females were 79–132 days old, with an average growth rate 0.93 mm DML per day, indicating a fast growth rate and short lifespan. Stomach-content analysis revealed the dominant prey were crustaceans. This species has commercial fishery in various parts of the world. Therefore, dedicated exploratory trawl surveys are recommended to better understand its distribution and population abundance for commercial exploitation.

Keywords

Age estimation, Arrow squid, Cephalopod resources, Dorsal mantle length, Oceanic squid, Statolith, Trawler



From data to decisions: LBB and LB-SPR based insights on two key tuna species in the Northwestern Bay of Bengal, India

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The small tuna species *Euthynnus affinis* (Kawakawa) and *Auxis thazard* (Frigate tuna) are among the most commercially significant pelagic resources exploited in the northwestern Bay of Bengal (NW-BoB), India. These species contribute substantially to the livelihoods of coastal fishing communities and support regional seafood markets. Despite their economic and ecological importance, reliable scientific information on their population status in this part of the Bay of Bengal has been limited, constraining effective management and conservation efforts. In this study, we applied two complementary length-based analytical approaches the Length-Based Bayesian Biomass Estimation (LBB) method and the Length-Based Spawning Potential Ratio (LB-SPR) model to evaluate the sustainability of these stocks. Length-frequency data were systematically collected from commercial fish landings between 2021 and 2025. Electronic length frequency analysis was first used to derive the von Bertalanffy growth parameters namely, the asymptotic length (L_{∞}) and the growth coefficient (K) which served as priors for subsequent LBB and LB-SPR estimations. The LBB approach generated key indicators of stock status, including relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}), allowing us to determine the degree of exploitation and assess whether the current fishing pressure is within sustainable limits. The LB-SPR model provided estimates of the spawning potential ratio (SPR) and corresponding exploitation rates, offering insights into the reproductive capacity of these stocks under present fishing regimes. Our findings highlight the utility of length-based methods for data-limited fisheries such as those in the NW-BoB. The integration of LBB and LB-SPR results offers a scientifically robust framework for evaluating stock health, guiding fisheries management, and supporting policy decisions aimed at ensuring the sustainable exploitation of *E. affinis* and *A. thazard*. Ultimately, this research contributes to safeguarding the productivity of small tuna fisheries in Indian marine waters while promoting long-term ecological and economic resilience.

Keywords

Auxis thazard, Bay of Bengal, *Euthynnus affinis*, Length-based assessment, Spawning potential ratio



Seasonal aggregation of large-bodied elasmobranchs along the Gujarat Coast

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The expansive continental shelf off the Gujarat coast in the north-eastern Arabian Sea, provides a unique environment for diverse marine life. Adjacent to this broad shelf lies a continental slope ecosystem, characterised by a sharp depth gradient. These dynamic areas are crucial fishing grounds, particularly for large pelagic species targeted by drift gillnets and longlines. Notably, pelagic elasmobranchs are frequently caught as by-catch in these commercial fisheries. The northern Arabian Sea experiences heightened productivity during the post-monsoon and winter months, driven by robust winter convective mixing. This surge in productivity extends beyond the shelf, with significant chlorophyll-a concentrations observed even in the deeper slope ecosystems. Data collected through participatory approach involving large meshed gillnet and long-line fishers of Gujarat fishers between 2020 and 2024 revealed consistent seasonal aggregations of several pelagic elasmobranch species, including devil fish (*Mobula mobular*), thresher sharks (*Alopias pelagicus*), hammerheads (*Sphyrna* spp.), and mako sharks (*Isurus oxyrinchus*), within the continental slope ecosystem. A higher incidence of these aggregations was recorded during post-monsoon along south Gujarat and winter along the North Gujarat continental slope, at depths ranging from 200 to 2000 m. Interestingly, most individuals observed in these aggregations were sub-adults, suggesting that these gatherings may primarily serve as feeding aggregations, capitalising on the seasonal abundance of prey. Furthermore, the pronounced depth changes along the continental shelf edge could serve as vital navigational cues, guiding these elasmobranchs during their extensive long-distance migrations.

Keywords

Aggregations, Arabian Sea, Continental shelf, Drift gillnets, Longlines, Participatory approach



Biological insights for the conservation of the grey bamboo shark *Chiloscyllium griseum* from the Southeastern Arabian Sea

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This study examines the morphological and reproductive characteristics of the grey bamboo shark *Chiloscyllium griseum* from multi-year (2018–2023) field observations that provide the baseline data vital for management and conservation of this demersal species. Biological parameters recorded included total length (TL), total weight (TW), sex, maturity stage, male clasper length, and reproductive condition. TL ranged from 21.5 cm in immature juveniles to 90.0 cm in mature adults, while TW varied from 153 g to over 3,500 g, reflecting substantial ontogenetic growth. The length–weight relationship indicated negative allometric growth (b significantly < 3 ; $R^2 \approx 0.996$) for both sexes, meaning weight increases at a slightly lower rate than predicted by isometry. Males reached sexual maturity at smaller sizes than females, with the smallest mature male at 47.5 cm TL and female at 54.5 cm TL. Logistic regression estimated length at 50% maturity (L_{50}) as 53.0 cm for males and 55.0 cm for females, with narrow bootstrap confidence intervals confirming robust estimates. Male clasper length increased positively with TL, supporting its use as a reliable maturity indicator. Females displayed a continuum of reproductive stages: immature, maturing, mature, and pregnant, throughout the study. Pregnant individuals carried varying numbers of yolky ova and embryos, including pups up to 17.5 cm long. The occurrence of gravid females in multiple months suggested prolonged or multiple breeding seasons, with asynchronous oocyte development indicative of extended reproductive cycles. Monthly maturity fraction analysis showed mature individuals year-round, with possible reproductive peaks in February–May and October. The overall sex ratio (M:F) was 0.88 indicating (χ^2 , $p > 0.05$) a balanced population structure. The study highlights distinct sexual dimorphism in size at maturity, continuous reproductive activity, and species-specific strategies, such as smaller male maturity size, asynchronous oocyte development, and extended breeding periods; patterns consistent with other small-bodied elasmobranchs. By integrating maturity estimates, reproductive biology, and seasonal occurrence, these findings provide critical parameters for population assessments and comparative life-history analyses. They also support the formulation of management measures for bamboo sharks in coastal ecosystems, where artisanal and small-scale fisheries often overlap with shark habitats. Such baseline data are essential for conservation planning, particularly in regions facing increased fishing pressure and habitat degradation, for ensuring sustainable populations of *C. griseum* in the southeastern Arabian Sea.

Keywords

Breeding, Clasper length, Conservation, Length–weight relationship, Sexual maturity, Size at maturity

Elasmobranch fisheries and biodiversity along the Malabar Coast, Kerala: An overview

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Elasmobranchs, encompassing sharks, rays, guitarfishes and skates, are apex predators that play a crucial ecological role in marine ecosystems. They also hold significant value in marine fisheries, providing essential resources such as meat, medicinal products, and materials. While there is no targeted elasmobranch fishery along the Malabar Coast, these species are commonly caught as bycatch in trawl, longline, and gillnet operations aimed at other commercially valuable fishes. From 2017 to 2022, the average annual elasmobranch landing in this region was approximately 274.5 t. Sharks accounted for the majority of these landings (61%), followed by rays (36%) and guitarfishes (3%). Shark landings peaked in 2022 at 345.6 t, while the lowest was recorded in 2018 (84 t). Ray landings were highest in 2022 (155.9 t) and lowest in 2020 (24.3 t). Guitarfish landings remained minimal, ranging from 1.3 t in 2017 to a peak of 15.1 t in 2018. A total of 41 species of elasmobranchs were recorded in the landings along the Malabar region, comprising 19 species of sharks, 16 species of rays, and 6 species of guitarfishes. Among sharks, the genus *Carcharhinus* (with six species) was the most commonly landed group. The ray landings were dominated by the genus *Himantura* (seven species), while *Rhinobatos* (two species) was notable among guitarfishes. Of the species recorded, 14 are listed as Endangered and 7 as Critically Endangered on a global scale (IUCN Red List). Occasional incidental landings of species such as the widenose guitarfish (*Glaucostegus obtusus*), bowmouth guitarfish (*Rhina ancylostoma*), and giant manta ray (*Mobula birostris*), all of which were added to India's Wildlife Protection Act through a 2022 amendment, were also reported. Additionally, a few incidental captures of the whale shark (*Rhincodon typus*), which has been protected under the Wildlife Protection Act (1972), were documented. In these cases, live releases were carried out by fishermen, reflecting the positive impact of awareness initiatives led by the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), which promote the sustainable use and conservation of elasmobranchs through stakeholder engagement and outreach efforts.

Keywords

Apex predators, Bycatch, Ecological role, Guitarfishes, Rays, Sharks, Skates



Investigations on the fishery and biology of the sandwich-tail whipray *Brevitrygon manjajiae* along the Maharashtra Coast

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Batoid fishes constitute an ecologically significant but highly vulnerable group of elasmobranchs in Indian coastal fisheries. Among them, the sandwich-tail whipray, *Brevitrygon manjajiae* (Dasyatidae), represents a recently validated species from the northern Arabian Sea. Members of the genus *Brevitrygon* are small-sized stingrays inhabiting soft-bottom habitats of the inner continental shelf across the Indo–West Pacific. Owing to their close morphological resemblance and overlapping characters, *B. manjajiae* has historically been misidentified as *B. walga* or *B. imbricata*, resulting in considerable taxonomic ambiguity in regional fishery records. Its formal recognition has thus created an imperative to re-examine its distribution, fishery contribution, and biological attributes from Indian waters. The species is recorded in trawl bycatch along the Maharashtra coasts, where it contributes a minor yet consistent component of elasmobranch landings. Although not a primary target, its retention for local consumption and processing underlines its economic relevance in artisanal and small-scale sectors. Given its relatively high occurrence in demersal trawl grounds, *B. manjajiae* merits attention within the broader batoid fishery complex of Maharashtra. However, intrinsic life-history characteristics typical of dasyatids such as low fecundity, extended gestation, and late maturation, render the species inherently susceptible to overexploitation. A rigorous understanding of its fishery biology is critical for several reasons. Precise species-level documentation is essential to correct historical misreporting of catch statistics and to enable reliable stock assessments. Knowledge of reproductive biology, growth, and population parameters provides the scientific basis for evaluating resilience to fishing pressure. Batoids increasingly subject to global conservation scrutiny, species-specific ecological and fishery information becomes indispensable for developing evidence-based management measures. The present investigation addresses the occurrence, morphometric characteristics, and biological features of *B. manjajiae* from the Maharashtra coast. Establishing a baseline for this taxonomically resolved species will contribute to improved understanding of regional batoid diversity, refine assessments of elasmobranch resources, and support policy interventions aimed at sustainable utilisation and conservation of vulnerable stingray populations in the Arabian Sea.

Keywords

Batoid fisheries, Conservation, Stingrays, Taxonomic ambiguity, Trawl bycatch



Assessment of croaker landings and stock status from the western Bay of Bengal along the southeast coast of India

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Croakers (Family: Sciaenidae) form one of the most important groups in India's marine fisheries, contributing significantly to both commercial landings and coastal livelihoods. They are highly valued for their high-quality meat, moderate market value, and steady demand in both domestic and export markets, particularly in dried and frozen forms. The larger croakers are highly valued for their swim bladder, commonly known as fish maw, which is considered a premium product in international trade. Croakers are landed year-round by mechanised trawlers, gillnets, and traditional crafts, with peak abundance during the post-monsoon and early summer seasons. Ecologically, they play a crucial role as mid-level carnivores, linking smaller forage fishes and crustaceans with higher predators in the marine food web. For fishing communities along the southeast coast of India, croakers represent a dependable source of income and nutrition, especially during lean seasons for other resources. Their importance has also been highlighted in management plans, as several species are vulnerable to overfishing and habitat degradation, underscoring the need for continuous monitoring and effective management to secure their long-term role in sustaining the coastal fisheries in the Bay of Bengal along the southeast coast of India. In this study, we present decadal landing trends of croakers and the stock status of the species that contribute most to the landings. The trend analysis is based on croaker landings by various gears at Visakhapatnam and Chennai on the Coromandel Coast, Therkuvadi and Pamban on the Gulf of Mannar and Palk Bay sides of Rameswaram island. The health of the stocks of important species was assessed using a combination of indicators such as Relative biomass (B/B_{msy}) and Relative fishing pressure (F/F_{msy}) estimated using the Thompson and Bell Model, a standard length-based dynamic pool model. The tiger tooth croaker *Otolithes ruber* was found to be overfished in the region. Although largely a bycatch in coastal trawl fisheries, the species exhibits seasonal, sporadic aggregations of breeding adults, which are exploited by seines. While the strict implementation of minimum legal size (MLS) and regulation of mesh size are necessary to avoid capture of juveniles, Marine spatial planning (MSP), including closure of fishing in known spawning grounds during peak spawning seasons, is called for to prevent the capture of breeding adults. These management measures must be supplemented with continuous monitoring and periodic stock assessment to ensure the sustainability of the stocks in the region.

Keywords

Coromandel Coast, Gulf of Mannar, Palk Bay, *Otolithes ruber*, Sciaenidae



Food and feeding ecology of the Pharaoh cuttlefish *Sepia pharaonis*, along the southwest coast of India

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The Pharaoh cuttlefish *Sepia pharaonis* is a commercially important cephalopod supporting fisheries along the southwest coast of India. Knowledge of its feeding ecology is crucial, as diet and feeding intensity regulate growth, maturation, and spawning success, thereby influencing recruitment and fishery sustainability. The present work investigated diet composition, feeding intensity, and associated indices with respect to sex, season, and maturity stages. Stomach contents were grouped into fishes, shrimps, crabs, cephalopods, and semi-digested matter. Empty stomachs were common, particularly during spawning months. The Index of Relative Importance (IRI) identified fishes as the dominant prey, followed by shrimps and crabs, while cephalopods contributed least. Ontogenetic shifts were observed, with shrimps forming the major prey in immature individuals, crabs in maturing stages, and fishes dominating in spawning and spent individuals. The Stomach Fullness Index (SFI) ranged between 0.33 and 1.68. Females showed peak values during May (1.37) and December (1.65), while males reached a maximum in August (1.68). The Gastro-somatic Index (GSI) exhibited similar trends, with females highest in May (1.31) and December (1.64), and males in August (1.64). Feeding intensity patterns revealed that females had a higher proportion of $\frac{3}{4}$ full and full stomachs during March–May (up to 43% $\frac{3}{4}$ full), whereas males showed enhanced feeding during August–December (up to 37% full stomachs). ANOVA revealed significant seasonal and maturity-related variations in diet and feeding indices ($p < 0.05$), but no significant differences observed between sexes. These findings demonstrate that *S. pharaonis* is an opportunistic carnivore exhibiting marked seasonal and ontogenetic dietary shifts. Females intensified feeding during reproductive recovery, while males fed more actively during monsoon months, reflecting different energy allocation strategies. The results highlight the ecological role of *S. pharaonis* in linking benthic and pelagic prey resources and emphasise the importance of incorporating feeding indices into fishery assessment models. This knowledge is vital for the sustainable utilisation and management of this commercially important species along the Indian coast.

Keywords

Cephalopods, Diet composition, Feeding indices, Fisheries management, Ontogenetic shifts



Reproductive biology of *Sepiella inermis* (Van Hasselt, 1835) along the Southwest coast of India

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Sepiella inermis is a vital cuttlefish resource supporting cephalopod fisheries along the southwest coast of India. Despite its economic significance, information on the reproductive biology of this species from the region is scarce, restricting the application of science-based fishery management practices. The present study was undertaken to investigate the reproductive cycle, size at first maturity, fecundity, and spawning season of *S. inermis*, providing essential baseline knowledge for sustainable utilisation. Specimens were collected monthly from trawl landings. Each individual was measured for dorsal mantle length (DML), body weight, and gonadal condition. Sex and maturity were identified through gonad examination following standard classification procedures. Reproductive activity was evaluated using the gonadosomatic index (GSI) and the nidamental gland somatic index (NSI). The size at 50% maturity ($L_{m_{50}}$) was estimated from maturity stage data, while fecundity was assessed by counting oocytes in fully mature females. Females ranged from 19-117 mm DML and males from 27-105 mm DML. The sex ratio (M: F = 1:1.3) indicated a higher proportion of females. The $L_{m_{50}}$ was estimated as 46 mm for females and 34 mm for males, showing that females mature at comparatively larger sizes. Both GSI ($p = 0.0096$) and NSI ($p < 0.001$) varied significantly across months, with the lowest levels observed in August and higher values recorded between October and March. This pattern indicates a major spawning season during October to March and a post-spawning recovery in August. Fecundity ranged from 235 to 820 oocytes per female and was positively correlated with body size. Evidence of batch spawning suggests the ability of females to spawn multiple times within a year. The study highlights region-specific reproductive characteristics of *S. inermis* and underlines the importance of management measures such as minimum size limits and seasonal closures. These strategies will help safeguard spawning populations and promote the long-term sustainability of the fishery in Indian waters.

Keywords

Cephalopod fisheries, Fecundity, Nidamental gland somatic index, Size at first maturity, Spawning season



Red crab (*Charybdis edwardsi*) menace in gillnet fisheries of the Bay of Bengal: A sustainable fisheries challenge

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The gillnet fisheries in the Parangipettai coast of Bay of Bengal face a growing sustainability challenge due to the menace of the red crab *Charybdis edwardsi*. These crabs are attracted by entangled fish in the nets and damage both nets and catch of the commercially valuable tuna species such as *Katsuwonus pelamis*, *Auxis thazard*, and *Enthynnus affinis*. Data collected focused on crab abundance, size, sex ratio, fish species affected, and economic losses. With a male-to-female ratio of 1:3, the crabs weighed between 8–15 g and a carapace width of 3.4–5.4 cm. *Euthynnus affinis* was found to be the most susceptible species, likely due to its high blood content and soft body tissue. Economic losses were significant as damaged fish had to be sold for ₹5–8 per kg compared to ₹15 per kg for undamaged fish. To reduce losses, fishers curtailed net soaking time from 8–9 h to 3–4 h, resulting in lower catches and income. Alarming, many shifted to alternate fishing methods such as purse seines which are banned as they are considered ecologically harmful. To address this emerging threat, the study calls for innovative, sustainable interventions, including developing crab-resistant net coatings, understanding depth and colour specificity in crab attacks, and optimising fishing schedules. The research underscores the importance of combining ecological awareness, technological innovation, and policy support to empower coastal fishing communities while promoting sustainable marine resource management. This integrated approach demonstrates that mitigating biological threats in fisheries, backed by science-driven strategies, can enhance sustainability, secure fisher livelihoods and support ecosystem conservation in the Bay of Bengal region.

Keywords

Ecosystem health, Gillnet, Livelihood security, Sustainable fisheries, Tuna fishery



Effect of hook size and shape on hooking location of *Epinephelus malabaricus* in the Gulf of Mannar longline fishery

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This study evaluated the effects of hook size (Nos. 12, 9, and 6) and shape (J-shaped, Kirbed, and Reversed) on the anatomical hooking locations of the commercially valuable reef fish *Epinephelus malabaricus* in the longline fishery of the Gulf of Mannar, southeast coast of India. The hooking locations were classified as: (i) jaw hooking, (ii) throat hooking and (iii) gut hooking. Jaw hooking occurred in 62%, 56%, and 56% of fish with hook sizes H12, H9, and H6, respectively; throat hooking in 25–28%; and gut hooking in 13–16%. Among hook shapes, jaw hooking ranged from 57–60%, throat from 26–28%, and gut from 14–16%. Sardine bait yielded 59% jaw, 26% throat, and 15% gut hooking, with comparable values in squid baits. The findings indicate that smaller hooks and certain shapes slightly increase the incidence of throat and gut hooking, although most fish were consistently caught in the jaw across all treatments. These results highlight the potential of gear modifications, particularly through the optimisation of hook size and shape, to reduce deep hooking and enhance post-release survival. Such practices can contribute to bycatch mitigation and support the sustainable management of longline fisheries in the Gulf of Mannar.

Keywords

Bait, Bycatch, Deep hooking, Gear modification, Sustainable management



Substrate preferences and assemblage pattern of estuarine fishes around the traditional fish aggregating devices in Kochi backwaters

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Kerala has a long history of utilising traditional fish aggregation techniques for fishing operations. This technique utilises the behaviour of the fish to aggregate around the submerged structures. Fishermen make use of different kinds of materials, such as old fishing nets, bamboo frames, tree branches, coconut leaves, or even plastic and fibre components to build the fish aggregating devices (FADs). A participatory field study was carried out to investigate fish assemblage dynamics in FADs. Five FAD units were installed in Veeranpuzha, a northern extension of Vembanad Lake, located in North Paravoor, Ernakulam District of Kerala. Four of the units were constructed using distinct tree substrates: Mango (*Mangifera Indica*), Indian tulip (*Thespesia populnea*), Cashew (*Anacardium occidentale*), and Wild jack fruit tree (*Artocarpus hirsutus*). The fifth unit contained a mixture of all these substrates. The structure was maintained for 60 days and harvested. The fish assemblage pattern of each unit was documented with the fishes identified up to the species level. Among the 12 species of finfish and 3 species of shellfish recorded, pearl spot (*Etroplus suratensis*) was dominant in all the units (targeted species). The percentage of juveniles in each unit was in the range of 3-10. This fishery could be made more effective and responsible by ensuring exclusion individuals below the minimum legal size (MLS).

Keywords

Etroplus suratensis, FADs, Fish assemblage dynamics, Traditional fishing techniques, Vembanad Lake



Feeding dynamics and prey composition of yellowfin tuna (*Thunnus albacares*): Implications for stock assessment and conservation

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Marine apex predators play crucial roles in maintaining ecosystem structure and function through their feeding behaviours, which directly influence population dynamics, community composition, and energy transfer pathways. Yellowfin tuna (*Thunnus albacares*), as a highly migratory pelagic species, occupies a central position in oceanic food webs, yet comprehensive understanding of their feeding ecology remains limited despite their commercial importance and ecological significance. While previous studies have documented general dietary preferences, the complex interactions between ontogenetic shifts, temporal variations, and prey availability patterns require detailed investigation to support ecosystem-based management approaches. To address these knowledge gaps, we conducted an extensive analysis of yellowfin tuna feeding ecology through systematic stomach content examination across multiple size classes and temporal scales. Our investigation reveals distinct ontogenetic dietary transitions, with smaller individuals exhibiting specialised feeding patterns that shift toward more generalized predation strategies in larger specimens. Cephalopods consistently dominated prey assemblages across most demographic categories, though significant seasonal variations in prey composition suggest strong coupling with oceanic productivity cycles and prey availability patterns. Temporal analysis demonstrated recurring seasonal feeding patterns, with distinct clustering of similar dietary compositions during specific periods. No substantial sex-based feeding differences were observed, reinforcing the opportunistic nature of Yellowfin tuna foraging strategies. The study also documented anthropogenic impacts through occasional debris ingestion, highlighting emerging conservation concerns in marine environments. These findings provide essential baseline data for understanding predator-prey dynamics in pelagic ecosystems and contribute to the development of more effective stock assessment models. The observed feeding patterns and seasonal variations offer critical insights for implementing ecosystem-based fisheries management strategies that account for the ecological role of yellowfin tuna as apex predators, ultimately supporting sustainable exploitation and conservation of this commercially valuable marine resource.

Keywords

Apex predator, Ecosystem-based management, Feeding ecology, Ontogenetic diet shift



Sustainable fisheries assessment of *Nemipterus japonicus* (Bloch, 1791) fishery using surplus production model: An assessment from coastal waters of Maharashtra

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Sustainable management of marine fishery resources is often constrained by the lack of species-specific stock assessments, particularly in data-limited fisheries. The Japanese threadfin bream *Nemipterus japonicus* (Bloch, 1791) is a key demersal species in the Northwestern Indian Ocean, yet its stock dynamics in Indian waters remain poorly understood beyond basic landings. Here, we reconstructed 25 years (2000–2024) of catch and effort data from Maharashtra, India and applied a comparative surplus production modelling framework. Four complementary approaches catch-based MSY (CMSY), Bayesian state-space Schaefer model (BSM), Catch and Effort Data Analysis (CEDA), and the stochastic Surplus Production model in Continuous Time (SPiCT)- were used to estimate maximum sustainable yield (MSY), biomass at MSY (Bmsy), and fishing mortality at MSY (Fmsy). The convergence of results across models provided the first quantitative benchmarks for this species in Maharashtra. More broadly, this study demonstrated the value of reconstructed catch and effort data and multi-model inference for strengthening the fish stock assessments in data-limited fisheries.

Keywords

Catch and effort data, Japanese threadfin bream, Multi-model inference, Stock dynamics, Sustainable management



Multiple trawl gears for multi-species fisheries? Technological and regional differentiation among trawlers in Palk Bay, India

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Palk Bay in the southwestern Bay of Bengal is a major fishing ground in Tamil Nadu, extending 296 km from Point Calimere to Dhanushkodi and spanning five coastal districts. The International Maritime Boundary Line (IMBL) divides the Bay between India, where trawling is widespread, and Sri Lanka, where it is prohibited. In the Indian sector, a temporal zoning system regulates access: mechanised trawlers operate on Mondays, Wednesdays, and Saturdays, while motorised vessels fish on alternate days. To characterise trawl fisheries, primary surveys were conducted at six landing centres: Rameswaram, Mandapam, Jegathapattinam, Kottaiapattinam, Sethubavachathiram, and Mallipattinam, together supporting ~1,610 trawlers which constitute 85% of the total trawlers in Palk Bay. Three major trawl types are operated in mechanised vessels: shrimp trawls, fish trawls, mixture 'madi' (prevalent in Jegathapattinam and often targeting juveniles), and a motorised trawl locally named 'thallumadi' which evolved from traditional sailboat. Vessels range from 4.5–12 m for 'thallumadi' and 15–24 m for mechanised vessels. Trawlers in Mandapam and Jegathapattinam primarily target crustaceans, while fish trawls predominate elsewhere. Mostly two-seam trawlers with mesh variations are used. An uncommon two mesh codend of 20 and 30 mm is found in Jegathapattinam and Kottaiapattinam, while other regions use a single mesh of 20 or 30 mm. The throat portion has 30 mm meshes with two belly sections expanding from 30–50 mm in shrimp trawl, and 30–3000 mm with up to nine belly sections in fish trawl. Compared to the upper panel, the lower panel uses smaller meshes to reduce wear. Wing portions range from 50 mm in shrimp to 6000 mm in fish trawl. Twine thickness contrasts regionally: in Jegathapattinam and Kottaiapattinam it increases from cod end to wings, while in other areas the reverse occurs. Various otterboards like wooden rectangular curved, steel oval slotted, and V-shaped are used, with lighter ones for shrimp trawls. For different grounds, modifications like rubber rollers on the lower panel are attached. Operations occur 3–15 nautical miles offshore on muddy, sandy, and coral substrates, with 5–6 crew per vessel and fuel use up to 350 l per trip. The fishing grounds contain seagrass beds and corals that support diverse catches, leading to gear alterations. Region-specific management and locally tailored rules are required to balance fishing practices with sustainable resource use.

Keywords

Bay of Bengal, Fishing ground, Gear diversity, Temporal zoning system



Length-weight relationship and feeding behaviour of the picnic sea bream *Acanthopagrus berda* (Forsskal, 1775), along the Karwar coast of India

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To investigate the length-weight relationship and feeding behaviour of picnic seabream *Acanthopagrus berda*, 285 samples were collected monthly from the Nagnathwada area (Kali River) and Aligadda beach along the Karwar coast, Karnataka, between January 2022 and December 2023. The results indicated that the mean total length of the fish ranged from 18.51 ± 3.7 cm (in December) to 29.4 ± 4.18 cm (in July). The mean total weight varied from 153.69 ± 137.42 g (in December) to 667.00 ± 418.29 g (in July). For males, the regression equation was $BW = 0.00002163 \cdot (TL)^{2.987}$ ($R^2 = 0.89$), and for females, it was $BW = 0.0000280 \cdot (TL)^{2.962}$ ($R^2 = 0.891$). The linear regressions of both males and females were found to be insignificant at the $p < 0.05$ level. The pooled b value of 3.08 was not significantly different from 3, suggesting proportional growth (isometric growth). The highest value of the gastro-somatic index (GSI), 3.93 ± 0.71 , was recorded in September, while the lowest value of 1.47 ± 0.51 was observed in January, resulting in an annual average of 2.35 ± 1.27 . The result of the GSI revealed that the highest feeding activity of *A. berda* was during the monsoon. The highest level of vacuity index was observed in winter (19.07 ± 7.98). The lowest was in monsoon (6.38 ± 0.24), indicating that the highest number of empty stomachs was in winter. The index of relative importance showed that barnacles, bivalves, and crabs were the major food items found in the stomach of *A. berda*, which alter according to season. The other smaller proportion of food items ingested includes cuttlefish, squid, squilla, aquatic plants, and gastropods. This study is valuable for formulating the grow-out feed for *A. berda* aquaculture and for evaluating the ecological role of *A. berda*, highlighting its position in the food chain of Indian coastal waters.

Keywords

Ecological role, Gastro-somatic index, Isometric growth, Regression equation, Vacuity index





Morphometric discrimination and distributional patterns of nine *Upeneus* species (Family: Mullidae)

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Morphometric analysis offers a robust approach for distinguishing closely related fish species and understanding morphological differentiation. In this study, nine species of the genus *Upeneus* (*U. guttatus*, *U. margarethae*, *U. heemstra*, *U. tragula*, *U. sundaicus*, *U. vittatus*, *U. moluccensis*, *U. supravittatus*, and *U. sulphureus*) were analysed using a suite of standardised morphometric characters (%SL). Principal component analysis (PCA) was employed to summarise body shape variation, and the first two principal components (PC1 and PC2) were used to assess interspecific differences. Statistical analyses, including Kruskal-Wallis test, and Dunn's post-hoc pairwise comparisons, revealed significant morphometric differences among most species. The most discriminating variables were body depth, fin position, and fin height characters. These findings demonstrate the effectiveness of multivariate morphometric techniques in *Upeneus* taxonomy and suggest links to ecological adaptations. The distribution patterns of the nine *Upeneus* species revealed that *U. sulphureus* was widespread along the Indian coasts, including the Andaman region, while *U. tragula* was restricted to the Andaman Islands. Most species were found to be concentrated along the south-eastern coast of India, suggesting a potential hotspot for *Upeneus* diversity.

Keywords

Ecological adaptation, Interspecific differences, Morphometric variation, PCA



An updated checklist and characterisation of sciaenid species from Indian waters

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The family Sciaenidae, commonly known as croakers or drums, represents a diverse and ecologically significant group of demersal marine and estuarine fishes found primarily in the tropical and subtropical waters worldwide. Information on taxonomy of sciaenids in India is limited. An ichthyofaunal survey conducted during 2020 to 2023 across selected marine and estuarine habitats revealed the presence of 27 sciaenid species in 14 genera (*Otolithes*, *Johnius*, *Daysciaena*, *Kathala*, *Nibea*, *Pennahia*, *Otolithoides*, *Protonibea*, *Pterotolithus*, *Panna*, *Atrobucca*, *Chrysochir*, *Macrospinosa* and *Dendrophysa*). Among these, *Johnius* was the most speciose, indicating a high degree of diversification within this lineage in Indian waters. This survey provides valuable baseline data and contributes to the broader understanding of sciaenid diversity in the region.

Keywords

Arabian Sea, Bay of Bengal, Croakers, Taxonomy



Population characteristics of the unicorn leatherjacket *Aluterus monoceros* along the South Tamil Nadu Coast

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The present study was conducted on the population characteristics of filefishes (Family: Monacanthidae) along the south Tamil Nadu coast (Nagapattinam, Thoothukudi and Kanyakumari) for a period of 18 months from February 2022 to July 2023. Age, growth, mortality, and exploitation rates were studied to assess the current status of the population. The asymptotic length (L_{∞}) and growth rate (K) (growth parameters) of *A. monoceros* were estimated as 59.05 cm and 0.29 yr^{-1} , respectively. The potential longevity (t_{max}) and length at first capture (L_c) were found to be 4.0 years and 34.14 cm, respectively. The fishing mortality ($F=0.60 \text{ yr}^{-1}$) of *A. monoceros* was higher than the natural mortality ($M=0.55 \text{ yr}^{-1}$), suggesting an optimum sustainable level of exploitation for the species within the present study area. The K value indicates the slow growth rate of this tropical demersal fish species. The recruitment of *A. monoceros* was recorded throughout the year, with two peaks in July. The current exploitation rate (E) is 0.52 yr^{-1} , which shows stocks are moderately exploited along the south Tamil Nadu coast. An integrative conservation approach, including fishing closure during spawning seasons and mesh size regulation will ensure sustainable harvesting for the species in the South Tamil Nadu Coast of India.

Keywords

Conservation, Exploitation rate, Filefishes, Fishing mortality, Mesh size regulation



Reproductive traits of *Ambassis dussumieri* (Cuvier, 1828) inhabiting Vembanad Lake

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Information on sexual maturity, spawning cycle and fecundity is important in determining the recruitment pattern of a fish in its habitat. *Ambassis dussumieri* (Cuvier, 1828) is a major ambassid species that supports a lucrative fishery in the Vembanad Lake, Kerala. The reproductive traits of *A. dussumieri* were studied by examining 262 gonads from 1,748 individuals sampled from the lake. The fish ranged in total length from 61 to 89 mm. Five maturity stages could be identified by examining the gonads. The pooled sex ratio was significantly skewed in favour of males 1:0.72 ($\chi^2=44.9$; $p<0.01$). Though mature and ripe gonads were encountered throughout the year, higher preponderances of ripe and spent gonads could be discernible from May to September. In June, only ripe and spent ovaries could be recorded, while mature males recorded high preponderances in June to September. The gonadosomatic index values worked out in females were high in June (6.71 ± 1.08), July (5.82 ± 1.64), November (4.45 ± 0.92) and December (4.90 ± 1.45), while the same recorded in males was high in June (6.98 ± 2.49). The length at first maturity was 52.97 mm in males and 51.25 mm in females. The mean fecundity was estimated at 3544 ± 219 (Range 438-12658).

Keywords

Fecundity, Gonadosomatic index, Recruitment pattern, Sexual maturity, Spawning cycle



A report on the *Encrasicholina* species occurring in Kerala waters

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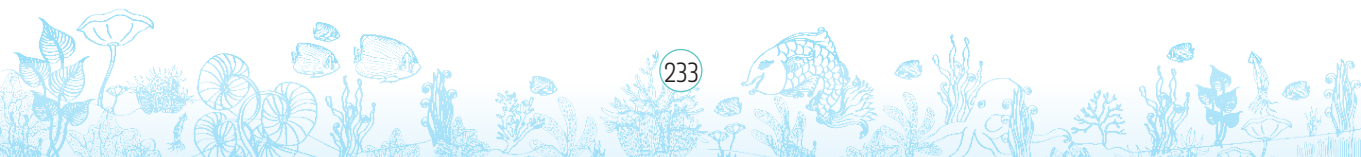
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The genus *Encrasicholina*, belonging to the family Engraulidae (anchovies), comprises several small, pelagic fish species of significant ecological and economic importance, particularly in Indo-Pacific fisheries. Accurate species identification within this genus is crucial for diversity discovery, biodiversity conservation, and ecological studies. Species identification is often carried out as a quick, on-the-spot method while collecting fish landing data, especially at busy landing sites, which can frequently lead to misidentification. We examined 525 specimens of *Encrasicholina* from the landings along the southern coast of Kerala. The study revealed that the major contribution from this genus was made by two species, *Encrasicholina punctifer* and *E. heteroloba*. We compared otolith shape and various morphometric and meristic characteristics, which showed considerable variation in overall shape, maxilla length (reaching or not reaching the preopercle), maxilla tip shape (pointed or blunt), fin ray counts, and body proportions. We did not record *E. devisi*, a species frequently cited in catch statistics, whereas *E. heteroloba* was documented for the first time, likely due to previous misidentifications. In light of these findings, we propose a rapid identification method for *Encrasicholina* species occurring along the Kerala coast, acknowledging the challenges posed by intraspecific variation and interspecific overlap that often lead to misidentification.

Keywords

Anchovies, Morphometry, Meristic characteristics, Otolith, Taxonomy



Truss morphometry in stock identification of fish

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The identification of self-sustaining elements in natural populations is the focus of the interdisciplinary field of stock identification. Despite genetic similarity, the concept of stock separates the population into groups with different growth rates and reproductive dynamics. The major objective of stock assessment programs is to manage fishery resources through providing advice on the most effective methods for exploitation. The discrimination of stock units may benefit from morphometric changes with growth that may vary between locations. As the traditional morphometric measurements have biased coverage over the body, the truss network system is the best alternative, which covers the fish in a uniform network and increases the likelihood of extracting morphometric differences within and between species. Truss network measurements are a series of distances calculated between landmarks that form a regular pattern of connected quadrilaterals or cells across the body form. Truss network system is a landmark-based method that uses geometric morphometrics and does not restrict the localisation of shape changes or the direction of variation. It is highly effective at capturing information regarding an organism's shape. Fishery management involves identifying stocks, distinguishing among them and determining the composition of mixed stocks. Determination of the population structure of species is an essential component for the successful management of fisheries.

Keywords

Fishery management, Landmarks, Geometric morphometrics, Population structure, Quadrilaterals



Bridging Palk Bay: A comparative study of Indo-Sri Lankan fisheries regulatory mechanisms for sustainable management

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Palk Bay is a shallow maritime area located between India and Sri Lanka and a crucial fishing ground for both Indian and Sri Lankan fishing communities. The region is separated by the International Maritime Boundary Line (IMBL) and has historically been central to Indo-Sri Lankan fisheries disputes. The dispute primarily stems from the abundant marine resources on the Sri Lankan side and the increasing use of modern fishing methods, such as bottom and pair trawling, by Indian fishermen operating in or near Sri Lankan waters, practices considered harmful and often unauthorised. Against this, the Tamil Nadu Marine Fishing Regulation Act (TNMFRA), 1983, and Sri Lanka's Fisheries and Aquatic Resources Act, No. 2 of 1996, along with the Regulation of Foreign Fishing Boats Act (FARA), No. 59 of 1979, play key roles in regulating fishing activities and controlling tensions in the region. The TNMFRA, together with its amendments in 2000, 2011, and 2016, constitutes India's primary legal framework governing fishing along the Tamil Nadu coast, especially in the Palk Bay. Its provisions cover licensing, vessel registration, zone restrictions [prohibiting mechanised vessels within 5 nautical miles (nmi) and motorised crafts within 3 nmi], and mandatory safety and surveillance systems. Amendments extended regulations to boat-building yards, net-manufacturing units, and penalised unlawful activities. However, the Act still permits bottom trawling, which continues to be a major source of dispute. In contrast, Sri Lanka's Fisheries and Aquatic Resources Act, No. 2 of 1996, and the Regulation of Foreign Fishing Boats Act, No. 59 of 1979 (amended in 2018), focus more strongly on conservation. The 2017 amendment imposed a comprehensive ban on bottom trawl nets, while the 2023 amendment introduced stringent action against Illegal, Unreported, and Unregulated (IUU) fishing, including forfeiture of vessels and registration cancellations. The 2018 amendment further strengthened deterrence through increased penalties and expanded liability to vessel owners and skippers. Despite their alignment with international best practices, Sri Lanka faces challenges in surveillance infrastructure and offering livelihood alternatives to fishers. A comparison reveals that India's TNMFRA is more livelihood-oriented, whereas Sri Lanka's framework prioritises conservation. Both approaches face implementation challenges, whether in addressing destructive fishing practices or ensuring socio-economic security for fishing communities. To reduce the tension, harmonising laws and creating a joint fisheries management authority are essential. Joint surveillance and humane conflict protocols can ensure long-term ecological and livelihood balance.

Keywords

Bottom trawling, Fisheries regulation, Indo-Sri Lankan dispute, Palk Bay, Sustainable fishing



Understanding responsible fishing behaviour among fishers based on theory of planned behaviour

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The right to fish carries along with it an obligation to do fishing responsibly which is the fundamental principle of the FAO Code of Conduct for Responsible Fisheries (FAO-CCRF). Individual behaviour and decision-making are critical in deciding sustainable levels of exploitation of fishery resources. Understanding responsible fishing behaviour among fishers will throw light into pathways required for development of sustainable fisheries management practices that can be effectively implemented for compliance by stakeholders. The hypothesis for this study was that, a positive attitude towards responsible fishing, with a favourable social norm and high level of perceived behavioural control form a behavioural intention and will lead to displayed behaviour. Attitude was assessed as the sum of 13 items using 5-point Likert scale. Items measured attitudes based around 5 most important responsible fishing practices. Subjective norm and Perceived Behavioural Control were assessed based on items corresponding to selected behavioural component on a 5-point Likert scale. Past behaviour (PB) was assessed for important and practically feasible behavioural component. Randomly Selected 60 fishermen from Kozhikode, Ernakulam and Kollam were the respondents of the study. Score of the all three TPB variables: attitudes, subjective norm and PBC were assessed using multiple regression analysis and it was found that the overall model was significant. The results of the study revealed that majority of the respondents had a positive attitude towards responsible fishing, social norms were found to be having weak (non-significant) influencing fishing Behaviour and Perceived behavioural control had a significant influence in responsible fishing Behaviour especially with respect to adoption of conservation technologies

Keywords

Attitude, Behavioural control, Likert scale, Perceived behavioural control, Subjective norm



Impact of non-state actors on fish resource management and fishers' welfare: The case of *Kadakkodi* in Kerala

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The management of marine resources and the improvement in fishers' livelihood have often been dominated by state-led interventions. However, non-state actors also play a crucial role in resource regulation and social protection. This study investigates the impact of the Puthiyangadi Kadappuram Malsyabandhana Thozhilaali Kadakkodi Samrakshana Samithi, a grassroot level non-state institution in Kannur District, Kerala, on fisheries management, fish marketing, and the socio-economic life of fishermen. Unlike most non-governmental organizations that are politically or religiously affiliated, this *Kadakkodi* (Kadal kodathi/Sea court) represents an inclusive model, uniting fishers across caste, religion, and politics to pursue collective welfare. Established informally in 1982 and registered in 2001, the *Kadakkodi* has grown into a strong institution with nearly 500 members, representing a large fishing community that includes both local fishers and migrant workers. The study employed primary data collection from fishers, wholesale agents, auctioneers, and interview with governing body members. Secondary data from fisheries records and *Kadakkodi* records were also used. The findings highlight that the *Kadakkodi* enforces community-based resource governance mechanisms such as a ban on night fishing, seasonal restrictions, prohibition of destructive gears, and a weekly holiday. These rules complement State Government's regulations and have been widely accepted by local fishers. Besides resource management, the committee intervenes in fish marketing as well. By instituting a licensed auction system, and appointing licensed auctioneers from the side of the *Kadakkodi*, it attempts to ensure fair prices to the fishers, improves marketing efficiency and guarantees timely payment to craft owners from the traders. Beyond resource and market regulation, the *Kadakkodi* functions as a social security provider. It offers financial assistance for accidents, death and medical emergencies. Revenue is sustainably generated through regulated contributions from each fishing craft. The study concludes that the *Puthiyangadi Kadakkodi* demonstrates how non-state institutions can effectively complement government mechanisms by integrating resource conservation, equitable marketing, and welfare provision. Its holistic approach makes it a replicable model for community-driven fisheries management in other coastal regions.

Keywords

Conflict resolution, Fish resource conservation, Governance system, Kadakkodi, Non-state institutions



Sustainable implications of capital dredging on ichthyodiversity and dipnet fishery in the Cochin tidal mouth

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Estuaries are ecologically dynamic and biologically diverse ecosystems that serve as critical transitional zones between freshwater and marine environments. The Cochin Estuary, one of the largest estuarine systems in southwest India, is part of the Vembanad-Kol wetland complex, which is recognised as a Ramsar site. Capital dredging, conducted primarily for navigation, port expansion, and infrastructure development, poses a significant threat to estuarine biodiversity and ecosystem sustainability. Dredging operations lead to sediment resuspension, increased turbidity, alteration of hydrodynamics, and loss of benthic habitats, all of which can disrupt fish communities and their associated food webs. During the period of capital dredging at Cochin estuarine mouth, a significant decline in species diversity was noted in the Chinese dipnet fishery could be noticed. The occurrence of reef-associated species at the estuarine mouth was considerably reduced. Also, significant reduction in the landings of major fishery resources could be noticed in the area, including mullets (reduced by 58.44%), mojjaras (reduced by 70.89%), and shrimps (reduced by 47.63%). The catch per unit effort (CPUE) of various species differed significantly between the pre-dredging and dredging periods ($p < 0.01$).

Keywords

Benthic habitats, Chinese dipnet fishery, CPUE, Estuaries, Sediment resuspension



Mapping the technological challenges encountered by deep sea fishermen in Tamil Nadu

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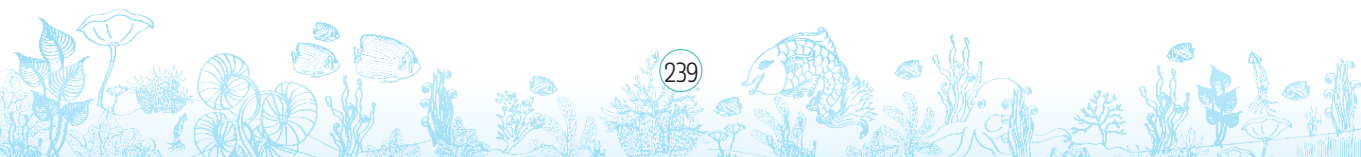
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Indian marine fish harvest mostly comes from coastal waters up to 100 m depth and about 90% of the catch comes from within the 50 m depth zone. Revalidation of marine fisheries potential has shown that fishing pressure on nearshore resources in India has increased considerably, with clear signs of overexploitation of several species. Tapping the under-exploited deep-sea resources offers the most viable pathway for enhancing marine fish production, diversifying fisher livelihoods, and contributing to both the state and national economy. Deep-sea fisheries in India have emerged as a crucial frontier in the expansion of marine capture fisheries. Therefore, deep-sea fishermen who engage in fishing operations beyond the continental shelf and at depths greater than 200 m need to be empowered with advanced technology for enhancing their fishing activities. Technology in fisheries encompasses tools, techniques, methods, and systems that help fishers to locate productive fishing grounds, improve efficiency, ensure safety during long voyages, and maintain the quality of their catch. Reliable and efficient fishing technology ensures sustainable and effective production and utilisation of marine resources. Moreover, the identification of suitable and productive fishing grounds is the need of the hour for better economically viable fishing. In recent years, government interventions such as vessel modernisation programmes and training in navigation and safety have significantly facilitated the growth of deep-sea fishing operations. Tamil Nadu is regarded as the flagship state of deep-sea fisheries in India where the government introduced a special scheme in 2017 to replace bottom trawlers with deep-sea fishing vessels, provided the highest subsidies, offered overseas training for fishermen, and developed dedicated harbours for deep-sea landings, making it the pioneer among Indian states. This study explored the technological challenges encountered by deep-sea fishermen in Tamil Nadu through a field-based survey using structured questionnaires. The findings highlight the urgent need for targeted technological interventions, improved access to equipment, and capacity-building programmes to strengthen the operational efficiency of deep-sea fisheries in India. To bridge the gap between policy and implementation in the deep-sea fishing sector, there is a need to strengthen institutional capacity and ensure timely access to modern technologies for the deep-sea fishers.

Keywords

Efficiency, Fishing grounds, Fishing technology, Safety, Vessel modernisation



Assessment of infrastructural constraints affecting coastal fishermen in Kerala

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Marine fishing population in Kerala is over 8 lakhs, of which nearly 2 lakhs are registered fishermen (2022–23) and therefore the fisheries sector remains a cornerstone of Kerala's economy and social fabric. Coastal fishers engaged in small-scale or artisanal fishing activities within the nearshore waters, generally up to 12 nautical miles from the shoreline, form a major share of the fisher population in Kerala. Majority of coastal fishermen rely on fishing for their livelihoods, making the development and maintenance of supportive infrastructure essential. Several government support schemes exist for the development of coastal fisheries infrastructure. Infrastructural facilities in the fisheries sector refer to the physical, organizational and technical systems that enable efficient fishing, post-harvest handling, preservation, processing, storage, transportation, and marketing. Efficient and well-maintained infrastructure forms the backbone of a sustainable fisheries sector, enabling fishers to maximise resource utilisation while supporting food security and economic growth. This study was conducted in selected coastal districts of Kerala based on field surveys using structured questionnaires which investigated the infrastructural limitations faced by coastal fishermen for fishing activities. The research highlighted the infrastructure gaps encountered by the coastal fishers in selected districts in Kerala. Harbours and landing centres, cold storage, transportation, and market facilities are the major gaps in infrastructure that can severely affect the livelihoods of coastal fishing communities if proper initiatives are not taken up. Many fishermen are unable to effectively access or benefit from the governance bodies, leaving a large section of the community still struggling with poor facilities. The findings provide valuable insights for policymakers and development agencies to address these bottlenecks through targeted infrastructural interventions. Strengthening fisheries infrastructure will be crucial to enhancing operational efficiency, reducing post-harvest losses and ultimately securing the socio-economic well-being of coastal fishing communities.

Keywords

Artisanal fishing, Challenges, Coastal fisheries, Livelihoods, Resource utilisation



Closing the blue nutrient gap: A new lens for sustainable fisheries and food security

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Global food systems face escalating pressures from climate change, environmental degradation, and persistent malnutrition. According to UNICEF, WHO and the World Bank (2025), over 150 million children remain stunted, 42.8 million wasted, and 35.5 million overweight, while 295 million people experienced acute food insecurity in 2024. Although food production is sufficient to feed 12 billion people, inequitable access and poor dietary diversity leave millions undernourished. This paradox underscores the urgency of closing the *blue nutrient gap*, the under-utilisation of aquatic foods in diets and policies despite their rich nutritional value. Various studies, including feeding trials, nutrient composition analyses, ecological case studies, and global reviews, have been conducted to evaluate the role of aquatic foods in sustainable nutrition and mariculture. Results of various studies show that small pelagic fish such as sardines and anchovies can provide up to 60% of daily iron needs and over 100% of vitamin B12 requirements per serving, while bivalves and seaweeds supply affordable protein, iodine, and omega-3 fatty acids. Innovations such as the utilisation of fish-processing waste, algae and insect meals can reduce fishmeal dependency by 30-40%, support circular bioeconomy models, and alleviate pressure on wild stocks. Framing food security through the blue nutrient gap provides a new lens for research and policy, positioning aquatic foods as a cornerstone of affordable, healthy, and climate-resilient food systems.

Keywords

Aquatic foods, Climate-resilient nutrition, Innovation, Small pelagic species, Sustainable fisheries



Broodstock availability, ovotestis development and spawning in the fanged seabream *Sparidentex jamalensis*, of the Korapuzha Estuary, Kerala

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The reproductive biology and availability of broodstock for the fanged seabream (*Sparidentex jamalensis*) were studied in wild populations of the Korapuzha Estuary, Kozhikode, Kerala, from 2016 and 2024. Spawning activity occurred from August to December, peaking from September to November, with no mature individuals observed from January to July. Histological examination of 300 gonad samples showed the presence of ovotestes in all specimens, indicating protandrous hermaphroditism. Ovotestes were categorised into four types: undifferentiated, testicular-dominant, ovarian-dominant, and transitional. Undifferentiated ovotestes were predominant from January to July, with the highest incidence in July. Ovarian-dominant ovotestes appeared in 115 individuals, which had a long resting phase from January to July. This phase was marked by the presence of oogonia, primary growth phase oocytes, and occasional yolk vesicle stage oocytes. Intense ovarian development took place from September to November, with advanced vitellogenic oocytes, while the testicular region in these individuals remained regressed. In 171 individuals, testicular-dominant ovotestes were functionally male and showed peak spawning activity aligned with females. Their ovarian regions contained only undeveloped oocytes that did not advance beyond the perinucleolar stage. The gonadosomatic index was highest during the spawning season, reaching peak values of 3.29 in females and 1.69 in males during September. The study also provided fecundity estimates, with average annual absolute fecundity at approximately 1,958,663 eggs and relative fecundity at 1,895 eggs per gram of female body weight. These findings provide key insights into the reproductive dynamics and hermaphroditic nature of *S. jamalensis*, contributing to the development of broodstock and breeding strategies for this species.

Keywords

Fecundity, Gonadosomatic index, Histology, Ovarian development, Protandrous hermaphroditism



Insights into *Sparidentex jamalensis*: Growth patterns, reproductive biology and feeding habits from Korapuzha Estuary, Kerala

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This study examined the growth pattern, reproductive and feeding biology of *Sparidentex jamalensis* (fanged seabream) in the Korapuzha Estuary, Kerala, India. An analysis of 365 fishes showed significant variability in size and weight, with lengths ranging from 6.7 to 53.5 cm and weights from 6.1 to 2505 g. The length-weight relationship parameters suggest isometric growth, with a mean b value of 3.09 ± 0.02 , similar to earlier observations on seabreams from a review of literature. The overall condition factor was 1.007, indicating a healthy population. A male-dominated population with notable size-related differences among the sexes was recorded. Males dominated smaller size classes, while females were more common in larger ones, reflecting protandrous reproductive behaviour. The length at 50% maturity for males was 22.5 cm total length (TL) and for females was 33.0 cm TL. Gonadosomatic index (GSI) analysis showed peak breeding activity from August to December, which aligned with the occurrence of fingerlings. Dietary analysis showed *S. jamalensis* as an opportunistic predator, mainly eating fish (45.99%), shrimp (26.63%), and crab (24.03%). Seasonal changes in diet composition were observed, with a more varied diet during the southwest monsoon period. The species showed omnivorous feeding habits, indicated by a relative gut length (RLG) of 0.94 ± 0.03 . Seasonal patterns in the gastric fullness index (GaSI) and vacuity index (VI) revealed active feeding during summer and pre-monsoon, with decreased feeding after the monsoon. These findings offer valuable insights into the growth, reproductive biology, and feeding ecology of *S. jamalensis* in the Korapuzha Estuary while offering foundational data for refining seed production technologies for *S. jamalensis*.

Keywords

Diet composition, Feeding biology, Gonadosomatic index, Growth, Vacuity index



Sea cage net enclosures and farms act as short-term nurseries of bivalve and seaweeds contributing to resource recruitment and enhanced coastal productivity

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Cage farms serve as recruitment zones, providing structural habitats and potential settlement surfaces that attract and facilitate the settlement and growth of wild bivalves and juveniles on cage enclosures, accessories and other farm structures. During farming demonstrations conducted over the past two decades along the Bay of Bengal coast spanning from Chennai, Tamil Nadu to Visakhapatnam, Andhra Pradesh, during the July-August period, the sea cage enclosures (HDPE and PE nets) attracted the spat of several settlers. These included green mussel (*Perna viridis*) 30-56 mm; Indian pearl oyster (*Pinctada fucata*, 20-50 mm); scallop (*Volachlamys tranquebarica*, 18-40 mm); oyster (*Crassostrea madrasensis*, 18-45 mm); ear shells (*Pteria sterna*, 21-65 mm), pearl oyster (*P. margaritifera*, 30-62 mm) and seaweeds such as *Ulva* sp. (5-6.5 %) and *Gracilaria* sp. (0.5-1%). Observed densities included pearl oysters (5-6%), scallops (1-1.5%), ear shells (1-1.2%), green mussels and oysters (15-20%), along with other invertebrates. The collected and sorted spat were packed into HDPE mesh bags, frame boxes and net tubes to assess survival, efficiency, and growth alongside regular finfish stocks within the cages. Green mussels suspended on ropes around the outer cage frames exhibited the highest growth rates. HDPE mesh bags supported better survival and growth of scallops, frame boxes were optimal for oyster seed, and HDPE flat pouches proved most suitable for pearl oysters. HDPE flat pouches proved most suitable for pearl oysters. While green mussels and oysters can be cultivated for seafood production, pearl oysters, scallops, and ear shells hold potential for ornamental use. The study also identified that bivalve and seaweed aquaculture support greater abundance and species richness of wild mobile macrofauna, contributing to measurable ecological enhancement. Such propagation provides multiple ecosystem services, including water quality regulation, restoration of native populations, and improved productivity of nearshore intertidal habitats. If repeatable operational conditions that enhance habitat benefits can be identified and incentivised through proactive policies or market-based mechanisms, localised impacts could be scaled up to achieve regional and national ecosystem gains. As understanding of the ecological functions of bivalve and seaweed aquaculture deepens, adaptive management practices can further strengthen the role of mariculture in delivering habitat values and ecosystem services, potentially driving positive outcomes at a global scale.

Keywords

Bivalve farming, Ecosystem services, Habitat value, Mariculture, Stock restoration, Seaweed



Enhancing growth and survival in mangrove red snapper (*Lutjanus argentimaculatus*) larvae through improved feeding and rearing practices

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The mangrove red snapper (*Lutjanus argentimaculatus*) is a commercially important brackishwater finfish, with captive maturation and breeding protocols successfully standardised by ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA). Despite these advances, larval survival remains a critical bottleneck limiting large-scale seed production. To address this challenge, experiments were conducted to evaluate the effects of feeding regimes, tank background colour, and delayed feeding on larval growth and survival. Freshly hatched larvae were stocked at a density of 2,000 individuals per 500 l FRP tank and reared under three feeding treatments during the first 10 days post-hatch (dph): (i) rotifers alone, (ii) copepod nauplii alone, and (iii) a mixed diet of rotifers, copepod nauplii, and ciliates. All live feeds were enriched with mixed microalgae before feeding. The mixed diet produced the highest survival ($51.67 \pm 3.5\%$), followed by copepod nauplii ($41.26 \pm 2.1\%$), while rotifers alone resulted in significantly lower survival ($18.22 \pm 1.02\%$). The inclusion of protozoan ciliates (*Euplotes* sp.) and $<70 \mu\text{m}$ copepod nauplii improved nutritional availability and enhanced feeding efficiency during the critical early larval stages. In a complementary trial, tank background colour significantly influenced larval performance: white tanks supported the highest survival ($42.66 \pm 2.6\%$) up to 12 dph, followed by green tanks ($35.82 \pm 1.99\%$), whereas transparent tanks yielded the poorest results. A delayed feeding trial further demonstrated that survival was higher when larvae initiated feeding at 1-2 dph compared to 3 dph, while complete mortality occurred by 5 dph when initial feeding was delayed until 4 dph. These findings emphasise the importance of dietary diversity, timely feeding, and optimal rearing environments in enhancing larval survival. Adoption of mixed live feed regimes and appropriate culture conditions could help overcome survival bottlenecks and support large-scale hatchery production of mangrove red snapper.

Keywords

Feeding efficiency, Larval survival, Live feed regime, Rearing environment, Tank colour



Best management practices (BMP) for coastal pond farming of Indian pompano for sustainable farming practices

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Indian pompano farming in coastal ponds leads to an increase in farming operations, which need development for specified culture operations. Thus, best management practices guidelines were developed for Indian pompano farming for complete culture operation. The square-shaped earthen pond of 1.5 m water depth with a 0.1 m slope is recommended. The water treatment is with 10% chlorination, followed by liming to maintain pH 7.5 to 8.5. Seed stocking can be performed with optimum seed size after a week of water treatment. Fish fingerlings of 25.0 ± 5.0 g can be stocked directly in the pond. The fingerlings below optimum size should be stocked in hapa, or an enclosed structure in 10% of the pond area, which supports survival >90%. With 12 h of transit time, the fish seed size <2.5 g can be transported in oxygen-filled polythene bags, and >2.5 up to 50 g is to be transported in tanks supported with oxygen of 8-10 ppm. Grow out pond is to be stocked with optimum size seed at a stocking density of 1.2 to 1.5 no. m⁻². During pre-grow out culture, the floating pellet feed of 45% protein and 10% fat is recommended for up to 75 ± 5.0 g with 4-5 times feeding, and should be broadcast in the feeding zone. In an advanced grow-out system, fish can be reared up to 1000 g in size with floating pellet feed of 40% crude protein and 10% crude fat of 3-6 mm feed. The recommended water quality parameters in grow-out culture include 15-30‰ salinity, 7.5 to 8.5% pH, <1.0 ppm ammonia and hydrogen sulphide, and 4.5 to 6 ppm of dissolved oxygen content. The pond should be provided with an aerator of 2-3 number per acre, with the minimum operation time of 5-10 h day⁻¹. Water exchange of 25% per month is necessary to maintain water quality to avoid the use of probiotics and water conditioners. Maintaining the prescribed management practices helps to achieve up to 4000 kg of fish of an average 1.0 kg size for a culture period of 12 months with survival >90%. The BMP adopted in the culture method will help farmers to achieve economic profit with a benefit-to-cost ratio >1:1.9. Adopting recommended best management practices for Indian pompano farming in coastal pond farming will bring economic profit to the farmers with healthy and sustainable production.

Keywords

Benefit-to-cost ratio, Pond culture, Stocking density, Sustainability, Water quality parameters



Copepods: A next-generation live feed for marine animals and larval forms

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Copepods are emerging as a superior live feed option for marine aquaculture, offering significant advantages over traditional live feeds such as *Artemia* and rotifers. Copepods naturally form an essential component of marine food webs and are the most important and abundant group in the zooplankton. These are superior in terms of high nutritional value, including essential fatty acids, essential amino acids and micronutrients crucial for the healthy development of marine animals, especially during their sensitive larval stages. Their small size, special swimming behaviour, and nutritional profile make them highly suitable for feeding a wide range of marine fish larvae and invertebrates, improving survival rates, growth performance, and overall health. This abstract explores the case studies of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) on the potential of copepods as a next-generation live feed, focusing on their cultivation techniques, nutritional benefits, and practical applications in modern aquaculture systems. ICAR-CMFRI has developed pure cultures of 12 species of marine copepods, which can be produced on a large scale for use as live feed in marine hatcheries. These include *Acartia southwelli*, *A. bilobata*, *A. sarojus*, *Parvocalanus crassirostris*, *Bestiolina similis*, *B. coreana*, *Pseudodiaptomus serricaudatus*, *P. annedale*, *Apocyclops cmfri*, *Dioithona oculata*, *Oithona brevicornis* and *Euterpina acutifrons*. These cultures offer a wide range of live feed options with size variations from 20 to 1500 µm. Nutritional studies indicated a higher percentage of essential amino acids and fatty acids in all the tested live feeds. Experimental studies have demonstrated higher success in utilising it as a feed for the larvae of marine food fish and ornamental fish. Currently, these are being utilised as initial larval feed for groupers, snappers, emperors, pompanos, trevallies, and sea breams. By integrating copepods into hatchery operations, the industry can enhance larval rearing success, support sustainable production, and meet the growing demand for high-quality marine fish and invertebrates.

Keywords

Hatchery, Live feeds, Larval survival, Marine fish seed, Nutritional profile



Mass seed production of double dot domino clown *Amphiprion ocellaris* and its design variation in F1 juveniles

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Marine ornamental fishes possess tremendous potential in the global market due to their attractive colouration and unique behaviour. However, the absence of sustainable hatchery production and the overexploitation of wild stocks pose serious threats to their natural ecosystems; hence captive production of reef-associated communities has become inevitable. The domino clownfish, a designer variant, has been developed through selective breeding of the Black and White Darwin Ocellaris clownfish (*Amphiprion ocellaris*). The Darwin Ocellaris is characterised by a striking jet-black body with three contrasting white stripes. Instead of orange body colour in the common ocellaris. This study documented the courtship behaviour, broodstock development, selective breeding, embryonic and larval development, as well as larval rearing for the mass production of designer Domino Clownfish under captive conditions. The broodstocks were developed from sub-adults of 60–100 mm TL double dot domino and stocked in 500 l glass aquaria in the hatchery at 28–29°C for pair formation. After six months, seven pairs were successfully established, with females ranging from 90–100 mm and males from 50–70 mm. Each pair was then transferred to 250 l perspex breeding tanks maintained under a 14L:10D photoperiod using a 40 W bulb suspended 20 cm above the water surface. Water quality parameters (temperature, salinity, dissolved oxygen, pH, NO₂, NO₃ and NH₃) were maintained at optimal levels and monitored daily. Broodstock were fed with minced squid, shrimp, green mussel meat, raw fish egg masses (5% of body weight, 6 doses daily), along with live adult *D. celebensis* (10–15 per day). Spawning began after six months of conditioning and each pair laid 300–400 eggs per pair per month. The incubation period lasted 144 h at 28±1°C, during which males predominantly guarded the eggs. Newly hatched larvae measured 1.5±0.1 mm in length, with a mouth gape of 90–110 µm. Larval rearing was carried out in 250 l rectangular tanks, using phytoplankton (*Nannochloropsis oculata* and *Chlorella salina*, 1:1 at 1–5×10⁶ cells ml⁻¹) along with different combinations of live microzooplankton. Metamorphosis to juveniles occurred within 25–30 days post-hatch (dph). The juveniles exhibited variable banding patterns: 50% without bars, 25% with one opercular white dot, 20% with two dots (cheeks and lateral side), and 5% with broken bands of different shapes. After 45 days, the juveniles reached an average total length of 28.82 mm and an average weight of 0.360 g.

Keywords

Embryonic development, Marine ornamental fish breeding, Photoperiod, Seed production.



Mass seed production and ranching of yellow foot clam *Paphia malabarica* for sustainable fisheries

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Broodstocks of the yellow foot clam *Paphia malabarica*, with an average shell length of 35.1 mm and weight of 17.1 g were collected from Ashtamudi Lake and conditioned under controlled hatchery conditions. After two months of rearing, the clams spawned volitionally. Fertilized eggs, averaging 57.42 μm in diameter, were incubated in two-ton FRP tanks for 16-18 h. D-shaped larvae (average size: 97.06 μm) were reared under optimal water quality conditions (salinity, 35 ppt, pH, 7.8-8.2, temperature, 28-31°C and dissolved oxygen, 4.4 mg l⁻¹) and fed a multispecies micro-algal diet twice daily. Larvae reached the umbo stage by 3 days post-hatch (dph) and developed foot structures by 6 dph. Settlement occurred on 9 dph, after which the spat were transferred to a micro-nursery system for further rearing. After 60 days, the juvenile clams reached a size of 3-5 mm and were oxygen-packed for transportation. Three million hatchery-produced clam seeds were successfully ranched at selected sites in Ashtamudi Lake to support sustainable fishery enhancement.

Keywords

Fish feed, Growth, Immune stimulation, Integrated aquaculture, Macroalgae, Sustainability



Optimising stocking ratios for polyculture of maze rabbitfish *Siganus vermiculatus* and silver pompano *Trachinotus blochii* in marine cage aquaculture

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An experiment was conducted to evaluate the growth performance of maze rabbitfish (*Siganus vermiculatus*) and silver pompano (*Trachinotus blochii*) stocked at different species ratios in sea cages. The study was carried-out in GI sea cages of 3 m diameter in the model marine cage farm at Karwar Regional Station of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) (14°80'59"N 74°11'39"E) for 180 days of culture (DOC). Hatchery-produced maze rabbitfish fingerlings (7.60±0.15 cm, 8.68±0.68 g) and silver pompano fingerlings (8.91±0.206 cm, 14.62±0.828 g) were stocked at different ratios at a stocking density of 15 nos. m⁻³. The stocked fingerlings were fed with feed containing 40 % crude protein and 10% fat in 2 rations per day (08.00 hrs and 14.00 hrs). The experimental treatments consisted of four groups with replications: Control (100% maze rabbitfish), T1 (50% maze rabbitfish+50% silver pompano), T2 (80 % maze rabbitfish+20 % silver pompano), and T3 (20% maze rabbitfish+80 % silver pompano). At the end of 6 months, the growth performance of *S. vermiculatus* showed a significant difference among the treatments ($p<0.05$). The mean total length (19.42±0.23 cm), final body weight (152.52±3.78 g), weight gain (143.84±3.78 g), specific growth rate (1.532±0.013% per day) of maze rabbitfish were recorded highest in control, T1 (50% maze rabbitfish+50% silver pompano), and T2 (80% rabbitfish+20% silver pompano), with no significant differences among them ($p>0.05$). The lowest final weight (99.00 ±4.36 g) and SGR (1.301±0.023% per day) were recorded in T4 (80% silver pompano+20% maze rabbitfish), indicating that a higher proportion of silver pompano negatively impacted the growth of maze rabbitfish. In contrast, the growth performance of silver pompano did not show any significant differences among treatments ($p>0.05$). Silver pompano attained total length ranging from 25.68±0.27 cm to 26.23±0.09 cm, final body weight from 261.13±3.12 g to 262.90±1.98 g, weight gain from 246.51±3.12 g to 248.28±1.98 g, in all the treatments. Survival rates were recorded from 84.22±3.09% to 88.66±2.70%. From the overall results, it is concluded that a stocking ratio of 50% maze rabbitfish and 50% silver pompano (T1) is optimal species ratio for polyculture, for better growth and survival of both the species.

Keywords

Fingerlings, Polyculture, Specific growth rate, Stocking ratio, Survival rate



Performance of mooring designs for sea cage stability in the coastal waters of Kerala

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Sea cage farming is increasingly recognised as a sustainable mariculture practice that supports the production of high-value finfish in coastal and offshore waters. Its success largely depends on two critical factors; appropriate site selection and robust mooring system design. Site selection requires multidisciplinary evaluation of hydrographic and environmental parameters such as water depth, current velocity, wave exposure, dissolved oxygen and carrying capacity, alongside socio-economic considerations including proximity to landing centres, market access, navigational safety and conflict avoidance with other coastal activities. Equally important is the design of mooring systems that ensure cage stability under dynamic marine conditions. Configurations such as single-point, double, and triple anchoring are chosen based on hydrodynamics, cage type, and cultured species, with emphasis on durability, maintenance, and cost-effectiveness. Advances in anchoring technology, hydrodynamic modelling, and engineering materials have significantly improved cage resilience, even against cyclonic disturbances. A four-year field study conducted in the coastal waters off Cochin (Malippuram and Njarakkal) to assess cage stability across different mooring systems using 6 m diameter cages fabricated from Galvanized Iron (GI) and High-Density Polyethylene (HDPE). Cages were installed 1 km offshore in favourable water depth and quality, with moorings using polyethylene ropes and anchors of 75 kg and 100 kg. Results demonstrated that triple anchoring consistently provided superior stability, withstanding seasonal rough weather and cyclone-affected periods. In contrast, cages under single-point and double anchoring exhibited drifting from their installed positions. The findings highlight that triple anchoring systems are the most reliable option for sustainable cage farming in exposed tropical marine environments.

Keywords

Anchoring, Cage stability, Current velocity, Hydrodynamic modelling, Sea cage stability



Innovative pen design for fish farming: A new approach to aquaculture in shallow coastal waters

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Galvanised iron (GI) and high-density polyethylene (HDPE) cages are widely used for culturing fishes in coastal and brackishwater bodies. Many farmers have adopted the cage farming technology developed by ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) as a livelihood option as an alternative to the traditional farming practices. However, in low-lying regions, cage fish farming becomes impractical due to declining depth caused by sand deposition as a result of frequent floods. To address this challenge, a modified pen culture system was designed for areas with depths less than 2.5 m. For this a site with 1.5-2.5 m depth was identified in Vembanad Lake, where a rectangular pen unit (6×3×3 m) was established under the Scheduled Caste Sub Plan (SCSP) scheme of ICAR-CMFRI. The pen frame, made of 1.5 inch GI pipes with outer and inner frames supported by 4 m poles was fixed by inserting the poles of 1.5 m into the mud, while clamps maintained a 30 cm spacing between the upper frames. An outer HDPE net (6.6×3.6×2.5 m, 40 mm mesh, 2 mm rope, open bottom) and an inner HDPE net (6×3×2.5 m, 20 mm mesh, 1.25 mm rope, closed bottom and provided a ballast) were installed, with the inner net corners tied to poles to prevent collapse. The top was covered with an anti-bird net (6.6×3.8 m, 50 mm mesh, 1.25 mm rope). The unit was stocked with 2,000 pearlspot (*Etroplus suratensis*) fingerlings (size, 4-5 cm, 15 g), fed with 1.8 mm pellets at 10% body weight for four months and later with 2.5 mm pellets at 5% of the body weight. After 11 months, the fish attained a total length of 20-22 cm and a body weight of 350-400 g, yielding an income of ₹2.65 lakhs from a single unit. Growth in the modified pen was comparable to cage farming, demonstrating its suitability for shallow coastal waters where cages are unfeasible. This innovation enabled effective utilisation of shallow water bodies, ensured easy harvest similar to cages, and was well accepted by farmers, leading to the successful launch of larger pens (dimensions, 6×6×6 m, 7×7×7 m, and 12×12×12 m) for enhanced aquaculture production and livelihood support in Ernakulam district.

Keywords

Etroplus suratensis, Fish culture, Low lying areas, Pearlspot, Pen design, SCSP *Etroplus suratensis*, Fish culture, Low lying areas, Pearlspot, Pen design, SCSP



Influence of light spectra on growth, survival, enzyme activity and stress in silver pompano *Trachinotus blochii* larvae under constant photoperiod

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Light is one of the multiple important environmental factors that regulates growth, development, maturity and other physiological processes in fishes. Understanding the optimal light spectra during early larval development is crucial for enhancing larval quality and survival. This study investigated the effects of four distinct light spectra, red (620-750 nm), blue (450-495 nm), green (495-570 nm), and white (broad spectrum) on the growth, survival, digestive enzyme activity and stress levels of silver pompano *Trachinotus blochii* larvae maintained under a continuous 24-h photoperiod. The experiment was conducted in triplicates using 500 l tanks filled with seawater of 32 ppt salinity for a period of 30 days. Each tank was stocked with 200 nos. of larvae at artemia feeding stage (12th day) (0.027 ± 0.006 g). At the end of the experiment, digestive enzyme activities, specifically lipase and amylase, total protein and cortisol concentrations in whole-body homogenates were analysed in addition to estimation of growth and survival. Larvae reared under the blue light spectrum exhibited the highest growth rates in terms of both total length and wet weight followed by those under white, green and red-light treatments that showed comparatively lower growth performance. The highest survival was also observed in larvae exposed to blue light ($22.67 \pm 3.54\%$), while the lowest survival was recorded under red light. Analysis of digestive enzyme activities indicated that larvae under blue light displayed significantly higher amylase activities compared to the other groups, suggesting enhanced digestive efficiency. Larvae reared under red light showed highest protein levels and elevated lipase activity, alongside the highest cortisol concentrations, indicating a physiological stress response. Blue and white light treatments resulted in comparatively lower stress levels. These findings suggest that the spectral composition of light significantly influences the physiological performance of silver pompano larvae. Blue light appears to be the most conducive spectrum for promoting growth, survival, and digestive enzyme activity while minimising stress in silver pompano larvae under a 24-h photoperiod regime. These results have significant implications for optimising for enhancing production efficiency and larval quality during silver pompano larviculture.

Keywords

Digestive enzyme activity, Environmental factors, Enzyme activity, Larviculture, Photoperiod



Maximising yield: Efficient strategies for large scale culture of calanoid copepod *Parvocalanus crassirostris*

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Copepods are primary natural prey for marine fish larvae. Hence it is necessary to develop culture techniques to ensure its reliable supply in marine hatcheries for enhancing larval survival and larval digestive health during the critical early stages. The calanoid copepod, *Parvocalanus crassirostris* has been successfully mass-cultured during 2023-2025 at the marine hatchery complex at the Karwar Regional Station of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). The objective of this study was to simplify the large-scale batch culture procedures for *P. crassirostris*. We conducted an analysis of culture density and total nauplii production during the specified period using the batch culture method. The results show that optimised adult stocking density (500 nos. l⁻¹) yielded an average nauplii production of 5.0 ± 2.0 individuals per ml over a period of seven days. The *P. crassirostris* (nauplii, copepodites and adults) exhibited notable differences in size that correlated with seasonal and salinity variations (15 to 33 ppt). The average nauplii production per batch, categorised by season were, September-November, $842,044 \pm 33,944$; December-February, $943,307 \pm 36,733$; March-May, $745,251 \pm 21,892$ and June-August, $663,188 \pm 18,894$. The peak nauplii production occurred in December, $1,032,188 \pm 30,612$; whereas the lowest production was recorded in June, $617,845 \pm 21,513$, with corresponding salinity levels of 30-32 ppt and 15-19 ppt, respectively. The weekly harvest yield from the 1000 l batch production tank averaged 3.4 ± 0.28 million nauplii per batch and exhibited significant variation in response to changes in salinity. This study illustrates that both the population growth rate (r) and tolerance to the culture environment showed marked improvement as a result of the domestication achieved through year-round production through batch culture of *P. crassirostris*.

Keywords

Batch culture, Larviculture, Nauplii production, Salinity, Stocking density



Comparative evaluation of growth dynamics in key marine microalgal species

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Marine microalgae play a vital role in mariculture, particularly in the early stages of finfish larval rearing. Microalgae such as *Isochrysis*, *Nannochloropsis*, *Tetraselmis* and *Chaetoceros* are commonly used to enrich live feed organisms like rotifers, copepod and *Artemia*, for enhancing their nutritional value with essential fatty acids, amino acids and pigments. In addition to their nutritional value, microalgae help to stabilise the water quality conditions by utilising nitrogenous wastes and releasing oxygen through photosynthesis. Their presence in larval rearing tanks also supports a more natural and balanced microbial environment, reducing the risk of pathogenic outbreaks during the vulnerable larval stages. In mariculture operation, especially in finfish and shellfish larviculture, the quality and availability of microalgae as live feeds are critical for the quality seed production. Therefore, comparative studies on the growth performance of different marine microalgae species are essential to ensure nutritional quality, production efficiency and economic sustainability of live feed culture. This study investigates and compares the growth parameters of five commercially important marine microalgae species; *Nannochloropsis* sp., *Isochrysis* sp., *Chaetoceros* sp., *Thalassiosira* sp. and *Pavlova* sp. The cultures were grown under standardised laboratory conditions including controlled temperature (19-25°C) light intensity (1500-2000 lux), salinity (23-30 ppt) and nutrient concentrations. Growth was monitored over a 10-day period and parameters such as specific growth rate, doubling time, and biomass productivity were assessed. Results revealed that *Nannochloropsis* exhibited the highest specific growth rate ($\mu=1.8\pm0.04\text{ day}^{-1}$), less doubling time ($td=0.64\pm0.01$) and volumetric productivity, P_x ($\text{cell l}^{-1}\text{ h}^{-1}$) which indicated high potential for large-scale biomass and lipid production. The diatoms, *Thalassiosira* and *Chaetoceros* showed comparatively moderate growth ($\mu=0.92\pm0.02$; $td=0.53\pm0.01$ and $1.3\pm0.02\text{ day}^{-1}$; $td=0.75\pm0.01$ respectively) but is valued for its silica-rich frustules serve as a dietary source of silica for organisms that feed on them and suitability in bivalve hatcheries. *Pavlova* and *Isochrysis* showed slower growth rates but demonstrated advantages such as motility and adaptability that are beneficial for live feed applications and dynamic aquatic environments. The comparative analysis highlights the importance of strain selection that should be based on both growth performance and functional traits tailored to specific aquaculture applications. For aquaculture use, no single microalga meets all requirements optimally; a combined or sequential application is recommended to maximise nutritional benefits. These insights can help to guide the selection and management of microalgal feeds to enhance larval performance, water quality and economic viability in aquaculture systems.

Keywords

Diatoms, Larval performance, Nannochloropsis, Productivity, Specific growth rate



Life cycle dependent role of bio-effectors on an industrially important red seaweed *Gracilaria dura* (C. Agardh) J. Agardh

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Declining natural populations of *Gelidium* due to over-harvesting, coupled with challenges in its propagation has positioned *Gracilaria* aquaculture as one of the fastest-growing sectors in the global aquaculture industry. In addition to agar and agarose, the potential for sequential extraction of multiple bio-products through a biorefinery approach has encouraged industry participation in the commercial farming of *Gracilaria dura* (C. Agardh) J. Agardh in India. Protocols for artificial seedling production via clonal propagation, involving treatment with bio-effectors [0.25 mg l⁻¹ 6-benzyl amino purine (BAP) for 60 min; 1 g l⁻¹ AMPEP for 60 min; 0.25 mg l⁻¹ kinetin (KIN) for 30 min], have been developed and successfully applied in the field. Furthermore, research indicated that the female gametophyte and tetrasporophyte phases of *G. dura* responded differently to bio-effectors such as AMPEP and plant growth hormones. It was confirmed that high survival rates (100%), regeneration (72–81.78%) and the emergence of lateral shoots per explant (1.81 to 1.9) make reproductively mature fronds excellent donor sources for seed production technologies. The study also demonstrated phase-specific modulation of chlorophyll-a, R-phycoerythrin (R-PE), R-phycocyanin (R-PC), respiration, total antioxidant capacity (TAC), protein, and carbohydrate contents. These findings provide valuable insights for refining seedling production protocols to support sustainable biomass generation and commercial applications. Further targeted studies on bio-effector-mediated gene expression are recommended to elucidate the molecular pathways underlying phase-specific responses in *G. dura*.

Keywords

Functional traits, Life cycle phases, Seaweed cultivation, Seedling production protocol



Captive propagation of the citron goby *Gobiodon citrinus*: A new candidate for sustainable marine ornamental aquaculture

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Marine ornamental gobies are ecologically and commercially important fish that rank among the top five most traded groups in the global marine ornamental fish industry. The citron goby, a member of the clown goby group, exhibits symbiotic association with corals of the genus *Acropora*, utilising them both as a shelter from predators and as a substrate for egg deposition. As the marine ornamental trade of the species is primarily dependent on wild collection, the development of captive seed production technology of these species is important from the perspective of species conservation and for the development of marine ornamental fish trade based on their sustainable aquaculture. In this study the successful captive seed production of citron goby is documented. Six broodfish (mean total length, 47.3 ± 3.7 mm, mean body weight, 2.1 ± 0.5 g) were reared in $2 \times 1.5 \times 1$ m well aerated FRP tanks (salinity, 33-35 ppt; temperature, $26-31^\circ\text{C}$). The tanks were provided with 5-6 hideouts (PVC pipes). Feeding was done with fresh trash fish and squid meat to satiation twice a day. Once pairing of broodfish was observed, the pair was separated and stocked in 250 l well aerated tanks provided with egg attachment substrates. After 2-3 months, noticeable reproductive behaviour was observed with the female was mostly swimming in the periphery of the substrate. The male kept guard at short distance. Breeding was observed early morning. The eggs were attached as a single layer to the substrate. The fecundity ranged between 400-600. Hatching was observed after 100-110 h; the hatching percentage was between 85-90%. Initial size of larvae ranged from 2.2-2.4 mm. Larval rearing was done using a combination of phytoplankton and copepod nauplii. Metamorphosis to fry stage was observed after 75-80 dph. The development of captive breeding protocol for the species marks a significant step in the process of developing sustainable marine ornamental aquaculture of the species.

Keywords

Captive breeding, Fecundity, Larval rearing, Ornamental fish, Seed production



Preliminary studies on capture-based aquaculture of mangrove red snapper *Lutjanus argentimaculatus* in cages

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Cage culture is successfully practiced in many regions of India and across the globe, with the cultivation of marine food fish in cages emerging as a profitable industry. However, the limited production of seeds for many commercially important marine finfish species in India highlights the urgent need to promote sustainable capture-based aquaculture among fishers. This approach supports both resource conservation and alternative livelihood opportunities. This study evaluates the growth and survival of wild-caught mangrove red snapper, *Lutjanus argentimaculatus* in a cage culture system. Juveniles were collected from the Pazhaverkadu region through bycatches, between February and April 2024. A total of 500 juveniles, with an average total length of 96.0 ± 17.7 mm and an average wet weight of 49.6 ± 11.4 g ($n=30$), were stocked in a single circular cage (114 m^3) during the period. The culture spanned eleven months, during which the fishes were fed chopped trash fish three times daily (at 06:00, 12:00, and 18:00 hrs) at a rate of 5–10% of their wet body weight. At the end of the culture period, the overall survival rate was 66.4%, with an absolute growth of 1.75 g day^{-1} and a specific growth rate of $0.762 \% \text{ day}^{-1}$. The findings of this study are encouraging, demonstrating the feasibility of cage farming of mangrove red snapper using juveniles sourced from bycatch. This approach provides fishers with a sustainable alternative livelihood while promoting responsible fishing practices.

Keywords

Alternative livelihood option, Cage culture, Livelihood, Specific growth rate, Survival rate



Optimising spat production of the tropical brown mussel (*Perna indica*) in a micro-nursery system

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The brown mussel *Perna indica* Kuriakose & Nair, 1976 is a commercially significant bivalve species in India with considerable potential for open-sea farming. In this study, broodstock of mussels collected from the Vizhinjam mussel beds were successfully induced to spawn through thermal stimulation. Fertilised eggs ($51.56 \pm 3.1 \mu\text{m}$) were incubated at $29 \pm 1^\circ\text{C}$ for approximately 18-19 h, resulting in the development of D-shaped larvae ($90.33 \pm 5.48 \mu\text{m}$). These larvae were stocked at a density of 0.8 nos. ml^{-1} in 1.5 t FRP tanks and reared till they reach the eyespot stage ($310.73 \pm 24.3 \mu\text{m}$) by day 13. For spat rearing, pediveliger larvae were transferred to a micro-nursery system (2000 l) equipped with 30 cm silos and stocked at four different densities; 1.5, 2.0, 2.5, and 3.0 lakh nos. ml^{-1} . The experiments were conducted in triplicate. A mixed diet comprising *Isochrysis galbana*, *Chaetoceros* sp. and *Tetraselmis* sp. was used as a feed to support larval and spat development. Growth and survival were recorded for all the stocking densities.

Keywords

Down-welling system, Hatchery rearing, Pediveliger, Thermal stimulation



Nursery rearing, grow-out farming and nutritional value of John's snapper: Preliminary information on a new candidate species for coastal aquaculture

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John's snapper presents a promising candidate for mariculture due to its consumer demand, adaptability to captivity, acceptance of artificial feed, and less aggressive nature. The study results show that the species accepts high-nutrient formulated floating feed (45% crude protein and 10% crude fat) in the nursery. Growth experiments with a salinity regime of 0-30 ppt observed that 15-20 ppt salinity resulted in optimum growth. A fish fry of 1.0 g in size attained 54 g with FCR of 1:1.4 for the period of 4 months. However, fingerlings are prone to *Amyloodinium* parasite infestation when nursery-reared in water salinity exceeding 25 ppt. Consequently, it is suggested that water salinity of 15-20 ppt be suitable for nursery rearing, ensuring a high survival rate. In grow-out sea cages, the fish fingerlings of 10 g in size were stocked with three different feed combinations. The fish fed feed combination of floating pellet feed and low-value fish meat exhibited maximum growth of 675 g in a 10-month culture period. Similarly, fish cultured in a coastal pond at 0.5 nos. m⁻² observed an average growth of 678 g in 7 months. Grow-out experiment demonstrated that fish fed with mixed feed in cage culture exhibited high growth with reduced size variation. Nutritional analysis of the fish was conducted across various culture systems, and the result indicated that cage fish fed with mixed feed of pellet feed and fish meat showed 82.5% crude protein, and fish fed with only fish meat showed maximum crude protein (15.22%) on a dry weight basis. A comprehensive analysis of the amino acid profile revealed the presence of 17 amino acids, with glycine, arginine, and phenylalanine each exceeding 10%. An analysis of 23 fatty acids revealed a remarkable ratio of ω -3 to ω -6, a high ratio of 1.35 in cage-raised fish fed exclusively on fish meat. This observation suggests that the species possesses exceptional growth potential, with the potential for accelerated growth in a favourable environment. Furthermore, the nutritional profile of the fish is highly favourable, indicating its suitability for human consumption. Consequently, the present study underscores the fish's potential as a promising alternative candidate species for Indian coastal mariculture.

Keywords

Floating feed, Growth, Nutritional value, Salinity regime, Species diversification



Embryogenesis and larval rearing of lemon damsel *Pomacentrus moluccensis* (Bleeker, 1853) under captive conditions

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The marine ornamental fishes of Pomacentridae family are the most dominant group of marine ornamental fish because of their vibrant colour, hardiness and small size. Larval rearing is one of the key bottlenecks that currently limit the expansion of marine ornamental fish aquaculture. The present work details the complete embryonic and larval development of the lemon damsel *Pomacentrus moluccensis* under captive conditions. Spawning onset of captive-reared broodstock maintained in a 350 l glass aquarium was recorded after three months of captivity. Fertilized eggs were capsule-shaped, demersal, and transparent, adhering to the provided substrate, with a size varying between 1026-1097 μm . Description of the different phases of embryogenesis, namely the zygote, cleavage, blastula, gastrula, and segmentation of the fish was recorded. The developmental stages during the larval development period after hatching, yolk sac absorption (pre-larvae) and the process of metamorphosis (post-larval) are included. Embryonic development concluded on the evening of the fourth day of incubation, yielding larvae with an average length of 2.78 ± 0.42 mm. Larvae emerged with unpigmented eyes, as well as an undifferentiated digestive tract. The mouth was closed at hatch and opened by the early endogenous feeding period with a mouth gape of around 190 μm . Yolk sac absorption was complete by 3 days post-hatch followed by the preflexion, notochord flexion and post flexion stages. Metamorphosis was completed with scale formation and adult colouration between 35-40 dph. Larvae were reared in FRP tanks using the green water technique with microalgae was done using a combination of phytoplankton, *Isochrysis galbana* or *Pavlova* sp, *Chlorella marina* or *Nanochloropsis* sp. Initial feeding post-yolk absorption included the nauplii of calanoid copepod *Parvocalanus crassirostris* diet followed by rotifer and artemia. This study provides critical baseline data for standardising larval rearing protocols for this species, supporting future aquaculture efforts and conservation programmes.

Keywords

Marine ornamentals, Microalgae, Pomacentrids, Metamorphosis, Yolk sac absorption



Optimising larval and nursery survival of the blue swimmer crab *Portunus reticulatus*: Influence of salinity and stocking density

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Portunus reticulatus, commonly known as the blue swimmer crab, is an economically and ecologically important species widely distributed in coastal and estuarine waters, playing a significant role in fisheries and aquaculture. This study evaluates the survival rates of blue swimmer crab larvae from zoea 1 to megalopa across different salinity levels during the larval rearing phase and subsequently assesses the survival of crab instars during the nursery phase at varying stocking densities under a fixed salinity of 24 ppt. There was no significant difference in survival between larvae reared at 20 ppt and those at 24 ppt salinity. The highest larval survival was recorded at 20 ppt, with a rate of $65.8 \pm 3\%$, suggesting this salinity level as the most favourable for early developmental stages. Survival rates at other tested salinities (16 and 28 ppt) were significantly lower, underscoring the larvae's sensitivity to changes in salinity. During the nursery phase, crab instars reared at 24 ppt salinity exhibited the highest survival at a stocking density of 50 megalopa m^{-2} (SD50), with a survival rate of $86.33 \pm 4.51\%$, whereas higher densities (SD100, SD150, and SD200) showed progressively reduced survival, suggesting crowding stress as a limiting factor. These results emphasise the critical influence of environmental parameters, including salinity during larval rearing and stocking density during nursery, on the successful seed production of *Portunus reticulatus*. Effective management of these factors can enhance the viability of blue swimmer crab culture, supporting commercial hatchery operations and conservation efforts.

Keywords

Crab instars, Crowding stress, Larvae, Megalopa, Nursery, Zoea



Observations on the large-scale rearing of phyllosoma of *Panulirus versicolor* (Latreille, 1804) using green water and diverse zooplankton in holding tanks

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The tropical spiny lobster *Panulirus versicolor* (Latreille, 1804) is a highly valued seafood resource globally. However, natural stocks face severe overexploitation due to their complex life cycle, fragile larval stages and inherently low recruitment rates. Therefore, developing viable hatchery techniques is crucial for both commercial aquaculture and conservation. The present study evaluated preliminary rearing protocols for *P. versicolor* phyllosomas under controlled hatchery conditions using large holding tanks supplied with green water (*Nannochloropsis oculata*) and wild-collected zooplankton. Five feeding regimes were tested: (i) enriched Artemia; (ii) copepodites; (iii) enriched rotifers (up to 5 days post-hatch, DPH); (iv) enriched Artemia in blue tanks and (v) enriched Artemia in yellow tanks. Wild zooplankton and microalgal cultures were separately maintained and periodically incorporated into the rearing system. Larval development was monitored through morphometric and microscopic evaluation. Phyllosoma progressed from stage I to stage II within 4 DPH and from stage II to stage III by 14 DPH, demonstrating measurable advancement under the tested conditions. These observations suggest that the integration of green-water systems and wild zooplankton supplementation can support larval survival and growth. These preliminary findings indicate the potential for refining hatchery methodologies to enhance tropical spiny lobster seed production with implications for sustainable aquaculture and resource conservation in Indian coastal ecosystems.

Keywords

Hatchery technique, Larval survival, Microalgal cultures, Spiny lobster, Zooplankton



Feasibility assessment of tank-based culture of *Kappaphycus alvarezii*

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Seaweed cultivation is increasingly recognised as a sustainable practice that contributes to global food security, environmental health, and the blue economy. While traditionally carried out in coastal and nearshore waters, the practice is now shifting towards land-based systems to overcome challenges posed by environmental variability, limited coastal space, and competing coastal activities. Tank and raceway pond systems provide controlled growth conditions, efficient water management, and the capacity for year-round production. These systems also mitigate risks of disease outbreaks, grazing by fish, and pollution. Moreover, integration with other aquaculture systems through nutrient recycling enhances circular bioeconomy approaches. Although land-based farming involves higher operational costs and energy demands, advances in technology and renewable energy integration are improving its long-term feasibility. The present study evaluated the feasibility of tank-based farming of *K. alvarezii*. An outdoor tank was filled with chlorinated seawater (32 ppt), and seaweeds were placed on a net bed positioned 10 cm below the water surface. The initial stocking weight averaged 1078 ± 33.54 g, which increased to 2005 ± 21.22 g after 30 days, demonstrating a near doubling of biomass. Daily 50% water exchange was maintained in the morning, and the tanks were exposed to natural sunlight at an intensity of 1000–3000 lux. Water quality parameters were monitored fortnightly to ensure optimal conditions for growth. The findings confirm that tank-based culture of *K. alvarezii* is technically feasible and offers significant potential as a sustainable, controlled-environment alternative for seaweed farming.

Keywords

Land-based farming, Nutrient recycling, Seaweed, Water management



Comparative analysis of capture-based farming of spiny lobsters (*Panulirus* spp.) in sea cages and pens in the Gulf of Mannar

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Spiny lobsters (*Panulirus homarus* and *Panulirus ornatus*) are high-value seafood in the international market with strong potential for seawater aquaculture. This study assessed the ecological and economic feasibility of capture-based farming of wild-caught juveniles in two culture systems: sea cages and sea pens along the Gulf of Mannar. Juveniles of spiny lobsters, with an average weight of 61.5 g, were collected from Kanyakumari District and stocked @ 600 individuals per unit in sea cages at Mandapam and sea pens at Vedhalai. Each cage measured 6 m in diameter and 3.5 m in depth, while each pen measured 6x6 m with a depth of 2 m. Artificial hide-outs were provided to minimise cannibalism, and lobsters were fed trash fish and clams @ 10% of their body weight. Over a 120-day culture period, growth and survival were monitored at 45-day intervals. Lobsters in sea pens showed superior performance, attaining mean weights of 101.6 g, 136.5 g, and 171.2 g at 45, 90, and 120 days, respectively, with 97% survival. In comparison, lobsters in sea cages reached 99.8 g, 130.3 g, and 160.0 g with 94% survival. Final harvest was 395 kg from pens (4 units) and 180 kg from sea cages (2 units), generating farm gate revenue (@`1000 per kg) of `3.95 lakh and `1.8 lakh, respectively. The enhanced growth and survival in pens may be due to the sandy sea bottom substrate providing a more favourable habitat than the suspended cage systems. This study demonstrates that pen-based farming is technically feasible and economically superior for spiny lobster aquaculture in coastal villages, supporting sustainable seafood production and improved livelihood opportunities for fishing communities.

Keywords

Artificial hide-outs, Cannibalism, Livelihood, Survival, Suspended cage system



GIS-based multi-criteria evaluation of brackishwater resources for aquaculture site suitability in South Andaman

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Brackishwater aquaculture has emerged as a critical livelihood and resource utilisation sector in the Andaman Islands, but systematic identification of suitable sites remains limited. The present study focuses on mapping and assessing the brackishwater resources of South Andaman using a Geographic Information System (GIS)-based multi-criteria evaluation framework. For geospatial analysis, multi-temporal datasets were employed, including Survey of India toposheets (1979 and 2015, scale 1:50,000), IRS LISS III (1998 and 2005, 30 m resolution), IRS LISS IV (2013, 5.6 m), and Sentinel-2B (2023, 10 m). The integrated field and satellite analysis identified approximately 200 ha of tsunami-inundated brackishwater area in the preliminary phase. Site suitability analysis was performed using the Analytical Hierarchy Process (AHP) supported by Inverse Distance Weighting (IDW) interpolation. Criteria included soil parameters (pH, electrical conductivity, organic carbon, nitrogen, phosphorus), water quality parameters (temperature, salinity, dissolved oxygen, ammonia, transparency), topography (depth, slope, soil texture), environmental constraints (proximity to mangroves, freshwater bodies, and Marine Protected Areas), and infrastructure (roads, jetties, and market access). Initially five sites comprising Wandoor, Ograbraj, Flat Bay, Sippighat and Namunagar were evaluated. Consequently, Wandoor (14 ha water spread) and Ograbraj (11 ha water spread) were shortlisted for detailed evaluation. Wandoor showed advantages in infrastructure accessibility, with a jetty within 500 m, however was in proximity to a Marine National Park. In contrast, Ograbraj, despite good soil and depth characteristics, faced limitations due to distant jetties and markets. Detailed suitability maps were generated for the two sites towards actionable insights for policymakers and stakeholders in the South Andaman to optimise resource allocation, strengthen livelihoods in tandem with environmental safeguards.

Keywords

Geospatial analysis, Infrastructure, Site suitability, Soil parameters, Topography



Green mussel (*Perna viridis*) landings and farming prospects in Andhra Pradesh with emphasis on IMTA

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Green mussel (*Perna viridis*) is a valuable bivalve resource with significant mariculture potential in India. However, the landings along the Andhra Pradesh coast remain relatively low compared to the west coast due to limited rocky substrata, freshwater inflows and high turbidity in estuarine-influenced areas. Despite these constraints, hydrographic conditions along this coast, particularly salinity (26–34 ppt) and temperature (24–30 °C) during the post-monsoon to summer months, provide favourable conditions for mussel farming. To evaluate this potential, site selection surveys were conducted at Visakhapatnam, Bheemunipatnam, Kakinada and selected pockets of Srikakulam recording hydrographic parameters and current patterns. Based on these assessments pilot-scale tube net trials were deployed in semi-sheltered open sea sites including areas adjacent to cage farms and seaweed rafts to test farming performance. The parameters that were evaluated included growth, survival, slippage/drop-off in open sea currents, spawning incidence and condition index. Preliminary results indicate that mussels attained marketable size (60 – 80 mm) in 5 – 7 months with indicative rope yields of 8–12 kg m⁻¹ and longline harvests of 1.6 – 2.4 tonnes per cycle under suitable conditions. Challenges observed included slippage during strong currents and reduced condition index after spawning, highlighting the need to define an ideal farming window for optimizing production. The ongoing trials confirm the technical feasibility of mussel farming in semi-sheltered coastal pockets of Andhra Pradesh. A particularly promising outcome is the integration of mussel farming with finfish cages and seaweed in an Integrated Multi-Trophic Aquaculture (IMTA) framework, where mussels act as natural biofilters, improving water quality and enhancing system sustainability. Preliminary estimates suggest that 8 – 15 m of mussel droppers are required per tonne of finfish biomass for effective nutrient assimilation. This study identifies feasible farming sites and strategies, demonstrating the potential to up-scale mussel culture in Andhra Pradesh through targeted pilots, adoption of IMTA and development of cold-chain marketing infrastructure. With growing demand in urban centres such as Visakhapatnam and Kakinada and opportunities for interstate trade, green mussel farming could play a key role in diversifying livelihoods and strengthening mariculture on the east coast of India.

Keywords

East coast, Integrated farming, Livelihood, Mariculture, Mussels



Establishing a Fish Farmer Producer Organisation (FFPO) for sustainable cage fish farming in Ernakulam District of Kerala

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Marine cage fish farming is gaining traction in India as a vital component of the blue economy, with significant contributions to coastal livelihoods. In Ernakulam District, Kerala, cage farming, particularly of Asian seabass and pearl spot in combination, has emerged as a major income source for many farmers living near coastal waters. Cage farmers were initially supported through various government schemes and technically guided by institutions like ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) and the State Fisheries Department. This action research project is working on establishing a viable Fish Farmer Producer Organisation (FFPO) to enhance the sustainability and economic viability of cage fish farming and giving the initial handholding for a period of 5 years by ICAR-CMFRI with funding support of NABARD. An initial survey was conducted among cage farmers in Ernakulam District revealed that it is predominantly a male-dominated sector (75.9%), whereas with respect to age, 53.3% were aged between 35-50 years of age and 25.5% were youth (20-35 years). Most farmers were educated (98.6% with formal education) and most farmers had undergone some type of training (93.6%), which underscores a skilled workforce. The 4x4x3 m³ cage was the most preferred (72.3%) for its economic feasibility (BCR 1.87, production cost of ₹241 per kg of fish) and ease of operation. Challenges faced in cage farming include high operational costs, seed availability in time and quality, and market uncertainties due to production glut. This is prompting many farmers to seek species diversification, supported by policy interventions like seed supply and technology demonstrations. The project employs a participatory approach, involving needs assessment, group mobilisation, and capacity building to form a legally registered FFPO. Training focuses on fish farming techniques, financial literacy, and governance. Monitoring, impact assessments, and feedback mechanisms will ensure operational efficiency, while financial sustainability, risk management, and policy advocacy address long-term viability. Despite constraints like coastal water pollution and limited credit access, the FFPO aims to empower farmers, enhance market access, and promote sustainable mariculture. This initiative highlights the potential of collective action to transform cage fish farming into a resilient, economically viable enterprise in Ernakulam, offering a scalable model for coastal livelihood.

Keywords

Asian seabass, Blue economy, Handholding, Participatory approach, Scalable model





Seaweed farming potential along the Kerala coast: A quantitative assessment of species performance, site suitability and cultivation methods

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Seaweed farming is emerging as a key component of India's blue economy, offering both livelihood support and significant ecological services. Following pilot-scale cultivation trials in Kerala coast, seven sites were identified for large-scale cultivation of three seaweed species; *Kappaphycus alvarezii*, *Hydropuntia edulis* and *Gracilaria salicornia*. To further evaluate detailed growth dynamics, experimental cultivation of these species was undertaken at two contrasting coastal sites in Kozhikode District; the wave exposed Elathur and the calmer, nutrient-rich Kodikkal, using standardised tube-net and monoline farming methods with concurrent environmental monitoring. The experiments revealed pronounced spatio-temporal variability in growth performance; *K. alvarezii* consistently exhibited superior growth, attaining a maximum daily growth rate (DGR) of 5.2% d⁻¹ at Kadalundi and Kodikkal under polyhaline conditions (salinity 29-32 ppt) and warm surface waters (30-31°C). In contrast, cultivation sites located in southern and central Kerala recorded comparatively lower growth. Seasonal trials in northern Kerala further confirmed the enhanced performance of *K. alvarezii*, achieving peak DGR values of 5.97±0.34% d⁻¹ during the winter monsoon (WM). *H. edulis* displayed maximum growth (4.52±0.47% d⁻¹) during the spring inter-monsoon (SIM), while *G. salicornia* reached peak performance (4.42±0.04% d⁻¹) during WM. Comparison between sites highlighted Kodikkal as consistently supporting higher growth rates than Elathur, irrespective of season, highlighting the importance of low-energy, nutrient-rich and less turbid conditions in enhancing growth rates. Method-specific responses were also evident; the monoline technique proved particularly effective for *K. alvarezii* in sheltered environments, whereas tube-nets provided greater resilience under high wave regimes. Conversely, *G. salicornia* performed better in tube-net systems. The study demonstrates that northern Kerala offers more favourable conditions for seaweed farming than the southern coast, primarily due to the consistent availability of inorganic nutrients, lower turbidity, and reduced hydrodynamic stress. Intensive cultivation experiments further established Kodikkal as an optimal site for upscaling seaweed farming in the region, where stable, nutrient-enriched and hydrodynamically calm waters provide a conducive environment for sustainable biomass production.

Keywords

Blue economy, *Kappaphycus*, Kerala coast, Kodikkal, Monoline, Tube-net



First successful larval rearing of the brackishwater ornamental goby *Mugilogobius tigrinus*

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The brackishwater tiger drawf goby *Mugilogobius tigrinus*, distinguished by its vivid tiger-like bands and adaptability to freshwater represents a promising yet underutilised ornamental species. Wild populations remain the sole source of supply, placing pressure on a rare taxon with high trade potential. Establishing reliable hatchery protocols is therefore vital for both commercialisation and conservation. In this study, we developed a sequential feeding strategy that supported complete larval development under controlled hatchery conditions. After spawning, eggs were transferred to 100 l black FRP tanks from the breeding tanks. Green-water system with *Chlorella marina* to enhance prey availability and maintain water quality was utilised for larval rearing. Salinity was maintained at 24 ± 2 ppt and temperature at $29 \pm 2^\circ\text{C}$, with daily 10% water exchange. First feeding began at 2 days post-hatch (DPH) with ciliates (*Euplotes* sp.) and copepod nauplii, followed by rotifers (*Brachionus plicatilis*) from 24 DPH, adult copepods (38–46 DPH) and *Artemia* nauplii (47–58 DPH). Beyond 58 DPH, larvae were weaned onto 0.5–0.8 mm formulated feed. This protocol yielded 40–50% survival up to metamorphosis, with no mortality observed during the critical benthopelagic transition. By 51 DPH, larvae displayed pigmentation and their morphology resembling miniature adults, marking the first successful documentation of full-cycle larval rearing in *M. tigrinus*. Our findings provide a foundation for commercial-scale aquaculture of this visually striking goby, simultaneously reducing pressure on wild populations and diversifying the ornamental fish industry.

Keywords

Formulated feed, Green-water, Hatchery protocols, Live feed, Metamorphosis, Tiger drawf goby



Description of embryonic development in *Caranx ignobilis* (Forsskal, 1775) from first division to hatching

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The *Caranx ignobilis* (Forsskal, 1775), commonly known as the giant trevally, is a highly-priced food fish widely distributed along the tropical and subtropical stretches of the Indian and Pacific Oceans. It is also a well-known game fish due to its giant size and strength. The giant trevally is the largest and fastest-growing carangid available in the Indian Ocean, hence an ideal species for aquaculture in tropical conditions. The success in induced breeding and seed production in captivity for the species has recently been achieved by the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). *C. ignobilis* is known for its commercial importance; however, the information on its biology is scant. Embryogenesis is fundamental yet important information for assessing larval health and standardising seed production. The present study forms the first detailed report on the normal embryonic development of *C. ignobilis*. Significant events during embryogenesis are described following standard methods and terminology. The eggs were collected immediately after spawning from the spawning tank. The eggs were disinfected using the iodophor solution. The developmental time for each event during embryogenesis was documented and photographed. The fertilised eggs were transparent and floating, having a spherical shape, with an average diameter of $728 \pm 2.2 \mu\text{m}$ ($n=40$). The activation of the eggs was completed within 0.25-0.40 hr, and the first cell division was noted at 0.45-0.55 hrs. The cleavage period (2-64 cells) lasted 1.23-1.45 hrs. The blastula period (128 cell-30% epiboly) was completed in 4.48-4.82 hrs, and the gastrula stage (50% epiboly-tail bud stage) lasted 6.75-6.98 hrs. The segmentation period (1 somite-24 somite) begins around 7-7.10 hrs and is completed by 13.85-14.20 hrs. Organogenesis and hatching were noted as the final events in embryogenesis of *C. ignobilis*, which lasted for 16.50-18.72 hrs. At $28 \pm 1^\circ\text{C}$, the average incubation time was 16 ± 2.55 hrs for *C. ignobilis* in captive conditions. The estimation of accurate timings and characteristics of the developing embryo will facilitate the assessment of egg quality and timing for transferring eggs from the spawning tank to the larval rearing tank, which is essential for maximising the survival.

Keywords

Carangidae, Embryology, Giant trevally, Induced breeding, Mariculture



Bioinvasion of *Mytella strigata* and its impact on cage culture along the northeast coast of Tamil Nadu, India

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A recent concern in marine ecosystem is bioinvasion as it significantly impacts biodiversity, alters ecosystems and occasionally causes economic losses. One of the recent bioinvasions recorded along the Northeast coastal region of Tamil Nadu was the invasive bivalve mussel *Mytella strigata*. This study evaluates its impact on cage culture activities at two distinct geo-locations, from February to November 2024. Initial fouling on the outer nets was observed within 5-10 days, with a density of 20-65 ind. m⁻², increasing to 120-951 ind. m⁻² within an additional 10-15 days. The primary bivalve foulants were identified through morphological, morphometric, and molecular analyses. Our molecular results revealed the existence of the invasive bivalve mussel *M. strigata* (*Musculus strigatus*; GenBank accession number PV426455 and PV426462), which was the major foulant in terms of number and biomass along with *Crassostrea madrasensis* (PV426263) and *Perna viridis* (PV426268). The recruiting size class of *M. strigata* ranged from 4 -47 mm in length and 2-24 mm in width. In the investigation young specimens of *M. strigata* formed nearly 5-15% of the fouling biomass throughout the study clearly indicating the multiple recruitment pattern. The estimated fouling biomass (dry weight) of *M. strigata* alone on the cage net was 80-450 g m⁻². Management strategies such as periodic net cleaning, prevention of nutrient leaching and regular net replacement are recommended to mitigate heavy fouling, net clogging and negative cage buoyancy. Further research is needed to explore alternative uses of *M. strigata* biomass to open ways for additional income generation in cage culture.

Keywords

Cage net fouling, Invasive bivalve, Molecular analysis, Net replacement



Size grading improves growth rate and population structure of pearlspot *Etroplus suratensis*

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Grading of pearlspot fish to three size classes viz., small, medium, and large, based on their body weights followed by separate rearing was evaluated as a strategy to segregate fast growing fish that achieves marketable sizes within short periods and improve growth of small and medium sized fish. Pearlspot fry reared in two sets (Set 1 and 2) was size sorted at the end of 117 days of nursery rearing (nursery phase). This resulted in identical proportions of small (19.4-19.6%), medium (52.6-53.7%), and large (26.8-27.6%) individuals in both sets. The size sorted fishes were further reared separately in hapas (400 nos. per hapa) for 100 days in the case of set 1 and 135 days for set 2, before the 2nd size grading (pre-growout phase). The proportion of small fish reduced from 19 to 14% and proportion of medium fish increased from 53 to 59% in the case of set 1. In set 2, the percentage of smaller fish reduced from 19 to 11% and that of medium sized fish increased from 53 to 58%. The proportion of large sized fish did not vary significantly, at the end of 2nd grading in both sets. Following this, size sorted fishes from set 1 was stocked to cages (5mx2mx2m) as large, medium and mixed (combination of S, M, and L) at 500 nos. per cage and fishes from set 2 were further reared separately in hapas as small, medium and large at 200 nos. per hapa (growout phase). The fishes were subjected to final size sampling after 173 days and 108 days for set 1 and set 2 respectively to determine the population structure. The proportion of large, medium, and small fish changed to 40.6, 49.5 and 9.8% respectively in set 1 and 38.6, 48.6 and 12.6% respectively for set 2. The proportion of large sized fish increased significantly post 2nd size grading, whereas the proportion of small sized fish reduce significantly. The trial clearly demonstrates the benefits of size grading in improving the population structure of pearlspot fish and adoption of the same can help farmers to realise a greater income.

Keywords

Growout phase, Hapa, Marketable size, Nursery rearing, Proportion



Effect of microalgal diets on egg production of *Acartia sarojus*, a potential species as live feed for fish larval rearing

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Copepods play a crucial role as primary food for many aquatic organisms and their larval forms. They are vital in aquaculture due to their nutritional value, diverse development stages with different size groups, and swimming behaviour that stimulates feeding even in weak fish larvae. Feeding copepods enhances larval survival, growth, and pigmentation in fishes. The copepods of the genus *Acartia* are popularly used as live feed because of their compatible size with the mouth gape of small altricial larvae and their ideal biochemical composition. In the present study, we evaluated the effect of different microalgal diets on egg production in a newly developed copepod, *Acartia sarojus*. *A. sarojus* is a suitable copepod for large-scale production and utilisation as live feed for marine fish larvae. The copepods and microalgae used in the study were obtained from the stock culture facility of the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kerala, India. Seven microalgae (*Chlorella marina*, *Dicrateria inornata*, *Isochrysis galbana*, *Nannochloropsis oculata*, *N. salina*, and *Pavlova lutheri*) were fed to *A. sarojus*, and the variations in total egg production were estimated. Copepods were acclimatised for one week on designated diets before the study. To assess the total egg production, a pair of newly moulted adults (one female and one male) of *A. sarojus* was stocked in 100 ml containers. Three replicates were kept for each treatment. Every 24 hr, the eggs and nauplii were separated by serial filtration. The total egg production was calculated as the average egg production over the total lifespan. The results showed that maximum egg production in the mono-algal diet of *Isochrysis galbana* (201.33 ± 17.09) and *D. inornata* (202.33 ± 6.65). Among all the microalgal diets fed to *A. sarojus*, *N. salina* and *N. oculata* resulted in the least egg production. In the present experimental conditions, the optimum diet for maximum egg production, in *A. sarojus*, is confirmed as *I. galbana*, and *D. inornata*. The study forms the essential initial step for the development of mass culture and the use of *A. sarojus* as live feed for fish larval rearing.

Keywords

Copepod mass culture, Biochemical composition, Larval rearing, Live feed, Microalgae



First report on the larval development and larviculture of the houndfish *Tylosurus crocodilus* under captive conditions

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Houndfish belongs to the family Belonidae. They are primarily caught as a food source in artisanal fisheries and is a significant gamefish in the Indo-Pacific region. A wild egg mass of *Tylosurus crocodilus* was collected from the Majali Coast of Karwar, Karnataka (14053'21.3" N; 74006'02.5" E). The egg mass was transported to marine hatchery and incubated in 500 l FRP tank filled with seawater (33 ppt). Water quality was maintained at optimum levels. The eggs were observed under a microscope for recording the embryonic development. Mouth opening was observed within the egg on the 3rd day of incubation. The larvae were well developed prior to hatching, with full body pigmentation. The pectoral and pelvic fins were well developed inside the egg. A hatching rate of 90% was achieved at 72 h of incubation at 30 °C. The hatched larvae had transparent yolk-sac with a single oil globule. The larvae were stocked at 30 nos l⁻¹. The FRP tank was added with microalgae (*Nannochloropsis salina* and *Isochrysis galbana* @ 2-3 x10⁵ cells ml⁻¹ tank density). Rotifers and copepods (@ 10-15 nos. ml⁻¹) were added on the day of hatching. Larvae were observed to be voracious feeders exhibiting high degree of cannibalistic behaviour. First feeding on copepod was observed at 0 days post hatch (dph). Artemia nauplii feeding stage commenced from 1 dph facilitated by the larger mouth gape >300 µm. At 1-3 dph, larvae were seen to be distributed on tank surface in sunlight with clusters forming close to tank walls. Cannibalistic behaviour was recorded by 5-7 dph. By 10-12 dph larvae were seen near tank wall hiding under air bubbles caused by aeration. By evening, majority of larvae exhibited benthic-oriented behaviour, aggregating near to tank bottom. Larvae were weaned to artificial feed on 19 dph, fed with larval feed of 0.3 mm size, on 23 dph larvae were fed larval feed of 0.8 mm size. Needle like beak protrusion was observed by 10-12 dph. The beak protrusion was much well-developed by 29 dph, which reached a completion by 34 dph. Metamorphosis was completed by 35 dph. On 50 dph, the larvae attained a total length of 6.16±0.2 cm with an average bodyweight of 0.2036±0.03 g with a survival rate of 1%. The above study provided first-hand information on larval development and behavioural aspects of hound fish, *T. crocodilus* under captive conditions.

Keywords

Belonidae, Cannibalism, Egg mass, Embryonic development, Marine hatchery, Water quality



Adult *Artemia* biomass as a bio-capsule for targeted nutrient delivery in shrimp broodstock: Role of short- and long-term enrichment exposure

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Live feeds are a critical component of shrimp maturation diets, supplying maturation-inducing hormones and essential nutrients. Among them, *Artemia* biomass has gained prominence as both a live feed and an effective bio-capsule for targeted nutrient delivery in broodstock nutrition. With their rapid ingestion and high gut-retention capacity, *Artemia* can incorporate and transfer essential nutrients that are often deficient in their natural profile. However, enrichment success largely depends on exposure duration, which influences both nutrient loading and survival. The present study evaluated the enrichment efficiency of adult *Artemia* biomass using cod liver oil, krill oil, and paprika extract, the major nutrients required for shrimp maturation, compared with live algae-fed group as a control. Prior to enrichment, *Artemia* were acclimatised in filtered seawater to clear gut contents. Preliminary trials optimised enrichment duration, identifying 2 h as the minimum period for effective gut loading. Post-enrichment, *Artemia* were transferred to fresh seawater (100 ind. l⁻¹) and monitored at 3, 6, 9, 12, and 16 h for gut content retention and survival. Survival varied with enrichment medium and duration. Control *Artemia* showed a steady decline from 93% at 3 h to 62.5% at 16 h. Cod liver oil maintained consistently higher survival (98% at 3 h, 72% at 16 h), followed by krill oil (98% at 3 h, 72.5% at 16 h) and paprika (97% at 3 h, 65.5% at 16 h). At short durations (3–6 h), survival exceeded 88% across treatments, while prolonged exposure (≥9 h) caused sharper declines, particularly in the control. Cod liver oil enrichment showed the greatest stability, surpassing the control by ~12–13% at 9–12 h. Overall, short-term enrichment supports immediate feeding through rapid gut loading, whereas long-term enrichment enhances assimilation and tissue deposition of lipids and micronutrients. Optimised enrichment protocols thus transform *Artemia* into dynamic nutrient carriers, improving broodstock maturation and larval quality in shrimp hatcheries.

Keywords

Bio-enrichment; Brine shrimp, Broodstock maturation, Cod liver oil, Enrichment protocols, Live feed



Broodstock development and spawning of Maldives damselfish *Amblyglyphidodon indicus* Allen & Randall, 2002 in captivity

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The family Pomacentridae is a group of small, ray-finned fishes predominantly found in tropical and sub-tropical marine waters, especially around coral reefs. Their adaptability and striking appearance make them popular in the aquarium trade. Among Pomacentrids, *Amblyglyphidodon indicus* commonly known as the Maldives damselfish, is native to the Indian Ocean. Maldives damselfish is a beautiful fish with a silvery body, greenish colouration on dorsal and a yellowish-white coloration on the ventral region. Maldives damselfish are mainly caught from their natural habitat for trade. Captive seed production will ensure the sustainable trade of the species. The present study reports the first successful captive broodstock development and spawning of Maldives damselfish. Subadults of total length (TL) 5.5-6.5 cm and total weight (TW) of 6-6.5 g were collected from Cape Comorin with the help of local fishermen and transported to the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). After a quarantine period of two weeks, the fish were transferred to the broodstock rearing tank of 500 l capacity filled with 280-300 l of filtered (one-micron) seawater and provided with a simple biofilter. During the rearing period, fish were fed with pellet feeds and mussel meat four times a day. The water quality was kept optimum in the broodstock tanks. The fish behaviour was periodically monitored and recorded. Potential broodstocks were identified after six to seven months of rearing, at a size of total length, 7.6-8.3 cm, body weight, 9.6-12.9 g. The males cleaned the spawning site (PVC pipe, 15 cm in length and 5 cm in diameter) and engaged in active territory maintenance. When females were ready to spawn, they entered the spawning site and attached the eggs to the roof of the PVC pipes and the male immediately fertilised the eggs. The males guarded the egg patch until the eggs hatched. The number of eggs varied from 950 to 3000 in different batches. The eggs are transparent, cylindrical and measured 1300 to 1350 µm in length and 500 to 600 µm in width. The eggs hatched in the late evening after 101 - 103 h of incubation and hatchlings measured 3400-3490 µm in TL and 530-580 µm in width. Regular spawning was observed in the same tank. The results also indicated that under hatchery conditions, year-round spawning is possible for Maldives damsel. Through this study we have developed the basic protocol for successful captive broodstock development and spawning of Maldives damselfish.

Keywords

Hatchery, Ornamental fish, Pomacentridae, Spawning, Territory maintenance



Broodstock development and spawning of Talbot's damselfish *Chrysiptera talboti* (Allen, 1975) in captivity

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Fishes belonging to the family Pomacentridae are among the most traded marine ornamental fishes globally. Among pomacentrids, Talbot's damselfish (*Chrysiptera talboti*) is a highly sought-after fish due to its attractive colour combination of purple body and canary yellow in the head and pelvic fins. The body has a distinctive black spot on the dorsal fin. For the trade, they are mainly captured from the coral reefs of the Indian and the Pacific Ocean using unsustainable methods. The captive breeding of the species will reduce the need for their wild collection, ensuring the sustainable trade. The present study represents the first successful captive broodstock development and spawning of *C. talboti*. Subadults of *C. talboti* (total length, 2.8 to 3.2 cm; body weight, 1.3 to 1.8 g) were purchased from a commercial aquarium vendor and transported to the Vizhinjam Regional Centre of ICAR-CMFRI in polyethylene bags filled with oxygen. After a two-week quarantine period, fish were transferred to the broodstock rearing tanks of 500 l capacity, filled with 350 l of filtered seawater and equipped with a biofilter system. The fish were fed four times a day using the broodstock diet. The water quality parameters were maintained at optimum levels and a natural light cycle (light: dark, 12 : 12 h) was followed. The behaviour of the fish was regularly monitored and recorded. After four months of rearing when the fish attained a size of 4.4-5.8 cm in TL, it displayed aggressive territorial behaviour. The males were dominant, frequently cleaned the spawning site and protected the territory from other fishes. When the fish started courtship behaviour, PVC pipes (15 cm in length and 5 cm in diameter) were provided as shelter. The spawning occurred in the early morning hours. After spawning, the male defended the territory and safeguarded the eggs. The number of eggs per spawning ranged from 350-700. The eggs were transparent and cylindrical, having 899.51 ± 33.51 μm in length and 423.54 ± 13.41 μm in width. The incubation period was 84-86 h at $28 \pm 1^\circ\text{C}$. Under hatchery conditions, year-round spawning of *C. talboti* was achieved with peak spawning in March and April.

Keywords

Breeding behaviour, Marine ornamental fish, Pomacentridae, Sustainable trade, Territorial behaviour



Broodstock development and spawning of two-tone chromis *Pycnochromis fieldi* in captivity

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The increasing demand for marine ornamental fishes has prompted aquaculture specialists to focus on captive breeding of ornamental fishes, aiming to reduce pressure on wild populations and promote sustainable aquaculture. The two-tone chromis or the chocolate dip chromis *Pycnochromis fieldi*, native to the Indian Ocean, is a small, reef-associated damselfish (Pomacentridae). It is a popular species in the marine aquarium trade due to its attractive colour pattern and peaceful nature. This species mainly feeds on zooplankton and inhabits coral reefs at depths of 1-40 m. Despite its ecological and commercial significance, the successful captive breeding of *P. fieldi* had not been documented. This study presents the first successful broodstock development and spawning of *P. fieldi* under hatchery conditions achieved at the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). Ten sub-adult specimens were collected from the coastal waters of Kanyakumari (East coast of India) and transported to the hatchery in oxygen-packed polyethylene bags. After a one week of quarantine and acclimatisation period in 300 L HDPE tanks, the fish were transferred to 500 l circular HDPE tanks with well-maintained biofiltration systems. The fish were maintained on a mixed diet of commercial pellet feed (1.2 mm) and fresh squid or mussel meat thrice daily. After three months, the fish had reached a total length of 5 to 7 cm and a body weight of 2.9 to 6.5 g and started to exhibit signs of reproductive behaviour. Spawning occurred naturally, with the number of eggs ranging between 400 to 600 per spawning. The eggs were oval-shaped and hatched within 55 to 60 h of incubation, and hatchlings measured 1850 to 2020 µm in length. The natural spawning without hormonal induction substantiates the adaptability of species to captive conditions. These findings provide a foundational protocol for the commercial-scale breeding of *P. fieldi* for the interests of aquaculturists and researchers. Future research will focus on the successful larval rearing techniques to establish a complete hatchery production technology for this species. This forms the first report of successful captive spawning of this species.

Keywords

Chocolate dip chromis, Damsel fish, Fish breeding, Ornamental fish, Pomacentridae



First report on the broodstock development and spawning of Andaman damsel *Pomacentrus alleni* in captivity

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Pomacentrus alleni, commonly known as the Andaman damsel, belongs to the family Pomacentridae is a highly sought-after fish due to its vibrant colour pattern. The present study evaluated the broodstock development and spawning potential of *P. alleni* in captive conditions at the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). Nine sub-adult specimens with a size range of 4.5 cm to 5.0 cm were collected from the Kanyakumari Coast in August 2024. These fish were quarantined for two weeks and transferred to two separate 500 l tanks. Fish were fed ad libitum with broodstock diet thrice in a day. Behaviour of each individual fish was carefully observed and documented. After five months of rearing, the fish with intensive territorial behaviour was identified as potential broodstock and segregated from the group, stocked in to broodstock/spawning tanks (500 l capacity) incorporated with a recirculatory aquaculture system (RAS). Water quality parameters were maintained throughout the study, with a pH of 8.2 ± 0.02 , temperature of $28.7 \pm 0.1^\circ\text{C}$ and with a salinity of 33-34 ppt. One male fish (5.5 cm and 5.3 g) and one female fish (5.7 cm and 5.5 g) exhibited a distinctive breeding colouration and courtship behaviour. Sexual dimorphism was evident at this stage; the males had a neon blue colour with a blending of yellow near the bottom of the body down to the anal fin, whereas females displayed a slightly muted neon blue coloration compared to the male. Near spawning, the male cleans the hideout provided in preparation for laying the eggs. The first spawning occurred early morning (7-9 h), with 500-600 eggs. The eggs were adhered to the substrate using adhesive tendrils. Following spawning and fertilisation, the male diligently guarded and aerated the eggs. The eggs were elliptical and measured $856.91 \pm 66.61 \mu\text{m}$ with a single oil globule. On the day of spawning, the eggs appeared transparent, making them difficult to detect underwater. As the development progressed, their colouration gradually shifted, turning into a metallic grey hue by the day of hatching. In case the eggs fail to develop properly, the male fish carefully removed them to maintain the health of the clutch. On the third day of incubation just after the sunset, the eggs hatched out. This is the first report of breeding of *P. alleni* and forms a baseline data for the successful captive seed production of this species.

Keywords

Captive breeding, Pomacentridae, RAS, Sexual dimorphism, Spawning, Water quality



Development and validation of climate-resilient mooring technology for sustainable seaweed farming using HDPE rafts in coastal Gujarat

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The expansion of seaweed farming along the Indian coastline, particularly in ecologically and geopolitically sensitive zones such as the Kutch Coast of Gujarat, faces significant structural challenges due to extremely high tidal amplitudes (8-12 m) and turbulent marine conditions. Traditional mooring and raft systems, such as bamboo rafts, often prove inadequate in these dynamic environments, resulting in structural failures, biomass loss, and limited scalability. To address these constraints and promote climate-resilient farming, this study aimed to identify and validate a reliable, site-specific mooring technology that can support sustainable seaweed cultivation in high-tidal zones. Two indigenously developed mooring systems were designed and tested for integration with 3×3 m HDPE floating rafts insulated with polyurethane foam (PUF): (i) a multigonal grid mooring, comprising four RCC anchor blocks positioned in a polygonal layout, with individual mooring lines securing each corner of the raft grid; and (ii) an umbrella mooring, using four symmetrically arranged RCC blocks (each 100 kg) connected through a centralised mooring line assembly. Both systems were deployed at 6-8 m depth in high tidal waters off the Kutch coast to evaluate structural performance and environmental adaptability. The umbrella mooring system exhibited superior structural integrity, positional stability, and resistance to tidal forces, consistently maintaining raft alignment and enabling effective seaweed culture under challenging marine conditions. Validated through field trials at strategic Indo-Pak border marine creeks Kori and Padala, and adjacent high-energy coastal sites, this configuration outperformed the multigonal grid design. The findings demonstrate that the umbrella mooring system, integrated with HDPE rafts, provides a resilient, scalable, and sustainable solution for seaweed farming in high tidal amplitude regions. This mooring technology offers a replicable model for other Indian coastal zones.

Keywords

Climate resilient farming, High tidal amplitude, Site-specific design, Umbrella mooring system



Empowerment of coastal scheduled caste communities through sustainable cage farming: A success story from Uttar Kannada District, Karnataka

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Cage farming is an emerging aquaculture technology that offers sustainable livelihood opportunities, particularly for coastal communities. This case study evaluated the performance of the Scheduled Caste Sub Plan (SCSP) program of the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) in various mariculture initiatives implemented to empower beneficiaries of the Scheduled Caste (SC) community in the Uttara Kannada District of Karnataka. The two selected groups were monitored for their coastal cage farming activities. In 2023-2024, the "Mahaganapati Panjarada Gudu" Group deployed 6x3x3 m GI cages for culturing Asian sea bass and silver pompano in Divgi, Kumta. After, 270 days of culture (DOC), the group harvested 160 kg of silver pompano, generating `56,000/- as net profit. Following this success, "Shri Naga Chowdeshwari Group" deployed similar types of cages in Horbag, Kumta and harvested 300 kg of silver pompano in 270 DOC and generating `1,35,000/- as gross revenue. This group also expanded their operations by receiving additional inputs to culture Asian sea bass, resulting in a harvest of 150 kg and `46,850/- as net profit. Additionally, the group diversified their farming practices by introducing green mussels (30 ropes) and fish farming in cages. They harvested 180 kg of green mussels and generated `1,83,850 as gross revenue in five months. This success illustrates the potential of integrated mariculture in cages as a sustainable livelihood opportunity for coastal SC communities. These present SCSP activities have not only enhanced economic resilience but also empowered these communities to adopt innovative aquaculture techniques, contributing to their socio-economic development. This case study highlights the success of coastal cage farming in promoting social empowerment, community development and skill enhancement, serving as a sustainable aquaculture model to support blue economy goals and ensure equity.

Keywords

Asian sea bass, Benefit-cost ratio, Gross revenue, Mariculture, Scheduled caste, Silver pompano



Harnessing seaweed cultivation to offset fishing-related carbon emissions and enhance coastal sustainability in Gujarat

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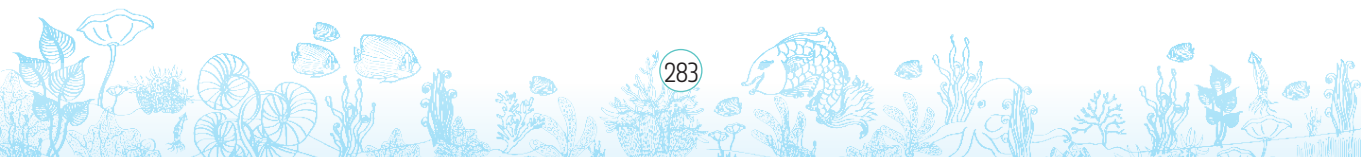
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Seaweed farming supports the livelihoods of remote coastal communities and contributes to achieving Sustainable Development Goals (SDGs) through climate change mitigation, maintaining healthy marine ecosystems, and promoting responsible consumption. According to ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) recent estimates the average emission from marine fisheries operations were estimated as 1.52 kg CO₂ (0.415C) e per kg of fish caught from fishing operations in India. According to a recent fish landing report by ICAR-CMFRI for 2023, Gujarat recorded a total fish landing of 8,22,786 t, resulting in the release of approximately 12 lakh t of CO₂ and 5 lakh t of carbon. As per the scientific studies 100 kg of seaweed can store approximately 2.72 kg of carbon. Based on this data, an estimated production of 19 million t of seaweed on an annual basis can offset the carbon emissions generated by fishing activities in Gujarat. With a cultivation cycle of 45 days the standard size seaweed HDPE raft has the capacity to produce 250 kg of *Kappaphycus* per cycle, resulting in an annual yield of approximately 1,250 kg per raft over five cultivation cycles. To achieve a production target of 19 million t of *Kappaphycus*, approximately 15,263 cultivation rafts would need to be deployed annually, requiring an estimated 30,548 ha of suitable coastal area. ICAR-CMFRI conducted a preliminary site-selection survey for seaweed farming across all Indian maritime states. Gujarat has 10,316 ha of potential area for seaweed cultivation. Full raft deployment over this area could offset 34% of carbon emissions from Gujarat's annual fish landings. Seaweeds store carbon, absorb CO₂, and act as natural biofilters. These farms reduce greenhouse gases, aid climate-change mitigation, and boost aquaculture resilience. The findings guide policymakers with recommendations for sustainable implementation.

Keywords

Carbon store, Climate change mitigation, cultivation cycle, *Kappaphycus*, Marine fisheries, SDGs



Development of tropical paracalanid copepod *Bestiolina similis* (Sewell, 1940) as live feed for *Siganus vermiculatus* larviculture

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Copepods are pivotal in marine ecosystems, linking primary producers to higher trophic levels and serving as a critical food source for fish larvae. In the present study, a tropical paracalanid copepod was isolated from the coastal waters of Karwar and identified as *Bestiolina similis* (Sewell, 1914). Furthermore, morphometric and molecular analysis were conducted for species identification (PQ881939; PQ882131). This native paracalanid copepod was successfully reared and mass-cultured in the laboratory using a mixed microalgal diet. It exhibited a high reproductive rate and remarkable tolerance to a broad range of salinities. (10-40 ppt). The developmental stages of *B. similis* revealed that the nauplii, measuring $56 \pm 2.0 \mu\text{m}$ in width, represent an ideal live-feed size for the early larval stages of *Siganus vermiculatus*. A prominent red colouration was observed in all stages of nauplii (N1-N6), copepodite (C1-C5) and adults. The experimental results of *S. vermiculatus* larviculture showed that larvae fed with *B. similis* exhibited a significantly higher growth rate than those fed with enriched rotifers. Furthermore, the analysis revealed that the early larval survival percentage was positively influenced by *B. similis* in the diet of *S. vermiculatus*. Results of this study indicate that *B. similis* has significant potential as a live feed for marine fish larviculture, offering advantages in terms of nutritional quality, growth enhancement, and survival rates in up-scaling seed production. *B. similis* cultured in mass quantities using relatively simple and cost-effective techniques, making it an economically viable option for commercial aquaculture operations.

Keywords

Copepodite, Enriched rotifers, Larviculture, Microalgae, Salinity, Survival percentage, Trophic level



Tolerance of calanoid copepod *Acartia sarojus* adults to abrupt salinity changes

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Members of the genus *Acartia* are one of the most popular calanoid copepods for mass production for the use as live feed in finfish hatcheries. Generally, the first nauplii of *Acartia* spp. measure 40-45 μm in width and can be used as a first feed for even altricial-type fish larvae. Recently, a native marine calanoid copepod *Acartia sarojus*, was isolated and developed for use as live feed in marine fish hatcheries at the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). This is one of the smallest *Acartia* species with very small first nauplii ($45 \pm 3 \mu\text{m}$) suitable for using as first feed for marine fish larvae. In general, *A. sarojus* is cultured in 35 ppt salinity. There is a need to explore its potential for utilising it as a live feed for marine and brackishwater fishes reared under various salinities. The salinity tolerance ability of *A. sarojus* was evaluated for efficient management and utilisation of the species as live feed for a wide range of fishes. The copepods for the present study were obtained from the stock culture of *A. sarojus* maintained at the Vizhinjam Regional Centre of ICAR-CMFRI. The adult survival was assessed in different salinities from 0 to 70 ppt at an interval of five ppt. All the experiments were run in triplicate, and copepods were fed with a mixture of microalgae. Results showed that after a 24 h period, more than 50% adult survival was found in the salinity range of 10 to 55 ppt and the maximum survival was obtained in the salinity range 15-35 ppt. Results emphasise the adaptability of *A. sarojus* in both brackish and seawater salinity conditions and can be utilised as live feed for the rearing of both marine and brackishwater fish larvae.

Keywords

Altricial, Larval rearing, Microalgae, Salinity tolerance, Survival



Successful broodstock development and spawning of black-bar chromis *Chromis retrofasciata* (Weber, 1913)

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Most members of the family Pomacentridae are popular in the marine ornamental fish trade. The genus *Chromis* includes many important high-value marine ornamental fish species with attractive colour patterns. The black-bar chromis *Chromis retrofasciatus* is a beautiful fish with a vertical black stripe just in front of the caudal region which forms high contrast with the grey-coloured body. Black-bar is a highly sought after fish due to its appearance and adaptability in marine reef tanks. Broodstock development and seed production of *C. retrofasciatus* is essential to reduce the risk of damaging their natural habitat during wild collection and to protect its wild resources. Captive seed production of this species is the only feasible method to produce fish sustainably for the ornamental trade. Broodstock development, spawning and larval rearing of *C. retrofasciatus* were successfully done at the Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). For broodstock development, 10 sub-adults of *C. retrofasciatus* were collected from Kanyakumari, East-coast of India, during December 2021. After proper quarantine, the fish were stocked in two broodstock tanks each with 500 L capacity, containing 350 l of fresh, filtered (one-micron) seawater. The tanks were equipped with a simple biofilter system. Fish were fed highly nutritious broodstock feed (crumble size, 0.5-0.8 mm) 4-5 times a day. The water quality parameters were maintained at suitable levels for the fish. Then subadults collected from the wild reached maturity within 2 months. The mature males and females measured mean total length, 4.4 ± 0.5 cm, mean body weight, 2.8 ± 0.5 g and mean total length, 3.6 ± 0.5 cm, mean body weight, 1.6 ± 0.3 g respectively. PVC pipes (15 cm in length and 5 cm in diameter) were provided as a hideout and also as a substrate for depositing eggs. Males showed territorial behaviour after pairing. Male fish cleaned the specific spawning area in the PVC pipe and started guarding the territory from other fish. The first spawning was recorded in April. Initially, the number of eggs were only up to 50. After two or three consecutive spawnings, the quantity and quality of eggs improved. Mostly spawnings were observed in the early morning hours between 5.45 h and 7.30 h. After spawning, male guarded the eggs. The eggs were ellipsoid in shape and similar to those of the genus *Dascyllus* (length 480-512 μ m and width 350-365 μ m). The incubation period observed was 56-60 h at $28 \pm 1^\circ\text{C}$. Hatching generally occurred in the late evening. The newly hatched larvae measured 1625-1700 μ m in TL and 280-290 μ m in width. This is the first report of the breeding of the black-bar chromis, *C. retrofasciata*.

Keywords

Damsel, Breeding behaviour, *Chromis retrofasciatus*, Incubation period, Pomacentridae, Spawning



Early insights into biofouling communities and their impact on cage culture nets at North Bay, Andaman and Nicobar Islands

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Biofouling on cage nets is a significant challenge and a major cost factor in marine finfish aquaculture worldwide. Various government agencies and private stakeholders are introducing intensive cage-farming systems along the Indian coast and in the sheltered bays of the Andaman and Nicobar Islands. These bays, with their shallow, warm, and nutrient-rich waters, provide ideal conditions for the rapid growth of aquatic flora and fauna, leading to the accumulation of fouling organisms and other substances on submerged cage components such as nets, frames, and ropes. The random quadrat method (one square metre) was used to quantify the fouling organisms, and physicochemical analyses of seawater were conducted to determine the relationship between fouling intensity and knotless polypropylene (PP) nets. Systematic studies on biofouling of cage culture nets in these regions have been lacking. In a one-year field study, the effects of immersion period (2 months), sampling time, mesh size (13- and 25-mm half-mesh), and variability among three individual cages on the biomass, species richness, and community composition of biofouling were investigated using net panels. The dry weight of a net before deployment was approximately 80 kg, which increased to about 1380 kg after fouling. Bryozoans, oysters, barnacles, sea anemones and ascidians were the dominant taxa (80–100 ind. m⁻²), exhibiting high attachment and rapid growth rates. Among the dominant phyla, Mollusca represented 30%, Ascidacea 29%, Arthropoda 28% and least diversity was recorded for Echinodermata. Numerous associated flora and fauna were also observed within the fouling community, utilising the substrate for shelter and feeding. The results indicate that net mesh size plays a crucial role in the attachment and growth of fouling organisms, which can significantly impede water exchange and, consequently, affect fish growth and overall cage performance.

Keywords

Barnacles, Disease susceptibility, Mesh size, Net panels, Quadrat method, Water exchange



BACI-based environmental impact assessment of lobster cage mariculture along the northwest coast of India: Ecological implications and bioindicator potential

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Open sea cage farming has emerged as a promising mariculture practice in India, offering significant production potential for high-value species such as spiny lobsters. This study investigates the environmental impacts of open sea cage farming along the north-western Saurashtra coast of India using a Before-After-Control-Impact (BACI) experimental design. The assessment focused on hydrobiological parameters and phytoplankton community dynamics across three seasonal phases before, during, and after cage culture operations. Significantly elevated concentrations of total suspended solids (TSS), nitrate, ammonia and phosphate were recorded during the active culture period, correlating with reduced phytoplankton diversity (Shannon's $H' = 3.02$) and increased species dominance (Simpson's $D = 0.0567$) at the cage site compared to the reference site ($H' = 3.33$; $D = 0.0420$). Dominance of opportunistic diatoms such as *Nitzschia* and *Navicula* was noted, indicating transient localised eutrophication. Multivariate and BACI analyses revealed that elevated TSS had the strongest negative influence on phytoplankton diversity, contributing to a 4.8% decline in H' , while also increasing species dominance by 19%. Cluster and PCA analyses further validated seasonal shifts in water quality and community structure driven by cage operations. Despite these changes, hydrodynamic current analysis indicated favourable flushing conditions (0.11–0.28 m/s), due to monsoon season which may mitigate long-term ecological impacts. The study highlights the potential for *Nitzschia* and *Navicula* as bioindicators and underscores the need for ecosystem-based management, including site-specific monitoring and adoption of Integrated Multi-Trophic Aquaculture (IMTA) practices. These findings provide a foundational framework for environmentally responsible mariculture development under India's expanding blue economy initiatives.

Keywords

Before-after-control-impact design, Hydrobiological parameters, Phytoplankton community dynamics, Sea cage farming, Sustainability





Two-tier cage culture of Asian seabass (*Lates calcarifer*) involving fisher communities in the coastal areas of Bangladesh

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An experiment was conducted to determine the possibilities of a two-tier system (nursery and grow-out stage) cage culture of Asian seabass *Lates calcarifer* in the coast of Munshiganj, Satkhira and Moheshkhali Channel, Cox's Bazar, in six cages (1 for nursery and 2 for grow-out in each location) with direct participation of coastal fisher communities for 365 days. Survival; growth performance in terms of weight gain (WG) and specific growth rate (SGR); and feed conversion ratio (FCR) (nursery stage); along with proximate composition, gut content, intestinal histology and cost-benefit were analysed in the grow-out stage. In the nursery stage (initial weight 1.05 g), fish fed with 52% crude protein feed at 10–8% of biomass twice a day for 90 days resulted in 61.13 and 57.47% survival rate, 9.20 and 6.98 g WG, 2.53 and 2.26% per day SGR, 1.97 and 2.85 FCR in Munshiganj and Moheshkhali, respectively. Subsequently, fish were distributed to the grow-out cages at a density of 15 fish m⁻³, fed with 45–40% protein supplemented feed at 5–1% of their body weight for 275 days. Results showed significantly higher survival (90.13%), WG (1009.15 g), and lower FCR (1.71) in Munshiganj compared to Moheshkhali (Survival 85.06%, WG 815.93 g, and FCR 1.93). Gut content analysis revealed that fish predated macro-sized natural food inside the cages during the culture period. Cage-cultured fish contained significantly higher amount of protein (highest in Munshiganj 19.07%) compared to the respective wild in both locations. Histo-morphology of the intestine revealed that the fish intestine was in better condition than that observed in the wild. Production was higher in Munshiganj (800–840 kg per cage) than Moheshkhali (600–650 kg per cage); thus, benefit-cost ratio was higher in Munshiganj (1.66) compared to Moheshkhali (1.37). This study explored the opportunities of marine cage farming of seabass in Bangladesh, ultimately, will help to increase mariculture production through cage farming of marine finfishes and ensure better food and nutritional security.

Keywords

Benefit-cost ratio, Coastal fishers, Livelihoods, Mariculture, Two-tier aquaculture



An efficient method for the mass cultivation of *Synechococcus salsus* for bioremediation of aquaculture effluents

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Synechococcus sp. comes under the group of unicellular cyanobacteria that are readily cultured for various industrial purposes. Despite its wide application in research and industry, the isolation and mass production of *Synechococcus* sp. is found to be difficult, as the media optimisation is highly challenging. Hence, the present study introduces an improved method for the isolation and mass culture of *Synechococcus* sp. from the south-west coast of India. The species identified in our study, *Synechococcus salsus* exhibits a remarkable capacity for ammonium uptake and cellular assimilation, enabling it to effectively remove ammonium from wastewater. This strong absorptive ability highlights its potential as a viable agent for bioremediation in wastewater treatment systems. Our findings demonstrate that culturing in BG11 medium supplemented with ammonium sulphate, under controlled natural light conditions, significantly reduces the lag phase and enhances both growth rate and cell density. The maximum observed growth rate of *S. salsus* was 0.30 day⁻¹ in BG11 medium supplemented with 2 g l⁻¹ ammonium sulphate under natural light conditions, significantly surpassing the growth rate of cultures maintained in standard BG11 medium. Additionally, the initiation period for bloom formation decreased from 9–10 days to 4–5 days when the medium was combined with 1.5–2 g l⁻¹ ammonium sulphate and kept in natural light. Growth rate and cell density increased with higher concentrations of ammonium sulphate; however, beyond 2 g l⁻¹, both parameters declined. Optimal growth occurred at a salinity of 22 ppt, pH 7.2, and temperature of 25°C. This study offers a promising approach for the efficient mass cultivation of *Synechococcus* sp., facilitating its application in ammonia removal from aquaculture effluents.

Keywords

Ammonium sulphate, BG11 medium, Cell density, Cyanobacteria, Natural light



Optimising mixotrophic cultivation of *Nannochloropsis oceanica* for enhanced biomass and nutritional yield

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Microalgae are efficient biofactories for producing long-chain polyunsaturated fatty acids (LC-PUFAs), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are vital for human and animal health. In this study, the cultivation of *Nannochloropsis oceanica* under mixotrophic conditions with varying concentrations of glucose and glycerol (0.03-0.5%) was investigated to optimise EPA production. Supplementation with 0.125% glucose and 0.125% glycerol significantly enhanced cell density ($OD_{664} = 1.186$ and 1.1251 , respectively), while fatty acid methyl ester (FAME) analysis revealed increased total lipid accumulation and EPA levels, rising from 13.56% in autotrophic control cultures to 20.03 and 20.65% with glucose and glycerol, respectively, indicating a strong stimulatory effect of organic carbon on PUFA biosynthesis. Alongside EPA, major fatty acids included palmitic acid (C16:0; 24.87–28.40%), palmitoleic acid (C16:1; 13.88–28.82%), and oleic acid (C18:1n9c; 13.94–21.26%), with distinct shifts in saturated and monounsaturated fatty acid profiles across treatments, while novel long-chain fatty acids such as C22:5n3 and C22:4n3 emerged under glycerol supplementation, suggesting activation of alternative biosynthetic pathways. Furthermore, experiments with different Carbon: Nitrogen: Salinity (C: N: S) ratios demonstrated that nutrient-limited conditions, particularly low-level treatments, promoted higher biomass yields ($OD_{664} = 1.508 \pm 0.03$), likely reflecting adaptive metabolic responses that optimise growth and lipid production under stress.

Keywords

Biofactories, DHA, EPA, FAME analysis, Lipid accumulation, Microalgae, PUFA



Socio-economic evaluation and constraints of cage fish farming: Insights from Alappuzha and Kollam districts, Kerala, India

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This study aims to bridge this gap by analysing the socio-economic characteristics, technology adoption patterns, production economics, and constraints experienced by cage fish farmers in these districts. A structured field survey was conducted among 75 respondents (40 from Alappuzha and 35 from Kollam). Major species cultured included Pearls spot (*Etroplus suratensis*), Nile tilapia (*Oreochromis niloticus*), Asian seabass (*Lates calcarifer*), and Silver pompano (*Trachinotus blochii*). Data were collected through personal interviews in the local language, covering socio-personal traits, economic status, adoption of technologies, and production challenges. Analytical tools such as frequency distributions, means, standard deviations, and chi-square tests were applied to examine differences between districts. Farmers widely adopted standardized 4x4x3 m cages with stocking densities varying by species (48/m³ for pearl spot, 45 m⁻³ for tilapia, 35 m⁻³ for seabass, and 80 m⁻³ for pompano). Feeding practices involved 3-4 daily applications of floating pellets, while disease management relied on disinfectants such as potassium permanganate and tetracycline. Manual cage cleaning, guarding, and occasional camera surveillance were common. Crop yields ranged from 100–800 kg, with farm-gate prices differing across districts (e.g., pearlspot at ₹47,800 per quintal in Alappuzha and ₹58,194 per quintal in Kollam). Investment in cages averaged ₹90,000–1,30,000, with feed and seed as the major operational costs. Reported survival rates varied between 25-80%. Socio-economic analysis revealed that most farmers were middle-aged, possessed secondary or higher education, and had less than six years of cage farming experience. While male ownership dominated, female participation in day-to-day management was notable. Participation in social or cooperative organizations, however, remained low, limiting collective bargaining and institutional growth. Key constraints included inadequate access to finance and insurance, high input costs, vulnerability to natural disasters, and conflicts over water use, compounded by weak institutional frameworks. Policy recommendations emphasise expanding financial and insurance support, developing indigenous hatcheries, enhancing capacity building, and promoting cooperative structures. This study highlights the socio-economic dynamics and challenges of cage farming in Kerala's coastal districts, underscoring the need for integrated policies and coordinated stakeholder efforts to strengthen sustainability and improve livelihoods in the aquaculture sector.

Keywords

Aquaculture sector, Crop yield, Livelihoods, Operational cost, Survival rate, Technology adoption



Biological control and sustainable utilisation of the invasive charru mussel *Mytella strigata* (Hanley, 1843) in coastal aquaculture facilities

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The invasive charru mussel *Mytella strigata* (Hanley, 1843) is a problematic biofouling organism in tropical and subtropical coastal aquaculture facilities, where it competes with cultured species, obstructs water flow, and disrupts ecological balance. Conventional removal methods are labour-intensive and may cause environmental disturbance, highlighting the need for sustainable alternatives. This study evaluates the potential of mud crabs (*Scylla* spp.) as biological control agents for *M. strigata*. Controlled feeding trials were conducted to assess predation rates, prey size preferences, and effects on mussel biomass. Results show that *Scylla* spp. readily consume *M. strigata* across size ranges, with significant biomass reduction observed within experimental enclosures. Predation was most effective on heavily fouled substrates, suggesting that mud crabs can target high-density mussel aggregations. Incorporating *Scylla* spp. into aquaculture systems could simultaneously control invasive mussel populations and yield an additional commercial product, aligning with integrated multi-trophic aquaculture (IMTA) principles. This approach offers a practical, low-impact, and economically beneficial strategy for invasive species management in cultured facilities along coastal environments.

Keywords

Aquaculture, Biofouling, Mud crab, Mussel biomass, Predation rate, Prey size preference



An innovative integration of a tide-fed farm in aquasilviculture model

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Innovative integration of tide-fed aquaculture into mangrove ecosystems supports ecological balance and sustainable resource utilisation. The model features a unique pond design with regulated sluice gates that use tidal flows for water exchange to achieve a zero-carbon footprint. This method ensures efficient water circulation, nutritional replenishment and improved culture conditions for euryhaline fish species by utilising natural tidal dynamics and eliminating the need for external water exchange. Through habitat restoration, carbon sequestration and biodiversity support, the combination of mangrove and tidal ecosystems not only increases aquaculture productivity but also fortifies ecological resilience. Furthermore, the approach has considerable socioeconomic benefits by improving coastal livelihood with high stability. As a nature-based solution, this integrated design highlights the transformation of underutilised coastal areas for productive ecological restoration and livelihood security.

Keywords

Climate resilience, Mangrove integration, Nature-based solution, Pond design, Tidal dynamics



Beyond the shoreline: Women leaders in seaweed farming - A case study from Kutch, Gujarat

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Women have made significant yet frequently unrecognized contributions to the advancement of seaweed farming across India's coastal regions. Over the past four decades, their persistence, resilience, and innovative practices have played a vital role in shaping a more inclusive and environmentally sustainable aquaculture sector. This study explores the role of women leaders in seaweed farming in Kutch region of Gujarat. The study investigated their leadership roles through a mixed-methods approach, combining structured data collection schedules, freewheeling interviews, personal narratives and field observations. The research highlights a case study of Smt. Sakina Bai A. Vagher, a pioneering woman seaweed farmer from the Vagher fishing community in Juna Bandar, Mundra Taluka, Kutch District. Her involvement in seaweed farming led to improved access to education for her children and increased household savings by 30%. Notably, she has demonstrated technological innovation by transitioning from traditional bamboo rafts to advanced HDPE seaweed raft systems. She has over 6 years of experience in seaweed farming and used to attend training programs to learn advanced techniques and best practices in sustainable seaweed cultivation. The results further reveal that she used to earn ₹2.5 lakhs per annum as per preliminary estimates from seaweed farming activities including net tube and monoline making, tying and attaching seaweed to rafts, seaweed drying and other post-harvesting works. She now manages over 20 seaweed farming rafts along with her family with a production of 200 kg per raft per season. The study reveals that women in Kutch, are not merely participants but are becoming leaders in coastal aquaculture systems, performing multifaceted roles from domestic roles to farming technologies to entrepreneurship in value-added product development. This study emphasises the need to integrate gender perspectives into blue economy strategies, empowering fellow women and formulating marine resource management frameworks. It further recommends the implementation of gender-sensitive indicators to effectively assess progress toward Sustainable Development Goal 5 (SDG5), "Achieve gender equality and empower all women and girls".

Keywords

Blue economy, Gender-inclusive aquaculture, Leadership roles, Seaweed farming, SDG5



Sustainable conservation and cultivation of marine macroalgae from the Dakshina Kannada Coast

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Seaweeds are important marine resources with application in food, pharmaceuticals and industry. However, their natural availability is restricted to certain seasons and it is further impacted by overexploitation and environmental fluctuations. To ensure a continuous supply and conservation through cultivation offers a sustainable pathway. The present study explores *in vitro* and *ex situ* cultivation techniques for seaweed conservation beyond their natural growing seasons. These techniques provide potential for maintaining culture, reducing dependence on seasonal harvests and supporting future large-scale cultivation. The study aims to contribute to the development of seaweed cultivation protocols for seaweed conservation, cultivation and utilisation.

Keywords

Continuous supply, *Ex situ*, *In vitro*, Marine resource, Seaweed culture



Tracking five decades of seaweed research in aquaculture: A global scenario

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To explore the global research landscape on seaweed, a search was carried out using specific criteria with refinement parameters; articles published in English language were considered. A total of 1000 articles having the 16,700 citations were retrieved from OpenAlex open-access research database. The publication trend showed gradual increase from 1970 to 2025 with peak observed between 2016-2024. University of Dar es Salaam leads with the highest publications (22) at the institutional level followed by 21 publications from the Scottish Association for Marine Science. Whereas at the affiliations of the corresponding authors, the University of Connecticut, University of Gothenburg, Scottish Association for Marine Science, and Hasanuddin University contributed equally with seven publications each. Followed by six publications contribution from the universities such as the University of Tasmania, the University of the Sunshine Coast, the University of Dar es Salaam, and the Chinese Academy of Fishery Sciences. Further, analysis was carried out in connection to FAO Sustainable Development Goals (SDGs); it revealed that, majority of publications were aligned with SDG 14 (Life Below Water- 377 publications), followed by 51 publications in SDG 12 (Responsible Consumption and Production). And, SDG 2 (Zero Hunger) and SDG 8 (Decent Work and Economic Growth) followed with 39 and 38 publications, respectively. This highlights the importance and association of seaweed farming and SDG 14 for ecological importance, specifically in promoting marine ecosystem health and enhancing biodiversity with reducing stress on wild fish populations. In individual contribution, Flower E. Msuya's position at first was with 24 publications, followed by Elizabeth Cook with 13. Whereas at the national scale, Indonesia was positioned at first with 174 publications, followed by the United States (88) and China (74). India ranked at eleventh position globally (26 publications), indicative of growing interest driven by the potential of seaweed farming as a sustainable income source and export opportunity. Globally, research is shifting toward seaweed farming to address food security, sustainable livelihoods, and climate change. Asian countries lead this transition. India must partner domestically and internationally to meet business needs, close research gaps, and expand seaweed farming areas.

Keywords

AI tools, Bibliometric analysis, Biodiversity, Ecosystem health, SDGs



Trends and gaps in Indian mariculture research: A bibliometric insight aligned with SDGs

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To gain an overview of mariculture research in India, a bibliometric study was conducted using the Dimensions AI database and VOS viewer software. The present study focused on abstracts and titles with designing the keywords as search strategy "Mariculture OR Marine aquaculture OR Opensea farming OR Offshore aquaculture OR Coastal aquaculture OR Seawater aquaculture OR Marine fish farming OR Sea cage farming AND India". The Dimensions AI (<https://app.dimensions.ai>) database returned 114 publications as search results, including 81 journal articles, 27 book chapters, 4 edited volumes, 1 preprint, and 1 conference proceeding. All 114 data were downloaded in the VOS viewer software format for further analysis. The publication started in the year 1980, but the amount of research on this topic increased dramatically between 2015 and 2020. 57 publications addressed sustainable development goals (SDGs); 14 (Life Below Water), 13 that addressed SDG 15 (Life on Land) and nine that addressed SDG 2 (Zero Hunger) and SDG 13 (Climate Action) in comparison to the FAOs Sustainable Development Goals (SDGs). Nonetheless, the Journal of Ocean and Coastal Management received the most citations, and the Indian Journal of Fisheries published the most papers about mariculture. A bibliographic coupling analysis at the organisational level revealed that only 14 organisations had at least two publications and 10 citations. With 139 citations and 16 publications, the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) took the lead, followed by the ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA). An author-level citation analysis revealed that 70 out of the 450 contributing authors had at least 25 citations. Four different clusters were formed as a result of the strong networks of cooperation exhibited by fourteen of these authors. The evolving institutional contributions and cooperative trends in Indian mariculture research are elucidated by this study. Overall, under the guidance of important institutions, mariculture research in India is expanding in line with SDG 14. This study only used data from the "Dimensions AI" database; data from the Web of Science and Scopus databases could improve in-depth analysis and produce conclusive findings.

Keywords

Citation analysis, Dimensions AI, Institutional collaboration, Mariculture, Research trends, SDGs



Comparative analysis of CAA Act, 2005 and its Amendment 2023

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Coastal aquaculture, particularly shrimp farming, has seen significant growth in India, boosting the rural economy and export revenues. However, this rapid expansion has resulted in environmental challenges like salinity intrusion and mangrove destruction. In response, the Government of India enacted the Coastal Aquaculture Authority (CAA) Act, 2005, to establish governance for sustainable practices. Yet, limitations in the Act, including outdated provisions and insufficient environmental protection, have hindered effective management. To address these issues, the CAA Amendment Act, 2023 was introduced to update regulations, enhance institutional frameworks, and assist small-scale farmers. This study presents a comparative analysis of the 2005 Act and its 2023 Amendment, utilising qualitative methods and software based thematic coding (MAXQDA). Key improvements highlighted include the appointment of enforcement and appellate officers, easier registration processes, flexible licensing, and the inclusion of new aquaculture systems such as seaweed farming and cage culture. A significant innovation is the retrospective validation of aquaculture farms, which offers protection from past and ongoing legal actions but raises environmental concerns. The 2023 Amendment enhances the Authority's capacity by enabling the formation of expert committees for technical guidance, the development of zonation maps via GIS technology, and the promotion of biosecurity standards to manage disease outbreaks. This legislation introduces beneficial provisions for stakeholders such as small farmers, feed and input suppliers, technology providers, and state fisheries departments, including product certification, digital monitoring tools, and specialised training programs. Despite recent advances, the Amendment's easing of specific environmental regulations, particularly the 200 m rule from the high tide line, has faced backlash from environmental organizations and traditional fishers. The Coastal Aquaculture Authority (CAA) Amendment 2023 introduces transformative changes to India's aquaculture sector, benefiting key stakeholders such as smallholder farmers, aquaculture entrepreneurs, and regulatory bodies. The policy promotes species diversification, modern farming systems, and eco-friendly practices, ensuring higher productivity and the certification of quality products. GIS tools identify optimal farming zones, while enhanced biosecurity measures reduce disease outbreaks and economic losses. Farmers benefit from reduced chemical use, technical support, and streamlined regulations that promote sustainability. The policy also strengthens governance through stakeholder engagement, knowledge transfer, and regulatory oversight.

Keywords

Coastal aquaculture, Expert committee, Shrimp farming, MAXQDA, Qualitative methods, Technical guidance



Salinity-induced lipid remodeling and gene expression in the marine medaka *Oryzias dancena*

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Environmental salinity is a key abiotic factor influencing energy metabolism and osmoregulation in euryhaline fishes. The marine medaka *Oryzias dancena* is a promising model species to study the physiological and molecular mechanisms underlying salinity adaptation. In the present study, fish were exposed to three salinities (5, 23, and 35 ppt), and hepatic histology, digestive enzyme activity, muscle fatty acid (FA) composition, and expression of genes related to osmoregulation and lipid metabolism were examined. Hepatic histology revealed distinct lipid vacuolisation patterns, with larger and irregular vacuoles at 5 ppt, small and uniform vacuoles at 23 ppt, and larger, rounded vacuoles at 35 ppt. Gene expression analysis showed upregulation of *NKA* at hypo and hyper salinity condition, while *FADS2*, and *ELOVL5* had no significant differences, whereas *PPAR-α* and *CPT1* were elevated at 23 ppt, indicating a trade-off between lipid storage and oxidation. Protease activity was highest at 5 ppt, while lipase activity peaked at 23 ppt, and amylase activity showed no significant variation among treatments. These findings suggest that lipid assimilation is enhanced at moderate salinity, consistent with observations from histological and gene expression analyses. Muscle FA profiles were largely conserved across salinities, although a significant decline in DHA (C22:6n3) and an increase in MUFA (C16:1) were observed at 35 ppt, suggesting selective remodelling of essential fatty acids under hyperosmotic stress. Together, these findings demonstrate that *O. dancena* employs tissue-specific lipid remodelling to cope with salinity stress, with the liver acting as a dynamic regulator and muscle remaining largely conserved, except for DHA depletion under hyperosmotic conditions. These results provide new insights into the metabolic basis of euryhalinity and highlight the utility of *O. dancena* as a model species for salinity adaptation studies.

Keywords

: Euryhaline fish, Marine model fish, *NKA*, Osmoregulation, Salinity stress





Isolation and characterisation of a *Rhodotorula* sp. as a novel pigment-producing probiotic for marine fish nutrition

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The aquaculture industry is rapidly expanding, yet it faces significant challenges in meeting the nutritional needs of farmed fish while reducing reliance on unsustainable feed additives. In particular, the demand for natural sources of bioactive compounds, probiotics, and pigments continues to grow, as these play crucial roles in fish health, growth, immune function of farmed marine fishes. This study explores the potential of *Rhodotorula* sp. a pigment-producing yeast, as a novel candidate for marine fish nutrition with dual functionality: providing natural carotenoid pigments and acting as a probiotic. A novel *Rhodotorula* strain was successfully isolated and evaluated for its growth performance, pigment production, nutrient composition, and probiotic attributes. We observed strong antioxidant potential and antibacterial activity was associated with the microbe. In addition we also evaluated the ability of the microbe to withstand the harsh gastrointestinal conditions and found that the viability of the microbe is minimally affected by the exposure to digestive enzymes and harsh pH conditions. Collectively, these findings highlight *Rhodotorula* as a promising dual-purpose candidate, providing both bioactive pigments and probiotic benefits, offering a sustainable alternative to synthetic additives in marine aquafeeds.

Keywords

Bioactive compounds, Mariculture, Pigment production, Probiotic yeast, Sustainable aquafeeds



De novo transcriptome assembly of intertidal clam *Gafrarium divaricatum*: A genomic resource for eco-toxicogenomics

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Bivalves are ecologically and economically important invertebrates that play vital roles in marine ecosystems, particularly as biomonitors due to their filter-feeding mechanisms. Despite their importance, many species still lack adequate genomic resources, hindering detailed molecular and functional studies. The intertidal clam *Gafrarium divaricatum*, widely distributed along the west coast of India, is one such species and is emerging as a potential model organism, though genomic information remains scarce. Developing molecular resources for this clam is crucial for advancing studies on its physiology, adaptive responses, and ecological roles. In this study, we present the first de novo transcriptome assembly of *G. divaricatum*. High-throughput RNA sequencing produced a substantial dataset that was assembled into over 661,000 unigenes, offering a comprehensive overview of the transcriptomic landscape of this species. The assembly quality, assessed using Benchmarking Universal Single-Copy Orthologs (BUSCO), demonstrated 98.8% completeness, underscoring the reliability and robustness of the assembly even in the absence of a reference genome. Functional annotation revealed a broad array of genes associated with stress responses, immune regulation, and antioxidant defense pathways, emphasizing the biological depth captured in this dataset. The transcriptomic resource developed in this study marks a significant advancement in the molecular biology and genomics of *Gafrarium divaricatum*, providing a pivotal foundation for future research in functional genomics, evolutionary biology, and ecological resilience. Beyond its application in understanding gene expression dynamics, this resource will also aid in conservation efforts, sustainable fishery management, and toxicogenomics across bivalve taxa. By delivering the first high quality transcriptome for *G. divaricatum*, this study bridges a critical knowledge gap and opens new opportunities to explore the utilization of this species as an eco-toxicological model organism, and the genetic basis of adaptation and survival against the environmental stressors.

Keywords

Bivalves, Biomonitors, Environmental stressors, Gene expression, RNA seq



PB1BrTr: A brain cell line from maroon clownfish as an *in vitro* tool for ecotoxicological studies

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Amidst rising ocean stress and coral reef degradation, marine ornamental fishes are emerging as vibrant symbols of coral reef ecosystems as well as vital contributors in ecological research, aquarium industry and biodiversity conservation. The spinecheek anemone fish, or maroon clown, *Premnas biaculeatus* (Bloch, 1790), is the sole species within the genus *Premnas*. The striking colouration and symbiotic association with sea anemones make this reef fish highly valued in the marine ornamental fish trade. Fish cell lines are indispensable, cost-effective *in vitro* research tools for biotechnology, developmental biology, toxicology, and virology. Aquatic ecosystems worldwide are exposed to contaminants such as heavy metals and pesticides originating from industrial, agricultural, and urban sources. These substances can impact fish health by inducing physiological stress, affecting reproduction, altering behaviour, and increasing mortality. Heavy metals like lead, cadmium, and mercury may accumulate in fish tissues, potentially transferring through the food chain and affecting higher trophic levels, including humans. Pesticide contamination can harm aquatic biodiversity, affecting fish growth and immune function. When combined with climate change, such pollution increases risks to marine life, highlighting the need for regular monitoring and sustainable management of aquatic ecosystems. This study examined the cytotoxic effects of heavy metals (cadmium and mercury) and pesticides (dichlorvos and cyfluthrin) using PB1BrTr, a newly developed brain cell line derived from *P. biaculeatus*. Cytotoxicity was evaluated using Neutral Red (NR), XTT, and Crystal Violet (CV) assays, which revealed a dose-dependent decrease in PB1BrTr cell viability upon exposure to these aquatic pollutants. Based on the IC₁₀ values, cell lines exposed to the selected concentrations were used for subsequent flow cytometry analyses. Flow cytometry is a powerful technique for detecting apoptotic cells by analysing nuclear DNA content and determining cell cycle phases. Together with SEM, these advanced tools provide valuable insights into transformed cell lines, revealing their growth patterns, cell cycle dynamics and apoptotic responses when exposed to pollutants. These findings highlight the potential of the cell line as a valuable tool for ecotoxicological research, enabling precise assessment of pollutant impacts at the cellular level and supporting efforts toward the sustainable management of aquatic environments.

Keywords

Aquatic pollutants, Cytotoxicity, Heavy metals, Pesticides. Ornamental fish cell line



Advancing fish oil replacement strategies: Growth optimisation of Thraustochytrids for marine aquafeeds

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This study evaluates the potential of Thraustochytrids, specifically *Schizochytrium* sp. and *Aurantiochytrium* sp. as sustainable alternatives to fish oil in aquafeeds. These microorganisms are notable for their ability to synthesise high levels of docosahexaenoic acid (DHA), an essential omega-3 polyunsaturated fatty acid critical for the growth and health of marine farmed fish. As demand for sustainable omega-3 sources increases, Thraustochytrids represent a viable option to reduce reliance on marine-derived fish oil. Our study examined the growth dynamic, biomass production, amino acid composition, and fatty acid profiles of *Aurantiochytrium*. Growth was significantly influenced by the presence of methyl donors in the culture medium, and the DHA content of the strains was comparable to that of conventional fish oil. These results demonstrate that Thraustochytrids are a feasible and sustainable source of omega-3 fatty acids for aquafeeds, offering a practical strategy to support environmentally responsible mariculture.

Keywords

Aurantiochytrium, Biomass production, DHA, Fish oil alternative, Omega-3 fatty acid, *Schizochytrium*





Isolation and characterisation of an ACE-inhibitory monogalactosyl monoacylglycerol from *Sargassum ilicifolium*

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The investigation of the brown alga *Sargassum ilicifolium* led to the isolation of a glycolipid, identified as 1-O-enanthoyl-3-O- β -galactopyranosyl glycerol, a monogalactosyl monoacylglycerol (MGMG). Its structure was elucidated through comprehensive spectroscopic analysis. The compound was evaluated for its potential antihypertensive and antioxidant activities. MGMG demonstrated significant angiotensin-converting enzyme (ACE) inhibitory activity with an IC_{50} value of 0.42 mg ml^{-1} . It also exhibited potent antioxidant capacity, with IC_{50} values of 0.52 mg ml^{-1} and 0.55 mg ml^{-1} in the DPPH and ABTS radical scavenging assays, respectively. In *silico* SwissADME prediction indicated a high bioavailability score of 0.55. Molecular docking studies with the ACE-I receptor revealed a strong binding energy of -9.61 kcal/mol for MGMG, which was superior to the standard drug captopril ($-6.61 \text{ kcal mol}^{-1}$), and involved the formation of four hydrogen bonds with key active site residues. These results suggest that MGMG from *S. ilicifolium* is a promising natural lead compound for the development of novel therapeutic agents against hypertension.

Keywords

ACE inhibition, Antihypertensive, Antioxidant activity, Brown alga, Glycolipid, Therapeutic agents



Bioactivity of coral-associated benthic *Leptolyngbya* spp. from Kavaratti island of Lakshadweep

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The rapid growth of aquaculture has made it one of the world's major food supply sectors. The growing demand for fish protein met by the intensification of aquaculture will lead to stress on the cultured species and the environment, along with the outbreak of diseases. Infectious diseases primarily caused by bacteria and viruses pose significant challenges to the sustainable development of aquaculture, leading to decreased productivity and substantial economic losses. In the long run, an integrated approach that takes into account the pathogen, host, and environment will be the optimal solution. Therefore, environment-friendly therapeutic strategies are needed, and the less explored metabolome of coral-associated cyanobacteria is a potential source for such novel molecules. The present study aimed to explore the antibacterial activity of cyanobacterial extracts and the antioxidant activity of their pigments, especially phycoerythrin. The potent cyanobacterial species were identified based on 16S rRNA gene sequencing. The antibacterial activity of the isolates against *Vibrio harveyi* and *Aeromonas caviae* was determined by resazurin assay, and *Leptolyngbya* sp. exhibited activity against *V. harveyi*, which proves its utility in the management of vibriosis in aquaculture. The antioxidant activity of the phycoerythrin pigment of *Leptolyngbya* spp. was confirmed through the DPPH free radical scavenging assay, which was comparable to that of ascorbic acid. Such natural antioxidants can serve as non-toxic alternatives to synthetic antioxidants in food, cosmetics, and drugs.

Keywords

Antibacterial activity, Antioxidant, Cyanobacteria, Metabolome, Phycoerythrin

Harnessing selected herbal fruit powders to boost immunity, growth, stress tolerance and disease resistance in whiteleg shrimp *Penaeus (Litopenaeus) vannamei* Boone, 1931

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Fish and shrimps are the major vital source of high-quality protein and fatty acid content, which serves as a primary source for the livelihood of global animal protein intake and it is easily affordable and accessible among the global animal population. For a successful shrimp production, the amount of feed and feeding management is one of the most important practices in the culture industry. In this study, we evaluated the dietary effect of selected herbal fruit powders on growth performance, immune response, antioxidant activity, stress tolerance and disease resistance in white leg shrimp *Penaeus (Litopenaeus) vannamei*. Triphala, an ayurvedic powder widely used for treating various diseases, improves blood and nervous function, enhances digestive activity and also stimulates the revitalization and endurance of individual cells with no reported side effects. A 45-day iso-nitrogenous feeding trial with 35% crude protein and 6% fat fed to the juveniles of *P. vannamei* (2.934 ± 0.014 g) followed by a challenge test for 7 days. Each dietary treatment (T0 to T4) consisted of four replicate tanks (100 l) that were stocked with 20 juvenile shrimps. The experimental diets were formulated with a 3% inclusion level of herbal fruit powders: *Terminalia chebula* (T1), *Terminalia bellirica* (T2), *Phyllanthus emblica* (T3) and *Triphala* (T4). Juvenile shrimps were fed the experimental diets four times per day. At the end of the feeding trial, significant improvements ($p < 0.05$) were observed in T4 in terms of final weight (10.513 ± 0.012 g), weight gain, specific growth rate (2.821 ± 0.017) and feed conversion ratio (1.870 ± 0.021). Immune parameters such as total haemocyte count ($8.300 \pm 0.091 \times 10^6$ cells ml^{-1}), phenoloxidase activity (0.105 ± 0.001 OD min^{-1}) and respiratory burst activity (0.153 ± 0.001 OD min^{-1}) were significantly ($p < 0.05$) elevated in T4. Antioxidant enzyme activities, including superoxide dismutase (SOD) and catalase (CAT), were significantly ($p < 0.05$) higher in T4, indicating enhanced antioxidant defense. Stress tolerance assessments using ammonium chloride and disease challenge with *Vibrio alginolyticus* revealed the lowest mortality and higher survivability in T4. Additionally, higher exuviae frequency and hepatosomatic index were noted in T4 and T2, while faecal nitrogenous protein content was highest in T1. The results from this prominent study suggested that dietary supplementation with 3% Triphala powder can significantly ($p < 0.05$) enhance growth, immunity, antioxidant activity and resilience against environmental and pathogenic stress in *P. (L.) vannamei*.

Keywords

Ayurvedic powder, Haemocyte count, Phenoloxidase activity, Triphala, *Vibrio alginolyticus*



Evaluation of the efficacy of *Shewanella* spp. isolated from the gut of Indian pompano *Trachinotus mookalee*

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A study on the efficacy of *Shewanella algae* and *Shewanella baltica* isolated from the gut of cultured marine fish *Trachinotus mookalee*, as a biocontrol agent against fish pathogens was carried out. Fifty six isolates of beneficial microbes were isolated from the gut of *T. mookalee*, out of which 58% isolates belonged to the genus *Shewanella*. All the isolates were screened for antagonistic activity against the fish pathogens viz., *Vibrio harveyi*, *V. alginolyticus*, *Aeromonas hydrophila* and *Photobacterium damsela* using agar well diffusion technique. The most effective isolates (P1 and P5) exhibited highest antagonistic activity. A significant variation was recorded between the scores of antagonistic activity of different isolates in inhibiting the growth of fish pathogens in the laboratory ($p < 0.05$). The other probiotic property tests were conducted for all the isolates showing higher zone of inhibition (> 25 mm). P1 and P5 exhibited higher tolerance to temperature, acid and bile salt. All the selected strains demonstrated significant tolerance to different NaCl concentrations (1, 2, 4, 6 and 8% salt) with increasing growth rate upto 4% and a slight decline in growth rates at 6 and 8% NaCl concentrations. Auto-aggregation of selected isolates varied from 15% to 48.78% at 2 h of incubation of cultures and were found increased with the incubation period. All selected strains revealed significantly lower auto-aggregation ability ($< 50\%$) for P1, P2, P5 strains at the first 3 h. All tested strains were able to co-aggregate with pathogens significantly, showing co-aggregation percentages between 40.23 to 88.57%. All the three isolates did not exhibit any haemolytic activity. The cell surface hydrophobicity percentages of the isolates ranged from 11.76 to 74.42%; 13.04 to 76.13% and 14.89 to 77.17% with toluene, xylene and toluene and xylene (1:1) respectively. The isolated species were identified based on their morphological, biochemical characteristics and confirmed by 16S rRNA sequencing. Based on various tests conducted, *Shewanella baltica* (P5) was identified as the native host-derived beneficial bacterial isolate which could contribute significantly to the mariculture of Indian pompano.

Keywords

Antagonism, Auto-aggregation, Efficacy, Haemolytic activity, Host gut, Hydrophobicity



Proximate composition and habitat-linked nutritional variation in *Mugil cephalus* (Linnaeus, 1758) from the west coast of India

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The flathead mullet *Mugil cephalus* is a widely distributed euryhaline fish of high ecological and commercial value. Although it supports major coastal fisheries in India, information on its habitat-linked nutritional dynamics remains limited. This study assessed the proximate composition and aquaculture potential of *M. cephalus* from two contrasting habitats: the Diu Lagoon and the Narmada Estuary, Gujarat, between July 2021 and June 2022. Seasonal sampling (n=240 individuals) was undertaken, and biochemical analyses of moisture, protein, lipid, ash, and carbohydrate content were conducted in muscle and liver tissues. Complementary salinity tolerance trials (10, 20, and 30 ppt; six-month duration) were carried out under controlled conditions. Moisture content varied significantly ($p<0.05$) across habitats and seasons, ranging from 73.1 to 80.9%. Protein constituted the major fraction, with muscle protein ranging from $49.2\pm1.5\%$ during spawning (September) to $65.3\pm2.3\%$ in winter (February). Liver protein was consistently higher ($65.8\pm1.7\%$) than muscle, indicating its metabolic role in gonadal development. Lipid content showed pronounced tissue-specific variation, being higher in liver (13.9-24.9%) than muscle (9.1-17.6%), with peaks during post-spawning months (December–February). Carbohydrate levels were relatively lower but demonstrated seasonal fluctuations, ranging from 5.6% in summer to 8.6% during gonadal maturation. Ash content varied between 0.8-1.8%, with higher concentrations observed in females during post-spawning phases. Significant sex- and habitat-linked differences were observed, with females generally recording higher protein and lipid reserves. Controlled salinity trials revealed optimal growth and nutrient assimilation at 20 ppt, where mean protein (53.9-57.7%) and lipid (12.6-13.6%) levels were significantly higher ($p<0.05$) compared to 10 and 30 ppt treatments. Growth performance (length and weight increments) was also highest at 20 ppt, with average final total length reaching 18.1 ± 0.1 cm and weight 53.2 ± 1.0 g, compared to 17.2 ± 0.1 cm and 50.1 ± 0.8 g at 10 ppt. Organoleptic evaluation further confirmed high consumer acceptability (hedonic score >4 on Day 1). This study highlights the strong influence of seasonality, reproductive cycle, and salinity on the proximate composition of *M. cephalus*. The findings provide the first baseline nutritional dataset for this species from the Gujarat coast and demonstrate its aquaculture potential under brackishwater conditions, particularly at intermediate salinity regimes. These insights are critical for fisheries management, value-added utilisation, and aquaculture expansion strategies along the Indian west coast.

Keywords

Biochemical composition, Brackishwater ecology, Coastal aquaculture, Estuarine fisheries, Euryhaline fish



An investigation on deciphering bacterial etiologies and zoonotic threats during disease outbreaks of cultured marine food fishes

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Mariculture is emerging as an option to supply the growing fish demand and achieve nutritional security. However, the intensification of mariculture practices has led to increased susceptibility of cultured animals to infectious diseases, with bacterial pathogens being a predominant cause of mass mortalities and economic losses. Understanding the diversity of bacterial pathogens associated with disease outbreaks in cultured marine fishes is essential for developing effective health management strategies. Equally important is the identification of zoonotic bacteria that can potentially affect farm workers, handlers, and consumers, thereby integrating the concept of One Health into aquaculture disease surveillance. In this context, bacterial pathogens associated with three natural disease outbreaks in edible marine fishes, two independent episodes in silver pompano (*Trachinotus blochii*) and one in mangrove red snapper (*Lutjanus argentimaculatus*), were identified in this study. Further, it focused on their possible implications in one health perspectives. The isolates were identified as *Vibrio alginolyticus*, *Vibrio harveyi*, *Vibrio vulnificus*, *Vibrio parahaemolyticus*, *Vibrio owensii*, *Shewanella submarina*, *Shewanella algae*, and *Bacillus subtilis*. Accordingly, among the 43 isolates, seven (16.28%) were identified as human-associated pathogenic *Vibrio* species, viz., *V. vulnificus* and *V. parahaemolyticus*. To assess potential public health risks, isolates of *V. parahaemolyticus* were screened for virulence genes *tdh*, *trh*, and *tlh*, while *V. vulnificus* isolates were evaluated for the presence of the *pilF* gene. The fish pathogenic potential of *V. vulnificus* was assessed by detecting the *bt2* gene. After the molecular screening for virulence genes, 50% of *V. parahaemolyticus* and 20% of *V. vulnificus* were categorised as strains of public health significance. Additionally, 60% of the *V. vulnificus* isolates were only identified as fish-pathogenic strains, even though all were from diseased fishes, suggesting that environmental strains of *V. vulnificus* can opportunistically colonise and infect immunocompromised fish during disease outbreaks. In conclusion, only a small fraction of the isolates posed notable public health risks. Despite the low prevalence of human-pathogenic strains, their presence is concerning, especially in areas where raw or undercooked seafood is consumed. These findings underscore the importance of regular microbiological monitoring in mariculture systems to protect fish health, ensure sustainable production, and safeguard public health.

Keywords

Bacterial pathogens, Disease surveillance, Marine fish diseases, One health, Zoonosis



Isolation and characterisation of bacteria degrading algal polysaccharides from *Sargassum wightii*

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Sargassum, one of the marine macroalgae belonging to the class Phaeophyceae, is widely distributed in tropical and temperate oceans. Complex polysaccharides (CPs) such as agar, alginates and carrageenan are largely present as component of cell wall of seaweeds, promoting structural integrity and shielding the host from pathogens or predators. The present study emphasises the isolation and characterisation of bacteria with the ability to degrade algal polysaccharides specifically agar, alginate, and carrageenan derived from the brown seaweed *Sargassum wightii*. These complex polysaccharides serve as major structural and storage constituents in brown algae, and their microbial breakdown is vital for nutrient cycling and bioconversion within marine ecosystems. *S. wightii* samples were collected from the rocky shores of Kovalam, Thiruvananthapuram (8.36644°N; 76.976122°E) at a depth of 5 m, where the salinity was 30 ppt and the water temperature was 30°C. All the organisms adhered to the surface of the sample were carefully removed through gentle scraping and rinsing and the cut sections of sterile thallus were inoculated into Zobell's Marine agar medium and pure cultures obtained from each chosen colony by quadrant streaking were characterised by 16S rRNA gene sequencing. Among a total of 15 isolates, *Bacillus* sp. emerged as the dominant genus and all the identified species were subsequently screened for their ability to degrade algal polysaccharides. For polysaccharide degradation analysis, the cultures were inoculated into mineral medium containing 0.5% of polysaccharide. After an incubation period of 18-24 h at 37°C, the plates were observed for polysaccharide utilisation and growth. Out of the 15 isolates, all the *Bacillus* spp. exhibited agarolytic, alginolytic, and carrageenase activities. In contrast, *Exiguobacterium*, a Gram-negative bacterium, displayed only agarolytic and alginolytic activities but lacked alginolytic activity. The results of the study point that *S. wightii* associated bacteria has potential applications in biomass conversion for value-added product development, which needs to be further validated.

Keywords

Agarolytic, Alginolytic, Biomass conversion, Carrageenase, Microbial communities



A novel approach for cultivation and treatment of marine microsporidia

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Heterosporis saurida is a microsporidian parasite that infects the lizardfish *Saurida undosquamis*, one of the most economically important species in the Arabian Sea and Red Sea regions. The parasite invades skeletal muscle, the body cavity, and mesenteric tissues, forming white, cyst-like structures densely packed with spores. Cell cultures are essential for the propagation and study of obligate intracellular pathogens such as microsporidia; however, research on fish microsporidia has been constrained by the lack of suitable *in vitro* systems. *In vitro* cultivation not only provides critical insights into parasite development but also supports the development of novel disease control strategies. In this study, we developed an *in vitro* cultivation model for *H. saurida* and applied it to evaluate therapeutic compounds for preventing microsporidiosis. Multiple fish and non-fish cell lines, along with a range of antimicrosporidial compounds, were tested against the spores of *H. saurida*. Developmental stages of *H. saurida* were observed exclusively in the eel kidney and rabbit kidney cell lines via light and transmission electron microscopy. Among the compounds tested, fumagillin and its analogue TNP-70 showed the greatest promise as therapeutic agents. This cell culture model offers a robust platform for exploring cellular and molecular interactions between microsporidia and fish hosts, and for advancing the development of effective treatment strategies against fish microsporidia.

Keywords

Drug development, *In vitro* model, *Heterosporis saurida*, Lizardfish, Therapeutic compounds



Diversity and proximate composition of deep-sea Acanthuriformes: A step towards sustainable utilisation

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Acanthuriformes is one of the most diverse fishery resource groups in Indian waters. However limited studies have been conducted, about its documentation and nutritional profiling. In this context, the present study investigates the diversity of the order Acanthuriformes. Sampling was carried-out along the deep-sea fish landing centres of India, during September 2024 to May 2025. The specimens were obtained as bycatch of deep-sea trawlers and, presently it is largely being utilised for the preparation of fishmeal and fish oil, while some species are commercially using for consumption also. Among the 16 species belonging to 11 genera and 6 families documented, the genus *Acanthocephala* and *Priacanthus* were found predominant and the southwest coast of India represented high abundance and diversity. The IUCN status revealed that 81.25% of the species belongs to this group were categorised as Least Concern, 12.5% were Not Evaluated, and 6.25% were Data Deficient. The members of Acanthuriformes are characterised by substantial body mass and fleshy composition, making them promising species for human consumption. Hence, the available secondary data about proximate composition of these fishes was collected and compared with other commercially important species for expanding its utility. The proximate composition revealed high protein (~16-18%) and moderate fat (~1.2-2.4%) levels in few species. Considering the high diversity, abundance and nutritive value, these species hold significant potential to serve as alternative resources for protein supplementation. The findings also provide essential baseline data for promoting its conservation and sustainable utilisation of these resources, which will enhance the nutritional security in India.

Keywords

Bycatch, Nutritional profiling, Protein supplementation, Proximate composition,



Unmasking *Amyloodinium ocellatum*: Molecular insights and gill pathology in maroon clownfish *Premnas biaculeatus*

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Amyloodinium ocellatum is a highly pathogenic dinoflagellate parasite affecting many marine fishes, including maroon clownfish (*Premnas biaculeatus*), leading to severe respiratory distress and mortality. In this study, infected maroon clownfish exhibited clinical signs such as lethargy, loss of appetite, and rapid respiration. Gross examination revealed a fine, dusty coating on the skin, suggestive of *A. ocellatum* infestation. Microscopic examination of gill biopsies confirmed the presence of trophonts at various developmental stages, causing severe gill damage. The parasitic frequency index (PFI) was 50%, indicating a “common” level of parasite presence based on the PFI classification scale. The infection sites included the gills, body surface, and fins, with the severity classified as high (severity score=1). Histopathological analysis demonstrated epithelial hyperplasia, mucus hypersecretion, lamellar fusion, and necrotic changes, all contributing to impaired oxygen uptake and systemic stress. Molecular detection using 18S rRNA gene-based PCR followed by BLAST analysis indicated a 60% identity match with *A. ocellatum* isolate from Java rabbit fish in India, and phylogenetic analysis positioned the detected isolate within a distinct clade of *Amyloodinium* species with strong bootstrap support of 99% from other countries. The findings highlight the significant impact of *A. ocellatum* on fish health, emphasising the need for early diagnosis and intervention in aquaculture settings.

Keywords

Dinoflagellate parasite, Clinical signs, PFI, Histopathology, Molecular detection, Trophonts



Copper sulphate as a chemotherapeutic agent against *Amyloodinium ocellatum* in broodstocks of cleaner wrasse *Labroides dimidiatus*

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Cleaner wrasse *Labroides dimidiatus* [total length (TL) 55 mm, standard length (STL) 44.3 mm and weight 1.704 g] were exposed to various concentrations of copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) to determine its tolerance to the chemical. The broodstocks of *L. dimidiatus* reared in the marine hatchery were infested by the parasitic dinoflagellate *Amyloodinium ocellatum* (Dinoflagellida) and mortality were noticed. The observation of gills under microscope showed the presence of trophonts on the gills and fins. Hence the study was conducted to eliminate this parasite from the affected broodstocks. The treatment with 0.05, 0.1, 0.2, 0.3 and 0.5 mg l^{-1} CuSO_4 for 15, 30, 45 min and one hour bath twice in 12 h for 5 days then after once in 12 h for 6-15 days were conducted to evaluate its efficacy against *A. ocellatum*. The study revealed that to eliminate *A. ocellatum* from cleaner wrasse, bath in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ concentration 2 mg l^{-1} twice in 12 h in daytime at interval of 6 h from day one to fifth day and then after single bath from day 6th to 15th day has been given 100% survivability and eradication of the *A. ocellatum* infection. The study also suggested that a lower concentration at shorter but repeated exposures may be considered for the complete eradication of *A. ocellatum* infection.

Keywords

Broodstock, Dinoflagellate, Eradication, Marine hatchery, Treatment protocol, Trophonts



Abundance and probiotic potential of microbial flora isolated from marine sediment of coastal Visakhapatnam, Andhra Pradesh

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A study was carried out on microbial abundance of in marine sediment of mariculture at three different locations (S1, S2, S3) along coastal Visakhapatnam. The study highlighted the dominance of genera, with *Bacillus* and *Vibrio*, being the most prevalent, followed by *Pseudomonas*, *Staphylococcus*, and *Streptococcus*. An analysis of the percentage distribution of different genera of heterotrophic bacteria in near shore waters and sediments provides important insights into microbial communities. In this study, the genus *Bacillus* emerged as the dominant group in marine sediment of S2 and S3. The dominance of *Bacillus* in three different stations varied significantly with higher density at S3 suggests that it plays a significant role in the aquatic ecosystem, potentially contributing to various biochemical processes, including nutrient cycling and organic matter decomposition. In sediment samples, The findings highlight the dominance of *Bacillus* spp. varied significantly ($p < 0.05$) between stations and between environments. Since *Bacillus* was found dominant in the water and sediment of coastal Visakhapatnam, the growth pattern, antagonistic activity and its safe level concentrations were determined. *Bacillus* species isolated from S3 exhibited maximum inhibition zone against *V. harveyi*, with longer growth time at room temperature. The study indicated that the bacterial strains isolated from marine sediment have shown strong antagonistic activity against *V. harveyi*, a pathogen known to affect various marine organisms. This finding is significant because it highlights the potential of certain bacteria to combat harmful pathogens in marine environments. By understanding how these bacteria interact with *V. harveyi*, new strategies to protect marine life can be explored, potentially reducing the impact of diseases that threaten fish and other aquatic organisms.

Keywords

Antagonistic activity, Aquatic ecosystem, *Bacillus*, Microbial abundance, Nutrient cycling, *Vibrio harveyi*



Synergistic effect of co-cultivation of *Isochrysis galbana* with single and multi-strain consortia of *Bacillus* spp.

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The co-cultivation of *Isochrysis galbana*, a marine microalga, and *Bacillus*, a beneficial bacterium, presents a promising approach to enhance microalgal growth and improve the production of valuable compounds. This synergistic relationship can particularly benefit aquaculture by promoting stress tolerance and increasing disease resistance in cultivated organisms. When cultivated together, these microorganisms may boost each other's growth, leading to more efficient nutrient utilisation and better overall productivity. The present investigation deals with co-culture of *I. galbana* with potential *Bacillus* strains isolated from *I. galbana* and study the optimisation of co-culture protocol to achieve the most effective *Bacillus* strains that can enhance the growth and resilience of *I. galbana*. The study envisages elimination of pathogenic *Vibrios* in co-culture system and recorded significantly higher loads of *Bacillus* strains in water and on algae as biofilm. The reisolated species significantly varied in their concentrations and recorded a positive correlation with algal densities. Although the potential is considerable, comprehensive studies are needed to determine the best co-culture conditions and to identify *Bacillus* strains that maximise the beneficial effects for *I. galbana* and other microalgal species.

Keywords

Biofilm, Disease resistance, Marine microalga, Stress tolerance, Synergistic relationship



Enhancing *Chlorella* sp. growth through symbiosis: Role of *Halomonas* sp. under nitrogen-stress conditions

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Chlorella, a green microalga recognised for its diverse bioactive compounds, has significant applications in various industries such as biofuels, pharmaceuticals, wastewater treatment, and aquaculture. In aquaculture, it is particularly important as a nutrient-rich feed that supports aquatic animal growth, enhances immunity, and improves water quality, thereby contributing to sustainable farming. However, its large-scale cultivation is often limited by high production costs and growth instability. Co-cultivation with beneficial bacteria offers a promising approach to overcome these challenges by promoting algal growth and enhancing culture stability. This study explores the growth-promoting properties of the phycosphere bacterium *Halomonas* sp. and investigates its impact on the growth of *Chlorella* sp. in a co-culture setup. Furthermore, the study evaluates the role of *Halomonas* sp. under nitrogen-stress conditions to determine its potential as a microbial growth promoter in nutrient-limited environments. The results demonstrated that the co-culture with *Halomonas* sp. significantly increased microalgal growth compared to control cultures without bacterial interaction, suggesting a mutually beneficial relationship between *Halomonas* sp. and *Chlorella* sp.. The growth-promoting effect of *Halomonas* sp. was particularly pronounced under nitrogen-limited conditions. This growth enhancement can be attributed to several microalgae growth-promoting traits exhibited by *Halomonas* sp., including nitrogen fixation, production of essential enzymes, secretion of phytohormones such as indole-3-acetic acid (IAA), and tolerance to abiotic stress. Collectively, these traits contribute to improved nutrient uptake, enhanced stress resilience, and increased algal productivity. These findings highlight the potential of *Halomonas* sp. as an effective microbial partner for *Chlorella* sp., particularly in nitrogen-limited environments. The study provides valuable insights into microalgae-bacteria interactions and their applications in sustainable algal cultivation, with promising implications for aquaculture, biotechnology, and biofuel production.

Keywords

Bioactive compounds, Biofuel, Co-culture, Growth-promoting traits, Microalga, Nitrogen stress



Biocrystallisation of *in vitro* cultured mantle epithelial cells of black lip pearl oyster *Pinctada margaritifera*

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Nacre secreted by mantle epithelial cells is a model of biomineralisation process in molluscs comprising of aragonite platelets and organic material. Epithelial cells from the mantle tissue of *P. margaritifera* were cultured *in vitro* using sterile seawater as the culture medium. The primary cultures comprising of granulated epithelial cells were established by periodic sub-culturing. Nuclear beads and cultured granulated epithelial cells were incubated in culture wells containing semi-solid medium in order to biomineralize the nacre secretion. The visual observation revealed a brownish discoloration on the surface of the bead after 7-10 days. The surface of the nuclear beads upon evaluation by scanning electron microscopy after 60 days of incubation revealed a good brick and mortar pattern, characteristic of nacreous layer formation. A bright intense lustrous hue was also seen to develop on bead surfaces after this stage. Cross section of the nacre-coated bead showed a pattern of arrangement of aragonite tablets similar to that seen in the nacre layer of mollusk shell. The refinement on the bright reflections of the lustrous nacre resulted in development of *in-vitro* marine black pearl prototype with increased intensity around the circumference of the nucleus owing to the thickness of nacre biomineralization. The thickness of the lustrous nacre was found to be 0.30 mm falling under good category gradation. The repeatability to form lustrous hue nacre was 72%. The functional ability of cultured granulated mantle epithelial cells was further confirmed by detecting gene expression of matrix proteins, namely Nacrein, Lustrin, Molluscan Shell Framework Protein and Amorphous calcium carbonate binding proteins which play an important role in biomineralization both by cultured cells and mantle tissue. There was a very high positive correlation between the expression patterns of the genes both in *in-vitro* cultured cells and mantle tissue, signifying that the *in-vitro* cultured mantle epithelial cells retain their functional characteristics of biomineralisation.

Keywords

Aragonite, Biomineralisation, Epithelial cells, Mantle, Nacre, Prototype



Comparative evaluation of *Ascophyllum* extract to mitigate transport-induced stress in *Gracilaria dura* propagules

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Efficient long-distance terrestrial transport of vegetative propagules remains a significant constraint on the expansion of commercial red-seaweed aquaculture. The physiological responses of *Gracilaria dura* after three sets of transport regimens spanning 2,500 to 3,500 km for 52-70 h were tested and compared from three individual studies where, (i) no pre-treatment, (ii) *Ascophyllum* marine-plant-extract powder (AE) treatment (0.1 g L^{-1} for 30 min), and (iii) AE treatment followed by a 15-day field cultivation (out-plantation) prior to transport were investigated. The moisture content, photosynthetic performance, pigment content, membrane integrity, antioxidant enzyme activity, and metabolic profiles, were analysed to understand the effects of long-distance transport stress and mitigation procedures in seaweed propagules. The untreated material lost moisture, chlorophyll-a (50%), and only 53% propagules survived. However, AE-treated propagules retained >90% moisture, displayed at least 7-fold increase in antioxidant enzyme content, and accumulated protective metabolites (palmitic, benzoic acids, and mannose), resulting in 90% survival. Further, the 3rd set parameters impaired the membrane integrity: pigment content by at least 73%, net primary productivity by 46%, and total antioxidant capacity by 25%, resulting in low survival and propagule quality. The data demonstrated that AE treatment aids in better stress mitigation ability whereas, out-plantation was counter-productive. The study also suggests that a 30 min AE treatment (0.1 g L^{-1}) followed by an air-cooled, aerated transport may lead to productive long-distance transport and higher stress-tolerant propagules. The protocol may be adopted to facilitate cost-effective and high-quality *Gracilaria* propagules transport over long distances to accelerate sustainable growth of the red-seaweed mariculture sector.

Keywords

AMPEP, Aquaculture, Biostimulant, Seedstock, Seed transport, vegetative propagules



Characterisation of hormone-secreting cell types in the pituitary gland of streaked spinefoot rabbit fish *Siganus javus*: Relating their role with reproductive traits

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The reproductive cycle of teleost is governed by the hypothalamic-pituitary-gonadal (HPG) axis, with pituitary gland playing a key role in regulating gonadal development. *Siganus javus*, a teleost of commercial and ornamental significance, shows potential for large scale aquaculture but limited data exist on its reproductive endocrinology. To augment artificial propagation, this study investigates the histology of major pituitary hormone secreting cell types in relation to gonadal development across reproductive phases in male and female *S. javus*. Wild *S. javus* were collected monthly from coastal waters of Tamil Nadu, India. Standard biometric data including length, weight, sex ratio and gonadosomatic index (GSI) were recorded, and gonads and pituitaries were dissected and fixed for histological processing. Pituitary were sectioned and stained using hematoxylin and eosin and Periodic Acid Schiff (PAS) techniques to differentiate acidophils, basophils cells. Pituitary cell types included acidophils (prolactin, adrenocorticotrophic hormone, melanocyte stimulating hormone) and basophils (gonadotrophs, thyrotrophs). Gonadotroph activity peaked with GSI. In females, early vitellogenesis showed increased basophilic density and dense granulation. In males, spermatogenesis involved basophilic hypertrophy and higher PAS reactivity. Acidophils varied, suggesting role in growth and metabolism during reproduction. This study contributes to the understanding of reproductive endocrinology in *S. javus* and provides a cellular profile of pituitary in *S. javus*, offering baseline for future work on hormonal function and regulation and captive breeding strategies.

Keywords

Endocrinology, Gonadosomatic index, Histology, Pituitary, Vitellogenesis



Marine bacterium-derived proteases: A novel probiotic approach for mariculture

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From the screening of possible strains to its implementation, the study examined the possibility of a novel probiotic consortium, offering insights into the sustainability measures currently used in aquaculture activities along India's southwest coast. The bacterial strains screened from marine environmental samples were characterised phenotypically and genotypically. The study intended to address issues of poor feed conversion ratio and early stage mortality in cultured fish. Five bacterial strains screened from the marine environmental samples, *Chryseobacterium indologenes*, *Chryseobacterium culicis*, *Bacillus aerius*, *Bacillus altitudinis*, and *Bacillus pumilus* were selected as potential probiotic candidates. At the end a feeding trial, growth parameters and digestive protease activity was assessed. The results revealed a significant improvement ($p < 0.05$) in the growth performance of the juvenile *T. blochii* supplied with the probiotic strains when compared to the control group. By creating customised probiotics to increase protein digestion in mariculture settings, this research advances environment friendly methods of commercial fish production.

Keywords

Aquaculture, *Bacillus*, Feeding trial, Protease, Sustainability



Temporal changes in serum biochemical parameters and gill morphology during extended transportation of cobia (*Rachycentron canadum*) juveniles

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A transportation stress study was conducted on juvenile cobia (*Rachycentron canadum*) to evaluate the physiological and histological impacts during extended transit up to 28 h. Fish were maintained at a fixed stocking density, and no significant differences were observed in length, weight, and packing density across treatments. The study revealed that the transport duration up to 28 h at the tested density is non-lethal. However, water quality parameters showed gradual changes, with dissolved oxygen (DO) declining from 7.23 ± 0.09 to 7.02 ± 0.54 mg l⁻¹, carbon dioxide increasing from 24.16 ± 0.07 to 29.66 ± 0.89 mg l⁻¹, and ammonia levels rising from 0.002 ± 0.0003 to 0.003 ± 0.0003 mg l⁻¹ over time. Physiological stress was evident from serum cortisol levels, which markedly increased between 24 and 28 h of transport, indicating heightened stress response. Gill antioxidant defense mechanisms were activated, as seen from the catalase (CAT) activity increasing from 0.49 ± 0.05 to 1.17 ± 0.09 U mg protein⁻¹. Similarly, serum alanine aminotransferase (ALT) levels surged from 45.61 ± 8.93 to 133.23 ± 10.22 U l⁻¹, reflecting potential hepatic stress or tissue damage. Total protein content in gill tissues increased from 3.31 ± 0.07 to 4.05 ± 0.06 mg per mg protein, suggesting an adaptive metabolic response. Histological and ultrastructural analyses revealed progressive gill degeneration, including necrosis, epithelial lifting, and fusion of secondary lamellae. Mucus secretion increased noticeably in secondary lamellae between 24 and 28 h. Ultrastructural observations indicated expansion in pavement cell surface area from 44.24 ± 6.78 to 61.3 ± 4.05 μm^2 and an increase in chloride cell diameter from 1.76 to 2.38 μm , suggesting osmoregulatory adjustments. Overall, although survival was unaffected, prolonged transport caused notable physiological stress and gill tissue alterations, emphasising the need for improved transport practices for cobia juveniles in mariculture operations.

Keywords

Catalase activity, Histology, Serum cortisol, Transportation stress, Ultrastructure



Derivation and prolonged culture of embryonic stem cells from climbing perch

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Climbing perch (*Anabas testudineus*) is one of the economically significant freshwater fishes in Southeast Asia, valued both for its nutritional quality and aquaculture potential. Developing advanced cellular models for this species is vital to support genetic improvement and functional genomics research. Embryonic stem cells, derived from early developmental stages, represent a powerful system for exploring vertebrate developmental biology while also providing a versatile bridge between *in vitro* cell-based studies and *in vivo* gene manipulation. In the present study, embryonic stem cells were successfully isolated from blastula-stage embryos of climbing perch and maintained in culture for more than four years using a species-specific culture medium. The cells demonstrated extended proliferation, and stable growth over prolonged passages, underscoring their suitability for long-term experimental applications. A standardised and reproducible protocol was established encompassing embryo processing, cell isolation, optimised culture conditions, and media formulation. The incorporation of species-specific components into the growth medium augmented cell proliferation, as confirmed by viability assays, and the cells were subsequently characterised for key stemness markers. These results establish climbing perch embryonic stem cell like cells as a reliable and versatile *in vitro* model system for functional genomics, genome editing using CRISPR/Cas9, and other advanced molecular applications. The cells maintained pluripotency for a defined period, after which the expression of stemness markers gradually declined, underscoring both their potential and the difficulties of sustaining long-term stemness in culture. Beyond basic developmental biology, these cells hold significant potential for diverse applied research areas including aquaculture biotechnology, toxicological screening, and disease modelling thereby opening new avenues for both fundamental and translational studies in fish biology.

Keywords

Anabas testudineus, Developmental biology, Differentiation, Pluripotency, Stemness markers



Effect of dietary exogenous enzymes on growth, feed utilisation, body indices and digestive enzyme activities in snubnose pompano *Trachinotus blochii*

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The snubnose pompano is an important candidate species for mariculture, with increasing interest in reducing fishmeal use through sustainable plant protein-based diets. However, plant proteins often contain anti-nutritional factors, which may impair nutrient utilisation. Supplementation with exogenous enzymes such as phytase and xylanase could enhance nutrient availability, thereby improving growth and feed efficiency. A 90-day feeding trial was conducted to evaluate the effects of exogenous enzymes on growth, feed utilisation, and digestive enzyme activities in snubnose pompano juveniles. Five dietary treatments were tested in triplicate: two controls (fishmeal-based control, C; plant protein-based control, V) and three plant protein-based diets supplemented with phytase (V+P), xylanase (V+X), or both enzymes (V+PX) at 0.5% each. All diets were iso-nitrogenous (38% crude protein) and iso-caloric (8% lipid) and formulated into slow-sinking crumble feeds (2.0–2.5 mm). Growth parameters, feed utilisation parameters, and digestive enzyme activities (protease, amylase, lipase) were analysed. The highest body weight gain, specific growth rate (SGR), average daily growth (ADG) and thermal growth coefficient (TGC) were recorded in the fishmeal-based control group, followed closely by the plant protein-based diet supplemented with both enzymes (V+PX). Statistical analysis revealed no significant differences ($p>0.05$) between these two groups in growth performance. Feed conversion ratio and protein efficiency ratio (PER) were better in the fishmeal-based control, followed by V+PX. The body indices such as viscerosomatic and hepatosomatic indices were found higher in fishmeal-based control group and V+PX. Protease activity was significantly higher ($p<0.05$) in the fishmeal-based control group, with V+X showing the next highest value, suggesting improved protein digestion with xylanase inclusion. The lipase and amylase activity were found higher in fishmeal-based control diet followed by V+PX group. Enzyme supplementation appeared to mitigate the negative effects of plant protein diets, likely by reducing the impact of phytates and non-starch polysaccharides, thereby enhancing nutrient absorption and utilisation. The study demonstrates that complete replacement of fishmeal with plant proteins in snubnose pompano diets is feasible without compromising feed intake. Supplementation with exogenous enzymes, particularly a combination of phytase and xylanase, significantly improves growth performance, feed utilisation, and digestive enzyme activity, achieving results comparable to fishmeal-based diets. These findings support the application of targeted enzyme supplementation in formulating cost-effective and sustainable feeds for pompano mariculture.

Keywords

Anti-nutritional factors, Growth co-efficient, Non-starch polysaccharides, Phytase, Protein digestion, Xylanase

Effect of microbial consortium on the bioconversion efficiency, nutritional profile and antibacterial properties of black soldier fly (*Hermetia illucens*, Linn. 1758) larvae reared on food waste

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Globally, food waste management is a major environmental challenge due to its high organic content and pathogenic risks. This study evaluated the efficiency of black soldier fly larvae (BSFL; *Hermetia illucens*) bioconversion with the assistance of microbial consortia to enhance composting and produce nutrient-rich larval biomass. BSFL were reared with four microbial consortia treatments (T1, T2, T3, T4) alongside a control (C) without consortia. Food waste was added daily, and larvae were harvested on days 16 (Set 1) and 24 (Set 2) for proximate and fatty acid composition analyses, while compost was collected after treatment completion. The results showed that microbial addition improved compost quality, with T2 and T4 producing finer, darker compost. Proximate analysis revealed Set 1 BSFL crude protein ranged from 38.73% to 40.62% and crude fat from 43.12% to 46.42%, while Set 2 larvae recorded protein between 38.99% and 39.95% and fat from 39.77% to 43.62%. BSFL set 1 has higher crude fat and comparable protein, making it excellent for energy-rich feed. BSFL set 2 has higher DM, lower moisture, higher NFE, and minerals, indicating better stability, higher energy from carbohydrates, and mineral richness. Compared to Control, compost treatment T4 is overall superior due to higher DM, CP, Ash, lower moisture, acceptable AIA increase. Gene characterization confirmed the larvae as *Hermetia illucens* with 99.84% CO1 gene identity. Cellulase and amylase activity showed significant improvement in treatments compared to control, with T1 recording the highest activity. Enzyme screening showed that cellulase activity was shown in all treatments, and cellulolytic bacterial isolates were identified predominantly as *Bacillus* spp. Microbial quality analysis demonstrated reductions in pathogenic bacteria, microbial load was lower in all treatments compared to control. Furthermore, antibacterial assays confirmed BSFL's potential in pathogen reduction, achieving a 500-fold reduction in *E. coli* load in sterilized food waste and a 3750-fold reduction in normal food waste after 4 days of treatment. Overall, BSFL integrated with microbial consortia effectively enhanced food waste degradation, improved compost nutrient quality and safety, and produced larval biomass rich in protein and fat, demonstrating a sustainable strategy for organic waste valorisation and pathogen risk mitigation.

Keywords

Amylase, Cellulase, Crude protein, Food waste, Proximate analysis, Waste valorisation

Development and characterisation of a heart cell line EC3H1Tr from the orange-spotted grouper *Epinephelus coioides* (Hamilton, 1822)

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Cell line derivation involves establishing stable cells from a primary cell population, enabling indefinite proliferation under *in vitro* conditions. This process includes tissue collection from the target fish species, isolation of primary cells through enzymatic digestion or mechanical dissociation, culture of the isolated cells in a suitable medium supplemented with essential nutrients, growth factors, and other supplements, followed by regular subculturing of successful primary cultures to generate continuous cell lines. The development of such cell lines is critical for advancing fish virology research and improving aquatic animal health management strategies. In this study, primary cell cultures were established from the heart tissues of the orange-spotted grouper (*Epinephelus coioides*), of the family Serranidae that inhabits estuaries, coastal areas, coral reefs, lagoons, and brackish waters. Primary cells were isolated using the trypsinisation method and maintained in Leibovitz's L-15 medium supplemented with 20% fetal bovine serum (FBS) at 28°C. The origin of the cultures was authenticated through DNA barcoding by amplifying the mitochondrial cytochrome oxidase subunit 1 (COI) gene. To determine optimal growth conditions, the cultures were evaluated under varying pH, temperature and FBS concentrations. Cell morphology was assessed using Giemsa staining, while cell type was characterised via immunofluorescence staining for specific markers. Chromosome spreads were prepared from early and late passages for cytogenetic analysis. The heart-derived cultures demonstrated sustained proliferation, forming confluent monolayers and successfully surpassing 35 passages. The cultures were cryopreserved and efficiently revived at different passage levels, laying the foundation for the establishment of immortal cell line for future research and applications.

Keywords

Chromosome analysis, DNA barcoding, Fish virology, Immunofluorescence, Trypsinisation



Naringenin enhances antioxidant defence and attenuates lipid accumulation in *Oryzias dancena*

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High-fat diets (HFDs) are commonly used in aquaculture to enhance growth and reduce feed costs; however, they can induce oxidative stress, disrupt lipid metabolism, and suppress immune function. This study investigated the protective effects of Naringenin (NGE) in *Oryzias dancena* fed a high-fat diet. Fish were assigned to four dietary groups: Normal Fat Diet (NFD, 8% crude lipid), High-Fat Diet (HFD, 15% crude lipid), HFD+N1 (0.075% NGE), and HFD+N2 (0.15% NGE). Effect on digestive enzymes, antioxidant enzymes, hepatic histology, lipid peroxidation and expression of antioxidant, lipid metabolism and immune related genes was evaluated at the end of 45 days feeding trial. Results showed that HFD feeding significantly modulated enzymatic activity in fish especially increasing lipase and decreasing amylase activity and protease activity. HFDs reduced muscle antioxidant enzyme activities of SOD and CAT while upregulating hepatic antioxidant gene expression of SOD and GPx indicating tissue-specific oxidative stress responses or enzyme deactivation due to increased lipid peroxidation products. ALT and AST activity was significantly lowered in HFD indicating metabolic shift from protein metabolism towards lipid metabolism. Supplementation with NGE, particularly at 0.15%, restored muscle SOD activity, elevated total antioxidant capacity, partially normalised ALT and AST activity and reduced lipid peroxidation. Furthermore, HFD-fed fish exhibited upregulated PPAR α and suppressed FADS2 expression, indicative of lipid metabolic stress, which was modestly improved by NGE. Hepatic histology revealed large and irregular vacuoles in HFD and HFD+N1 fed groups. Supplementation with 0.15% NGE significantly reduced lipid accumulation. Collectively the results indicate that Naringenin supplementation at 0.15% mitigates HFD-induced oxidative stress and lipid accumulation in *O. dancena* by enhancing antioxidant defence, reducing lipid accumulation, lipid peroxidation and stabilising metabolic enzymes.

Keywords

Histology, Lipid metabolism, Marine model fish, Metabolic enzymes, Oxidative stress



Transcriptome assembly and gene annotation of the Indian halibut *Psettodes erumei*

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Transcriptome profiling of the metamorphosing flat fish *Psettodes erumei* has been completed for better understanding of their cellular, biological and functional modifications. A total of 289.6 million raw reads, with average read length of 154 bp were generated from the libraries constructed from all tissues. Quality assessment and filtering retained 236 million high quality reads with average read length of 150 bp. Trinity assembly of high quality reads yielded 2,93,901 transcripts with an average contig length of 1049 bp and N50 as 2477 bp. Preliminary assessment of the quality of assembly by mapping RNA-seq reads back to assembled transcriptome resulted in mapping percentages ranging from 95.94 to 99.12 suggesting a well-assembled transcriptome. BUSCO analysis indicated 91.7 % completeness of transcriptome assembly of which 68.2% were duplicated and 23.5% as single copy. TransDecoder analysis predicted 2,43,784 transcripts with coding potential which on cd-hit analysis clustered transcripts with sequence identity of 95% resulting in final non-redundant assembly of 87,018 transcripts. Homology-based annotation using Blastx obtained hits for 53,770 (61.8%) transcripts. Intropo scan obtained hits for 57,087 (65.60%) transcripts. From these, 47,699 (54.8%) were functionally annotated and 42,179 (48.47%) were mapped with enzyme codes. The most dominantly expressed enzyme classes were hydrolases, transferases and oxidoreductases. Gene ontology revealed that the most expressed categories were macromolecule biosynthetic process, anion binding and intracellular membrane bounded organelle. KEGG analysis identified 351 pathways in which the most dominant were relative to metabolism. Combined evidences from ab-initio and RNA seq predicted a total of non redundant 26,401 protein coding genes. The longest gene, exon and intron lengths were 98632, 13598, and 59052 bp, respectively with mean exon length of 178bp and mean intron length of 1098 bp. Homology-based annotation using Blastx obtained hits for 19,842 (75.15%) transcripts. Intropo scan obtained hits for 20,339 (77.03%) transcripts. From these 19697 (74.60%) were functionally annotated and 7709 (29.19%) were mapped with enzyme codes. The most dominantly expressed enzyme classes were Transferases, Hydrolases, and Oxidoreductases. Gene ontology revealed that the most expressed GO categories were macromolecule biosynthetic process (biological processes), anion binding (molecular function) and intracellular membrane bounded organelle (cellular component). KEGG analysis identified 348 pathways in which the most dominant pathways were relative to metabolism. The information generated helps in indentifying unique sets of candidate genes involved with various biological processes and helps researchers in functional studies of the flat fish.

Keywords

Gene ontology, Hydrolases, KEGG analysis, Metabolism, Oxidoreductases, Protein coding genes, Transferases



Dietary probiotic supplementation in shrimp feed: Influence on growth, survival, and immune parameters of the black tiger shrimp (*Penaeus monodon*) post-larvae

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Nutritional interventions play a crucial role in addressing key challenges in shrimp hatcheries, particularly in enhancing the growth and survival of post-larvae (PL) while mitigating microbial infections. This study evaluated the efficacy of a probiotic-based attenuated spray-dried product (ASP) derived from *Pseudomonas aeruginosa* on the growth performance, survival, and health status of black tiger shrimp (*Penaeus monodon*) post-larvae. *P. aeruginosa* was selected for its broad-spectrum antibacterial properties and the stability of its antimicrobial metabolites. Five experimental diets with isonitrogenous (50% crude protein) and isolipidic (8% crude lipid) were formulated: a control diet (C) and four probiotic-supplemented diets containing ASP at 0.5% (T1), 1% (T2), 1.5% (T3), and 2% (T4). A total of 4,000 PL (mean length: 3.15±0.11 mm; weight: 1.24±0.03 mg) were distributed into 15 rectangular glass tanks (50 l capacity; 200 PL per tank) at a salinity of 25‰. After a 41-day trial, the T3 group (1.5% ASP) exhibited significantly improved growth performance, survival rate, stress tolerance, nutritional quality, and metabolic enzyme activity compared to other treatments, while the control group showed the lowest performance. Quantitative analysis revealed significant improvements ($p<0.05$) in the T3 group (1.5% ASP inclusion) across multiple metrics: 29.5% increase in final body weight, 14.5% enhancement in specific growth rate (SGR), and 19.2% improvement in feed conversion ratio (FCR) compared to controls. Notably, survival rates in T3 reached 75.3% versus 60.6% in controls. Biochemical assays demonstrated elevated activity of digestive enzymes (trypsin: 39%; amylase: 33%) and immune parameters (phenoloxidase: 59%; superoxide dismutase: 36%) in T3 samples. Moreover, dietary supplementation with probiotics significantly enhanced resistance against *Vibrio* spp. in the experimental groups, with T3 larvae exhibiting 3.1-fold greater survival following challenge compared to controls. These findings demonstrate that dietary incorporation of *P. aeruginosa*-derived ASP at 1.5% inclusion level optimally enhances growth performance, stress resilience, and disease resistance in *P. monodon* post-larvae, while maintaining cost-effectiveness for commercial application. The conclusions of this study emphasise the importance of probiotic formulation as a sustainable alternative to antibiotics in intensive shrimp hatchery systems, with particular relevance for vibriosis management in tropical aquaculture operations.

Keywords

Disease resistance, Growth performance, Immune response, Probiotic formulation, Sustainable aquaculture



Isolation and characterisation of rare *Actinomycetes* from mangrove sediments of Honnavar, Karnataka and evaluation of antimicrobial activity against aquatic pathogens

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Antibiotic resistance is a global health concern caused by the misuse and overuse of antibiotics. Aquaculture, a rapidly growing food-producing industry, faces major threats from antimicrobial-resistant pathogens. Gram-negative bacteria, particularly *Vibrio* sp. and *Photobacterium* sp., are major culprits behind aquatic diseases, posing zoonotic threats to human health and causing economic losses. The rapid rise of resistance, driven by conventional drug overuse and the limited chemical diversity of current antibiotics, makes discovering new antimicrobial compounds essential. Mangrove ecosystems, known for their rich biodiversity, harbour rare *Actinomycetes* capable of producing novel bioactive metabolites. The genus *Micromonospora* stands out as a promising source of antimicrobial compounds making it a central focus of ongoing research. This study aimed to isolate, identify and characterise *Actinomycetes* from mangrove sediments of Honnavar, Karnataka, India. The antimicrobial activity of the isolates was evaluated against five aquatic pathogens (*Vibrio alginolyticus*, *Vibrio campbellii*, *Vibrio harveyi*, *Vibrio parahaemolyticus*, and *Photobacterium* sp.) through primary and secondary screening. From 24 isolates obtained, two isolates (ACT-C and ACT-Q) demonstrated significant antimicrobial activity. Morphological observations by scanning electron microscopy revealed substrate mycelia with spore clusters, and molecular sequencing confirmed their classification under the genus *Micromonospora*. The screening phases exhibited good zones of inhibition, indicating potent bioactive compound production. Crude extracts were evaluated for minimum inhibitory concentration (MIC) and IC₅₀ values using broth microdilution assays. FTIR analysis identified key functional groups linked with antimicrobial activity. Crude extract of ACT-Q demonstrated superior potency with low IC₅₀ values of 9.73 mg ml⁻¹ against *Vibrio alginolyticus*, 55.40 mg ml⁻¹ against *Vibrio campbellii*, and 15.05 mg ml⁻¹ against *Photobacterium* sp., while ACT-C was more potent against *Vibrio harveyi* (139.3 mg ml⁻¹) and *Vibrio parahaemolyticus* (29.43 mg ml⁻¹). The findings highlight mangrove-derived *Actinomycetes* as a valuable source of antimicrobial compounds unfamiliar to pathogens, making them promising for next-generation therapeutics. This study lays a foundation for alternatives to synthetic antibiotics with direct applications in sustainable aquaculture, reducing production losses, supporting coastal livelihoods, and preventing resistant pathogens from entering the food chain. Beyond aquaculture, these bioactives hold pharmaceutical promise for new clinical drugs. Future research should focus on purifying and characterising the bioactive compounds and elucidating their mechanisms to develop strategies against antimicrobial resistance.

Keywords

Antimicrobial resistance, Bioactive compounds, FTIR analysis, MIC, *Micromonospora* sp.

Enzyme-producing *Pseudomonas parafulva* from the gut of *Metapenaeus dobsoni*

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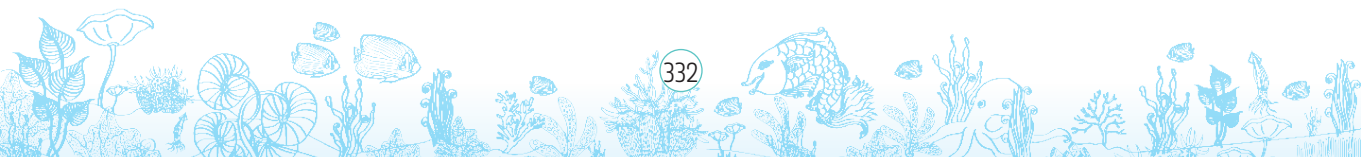
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The gastrointestinal (GI) microbiome of marine organisms plays a crucial role in host physiology, contributing to digestion, nutrient assimilation, immune regulation, and ecological balance. In aquaculture species such as shrimps, gut-associated bacteria not only support host nutrition but also enhance disease resistance and overall health. *Metapenaeus dobsoni* (Miers, 1878), a commercially important marine shrimp widely distributed along the Kerala coast, was selected in the present study to investigate its GI tract bacterial flora with a focus on enzymatic potential. Samples were collected from Fort Kochi Harbour, and bacterial isolates were obtained through selective culturing techniques. Among the isolates, a Gram-negative, rod-shaped bacterium was consistently recovered and subjected to detailed morphological, biochemical, and physiological characterisation. Molecular identification using 16S rRNA gene sequencing confirmed the isolate as *Pseudomonas parafulva* AN-24, and the sequence was deposited in GenBank under the accession number MN880153. Functional assays revealed that this isolate exhibited significant extracellular enzymatic activities, as evidenced by distinct clear zones on skim milk agar and starch agar, indicating the production of protease and amylase, respectively. These hydrolytic enzymes suggest an important role for *P. parafulva* in the digestion of proteins and carbohydrates within the shrimp gut, thereby enhancing nutrient utilisation by the host. The findings highlight the contribution of GI tract bacteria to the functional diversity of the gut ecosystem in *M. dobsoni*. Furthermore, the enzymatic capabilities of this isolate suggest its potential application as a probiotic or as a source of novel enzymes with industrial and biotechnological relevance. This study thus provides valuable insights into host–microbe interactions in marine shrimps and emphasises the significance of gut microbial diversity in sustainable aquaculture.

Keywords

Amylase, Gut-associated bacteria, Hydrolytic enzymes, Nutrient utilisation, Protease,



Comparative evaluation of black soldier fly larvae-based sustainable feed in oscar and guppy

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Ornamental fish production and trade opens a profitable alternative in aquaculture sector. The over reliance on fish meal as protein source in feeds has been heavily criticised as an unsustainable and environmentally destructive practice, leading to search for viable alternatives. Insects have emerged as superior protein source especially *Hermetia illucens* or black soldier fly larvae (BSFL) have been widely studied as a fish meal (FM) replacer in many studies and acknowledged as an aqua feed due to the comparable protein content to FM. The present study aimed to compare the effect of three commercial larval rearing diets with different protein sources. Quantitative and qualitative parameters were compared using BSFL meal based larval rearing feed (T1-ZEWA feed) and other two commercially available premium quality feed prepared (T2 and T3) with shrimp meal and fish meal in *Astronotus ocellatus* (oscar) and *Poecelia reticulata* (guppy) jet black variety. A sixty day feeding trial was conducted employing the three larval rearing diets. Early weaned fries of oscar and guppy were stocked in plastic tubs in three replications with mean total initial weight 1.92 ± 0.14 g and 1.33 ± 0.11 g. Growth performance indices showed that weight gain (49.15 ± 5.94), specific growth rate (7.77 ± 0.04), mean length (5.63 ± 0.11 cm) of oscar fed T1 feed was significantly higher ($p < 0.05$) from T2 and T3 groups. The feed conversion ratio (FCR) was 1.38, 1.80 and 4.07 in T1, T2 and T3 respectively. Colour parameters like lightness, redness and chroma (total colour concentration) were also found significantly higher in T1 fed group. But the effects of same feeds in guppy were different. At the end of the experimental trial significant differences were observed in weight gain, SGR and final length for T1 fed group but on par with T2. Colour parameters like lightness, redness and Chroma (total colour concentration) were found non-significant between the treatment groups. Among the treatments, breeding was first observed in T1 fed guppy group (48 days) followed by other groups (54 days). From the above findings it can be stated that BSFL meal based ornamental larval diet is highly effective in growth performance and colour enhancement in ornamental fishes.

Keywords

Colour enhancement, Growth study, Insect protein, Ornamental fish, Sustainable aquaculture

Characterisation of an *Aurantiochytrium* sp. as a novel probiotic for marine fish nutrition

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The marine finfish farming sector of India is rapidly expanding, but it faces significant challenges in meeting the lipid requirements of marine fish while reducing the reliance on fish oil. In particular, the demand for DHA is crucial in health, growth performance and immune function of farmed marine fishes. This study explores the potential of *Aurantiochytrium*, a DHA producing microbe, as a novel candidate for marine fish nutrition with dual functionality: providing DHA and acting as probiotic. An *Aurantiochytrium* strain was evaluated for its DHA production, antioxidant and antibacterial capacity and probiotic attributes. We observed a high DHA production capacity and strong antioxidant, and antibacterial potential associated with the *Aurantiochytrium* sp. In addition, we also evaluated the ability of the microbe to withstand the harsh gastrointestinal conditions and found that the viability of the microbe is minimally affected by the exposure to digestive enzymes and harsh pH conditions. Collectively, these findings highlight *Aurantiochytrium* as a promising dual-purpose candidate, fulfilling polyunsaturated fatty acids requirement of marine fishes and probiotic benefits offering a sustainable alternative to synthetic additives in marine aquafeeds.

Keywords

Fish oil replacement, Mariculture, Probiotic potential, Sustainable aquafeeds



Polymerase spiral reaction assay for simultaneous detection of *Aeromonas hydrophila* and *Edwardsiella tarda*

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Globally, aquaculture is one of the fastest growing food production sector. But its expansion is threatened by bacterial pathogens that cause high mortality and significant economic losses. Among these *Aeromonas hydrophila* and *Edwardsiella tarda* are major pathogens responsible for severe diseases in fish, impacting both farm productivity and food safety. Conventional diagnostic methods for detecting these pathogens are often time-consuming, costly and require advanced laboratory facilities, making them unsuitable for field-level application. Current study focused on the development of a rapid, sensitive and field-deployable diagnostic assay using isothermal amplification techniques like polymerase spiral reaction (PSR). Specific primers for *A. hydrophila* and *E. tarda* were designed and optimised. Amplification can be detected with naked eye using hydroxy naphthol blue dye. Validation was done with DNA from moribund fish and water samples. The outcome is a PSR-based rapid detection kit for simultaneous detection of major fish pathogens viz., *A. hydrophila* and *E. tarda*. PSR is expected to support early disease detection, improve fish health management and contribute to the sustainability and productivity of aquaculture systems.

Keywords

Aquatic pathogens, Diagnostic assay, Field-level application, Polymerase spiral reaction, Rapid detection



Evaluation of the efficacy of eugenol as an anesthetic agent for live transportation of cobia (*Rachycentron canadum*) juveniles

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This study evaluated the effects of eugenol anesthesia on the physiological, biochemical, and histological responses of juvenile cobia (*Rachycentron canadum*) during an 18 h simulated transport period. Fish were assigned to two treatments: a control group transported without anesthetic and a treatment group exposed to eugenol (20 $\mu\text{l l}^{-1}$). Morphometric parameters, including total length, weight, and packing density, did not differ significantly between groups, and 100% survival was recorded under both conditions. Water quality remained within acceptable limits, with slightly lower dissolved oxygen ($6.6 \pm 0.17 \text{ mg l}^{-1}$) in the eugenol group compared to the control ($6.9 \pm 0.15 \text{ mg l}^{-1}$). Carbon dioxide and ammonia concentrations were marginally reduced in anesthetised fish, reflecting lower metabolic activity, though differences were not statistically significant. Serum cortisol levels were significantly lower in the eugenol group ($17.0 \pm 1.54 \text{ ng ml}^{-1}$) relative to the control ($25.3 \pm 4.42 \text{ ng ml}^{-1}$), indicating reduced stress. Oxidative stress markers were also reduced, with lower catalase activity in gills (0.62 ± 0.25 vs $2.55 \pm 0.22 \text{ U mg}^{-1} \text{ protein}$) and reduced liver AST activity (52.3 ± 9.67 vs $118.8 \pm 16.1 \text{ U l}^{-1}$). Liver total protein content was significantly lower in anesthetised fish ($1.62 \pm 0.13 \text{ mg mg}^{-1} \text{ protein}$), suggesting a reduction in protein synthesis under sedation. Histological and ultrastructural assessments of gills showed no pathological alterations, with intact lamellae, with no signs of epithelial lifting, necrosis or cellular deformation. Ultrastructural features, including pavement cell microridges, and chloride cell integrity, remain unaltered. Overall, eugenol effectively reduced transport-induced stress in juvenile cobia without compromising gill integrity, supporting its application as a safe anesthetic for live transport in aquaculture.

Keywords

Gill morphology, Live fish transport, Oxidative stress, Metabolic activity, Stress biomarkers



Comparative analysis of parasitic infections in marine fishes along the Karwar Coast, Karnataka, India

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The present study is a comparative investigation on parasitic infections in important marine fish species collected from Karwar landing centres along the Karnataka coast. It focuses on the host species, parasite attachment modes, and site-specificity of external parasites. Parasites are known to adversely impact the growth and physiological functions of major fishery resources, often leading to economic losses due to reduced market value. For this study, two major landing centres, Ravindranath Tagore and Majali, were surveyed to assess the presence of crustacean parasites in marine food fishes. A total of 1,006 fish specimens were collected, from which 593 parasitic organisms were identified, representing five different parasite families. These included Isopods (290), *Dactylogyrus* spp. (176), *Caligus* spp. (45), Nematodes (70), and Helminth parasites (12). Among 868 infected fish specimens, the highest parasite load was recorded in *Rastrelliger kanagurta*, *Mugil cephalus*, and *Terapon jarbua*. Most copepod parasites belonged to the family Caligidae, while isopods were predominantly from Cymothoidae. Isopods and *Dactylogyrus* spp. were common across all sampled species, whereas *Caligus* spp. and helminth developmental stages were primarily found in *Mugil cephalus*. Nematodes were observed in *Tylosurus crocodilus*. Parasites were found highest in the gill filaments of infected fishes. The attachment sites included the gill, body surface, inner regions of the fins and gut, with parasites anchoring themselves to the host using hook-like or needle-like appendages. Histopathological examination revealed epithelial hyperplasia, excessive mucus secretion, lamellar fusion, and necrotic alterations, all of which contributed to reduced oxygen uptake and increased systemic stress. The study highlights a high prevalence, intensity, and severity of parasitic infections in selected marine fishes, which contribute to physiological stress and potential economic losses, emphasising the importance of regular monitoring and management strategies in marine fisheries.

Keywords

Economic losses, Histopathology, Intensity, Physiological stress, Prevalence, Severity



Molecular cloning and sequence analysis of the antimicrobial peptide encoding gene *stylicin* of *Penaeus (Litopenaeus) vannamei*

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Bacterial diseases pose significant threat to shrimp aquaculture, affecting productivity. With growing antimicrobial resistance concerns, antimicrobial peptides (AMPs) have emerged as a promising alternative. Shrimp AMPs play a vital role in the innate defence mechanism of shrimp, providing adequate protection against a broad range of shrimp pathogens. Among the AMPs, *stylicin*, a class of cationic AMPs, play a vital role in the immune defense of *Penaeus (Litopenaeus) vannamei*. Therefore, the molecular identification and characterisation of *stylicins* can provide valuable insights into their functional roles and therapeutic potential in shrimp aquaculture. This study aimed to identify and analyse the *sylicin* encoding gene in *P. (L.) vannamei* to study its functional characteristics for a potential role in shrimp immunity. *P. (L.) vannamei* were challenged with heat-killed *Vibrio harveyi* BB120. Followed by this, total RNA was extracted from the gills, and cDNA was synthesised. The *sylicin* gene was then subjected to PCR amplification using the designed primers. The amplified fragment was purified and ligated into the pDrive cloning vector, and the transformants were screened and confirmed using PCR. Further, a positive clone was subjected to Sanger sequencing, which was after validation. The sequence was analysed using various tools, multiple sequence alignment and phylogenetic tree construction were performed, and submission was made to GenBank. PCR amplification with the gene-specific primers for *stylicin*, yielded a product of the expected size, which was purified and cloned successfully into the pDrive vector. Screening of the recombinant transformants confirmed positive clones, and the sequencing validated the *stylicin*-encoding gene. Further sequence analyses revealed conserved functional domains and highlighted evolutionary relationships of *stylicin*. This study offers insights into the shrimp AMP at the molecular level. The presence of conserved domains and evolutionary links underscores their biological significance and establishes a foundation for the functional validation of *stylicin* in sustainable shrimp farming.

Keywords

Bacterial diseases, Defence mechanism, Functional role, Shrimp farming, Therapeutic potential

Characterisation of Indian pompano (*Trachinotus mookalee*) *mstnb* gene 3' region and construction of a CRISPR/Cas9 vector for its knockout

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Indian pompano (*Trachinotus mookalee*) has emerged as a promising candidate species for mariculture in Indian waters due to its market demand and adaptability. However, limited genomic resources for this species have impeded the development of functional genomics and genome editing strategies. This study aimed to characterise the 3' regulatory region of the *myostatin b* (*mstnb*) gene, an established negative regulator of muscle growth in teleost fish, and to develop a CRISPR/Cas9-based gene-editing construct targeting the *mstnb* gene in Indian pompano. Using a genome walking approach, the downstream regulatory region of the *mstnb* gene was explored, and the canonical polyadenylation [poly(A)] signal was identified approximately 1.5 kb downstream of the last exon. Further, using available sequence information, and to enable CRISPR/Cas9-mediated knockout, a 20 bp guide RNA (gRNA) target sequence located within exon 1 of the gene was identified. Forward and reverse oligonucleotides coding the selected gRNA sequence, with suitable linkers, were designed and annealed to facilitate directional cloning of the gRNA-coding double-stranded DNA into a plasmid vector pSpCas9(BB)-2A-GFP (PX458) (Addgene #48138) expressing Cas9 protein and a GFP reporter gene. A cloning strategy using restriction enzyme BpiI and T4 DNA ligase was employed for single-step digestion and ligation. The recombinant plasmid was transformed into *Escherichia coli* DH5α cells, and successful insert ligation was validated through Sanger DNA sequencing of the isolated plasmid from a putative recombinant colony. The transformation efficiency was greater than 90%, and sequencing confirmed the successful ligation of the gRNA targeting the *mstnb* gene coding sequence into the vector. This recombinant vector allows for simultaneous expression of the cognate gRNA, Cas9 nuclease, and the GFP reporter gene in future transfection or microinjection experiments. This study demonstrates the applicability of integrated molecular tools for structural and functional genomics in aquaculture species with limited genomic information. The approach outlined here establishes a framework for initiating CRISPR/Cas9-based genome editing programs in Indian pompano and potentially other marine finfish species.

Keywords

CRISPR/Cas9, Functional genomics, Genome walking, Mariculture, Muscle growth, Myostatin b



Etiopathology of lymphocystis disease (LCD) in domesticated Koran angel *Pomacantus semicirculatus* (Cuvier, 1831): A case report

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Infectious disease is an alarming issue in aquaculture industry and poses a constraint for the development of farming of new species. The Koran angel is a very popular coral reef fish in the marine ornamental fish trade. The present investigation describes the incidence of lymphocystis disease caused by an iridovirus in koran angelfish which were kept for the breeding purpose in ornamental RAS system at Mandapam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). A small reddish lesion or patch was noticed in the left and right rail region of the caudal peduncle of the fish after 2-3 months of conditioning. Cytologically, the tumour mass revealed numerous packets on nodules which was transparent with double layered membrane. The mass showed bundles of fibrous tissue with demarcation and proliferating fibroblast cells in between the nodules. The histology of the tumour mass revealed proliferation and hypertrophy of fibroblast of the skin epithelium or epidermis. In the current study, lymphocystis nodules were only found in the connective tissue and fins of the skin beneath the epidermis and not in any other tissues of the fish. DNA isolation from the tumor mass and subsequent molecular analysis revealed the presence of iridovirus in Koran ange and was designated as Koran angelfish iridovirus (KAIV). *In vitro* virus cultivation on the monolayer of the *Astronotus ocellatus* fin (AOF) cell line showed cytopathic effects indicating the presence of virus inside the cells. DNA isolated from the infected cells subjected to PCR also confirmed the presence of the virus. This is the first detailed investigation of lymphocystis in Koran angelfish.

Keywords

Coral reef fish, Fibrous tissue, Histology, Hypertrophy, Iridovirus, Tumour



Microencapsulation of *Lactobacillus plantarum* and *Bacillus subtilis* in yeast cell walls: Characterisation and stability assessment

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The large-scale application of probiotics is often restricted by their limited stability during processing, storage, and gastrointestinal transit. To overcome these challenges, baker's yeast (*Saccharomyces cerevisiae*) cell wall components, which are natural, biodegradable, and GRAS-certified, were investigated as carriers for probiotic encapsulation. A sequential acid–alkali treatment produced hollow, porous yeast cell wall matrices that retained their native honeycomb-like structure, providing an efficient framework for entrapment of *Lactobacillus plantarum* and *Bacillus subtilis*. Structural characterisation confirmed successful encapsulation. Scanning electron microscopy revealed porous structures of 3–6 μm , while dynamic light scattering indicated an increase in particle size distribution upon probiotic loading. Zeta potential analysis showed enhanced colloidal stability in encapsulated forms, with *B. subtilis* (-32.73 ± 1.39 mV) and *L. plantarum* (-30.36 ± 0.42 mV) compared to unloaded carriers (-16.4 ± 0.53 mV). Fourier-transform infrared spectroscopy validated strain-specific interactions between probiotic surface molecules and yeast cell wall components, with protein-rich signals in *B. subtilis* and polysaccharide-associated features in *L. plantarum*. Encapsulation efficiency was high, with viabilities of $89.6 \pm 3.19\%$ (*B. subtilis*) and $86.57 \pm 1.5\%$ (*L. plantarum*), surpassing non-encapsulated controls ($75 \pm 2.26\%$ and $40.6 \pm 16.3\%$, respectively). Encapsulated probiotics also demonstrated superior survival under simulated gastric and intestinal conditions, maintaining higher viability compared to free cells. Overall, baker's yeast cell wall-based encapsulation significantly enhanced probiotic stability, structural integrity, and gastrointestinal resilience. This natural and cost-effective approach presents a sustainable alternative to synthetic encapsulants, with broad potential for functional feed development, aquaculture health management, and pharmaceutical probiotic formulations.

Keywords

Biodegradable carrier, Functional feed, Gastrointestinal resilience, *Saccharomyces cerevisiae*, Structural stability

Outbreak of mud crab reovirus (MCRV) in an aquasilvi polyculture farm: Implications for sustainable mud crab farming in Tamil Nadu

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Mud crab (*Scylla serrata*) farming integrated with aqua silviculture practices has gained prominence in Tamil Nadu, India, as a sustainable livelihood approach. However, disease emergence in such systems poses serious challenges. In 2025, a significant outbreak of Mud Crab Reovirus (MCRV) was recorded in a tide-fed aquasilvi polyculture farm at M.G.R. Thittu, Killai, Tamil Nadu, where *S. serrata* was cultured along with Asian seabass (*Lates calcarifer*). Mortality in mud crabs commenced at 20 days of culture (DOC), with progressive losses reaching over 55%, while seabass remained unaffected. Affected crabs exhibited lethargy, reduced feeding activity, soft exoskeleton, and debris-laden gills. Histopathological analysis of hepatopancreas, muscle, and gill tissues revealed characteristic cytoplasmic inclusions, necrosis, and vacuolation. Molecular confirmation by RT-PCR targeting the RNA- dependent RNA polymerase gene detected MCRV in crab tissues, and transmission electron microscopy identified icosahedral viral particles of ~70 nm diameter, consistent with reoviruses. The findings confirm MCRV as the causative agent of mass mortality in *S. serrata* under aquasilvi farming conditions. This report underscores the vulnerability of tide-fed polyculture systems to emerging viral pathogens and highlights the urgent need for surveillance programs, biosecurity interventions, and better management strategies to safeguard the sustainability of mangrove-associated aquaculture practices.

Keywords

Exoskeleton, Histopathology, Lethargy, Reduced feeding, *Scylla serrata*





Evaluation of chitosan derived from black soldier fly (*Hermetia illucens*, Linnaeus, 1758) pupae shell and its potential for sustainable applications

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The production of chitosan has diverse applications in agriculture, biomedicine, food, textiles and as a chelating agent for waste water treatment. However, limited research has focused on chitosan extracted from black soldier fly (BSF) pupae shells, which are abundantly available as byproducts of insect farming enterprises. This study analyses the chemical extraction of chitosan from BSF pupae shells. The extraction process involved deproteinisation and demineralisation using 2N NaOH for 2 h at 80°C and 1.5N HCl for 2 h at 80°C, respectively. The resulting chitin was converted to chitosan through deacetylation using 30% NaOH for 2 h at 80°C, followed by decolourisation with 5%, 8% and 10% H₂O₂. The highest chitosan yields, was obtained with 8% H₂O₂ treatment. Proximate composition analysis of the extracted chitosan revealed the following values: dry matter (99.05±0.03%), moisture (0.94±0.03%), ash (9.73±0.49%), acid-insoluble ash (1.72±0.94%), protein (43.03±0.73%), and crude fat (0.47±0.17%). Chitosan characterisation was conducted using UV-Vis-spectroscopy, Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM), and powder X-ray diffraction (PXRD). UV-Vis-spectroscopy shows presence of amino (–NH₂) and hydroxyl (–OH) groups, FTIR spectra showed characterisation peaks at 1374 and 1028 cm⁻¹, corresponding to C-H bending and C-O stretching, respectively. SEM analysis revealed a surface morphology lacking fibres and pores, while PXRD confirmed a semi-crystalline structure. The identity of the BSF-derived chitosan was further validated through molecular gene characterisation. Antimicrobial activity, assessed using disc diffusion method, showed minimal growth inhibition of *Escherichia coli* and *Vibrio harveyi* at a chitosan concentration of 250 mg per 20 ml. This study demonstrates a promising approach for the economical and environmentally friendly production of chitosan from BSF pupae shells.

Keywords

Antimicrobial activity, BSF, Proximate composition, Pupal exuviae, Structural analysis



Marine derived chitosan tryptophan conjugates: A functional biomaterial for aquafeed applications

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Marine derived chitosan was functionalised with tryptophan (CS-TRP) using an eco-friendly free radical grafting method and thermal-assisted crosslinking. Dynamic light scattering confirmed improved colloidal stability of the conjugates. Structural analysis through FTIR and Proton Nuclear Magnetic Resonance spectroscopy (¹H NMR) verified successful conjugation, while X-ray diffraction showed reduced crystallinity and thermogravimetric analysis indicated decreased thermal stability due to molecular rearrangements. Transmission electron microscopy (TEM) revealed particles have size less than 200 nm and scanning electron microscopy (SEM) displayed higher porosity and distinct morphological features, particularly in thermally treated samples. These modifications enhance surface area, stability, and loading efficiency, making CS-TRP suitable as a functional ingredient in aquafeeds. Incorporation of such conjugates in fish diets could improve nutrient bioavailability, growth performance, stress tolerance, and immune response. The study highlights the potential of CS-TRP conjugates as a novel feed additive, contributing to sustainable aquaculture and value addition to marine-derived biomaterials.

Keywords

Colloidal stability, Conjugation, Fish diets, Free radical grafting, Functional ingredient, Sustainable aquaculture





Therapeutic potential and clinical prospects of bioactive compounds from the sea anemone *Bunodosoma*: From ocean depths to clinical applications

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Sea anemones possess a wealth of bioactive compounds, many of which remain unexplored. They represent a true treasure trove of potential pharmaceutical discoveries from the ocean's depths. More specifically, the *Bunodosoma* genus represents a distinct group among the many sea anemone species abundantly distributed along the world's continental coasts. These anemones play a vital role in enriching the largely unexplored reservoir of biologically active compounds, offering immense potential for diverse therapeutic applications. The bioactive materials currently being studied primarily consist of peptides, proteins, and other derivatives of biomolecules. These molecules have demonstrated a range of neurotoxic and cytotoxic effects on various animal models, making them promising candidates for drug development. To date, the chemical composition and pharmacological effects of the bioactive compounds on the genus have been documented in species such as *Bunodosoma caissarum*, *Bunodosoma granuliferum*, *Bunodosoma cangicum*, *Bunodosoma capense*, *Bunodosoma zamponii* and *Bunodosoma cavernatum*. This paper comprehensively examines the intricate details of each bioactive compound and its biological activity. It also explores the potential pharmacological applications of the species within the genus *Bunodosoma*. There is an increased emphasis on studying these species, as they could potentially contribute novel drugs to treat numerous life-threatening diseases

Keywords

Biomolecules, Bioprospecting, Drug development, Natural compounds, Therapeutic applications



Moderate supplementation of *Sargassum wightii* improves growth, nutrient deposition and digestive efficiency in the pearlspot *Etroplus suratensis*

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The present study evaluated the dose-dependent effects of dietary supplementation brown macroalga *Sargassum wightii* on growth performance, muscle proximate composition, and digestive enzyme activities in pearlspot (*Etroplus suratensis*), a commercially important brackishwater cichlid. A 90-day feeding trial was conducted with 200 healthy juveniles (approx. 6±0.5 g), randomly distributed into five experimental groups and fed with iso-nitrogenous and iso-caloric diets containing *S. wightii* at 0% (control), 5%, 10%, 15%, and 20% inclusion levels. Growth indices, including final body weight, weight gain (%), specific growth rate (SGR), feed conversion ratio (FCR), survival, muscle biochemical composition and digestive enzyme activities were evaluated. The 5% *S. wightii* supplementation yielded significant increases ($p<0.05$) in growth performance, survival, and feed efficiency, while higher inclusion levels (10, 15 and 20%) showed reduction in growth performance compared to control group. Proximate muscle analysis revealed that protein, lipid, carbohydrate, ash, and moisture contents were significantly elevated in fish receiving the 5% diet compared to other treatments, indicating enhanced nutrient assimilation and metabolic deposition. Additionally, digestive enzyme profiling showed a marked enhancement in protease, amylase and lipase activities at 5% inclusion, reflecting improved digestive efficiency and overall metabolic performance. Overall, moderate inclusion of *S. wightii* (5%) enhanced growth performance, nutrient deposition, and digestive efficiency in *E. suratensis*. The study highlights the potential of *S. wightii* as a functional feed ingredient for sustainable aquaculture.

Keywords

Aquaculture nutrition, Digestive enzymes, Growth performance, metabolic performance, Proximate composition



Improving the nutritional and bioactive properties of brown seaweed *Sargassum wightii* through microbial fermentation

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Brown seaweeds are abundant marine resource with considerable nutritional and functional value, making them a promising sustainable alternative to conventional fish feed ingredients. *Sargassum wightii*, though naturally low in protein, is rich in minerals, vitamins, polysaccharides, and secondary metabolites. However, its direct use is aquafeed limited due to the presence of anti-nutritional factors. The present study evaluated the potential of lactic acid bacterial (LAB) fermentation to improve the nutritional and functional properties of *S. wightii*. Fermentation was carried out using *Lactobacillus plantarum*, *L. fermentum*, and *L. brevis* individually and in combination under optimised conditions of pH, temperature, and fermentation duration (up to 18 days). Fermentation significantly increased free amino acids (FAA) levels, enriched essential amino acids, with variations depending on the inoculum used. Additionally, fermented biomass exhibited significantly higher antibacterial activity and enhanced antibacterial activity against the selected pathogens *Vibrio harveyi* and *V. parahaemolyticus* compared to unfermented. These findings confirm LAB fermentation as an effective bioprocess for enhancing the nutritional value and bioactivity of *S. wightii*. Further in vivo studies are needed to validate its potential as a sustainable aquafeed ingredient.

Keywords

Antibacterial, Anti-nutritional factors, Antioxidant, Feed ingredients, Fermentation, Lactic acid bacteria



Subtilisin from *Bacillus subtilis* to control fish pathogens: A step towards sustainable aquaculture

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The increasing incidence of antibiotic resistance among fish pathogens emphasises the need for sustainable alternatives to antibiotics in aquaculture. Bacteriocins, antimicrobial peptides produced by probiotic bacteria, have shown promising effects on pathogens in various industries due to their broad-spectrum activity and environmentally friendly nature. In particular, *subtilisin* is a class 1 bacteriocin, produced by *Bacillus subtilis*. However, native yields of this peptide limit large-scale applications, thus making recombinant production a viable strategy. The present study aims to achieve recombinant expression and purification of the *bacteriocin subtilisin* (*sboA*) gene product in *Escherichia coli* for aquaculture disease management. The *sboA* gene encoding *subtilisin* was amplified from *B. subtilis* (TLDK301120C24), isolated from the gut of freshwater fish. The amplicon was cloned into a pDrive cloning vector, then subcloned into the pBAD expression vector and transformed into *E. coli* TOP10 cells. The expressed recombinant protein was purified under native conditions using Ni-NTA affinity chromatography with imidazole-based buffers and confirmed with western blotting. Recombinant subtilisin production was successfully achieved in *E. coli* TOP10 cells using the pBAD expression system. Optimisation of induction conditions results in the appearance of a distinct band at the expected molecular weight on SDS-PAGE, confirming protein expression. Purification through Ni-NTA affinity chromatography yielded a soluble protein with good recovery, which was validated by the presence of a band on SDS-PAGE and western blotting. Quantification was done using a BCA assay, which indicated a concentration of approximately 1 mg ml⁻¹. These results establish the feasibility of expressing and purifying *subtilisin* in a heterologous host. Establishing the recombinant production of *subtilisin* provides options for scalable production. Future work will focus on optimisation of refolding strategies to obtain its biologically active form, followed by antimicrobial assays against key fish pathogens to confirm its functionality. In the long-term aquaculture application, *subtilisin* holds promise as an alternative to antibiotics, which can be used to support sustainable aquaculture practices.

Keywords

Antibiotic resistance, Antimicrobial peptides, Bacterial diseases, Bacteriocins, Fish health



Enhancement of biomass and biochemical composition in *Nannochloropsis oceanica* using tryptophan-enriched F/2 medium

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Microalgae play an indispensable role in aquaculture as live feeds for zooplankton, which in turn serve as food for fish larvae, and as sources of high-value biomolecules such as omega-3 long chain polyunsaturated fatty acids (n-3 LC-PUFAs) and bioactive compounds. Among these, *Nannochloropsis oceanica* is widely cultivated due to its ability to produce eicosapentaenoic acid (EPA), carotenoids, triacylglycerols, and phenolics, making it a strong candidate for both nutritional supplements and third-generation biofuels. However, large-scale utilisation is often constrained by high production costs and limited productivity. Therefore, optimising culture conditions through supplementation with bio-stimulatory compounds represents a promising approach to enhance growth efficiency. This study examined the effect of tryptophan, an essential amino acid, on the biomass and biochemical profile of *N. oceanica*. F/2 medium was supplemented with graded concentrations of tryptophan (0.015, 0.035, 0.055, 0.075, and 0.095%) and cultures were incubated at 25°C under a 16:8 h light–dark cycle for 20 days. The algal productivity was assessed after 20 days through optical density at 679 nm, dry cell weight (DCW) and algal cell count. Optical density increased from 1.25 in the control to 1.88 in the lowest supplemented group (W_1) and 2.08 in the highest (W_5) at 679 nm. Cell counts rose from 1.0×10^6 cells ml^{-1} in the control to 2.17×10^6 cells ml^{-1} in W_5 . DCW increased from 0.0169 g in the control to 0.0379 g in W_5 after centrifuging 30 ml cultures at 8000 rpm for 5 min. Visual inspection revealed distinct pigment variations between treatments, indicating tryptophan's role as a phytostimulator by promoting cell division, enlarging cell size, and enhancing pigment biosynthesis. In conclusion, these findings demonstrate that tryptophan supplemented with F/2 medium significantly accelerates biomass production there by enhances biochemical quality in *N. oceanica*. So this study revealed that tryptophan is a promising simple, sustainable cost-effective metabolic enhancer to improve microalgal productivity for aquaculture, biofuel, and nutraceutical industries.

Keywords

Bioactive compounds, Biofuel, Microalgae, Phytostimulator, Pigment biosynthesis



Screening of finfish-associated microbiota for probiotic applications in aquaculture

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The increasing demand for sustainable aquaculture practices has led to a shift away from antibiotics and chemical additives, owing to their negative impacts on fish health, product safety, and the aquatic environment. Probiotics have emerged as a promising alternative for disease management and growth promotion in cultured species. The present study aimed to isolate and characterise potential probiotic bacteria from the gastrointestinal tract (GIT) of two cultivable marine finfish, *Trachinotus blochii* (snubnose pompano) and *Lates calcarifer* (Asian sea bass). GIT samples were aseptically collected, homogenised in saline, and plated on nutrient agar. Colonies obtained were purified and subjected to morphological and biochemical identification. Probiotic attributes were evaluated based on antagonistic activity against fish pathogens (*Vibrio harveyi* and *Vibrio parahaemolyticus*), antibiotic susceptibility, tolerance to bile salts, salinity, low pH, and enzyme production. A total of 27 bacterial isolates were recovered, among which two strains (AS9 and SP8) demonstrated strong inhibitory activity against the tested pathogens. These isolates were non-haemolytic, proteolytic, and exhibited sensitivity to most antibiotics tested. In addition, they showed the capacity to tolerate varying concentrations of bile salts, acidic conditions, and salinity levels, supporting their suitability for survival in the fish gastrointestinal environment. Molecular identification was done and identified as *Bacillus albus* and *Bacillus paramycoides*. The findings highlight the potential of these isolates as probiotic candidates for finfish aquaculture, offering environmentally friendly alternatives to conventional therapeutics. Further in vivo trials are warranted to confirm their efficacy and safety.

Keywords

Antibiotic susceptibility, Fish pathogens, *Lates calcarifer*, Sustainability, *Trachinotus blochii*



Isolation and characterisation of pathogenic bacteria from diseased fishes

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India ranks as the second-largest aquaculture producer in the world after China, reflecting a steady shift from traditional farming to more intensive aquaculture practices. According to FAO estimates, the country contributes nearly 8% of the world's fish capture. Fish and fish products not only generate significant export revenue but also serve as a vital source of high-quality, easily digestible protein, essential amino acids, vitamins, polyunsaturated fatty acids (such as omega-3), and various minerals and trace elements. With the growing population, the demand for fish production has increased, driving the intensification of aquaculture to balance supply and demand. Emerging infectious diseases (EIDs), CAUSED by bacteria, viruses, parasites, and fungi, have increased in frequency as aquaculture has intensified. Bacteria account for the largest portion of these (34%), followed by viruses (25%), protists (19%), and metazoans (18%). In aquaculture, these bacterial pathogens cause significant morbidity, mortality, and financial losses. Low immunity in fish, high stocking densities, environmental stress, and poor water quality are all strongly associated with the disease outbreak due to imbalance in host-pathogen-environment interactions. Numerous bacterial pathogens have been identified, including Gram-positive species linked to systemic and chronic infections like *Lactococcus garvieae*, *Streptococcus iniae*, and *Nocardia seriolae*. In fish culture, Gram-negative bacteria are the most prevalent pathogens; *Aeromonas hydrophila*, *Vibrio* spp., and *Edwardsiella tarda* are commonly isolated. In particular, motile *Aeromonas septicemia* is considered one of the most devastating diseases in freshwater aquaculture. As a result, bacterial pathogens which cause 34% of infectious diseases in aquaculture continue to be a major obstacle to sustainable fish production, underscoring the need for improved management and diagnostic techniques. New approaches have been employed to control the bacterial infections by vaccination, immunostimulants, phage therapy, probiotic, prebiotics, phytobiotics and microbiome management.

Keywords

Aquaculture, Bacterial diseases, Fish health, Morbidity, Mortality



BaCf3 bacteriocin, a novel antimicrobial and antibiofilm agent from marine-derived *Bacillus amyloliquefaciens* BTSS3

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Marine ecosystems host immense microbial diversity, providing a rich reservoir of novel bioactive compounds. BaCf3 is a recently discovered, highly thermostable bacteriocin produced by *Bacillus amyloliquefaciens* BTSS3. It was isolated from the gut microbiota of the deep-sea black dogfish shark (*Centroscyllium fabricii*), highlighting the unmined potential of marine microbes for antimicrobial discovery. This study summarises the current research on BaCf3's unique marine origin, remarkable physicochemical stability, potent antimicrobial and antibiofilm properties, and its broad potential applications as a sustainable alternative to conventional antibiotics in marine, food, medical, and environmental settings. The literature study emphasized BaCf3's structural characterisation, mode of action, efficacy against multidrug-resistant and biofilm-forming pathogens, and versatility in diverse applications. BaCf3 exhibits exceptional heat and pH resilience, retaining activity after extreme environmental stresses common to those in marine habitats. It strongly inhibits marine and foodborne pathogens, including biofilm eradication, supporting sustainable aquaculture and food safety. Its non-toxic behaviour in mammalian cells suggests potential for therapeutic use and biofilm control in medical and industrial settings. BaCf3's biodegradability and marine origin also point to eco-friendly environmental applications, such as water treatment. Its novel peptide sequence and marine source reflect a unique evolutionary adaptation in deep-sea microbial communities. BaCf3 represents a potent marine-derived bacteriocin with wide-ranging practical applications, advancing sustainable antimicrobial strategies that integrate marine biodiversity with challenges like antibiotic resistance and biofilm-related infections.

Keywords

Antimicrobial peptides, *Centroscyllium fabricii*, Marine-derived antimicrobials, Physicochemical stability



Investigations on selected reproductive parameters of the striped bonito *Sarda orientalis*

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Marine capture fisheries have reached almost their maximum sustainable level and aquaculture is the only available option to meet the increasing demand of fish for the future. It is well known fact that the availability of hatchery-produced seed is the prerequisite for the mariculture. Seed production technology has been standardised only for a few tropical marine fishes. The striped bonito (*Sarda orientalis*; family Scombridae), is already selected as potential candidate species for mariculture by ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI). Locally in Kerala, *S. orientalis* is known as 'Neymeen choora' and forms a commercially important fin fish with high consumer demand. A total of 553 fish (260 females and 293 males) were purchased from the Vizhinjam fish landing centre, located on the southern west coast of Kerala, India, between January and December 2022. Gonadal developmental studies, sex ratio, size at maturity, reproductive maturity phases, and fecundity of *S. orientalis* were estimated following standard methods. Sexual and reproductive categorisation was ascertained via macroscopic, microscopic, and histological evaluation of the gonads. The chi-square test was applied at a 5% significance level to detect possible significant differences in the proportions of females and males (1:1). To estimate size at maturity (L_m 50), females and males were grouped separately, and maturity curves were drawn as scatter plots. A five-stage maturity scale was used to classify gonads as immature, developing, spawning-capable, regressing, and regenerating. The gonadosomatic index (GSI) and fecundity were estimated. Microscopic examination of the oocyte and histological studies revealed that ovarian development in *S. orientalis* is asynchronous, with multiple batches. The sex ratio shows slight dominance of males over females and the L_m 50 was calculated as 39.3 cm FL for females and 41.4 cm FL for males. Monthly distributions of spawning-capable females and males were dominant during July (69.7%) and May (63.3%). High GSI values were recorded for females (4.87 ± 0.46) and males (3.95 ± 0.10) in July and May. Fecundity ranged from 151,573 to 724,856 eggs (38.5-48.0 cm FL) with an average of 432,983 eggs. Reproductive parameters studied suggest that *S. orientalis* has good mariculture potential and hatchery production is also possible. Additionally, the study results are also be useful for developing management strategies for the conservation and judicious exploitation of *S. orientalis* from the wild.

Keywords

Fecundity, Gonadosomatic index, Maturity phases, Sex ratio, Size at maturity



Expression of HSP70 as a biomarker of abiotic and biotic stress in *Trachinotus blochii*

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Heat shock protein 70 (HSP70) is a highly conserved molecular chaperone that plays a crucial role in maintaining cellular homeostasis and stability in fish under stress. Its expression is induced by environmental and pathogenic factors, including salinity fluctuations, temperature changes, oxidative stress, and infections. Elevated HSP70 levels in fish from extreme habitats highlight its role in stress adaptation, making it a valuable biomarker for assessing stress tolerance and adaptive capacity in commercially important marine species, though its application in aquaculture remains limited due to incomplete knowledge of its regulation. Coastal aquaculture, a rapidly expanding sector, faces challenges from fluctuating environmental conditions and intensive farming, which can induce physiological stress and increase susceptibility to infections. *Trachinotus blochii*, a euryhaline species with high growth and market value, is particularly prone to bacterial infections and osmotic stress during salinity changes. Understanding biomarkers like HSP70 is therefore essential for improving fish welfare and aquaculture practices. This study examined the tissue-specific expression of inducible HSP70 (*tb-ihsp70*) in *T. blochii* and evaluated its transcriptional response to a representative abiotic (salinity) stress and biotic (pathogen exposure) using qPCR with the amplification efficacy of 98.5%. *tb-ihsp70* showed constitutive, tissue-specific expression under routine culture conditions (salinity: $20 \pm 1\text{‰}$; pH: 7.8 ± 0.3 ; temperature: $27 \pm 1.2^\circ\text{C}$), with the highest levels in gill, followed by kidney, spleen, liver, and heart. Salinity stress significantly ($p < 0.05$) upregulated *tb-ihsp70* at 3‰, peaking on day two (7.95-fold) and remaining elevated on day three (5.26-fold), while no significant changes occurred at 42‰, indicating a stronger and more sustained response at lower salinity. Following the pathogen (intramuscular injection of *Vibrio harveyi* @ $105.5 \text{ CFU ml}^{-1}$) challenge also, there was an increased expression in a tissue- and time-specific manner, peaking at 12 h in spleen (~73.41-fold), heart (~40.87-fold), and posterior kidney (~23.10-fold). These findings demonstrate that *tb-ihsp70* plays a crucial role in both abiotic and biotic stress adaptation, establishing it as a reliable biomarker for monitoring physiological responses and fish health in *T. blochii*. This provides a foundation for future studies on sustainable aquaculture, climate resilience and environmental stress management. These findings provide the first comprehensive insight into HSP70 expression in *T. blochii*, with implications for health management and adaptive potential in sustainable coastal aquaculture.

Keywords

Adaptation, Expression profiling, Molecular chaperone, Salinity stress, *Vibrio harveyi*



Introducing effective spawning stock biomass (SSBe) to model stock-recruitment relationship in fast growing tropical shrimps

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The stock-recruitment relationship (S-R) is a critical yet often poorly understood aspect of population dynamics in tropical marine fisheries, particularly for fast-growing, short-lived shellfish species. This knowledge gap is primarily due to insufficient data on spawning stock biomass and recruitment strength, and the inapplicability of single annual spawning assumptions to these species. This study addresses these challenges by developing a novel framework for establishing S-R relationships in short-lived species, exemplified by *Paraapenaeopsis stylifera*. To accurately capture intra-annual spawning and recruitment pulses, the data time step was reduced from annual to monthly. A new analogue of spawning stock biomass, termed effective spawning stock biomass (SSBe), is introduced. SSBe is derived as the sum product of the proportion of mature specimens and the total estimated biomass within each length class. Monthly data pairs of SSBe and recruitment (biomass) were generated, incorporating a recruitment lag (t_r) equivalent to the age at recruitment, calculated using the inverse von Bertalanffy growth function. Three established S-R models (Beverton and Holt; Cushing, and Ricker), were fitted to the SSBe and recruitment data. Model fit and performance were rigorously evaluated using AIC and BIC values. The Ricker model consistently demonstrated the best fit, effectively explaining the S-R relationship of *P. stylifera* in the Northeastern Arabian Sea. This framework offers a robust approach for assessing and managing short-lived tropical shrimp populations.

Keywords

Fisheries management, SSBe, *Paraapenaeopsis stylifera*, Population dynamics, S-R relationship, Tropical shrimp



Theme 3

Climate and Environment Resilience(CER)

Oral Presentations



Spatio-temporal delineation of phytoplankton bioregions in the Northern Indian Ocean using multi-decadal satellite reconstructions

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Phytoplankton seasonality and its environmental drivers play a crucial role in predicting biological productivity in the Northern Indian Ocean, particularly in the Arabian Sea (AS) and Bay of Bengal (BoB). Despite being at similar latitudes and influenced by monsoon-driven processes, the two regions differ markedly in productivity. The BoB, with its strong surface salinity stratification, limits vertical nutrient mixing, making its waters more oligotrophic and biologically less productive than the AS. This study utilizes a long-term, multi-satellite DINEOF-reconstructed chlorophyll-*a* (Chl-*a*) dataset to investigate winter phytoplankton seasonality and delineate bioregions in the AS and BoB. Using an objective clustering approach, we identified distinct winter Chl-*a* patterns, offering improved insight into regional biogeographical boundaries and the environmental drivers of bloom variability. The findings highlight the significant influence of climate modes, particularly the Indian Ocean Dipole (IOD) and El Niño-Southern Oscillation (ENSO) on interannual variability in Chl-*a* concentrations and their biogeographical boundaries. In the BoB, significant interannual shifts in Chl-*a* concentrations and bioregions were observed during winter following positive IOD events. These shifts are linked to remotely forced upwelling by Kelvin and Rossby waves, which elevate the nutricline and enhance offshore nutrient supply, driving Chl-*a* blooms in the southeastern BoB, while the southwest remains largely oligotrophic. In the northern Arabian Sea, biogeographic shifts are mainly influenced by variations in mixed layer depth (MLD), wind mixing power, and Ekman dynamics that modulate vertical nutrient transport. By linking regional phytoplankton bioregions with basin-scale climate variability, this study demonstrates how ocean ecosystems in the Northern Indian Ocean respond to and cope with environmental perturbations. These insights contribute to understanding the resilience of marine productivity and biogeochemical cycling under changing climate conditions, offering a scientific basis for projecting future ecosystem responses.

Keywords

Arabian Sea, Bay of Bengal, ENSO, IOD, Surface chlorophyll



Physical drivers of winter surface chlorophyll blooms in the Southeastern Bay of Bengal

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The southeastern Bay of Bengal (BoB) exhibits pronounced seasonal and interannual variability in surface chlorophyll-*a* (SChl) concentrations, with a consistent peak during the winter monsoon season (December–February). Understanding the resilience of these blooms to large-scale climate variability is essential for assessing marine ecosystem productivity and regional biogeochemistry. Such resilience is critical, as phytoplankton form the base of the marine food web and directly influence fisheries, carbon cycling, and the capacity of the ocean to buffer climate change impacts. This study investigates the drivers of interannual variability in winter SChl blooms, emphasizing their modulation by climate modes, particularly the Indian Ocean Dipole (IOD). Twenty-eight years (1997–2024) of satellite-derived SChl, sea level anomaly (SLA), mixed layer depth (MLD), and surface current data were analysed to examine the coupling between biological productivity and upper-ocean dynamics. Climatological analysis reveals a consistent winter maximum in SChl, while interannual anomalies highlight episodic bloom enhancements linked to ocean-atmosphere interactions. Among the climate indices, the SLA based Dipole Index (SDI) showed strongest correlation with SChl anomalies, outperforming both the Dipole Mode Index (DMI) and Niño 3.4. Positive SDI phases are associated with negative SLA, intensified westward surface currents, and elevated SChl concentrations, indicating enhanced offshore nutrient transport and lateral spread of the bloom. During strong IOD years, westward-propagating SChl anomalies match the phase speed of second-mode baroclinic Rossby waves, suggesting a dynamic coupling between upper-ocean circulation and productivity. In contrast, weaker IOD or El Niño events fail to produce similar responses. These findings underscore the dominant influence of the IOD over ENSO in shaping winter biological interannual variability in the southeastern BoB and highlight the critical role of upper-ocean dynamics in regulating surface productivity in response to climate forcing. By revealing how physical drivers shape biological responses, this study contributes to a broader understanding of ecosystem resilience in a climate-sensitive region, with implications for food security, fisheries management, and adaptation strategies in the Indian Ocean.

Keywords

ENSO, Interannual variability, IOD, Surface chlorophyll



Ecological sensitivity, shoreline dynamics and resource vulnerability in Car Nicobar: Towards a sustainable small island management plan

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Small Island ecosystems such as Car Nicobar, located in the Nicobar Archipelago of the Bay of Bengal, face unique challenges due to their geographic isolation, limited resources, fragile biodiversity, and increasing exposure to climate change and natural disasters. This study aimed to develop a Small Island Management Plan (SIMP) for Car Nicobar using a multidisciplinary approach that integrates ecological, socio-economic, cultural, and geospatial assessments. Field surveys, stakeholder interviews, and citizen science initiatives were conducted to identify ecologically sensitive habitats, with a particular focus on sea turtle nesting grounds, coral reefs, mangroves, and freshwater turtle habitats. Land Use and Land Cover (LULC) mapping using Sentinel-2 and Landsat imagery revealed that over 80% of the island is covered by dense and mixed forests, while settlements are concentrated along the eastern coast, exposing critical infrastructures to disaster risk. Shoreline dynamics of Car Nicobar exhibited alternating phases of erosion and accretion from 1992 to 2024. During this period, the island experienced moderate shoreline instability, with an average erosion rate of -0.81 m yr^{-1} , highlighting its vulnerability to extreme events and coastal changes. Tsunami vulnerability mapping showed that up to 42.8% of the island could be inundated under extreme run-up scenarios. Water resource assessments projected future demand exceeding seasonal availability, underscoring the urgent need for conservation measures and rainwater harvesting. Biodiversity surveys documented the nesting activity of sea turtles across key beaches, highlighting previously undocumented nesting sites that require designation as Ecologically Sensitive Areas (ESAs). The proposed SIMP emphasises regulated development zones, ecosystem-based disaster risk reduction, sustainable agriculture, and inclusive governance that actively engages local communities. Recommendations include rainwater harvesting, agroforestry diversification, coral and mangrove conservation, and citizen science-led monitoring of turtle nesting sites. By combining scientific evidence, traditional knowledge, and participatory planning, this study provides a framework for sustainable development, climate resilience, and biodiversity conservation in Car Nicobar. The findings can serve as direct inputs to strengthen future island management policies and planning across the Andaman and Nicobar Islands.

Keywords

Disaster risk, Ecologically sensitive areas, Resource management, Turtle nesting sites, Vulnerability



Mangrove ecosystem and blue carbon trade: Prospects and challenges in India

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Mangroves are keystone ecosystems and assume significance owing to the numerous environmental services and critical ecological functions they provide. These blue carbon ecosystems are rich in floral and faunal biodiversity, and render many goods and services ranging from coastal protection to climate regulation. They protect the coasts during cyclonic storms and floods, prevent soil erosion, and serve as breeding and nursery ground for many aquatic species. They are highly productive, and many commercially important fish species spend at least part of their life cycle in these ecosystems. Mangroves play an important role in supporting coastal food webs and nutrient cycles in the adjacent coastal ecosystems, and the health of mangrove ecosystems have a direct reflection on the coastal fish production. The mangroves are also reservoirs of carbon stocks, due to their ability to sequester and store atmospheric carbon in their biomass and underlying sediment, and are therefore significant in view of climate change mitigation. Our studies in different mangrove ecosystems along the Malabar coast of Kerala indicated that mangrove wetlands stored about 150 to 190 t C ha⁻¹ which is equivalent to 550 to 700 t CO₂ ha⁻¹. Even at a moderate storage rate of 100 t C ha⁻¹, the estimated 4,991.68 sq. km of mangrove cover of the country would have the potential to sequester and store about 50 million t of Carbon. Mangroves though considered as potential store houses of carbon, are fragile and vulnerable to natural and man-made disturbances. Worldwide, mangroves face rapid degradation due to several factors including urbanisation and it is reported that the world has lost 1.04 million ha (6.6%) of its mangrove forests in three decades between 1990 and 2020. The continued degradation has resulted in a surge of interests in conservation and restoration of mangrove ecosystems. The voluntary carbon market has emerged as an effective way of realising the inherent value of these ecosystems, and can have a transformative effect on the scale of institutional finance for mangrove restoration projects. In India, developing voluntary carbon market projects for mangrove restoration is still in a nascent stage and the country is in the process of developing a structured and regulated carbon pricing ecosystem as part of our climate action agenda.

Keywords

Climate regulation, Coastal protection, Conservation, Restoration, Voluntary carbon market



Lagged environmental forcing improves predictive models of trawl CPUE off Gujarat Coast

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Demersal and benthic resources such as threadfin breams and penaeid shrimps form a major component of trawl fisheries along the Gujarat Coast, and their variability is closely linked to oceanographic processes. This study evaluates the influence of mixed layer depth (MLD), a key driver of primary productivity and benthic-pelagic coupling, on catch per unit effort (CPUE) of threadfin breams (CPUE_TB) and penaeid shrimps (CPUE_PP) during 1993–2019. Surplus production models were developed under three scenarios: (i) with lagged MLD, (ii) with non-lagged MLD, and (iii) without environmental covariates. The lag structure was determined from length-frequency observations, identifying the most dominant size classes contributing to the fishery. This approach allowed estimation of the time required for environmental effects on early life stages to translate into fishable biomass. Model diagnostics revealed that lagged MLD significantly improved explanatory power. CPUE_PP was best predicted by MLD_lag1 ($R^2 = 0.675$, AIC = 89.81), while CPUE_TB responded strongly to MLD_lag2 ($R^2 = 0.725$, AIC = 69.7). In contrast, non-lagged and non-covariate models performed poorly. These findings highlight the ecological relevance of MLD variability for demersal and benthic resources, with species-specific lagged responses reflecting differences in life history and recruitment pathways. Incorporating lagged ocean indicators enhances predictive skill and provides a robust framework for ecosystem-informed fisheries management under changing climate regimes.

Keywords

Catch per unit effort, Mixed layer depth, Penaeid shrimps, Surplus production models, Threadfin breams, Trawl fisheries



Resilience for survival: Assessment of mangroves in relation to climate change using remote sensing and satellite imagery

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Satellite imaging is widely used in the field of science and technology for survey of coastal and terrestrial areas since the early 1950s. Remote sensing data is an important component of marine and coastal biodiversity studies and assessment. This study focused on the temporal changes observed on the topography, density and abundance of mangrove patches in the Bhavnagar District of the Gulf of Khambhat using the image processing techniques of Quantum Geographic Information System (QGIS) software. Mangroves are an important part of the coastal ecosystem that provides various ecosystem services and are mainly found in the intertidal regions of the sea which are near the equator. These halophytes are resistant to the saline conditions of the seawater and are able to thrive the best in such habitats. They provide services such as protecting the coastal areas from various coastal hazards such as tsunamis, and cyclones. They provide breeding and nursery grounds for various fish and crustacean species as well. Recent studies reveal a drastic impact of the anthropogenic activities on the cover of the mangroves in the coastal regions. Owing to the ability to protect the coastline from catastrophic coastal hazards, conservation of mangroves is much needed. The total cover of mangroves in the Indian peninsular region according to the Indian State Forest Report is 4991.68 sq. km. as of 2023 out of which 1177.27 sq. km. is the mangrove cover in the Gujarat State. The total mangrove cover in the Bhavnagar District is 134 sq. km. Increasing anthropogenic pressures threaten this vital ecosystem, underscoring the need for its conservation. This study assessed mangrove patches of Bhavnagar District over a 25-year period (January 2000–January 2025) using satellite imagery. It also examined the resilience of selected mangrove stands and their correlation with the coastal boundary layer and key climatic factors.

Keywords

Anthropogenic pressures, Coastal boundary line changes, Key climatic factors, QGIS



Projections of temperature and precipitation for the coastal districts of India, using MIROC6 and MPI-ESM1-2-HR under SSP1-2.6 and SSP5-8.5 scenarios

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India's coastal regions are highly vulnerable to climate change, with rising temperatures and shifting rainfall regimes posing critical threats to ecosystems, livelihoods, and regional economies. This study assessed long-term temporal and spatial trends in temperature and precipitation across coastal districts of India using projections from the MIROC6 and MPI-ESM1-2-HR global climate models under two Shared Socioeconomic Pathways, SSP1-2.6 and SSP5-8.5. Historical climate data (1970 - 2000) were compared with future projections (2021 - 2100) across four time slices: 2021 - 2040, 2041 - 2060, 2061 - 2080, and 2081 - 2100. Results indicated that under SSP5-8.5, annual mean temperature increases exceed 3°C relative to the baseline, showing a near-linear rise from 2021 onwards while maintaining seasonal variability, with January remaining the coolest and May the warmest. Precipitation exhibited significant upward trends after 2061, with the months September-October showing pronounced increases. These shifts may heighten flood risks, disrupt fisheries and aquaculture, and challenge coastal infrastructure. Spatially, both models showed the largest temperature deviations in Gujarat, Maharashtra, Goa, Kerala, Karnataka, West Bengal, and Odisha, while Tamil Nadu and Andhra Pradesh experience accelerated warming in later periods. Under MPI-ESM1-2-HR, Karnataka showed the highest warming. For precipitation, MIROC6 projected increases in Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, West Bengal, and Odisha, with slight declines in Kerala and Karnataka, and moderate rises in Goa as well as the Andaman and Nicobar Islands. MPI-ESM1-2-HR indicated maximum positive precipitation anomalies in Gujarat, Andhra Pradesh, and Odisha, moderate increases in Maharashtra, Kerala, Tamil Nadu, and West Bengal, and negative deviations in Goa and Karnataka. These spatio-temporal trends highlight regional vulnerabilities, underscoring the urgency of resilience strategies such as early warning systems, climate-resilient infrastructure, and adaptive livelihood planning.

Keywords

Coastal resilience, Shared socioeconomic pathways, Seasonal variability, Vulnerability



Influence of climate oscillations on oceanographic conditions and Indian oil sardine population dynamics in the Southeastern Arabian Sea

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The Indian oil sardine (*Sardinella longiceps*) is a key small pelagic species in the Southeastern Arabian Sea serving as an ecological and economic sentinel of climate variability in the region. Their population dynamics are strongly modulated by basin-scale climate oscillations influencing local hydrography, nutrient fluxes, and primary productivity. The present study examined the decadal variability (2010–2020) in sardine landings along the Kerala coast using a suite of datasets encompassing fisheries, sea surface temperature (SST), nutrients, chlorophyll-*a*, and phytoplankton size classes. From 2010 to 2020, sardine landings along Kerala's coast reflected the modulating impact of major climate oscillations, such as, El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), having distinct influence on the regional oceanography. Landings increased sharply between 2010 and 2011, coinciding with strong and moderate La Niña and negative IOD phases. These years were marked by moderate sea surface temperatures (SST, $8.7 \pm 1.1^\circ\text{C}$) and elevated chlorophyll-*a* concentrations ($1.37 \pm 1.4 \text{ mg m}^{-3}$), indicating intense upwelling and nutrient enrichment. Enhanced phytoplankton biomass across all size classes: micro ($0.40 \pm 0.59 \text{ mg m}^{-3}$), nano ($0.08 \pm 0.05 \text{ mg m}^{-3}$), and pico ($0.78 \pm 0.48 \text{ mg m}^{-3}$) in these years created favourable trophic conditions for sardine recruitment and growth. However, the El Niño and positive IOD events during 2015 and 2019 caused sea surface warming in this region, resulting in higher SSTs ($29.1 \pm 0.8^\circ\text{C}$) and reduced chlorophyll-*a* concentration ($0.69 \pm 0.58 \text{ mg m}^{-3}$), suggesting suppressed upwelling. Phytoplankton biomass declined noticeably (micro: $0.12 \pm 0.1 \text{ mg m}^{-3}$; nano: $0.07 \pm 0.05 \text{ mg m}^{-3}$; pico: $0.32 \pm 0.07 \text{ mg m}^{-3}$), causing food-limited conditions that hindered the sardine recruitment and population growth. In 2020, a noticeable collapse in sardine stocks occurred despite moderate La Niña conditions. SSTs remained elevated ($\sim 29.0^\circ\text{C}$), and only partial recovery in chlorophyll-*a* (1.05 mg m^{-3}) was observed, suggesting a lagged ecological response and cumulative thermal stress within the ecosystem. Overall, the findings demonstrate that ENSO- and IOD-driven climate oscillations regulate the thermal and biogeochemical dynamics of the southeastern Arabian Sea, shaping the productivity pathways that sustain sardine populations. The persistence of elevated SSTs in the latter half of the decade highlights the vulnerability of coastal upwelling ecosystems to climatic oscillations. *S. longiceps*, thus serves as a key bioindicator of climate-driven changes, reflecting the resilience and sustainability of India's small pelagic fisheries in a warming ocean.

Keywords

Climate variability, Ecosystem resilience, El Niño–Southern Oscillation, Indian Ocean Dipole, *Sardinella longiceps*

Theme 3

Climate and Environment Resilience(CER)

Poster Presentations



Documentation of stranding of marine mammals along the coast of Maharashtra

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The Citizen Science Programme in Vembanad Lake, India, actively involves local communities in environmental monitoring by utilising digital tools for water quality assessment. This study focuses on the innovative application of smartphone-based digital imagery, to assess water quality in the lake by analysing the hue colour angle (α), a parameter in the International Commission on Illumination (CIE) colour space. A dataset of over 1,000 smartphone-based digital images were collected by citizen scientists using tools such as the Mini Secchi Disk and the TurbAqua App in 2024, providing quantitative measurements of water colour derived from the CIELAB colour space. The hue colour angle (α), expressed as an angle ranging from 0° to 360°, provides a quantitative descriptor of water colour, with distinct ranges corresponding to specific perceptual colours. Water bodies experiencing pollution or changes in their ecosystem often show anomalous colours, such as black, grey, or red, which can be identified through this method. Hue colour angle values were extracted from digital images using the WAtER COlor from Digital Images (WACODI) algorithm. The hue angle values ranged from a minimum of 23.69° to a maximum of 220.02°, with an average of 51.13°. The dominant colour of the lake's water was within the greenish-brown range (14–17 FUI), indicative of eutrophic to mesotrophic conditions driven by nutrient enrichment and biological productivity. Rare instances of high hue values (>200°) were observed, suggesting that clear, oligotrophic conditions are infrequent in the lake. This study contributes to the foundational development of a Digital Twin of Vembanad Lake by establishing a baseline of hue colour angle (α) values derived from digital image analysis. The study highlights the potential of digital image-based colour analysis as a cost-effective and scalable approach for assessing water quality in natural water bodies. Although relatively new to the freshwater science community, the hue colour angle (α) offers valuable insights into water colour dynamics, particularly in the context of climate change and increasing human impact. This work lays the groundwork for future integration with biogeochemical, hydrological, and ecological datasets

Keywords

Forel-Ule Index, Hue colour angle, Mini Secchi Disk, Oligotrophic conditions, TurbAqua App



Shoreline change and its impact on coastal ecosystems under rising sea levels: A case study from Kerala coast

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Indian coastlines are undergoing rapid transformations due to natural processes, anthropogenic pressures, and accelerating sea-level rise (SLR), threatening coastal ecosystems, infrastructure, and livelihoods. This study examined shoreline dynamics along the entire coast of Kerala over the past three decades using multi-decadal Landsat imagery, Sentinel-2 datasets, and reanalysed sea level anomaly data from CMEMS. Shoreline change rates were quantified using the Digital Shoreline Analysis System (DSAS). Ecological impact of shoreline change was assessed by mapping the variability in coastal vegetation through field surveys and satellite-based vegetation mapping. Cloud free multispectral images for dry months were selected for the years of study. Using supervised machine learning, coastal vegetation was mapped along with NDVI estimation. Relative change in the coastal vegetation was then calculated as an estimate on ecosystem change. Results revealed extensive erosion hotspots, especially in the central and northern parts of Kerala, with erosion rates exceeding about 11 m per year in some locations. Concurrently, sea-level rise, averaging approximately 3.2 mm per year, is intensifying inundation and accelerating the loss of mangroves, and other coastal vegetation, potentially critical to artisanal fisheries. These physical changes threaten biodiversity and the socio-economic resilience of dependent communities. The findings highlight the urgent need for adaptive management strategies, such as mangrove restoration, beach nourishment, and implementation of coastal setback zones, to mitigate ongoing risks. Moreover, integrating satellite-derived shoreline monitoring, sea-level projections, and ecosystem vulnerability assessments into marine spatial planning is essential to strengthen coastal resilience under rising climatic and anthropogenic pressures.

Keywords

Climate change, Coastal erosion, Ecological impact, Erosion hotspots, Satellite, Vegetation mapping



Cyclonic systems of the Northern Indian Ocean: Impacts on fisheries

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Climate change has significantly affected the Indian subcontinent due to its proximity to the equator. Almost 50% of Indians live in climate hotspot regions and work in climate-sensitive sectors like agriculture and fisheries. By 2050, 148.3 million Indians are projected to reside in extreme climate hotspots. India has a coastline of 11,098.8 km with numerous dense coastal settlements that rely on capture fisheries as their primary source of income. The socio-ecological effects of climate change are much more severe in these areas. Sea level rise and extreme weather events are the main threats to coastal life. They are highly vulnerable to tropical cyclones and the ensuing storm surges, torrential rain, runoff, erosion and devastating floods. The Indian subcontinent is exposed to nearly 10% of the tropical cyclones in the world. The primary devastation in coastal areas caused by these disastrous events includes loss of fishing days, damage to transport boats, fishing gears and equipment, motors, as well as common facilities like harbours, net mending units and other essential infrastructure. However, cyclones are also known to make the coastal waters more productive by breaking stratification, churning water column and increasing runoff, which makes the surface waters nutrient rich. The frequency and magnitude of tropical cyclone are expected to increase in the future. A significant 52% rise in the frequency of cyclonic storms along India's west coast has already been observed. The cyclonic systems that were formed in the Northern Indian Ocean region during the period 2011-2024 were compiled. There were 147 cyclonic systems formed in the area, out of which 96 systems were in the category of deep depression to extremely severe cyclonic storm. These systems can affect fishing activity due to total suspension of fishing operations as per the warnings issued by the India Meteorological Department. It leads to hardships for the fishing community, making them economically more constrained. Altogether, 70 fishing days were lost in 2024 and on an average 59 days per year were lost during 2011-2024. The study reveals one of the facets of how cyclonic systems are impacting the marine fisheries sector. Timely assessment of weather warnings issued by the government agencies and proactive strategies are vital to minimise the impacts of cyclonic events.

Keywords

Climate hotspots, Deep depression, Fishing days, IMD, Sea level rise, Weather warnings



Shoreline change and its impact on coastal ecosystems under rising sea levels: A case study from Kerala coast

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Indian coastlines are undergoing rapid transformations due to natural processes, anthropogenic pressures, and accelerating sea-level rise (SLR), threatening coastal ecosystems, infrastructure, and livelihoods. This study examined shoreline dynamics along the entire coast of Kerala over the past three decades using multi-decadal Landsat imagery, Sentinel-2 datasets, and reanalysed sea level anomaly data from CMEMS. Shoreline change rates were quantified using the Digital Shoreline Analysis System (DSAS). Ecological impact of shoreline change was assessed by mapping the variability in coastal vegetation through field surveys and satellite-based vegetation mapping. Cloud free multispectral images for dry months were selected for the years of study. Using supervised machine learning, coastal vegetation was mapped along with NDVI estimation. Relative change in the coastal vegetation was then calculated as an estimate on ecosystem change. Results revealed extensive erosion hotspots, especially in the central and northern parts of Kerala, with erosion rates exceeding about 11 m per year in some locations. Concurrently, sea-level rise, averaging approximately 3.2 mm per year, is intensifying inundation and accelerating the loss of mangroves, and other coastal vegetation, potentially critical to artisanal fisheries. These physical changes threaten biodiversity and the socio-economic resilience of dependent communities. The findings highlight the urgent need for adaptive management strategies, such as mangrove restoration, beach nourishment, and implementation of coastal setback zones, to mitigate ongoing risks. Moreover, integrating satellite-derived shoreline monitoring, sea-level projections, and ecosystem vulnerability assessments into marine spatial planning is essential to strengthen coastal resilience under rising climatic and anthropogenic pressures.

Keywords

Climate change, Coastal erosion, Ecological impact, Erosion hotspots, Satellite, Vegetation mapping



Role of atmospheric forcing in triggering surface phytoplankton blooms in the Northern Arabian Sea

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Diverse hypotheses exist regarding winter phytoplankton bloom dynamics in the Northern Arabian Sea (NAS), yet the applicability of the convection shutdown hypothesis (CSH), a key conceptual model in temperate systems remains untested in this basin. CSH posits that bloom initiation is triggered by the abrupt cessation of deep convective mixing, driven by seasonal shift in net surface heat flux (Q_{net}) from negative (cooling) to positive (heating). This study evaluates the relevance of CSH in the NAS using two decades of satellite-derived surface chlorophyll (SChl) and atmospheric reanalysis data. A phenology-based K-means clustering approach identifies three bioregions with distinct bloom timings: Bioregion-1 (February-March), Bioregion-2 (February), and Bioregion-3 (December-January). In Bioregions 1 and 2, bloom initiation coincides with Q_{net} reversal and a sharp decline in vertical mixing, consistent with CSH and resembling detrainment-blooms in higher latitudes. Here, Q_{net} reversal serves as a robust indicator of bloom onset and its interannual variability, a simpler alternative to mixing layer depth. In contrast, Bioregion-3 exhibits blooms under sustained convective mixing and negative Q_{net} , consistent with entrainment-blooms, typical of subtropical regimes. These findings extend the applicability of CSH to tropical waters, highlight regional bloom variability, and support improved predictive and biogeochemical modeling in the NAS.

Keywords

Convection shutdown hypothesis, Phytoplankton bloom, Surface chlorophyll, Surface heat flux



Monitoring and detection strategies for algal blooms in the Saurashtra coast of Gujarat, India

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Algal blooms are mainly composed of autotrophic algae, though heterotrophic species may also be present at times. The incidence of these blooms in coastal waters around the world has been on the rise. Algal blooms are affected by multiple environmental factors such as nutrient concentrations, especially nitrogen and phosphorus, along with water temperature and sunlight, all of which contribute to creating favourable conditions for algal growth. A total of 75 algal bloom events were documented along India's west coast between 1916 and 2019. Among the recorded events, dinoflagellates were the most dominant bloom-forming group, responsible for 52 cases, followed by diatoms (29), cyanobacteria (24), rhodophytes (4), and haptophytes (1). Overall, algal blooms comprised approximately 58% dinoflagellates, 18% diatoms, 16% cyanobacteria, 8% raphidophytes, and 1% haptophytes. Monitoring and tracking algal blooms are a vital research focus for interpreting ecological trends, identifying indicators of climate change, and assessing potential effects on food webs, especially those related to fisheries and the management of harmful algal toxins. Furthermore, this research contributes to the development of predictive models for the occurrence and behaviour of blooms. Remote sensing technology is essential for monitoring and tracking algal blooms, as it captures spectral information, particularly in the visible and near-infrared ranges, to detect chlorophyll a, a primary indicator of algal presence. Generally, three main approaches are employed for monitoring algal blooms: (i) Field sampling, which involves collecting water samples to assess physio-chemical properties like sea surface temperature, pH, and dissolved oxygen, along with nutrient concentrations such as nitrogen and phosphorus, and productivity indicators like chlorophyll-a and primary productivity); (ii) Remote sensing techniques: which utilise ocean colour data to detect and monitor algal blooms and (iii) Citizen science initiatives, involving local fishermen in reporting algal blooms and collecting samples which strengthens both community participation and data collection efforts. A well-rounded sampling strategy that combines these approaches can support accurate reporting, real-time monitoring, and timely advisories for fishers and coastal visitors.

Keywords

Arabian Sea, Citizen science, Dinoflagellates, Field sampling, Ocean colour data, Remote sensing



Application of multi-sensor ocean colour data for understanding chlorophyll-a dynamics in the Southeastern Arabian Sea

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Chlorophyll-a (Chl-a) is a widely used proxy for phytoplankton biomass and primary productivity, and its variability reflects the influence of monsoon-driven hydrography in the Southeastern Arabian Sea. Monitoring these dynamics is challenging in optically complex coastal waters due to cloud cover and retrieval uncertainties. This study investigated seasonal Chl-a variability along the Kerala coast during 2024 using OCM-3 (EOS-6), Sentinel-3A/3B (OLCI), and the merged OC-CCI products. To address discontinuities in single-sensor datasets, data gaps in OCM-3 and OLCI were first systematically filled using OC-CCI, producing continuous gap-filled time series. These merged datasets were then used to generate monthly composites, which revealed a clear seasonal cycle: elevated Chl-a during the southwest monsoon (June-September), associated with upwelling and terrestrial inputs, and lower concentrations during the pre-monsoon (March-May). Spatial averaging within $0.4^\circ \times 0.4^\circ$ boxes distributed along the Kerala coast within the 200 m isobath revealed regional contrasts, with some sectors exhibiting stronger monsoon peaks than others, reflecting local hydrographic and terrestrial influences. Cross-validation highlighted moderate but consistent agreement among sensors. OCM-3 correlated reasonably with Sentinel-3A ($R^2 = 0.51$) and Sentinel-3B ($R^2 = 0.53$), with stronger alignment against OC-CCI ($R^2 = 0.61$). Comparisons of OC-CCI with Sentinel-3A ($R^2 = 0.59$) and Sentinel-3B ($R^2 = 0.51$) further emphasised sensor-dependent performance, with Sentinel-3B showing lower reliability in coastal waters. Overall, the merged OC-CCI product demonstrated the strongest and most stable inter-sensor consistency, confirming its dual role as a gap-filling dataset and a validation benchmark. By integrating multi-sensor datasets with systematic gap filling, this study improves temporal coverage and enhances confidence in seasonal Chl-a assessments. Importantly, the approach provides continuous, climate-quality information on coastal productivity, thereby strengthening the capacity to monitor ecosystem responses to monsoon variability and contributing to environmental resilience in tropical coastal waters

Keywords

Kerala coast, OC-CCI, OCM-3, Phytoplankton biomass, Primary productivity, Sentinel-3A/3B



Spatio-temporal distribution of chlorophyll-a associated with physicochemical parameters in Cochin and Mandapam coastal waters

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Phytoplankton, through chlorophyll-a, are central indicators of primary productivity and ecosystem health in coastal waters. Understanding their spatio-temporal variability in relation to physico-chemical parameters provides crucial insights into biogeochemical cycles, fisheries potential, and climate influences. This study investigated two contrasting coastal ecosystems of India: Cochin, along the southwest coast influenced by freshwater inflows, nutrient enrichment, and upwelling-downwelling regime; and Mandapam, on the southeast coast, influenced by tidal currents, nutrient input from aquaculture cages, and unique environmental dynamics of the Gulf of Mannar. Surface water samples were collected monthly from January to December 2024 to examine Chl-a, physico-chemical parameters, and nutrients. In coastal waters of Cochin, peak concentrations of Chl-a (8.23 mg m^{-3}) and elevated nitrate levels ($8.14 \text{ } \mu\text{mol l}^{-1}$) were observed during post-monsoon (October), when diatoms dominated the plankton community. This suggests that nutrient influx during the monsoon does not directly enhance Chl-a. Nutrient variability, particularly nitrate ($8.14 \text{ } \mu\text{mol l}^{-1}$ in October) and silicate ($12.29 \text{ } \mu\text{mol l}^{-1}$ in August), strongly influenced diatom dominance during the post-monsoon and monsoon seasons. In contrast, elevated nitrite ($0.46 \text{ } \mu\text{mol l}^{-1}$) and phosphate ($1.69 \text{ } \mu\text{mol l}^{-1}$) levels in March supported higher cyanobacterial biomass. Along the Mandapam coast, the highest Chl-a concentration (6.27 mg m^{-3}) was recorded in October, coinciding with the post-monsoon, when diatoms dominated the phytoplankton community. In contrast, the southwest monsoon (August–September) was characterised by cyanobacterial dominance, and the nutrient levels recorded were; nitrate ($5.01 \text{ } \mu\text{mol l}^{-1}$ in September), phosphate ($2.0 \text{ } \mu\text{mol l}^{-1}$ in September), and silicate ($10.35 \text{ } \mu\text{mol l}^{-1}$ in August). Unlike Cochin, these nutrient peaks did not align with diatom dominance, indicating that in Mandapam, nutrients alone do not directly regulate Chl-a concentration. PCA revealed, on an annual scale, Chl-a was more strongly associated with nitrate and nitrite, suggesting that nitrogenous nutrients were the dominant regulators of phytoplankton biomass at Cochin. In contrast, at Mandapam, Chl-a showed a closer association with temperature, while nitrate and nitrite showed negative relationship with phytoplankton biomass. These findings highlight regional contrasts in hydrographic control of phytoplankton productivity as well as community structure, emphasising the need for region-specific monitoring to predict ecosystem productivity and support sustainable fisheries management.

Keywords

Coastal productivity, Cyanobacteria, Nutrients, Plankton community, Seasonal dynamics



Surface chlorophyll-*a* dynamics in the Sri Lanka Dome: Influence of seasonal and interannual variability

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The Bay of Bengal is a highly dynamic, monsoon-driven basin where physical and biogeochemical processes vary significantly with the seasons. Among its prominent features is the Sri Lanka Dome (SLD), a region of summer upwelling and enhanced biological productivity. This study examined the seasonal and interannual variability of the SLD using satellite-derived and reanalysis datasets, with a focus on its links to climate variability and environmental resilience. During the southwest monsoon, the SLD is marked by negative sea level anomalies, shoaling of the thermocline (D26), and a shallow mixed layer, all of which promote nutrient enrichment, particularly phosphates in surface waters. These inputs support a chlorophyll-*a* bloom that peaks in August and declines by September, with a one-month lag between thermocline shoaling and bloom onset suggesting subsurface nutrient buildup is key for sustaining surface productivity. Interannual variability revealed that the strength and extent of the SLD are sensitive to Indian Ocean Dipole (IOD) events. Positive IOD phases weaken upwelling and nutrient supply, reducing productivity, while negative IOD conditions favour stronger circulation-driven inputs and higher biological response. The zonal current variability aligns with productivity changes, while meridional current shifts influence the dome's position, underscoring the sensitivity of regional ecosystems to climate forcing. Overall, the findings demonstrate that climate-driven changes in circulation and stratification directly modulate the physical structure and biogeochemical functioning of the SLD. By linking thermocline shoaling, nutrient supply, and chlorophyll dynamics with large-scale modes such as the IOD, this study provides a process-level understanding of how the SLD regulates regional productivity and highlights its importance as a key ecological hotspot within the Bay of Bengal.

Keywords

Bay of Bengal, Climate forcing, IOD, Southwest monsoon, Sri Lanka Dome, Thermocline shoaling



Impact of sea surface temperature variability on marine fishes and spawning patterns along the north Tamil Nadu coast

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Marine ecosystems are susceptible to climate variability, with sea surface temperature (SST) acting as a key regulator of fish distribution, productivity, and reproductive success. The north Tamil Nadu coast, stretching from Pulicat Lake to Point Calimere, forms part of the southeast Indian shelf and supports ecologically rich estuaries, backwaters, and highly productive fishing grounds. Seasonal rains, freshwater influx, and SST variability strongly influence fish abundance and spawning, rendering this region particularly vulnerable to climate change. This study investigated the influence of SST on fisheries and reproductive dynamics along the north Tamil Nadu coast using long-term fish landing records and field data (2020–2025) on the reproductive biology of key resources. Correlation analyses revealed significant associations between SST fluctuations and landing trends, while marked shifts in spawning phenology and extended spawning windows were observed in several commercially important species. The abundance of *Nemipterus japonicus* showed a strong correlation with cooler months and higher rainfall. The landings of *Rastrelliger kanagurta* were dominated by sub-adults, raising concerns about the sustainability of the spawning stock. The evidence from this study suggests that climate-driven changes in SST and rainfall are restructuring catch dynamics, spawning periodicity, and recruitment patterns in coastal fisheries. These findings highlight the urgent need for adaptive, climate-responsive management strategies to ensure the resilience and long-term sustainability of marine fisheries in the region.

Keywords

Climate change, Fish distribution, Recruitment patterns, Spawning stock, Sustainability



Depth-dependent stratification and spatial heterogeneity of microalgal communities in Kongsfjorden, Svalbard

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The Arctic, with its unforgiving climate and unique biodiversity, serves as a natural laboratory for studying life's adaptations to extreme conditions. Among its inhabitants, microalgae from Svalbard's Kongsfjorden hold immense promise for biotechnology, particularly as sustainable producers of high-value biomolecules. Despite their potential, the molecular mechanisms governing these cold adaptations and lipid biosynthesis in the arctic phytoplankton communities remain largely unexplored, limiting their application in health and nutrition. The study aims to isolate and characterise extremophile microalgae from Kongsfjorden, Svalbard, to unlock their potential as sustainable sources of high-value lipids for biotechnology. During the expedition, field sampling was conducted at three stations across the glacio-marine fjord system of Kongsfjorden, including sites near the Kronebreen glacier. Water samples were collected at depths of 20 m and 50 m using Niskin bottles and plankton nets, supported by CTD profiling to document environmental parameters. The multivariate analyses indicated variation in environmental parameters at two depths (20 m and 50 m) across three sampling sites in Kongsfjorden. At 20 m, higher values of temperature, oxygen, and photosynthetically active radiation (PAR) were observed, reflecting the influence of surface conditions. In contrast, samples from 50 m depth were characterised by stronger associations with pressure, density, and salinity, indicating more stable deep-water conditions. Comparatively, Site 1 exhibited higher temperature and fluorescence, while Site 2 displayed intermediate profiles, and Site 3 was found more strongly associated with turbidity and density. Together, these patterns highlight depth-related stratification as well as spatial heterogeneity within the fjord system

Keywords

Biomolecules, Community structure, Extremophile, Fjords, Multivariate analysis



Spatio-temporal dynamics and functional role of mixoplankton in shaping ecosystem resilience in the nearshore and estuarine waters of Dakshina Kannada, Southwest India

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Mixoplankton represent a diverse group of protist plankton that combine phototrophic and phagotrophic modes of nutrition. Functionally, they can be classified into two major groups: those with an innate ability to photosynthesise (constitutive mixoplankton-CM) and those which need to acquire phototrophic capabilities (non-constitutive mixoplankton-NCM). The NCM are further subdivided according to how they acquire their phototrophic potential, either by sequestering plastids from various prey types (GNCM), or by stealing photosynthetic machinery (including nuclear material) from specific prey (plastid specialists-pSNCM) or through symbiotic associations with endosymbionts (eSNCM). Understanding energy and nutrient transfer in marine ecosystems requires better quantification of mixoplankton, whose role remains poorly understood. Unlike phytoplankton, whose growth is nutrient-limited despite physiological adaptations such as reduced respiratory cost, enhanced thermal tolerance, and pH resilience, mixoplankton are predicted to evolve rapidly under changing environmental regimes. The study investigated mixoplankton dominance along with the seasonal dynamics of other plankton communities, in the nearshore and estuarine waters of Dakshina Kannada. Water quality in the estuarine stations was assessed using indicators following USEPA (2012) and APHA (1981) methodologies. Among the seven stations studied, one recorded the highest fair water quality rating of 94.12%, three showed good ratings of 5.8%, and four exhibited poor ratings ranging from 5.8% to 17.6%. Highly significant variation ($p < 0.0001$) was observed among stations for pH, salinity, total dissolved solids (TDS), and chlorophyll-*a*. Water temperature showed a significant positive correlation ($p < 0.01$) with pH, salinity, TDS, and chlorophyll-*a*, and a negative correlation with ammonia, phosphate, silicate, nitrite, and nitrate. Diatoms such as *Coscinodiscus* sp., *Skeletonema* sp. and *Thalassiosira* sp. dominated during January to April at selected stations, while the dinoflagellate *Pyrophacus* sp. dominated during January and February in the remaining stations. Mixoplanktonic dinoflagellates such as *Tripes mulleri* (CM), *Tripes azoricus* (CM), *Ornithocercus magnificus* (pSNCM) were abundant in both estuarine and coastal stations. In addition, the foraminifera *Globigerina* sp. (eSNCM) was found abundant along the estuarine stations during pre-monsoon. HAB forming mixoplankton such as *Alexandrium* sp. (CM), *Gonyaulax spinifera* (CM), *Dinophysis caudata*, and *Noctiluca scintillans* (eSNCM) were also recorded. Understanding the spatio-temporal distribution of mixoplankton alongside environmental parameters can provide valuable insights into ecosystem resilience.

Keywords

Diatoms, Dinoflagellates, Foraminifera, HAB, Phagotrophic, Phototrophic, Water quality



Influence of hydrological parameters on phytoplankton density in the coastal waters of Veraval, Gujarat

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The present study investigated the diversity and density of marine phytoplankton in relation to key abiotic factors along the coastal waters of Veraval, Gujarat, India. The research was conducted from May 2023 to April 2024, at two ecologically significant locations: Jaleshwar (Location-1) and Bhidbanjan Mandir (Location-2). Phytoplankton samples were collected monthly and associated environmental parameters (temperature, salinity, pH, and dissolved oxygen) were monitored to understand their influence on phytoplankton community structure. A total of 100 species of marine phytoplankton, belonging to six major classes, were recorded during the study period. Diatoms emerged as the dominant group accounting for 120 species followed by dinoflagellates (10 species), along with lesser representations of blue-green algae (Cyanophyceae), green algae (Chlorophyceae), and brown/orange groups (Chrysophyceae and Xanthophyceae). The dominance of diatoms indicates a nutrient-rich coastal environment favourable for primary productivity. Phytoplankton density exhibited notable seasonal variations, with the highest abundance observed in January (7,56,150 cells l⁻¹) and the lowest in March (3,40,485 cells l⁻¹). At Location 1, cell densities ranged from 4,50,395 to 7,56,150 cells l⁻¹, while at Location 2 they ranged from 3,40,485 to 7,45,565 cells l⁻¹. Statistical analysis revealed a positive correlation between phytoplankton density and both dissolved oxygen and pH, whereas temperature and salinity exhibited negative correlation with phytoplankton abundance. These findings highlight the significance of phytoplankton as bio-indicators of water quality and ecosystem health, emphasising the need for continuous monitoring amidst growing climatic and anthropogenic pressures on coastal environments.

Keywords

Coastal ecology, Hydrological parameters, Marine productivity, Phytoplankton community



Effects of coral bleaching on non-scleractinian reef organisms in the Lakshadweep atolls

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Lakshadweep, the only atoll reef formation in India, is highly threatened by recurring bleaching events caused by global climate change. In 2024, the Lakshadweep Islands experienced a severe mass coral bleaching event when the sea surface temperature (SST) peaked at 32.2°C and Degree Heating Weeks (DHW) rose to 9.2°C-weeks. Two underwater surveys were conducted using the Line Intercept Transect (LIT) method to assess the severity of bleaching and the post-bleaching response in the shallow lagoon waters of Kavaratti and Agatti in May 2024 and 2025. During the initial survey, along with scleractinian corals, several non-scleractinian corals were also observed to be affected by the bleaching event. We studied four commonly occurring non-scleractinian organisms during this period. *Radianthus magnifica* (Ritteri anemone) and *Tridacna maxima* (giant clam) were more severely impacted, and all individuals studied were observed to be in a completely bleached state. At the same time, *Heliopora coerulea* (blue coral) and *Anemonia cf. majano* (carpet anemone) showed 60% and 55% bleaching, respectively. During the second survey, after a relatively milder bleaching episode in 2025, characterised by SST exceeding the bleaching threshold but with DHW < 4 °C-weeks, bleaching was recorded only in *H. coerulea*. These findings suggest that DHW values exceeding 4°C-weeks can induce widespread bleaching in non-scleractinian corals, just as in scleractinian corals, while also underscoring species-specific thresholds and differential responses to varying intensities of thermal stress.

Keywords

Coral reefs, Degree heating weeks, Line intercept transect, Reef survey, SST, Temperature threshold



Depth-dependent stratification and spatial heterogeneity of microalgal communities in Kongsfjorden, Svalbard

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The Bay of Bengal is a highly dynamic, monsoon-driven basin where physical and biogeochemical processes vary significantly with the seasons. Among its prominent features is the Sri Lanka Dome (SLD), a region of summer upwelling and enhanced biological productivity. This study examined the seasonal and interannual variability of the SLD using satellite-derived and reanalysis datasets, with a focus on its links to climate variability and environmental resilience. During the southwest monsoon, the SLD is marked by negative sea level anomalies, shoaling of the thermocline (D26), and a shallow mixed layer, all of which promote nutrient enrichment, particularly phosphates in surface waters. These inputs support a chlorophyll-*a* bloom that peaks in August and declines by September, with a one-month lag between thermocline shoaling and bloom onset suggesting subsurface nutrient buildup is key for sustaining surface productivity. Interannual variability revealed that the strength and extent of the SLD are sensitive to Indian Ocean Dipole (IOD) events. Positive IOD phases weaken upwelling and nutrient supply, reducing productivity, while negative IOD conditions favour stronger circulation-driven inputs and higher biological response. The zonal current variability aligns with productivity changes, while meridional current shifts influence the dome's position, underscoring the sensitivity of regional ecosystems to climate forcing. Overall, the findings demonstrate that climate-driven changes in circulation and stratification directly modulate the physical structure and biogeochemical functioning of the SLD. By linking thermocline shoaling, nutrient supply, and chlorophyll dynamics with large-scale modes such as the IOD, this study provides a process-level understanding of how the SLD regulates regional productivity and highlights its importance as a key ecological hotspot within the Bay of Bengal.

Keywords

Bay of Bengal, Climate forcing, IOD, Southwest monsoon, Sri Lanka Dome, Thermocline shoaling



Hierarchical modelling of pelagic fish communities in relation to oceanographic drivers in the Indian Ocean

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Understanding the distribution of pelagic fish communities is crucial for advancing ecosystem-based fisheries management in the Indian Ocean. In this study, we applied the Hierarchical Modelling of Species Communities (HMSC) framework to jointly model the occurrence patterns of six commercially important pelagic fish species: *Trichiurus lepturus*, *Decapterus russelli*, *Sardinella fimbriata*, *Stolephorus indicus*, *Rastrelliger kanagurta*, and *Sardinella longiceps*, within India's Exclusive Economic Zone (EEZ) of the Indian Ocean. The model incorporated key oceanographic predictors, including net primary productivity (NPPv), mixed layer depth (MLD), sea surface temperature (SST), pH, dissolved oxygen (DO), chlorophyll-a concentration (CHL), and sea surface salinity (SSS), together with random effects to account for spatial structure and potential phylogenetic influences. Model inference was obtained through Markov Chain Monte Carlo (MCMC) sampling, and predictive performance was assessed using cross-validation. Results demonstrated that species-specific responses to environmental gradients, coupled with interspecific associations, jointly shape pelagic fish community structure. This study underscores the value of HMSC in disentangling the combined effects of environment, space, and species interactions on marine fish distributions

Keywords

Climate change, Environmental gradients, HMSC, Oceanographic predictors, Predictive performance



Interannual variability of tuna habitats along the east coast of India in relation to climatic and oceanographic parameters

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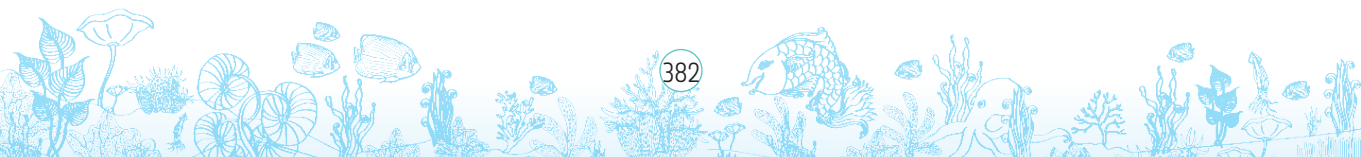
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This study investigated the interannual variability of tuna habitat along the east coast of India during 2015–2022, with particular emphasis on climatic and oceanographic parameters. Tuna fishing locations were collected from fishermen of Pudimadaka, Andhra Pradesh using log sheets. Tuna occurrence records were analysed in relation to sea surface temperature (SST), subsurface temperature, dissolved oxygen (DO) in depth layers, chlorophyll-a (Chl-a), and mixed layer depth (MLD), derived from satellite and reanalysis datasets. The analysis revealed clear year-to-year shifts in tuna distribution, strongly influenced by thermal structure, oxygen availability, and water column stratification. Higher habitat suitability was associated with favourable productivity and moderate vertical profiles of temperature and oxygen, whereas anomalous oceanographic conditions, including warming and deepening of the mixed layer, corresponded with displacement of suitable habitats. These findings highlight the sensitivity of tuna in the Bay of Bengal to both surface and subsurface oceanographic variability, underscoring the importance of integrating climate drivers into fisheries management and adaptation strategies under future ocean change scenarios.

Keywords

Bay of Bengal, Climate drivers, Habitat suitability, Skipjack tuna, Yellowfin tuna



ENSO phases and their impact on the fish community composition and trophic structure in the coastal waters off Kochi, in the Southeastern Arabian Sea

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Climate change, coupled with the ongoing warming of oceans, have prominent influence on the diversity and distribution of marine organisms globally. In this context, the present study investigated the influence of El Niño Southern Oscillation (ENSO) phases on fish community composition and trophic structure in the coastal waters of Kochi, southeastern Arabian Sea. Monthly trawl surveys were conducted during the post-monsoon periods (October–January) across shallow and deeper coastal waters to evaluate the spatio-temporal variations in the fish diversity during a weak La Niña and a weak El Niño phase. The results revealed distinct patterns in fish community structure, habitat preference, and trophic organization between the two periods. Fish diversity was higher during weak El Niño phase compared to the weak La Niña phase. A shift in habitat preference was also observed, with demersal species prevailing during the La Niña phase and pelagic species during the El Niño phase. Trophic level assessment classified fishes across five levels (TrL I–VI) in both years, but the weak El Niño phase supported higher abundance of planktivores and species of mid-to-higher trophic levels. Variations in the intensity of the Oceanic Niño Index (ONI) prior to the sampling periods had a significant influence on ichthyofaunal diversity and trophic composition. The results suggest that both the prevailing ENSO conditions and the preceding hydrographic scenarios strongly affect growth, recruitment success, habitat use, and trophic interactions within the fish community

Keywords

Demersal, El Niño, Fish diversity, La Niña, Pelagic, Planktivores, Trophic levels



Climate change and marine fish phenology in the Indian Ocean: A systematic synthesis

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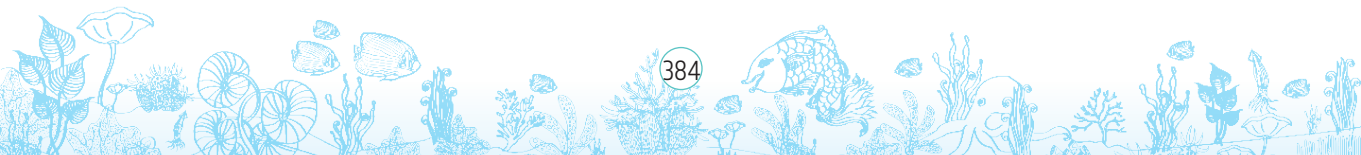
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Climate change is reshaping the timing of life-history events in marine fishes, yet evidence from the Indian Ocean is scattered across taxa and sub-regions. We conducted a systematic synthesis (2005–2025) of peer-reviewed studies and assessments on phenological responses covering spawning/maturity timing, migration, recruitment windows and size/age at maturity covering small pelagics (oil sardine and mackerel), demersal fish (threadfin breams), tunas (skipjack, yellowfin and albacore), anadromous clupeids (hilsa) and planktonic baselines. Across studies, warming sea surface temperatures, monsoon weakening or shifts and basin-scale modes (ENSO, IOD), aided by thermal stratification, deoxygenation and acidification were found consistently related to: (i) seasonal shifting of spawning toward cooler months; (ii) delays or poleward/depthward shifts in migration; (iii) trophic mismatches between plankton blooms and larval windows; and (iv) altered size-at-maturity and recruitment variability. The evidences are strongest for western/central sub-basins and species of commercial value; while time series are sparse for the eastern Indian Ocean and for early life stages. Modelling studies consistently projected poleward/deeper redistribution and mid-century biomass declines for tropical tunas under high-emission scenarios. These phenological disruptions alters the timing and geography of fish availability to fleets, challenge seasonal closures and redistribute benefits among EEZs, with serious implications for livelihoods and food security. Through this synthesis we highlight critical gaps in standardised phenology monitoring, larval/egg time series, east-coast coverage and mechanistic links from phenology to population dynamics and propose a regional agenda integrating long-term observations, habitat/food-web models and adaptive harvest calendars. Consolidated evidence from the Indian Ocean identifies the regions and species where phenological shifts are already occurring and highlights priority areas for management interventions.

Keywords

Adaptive fisheries, ENSO, IOD, Seasonal closures, Spawning shift



Climate change responses in tropical finfishes: A meta-analysis for climate-smart mariculture

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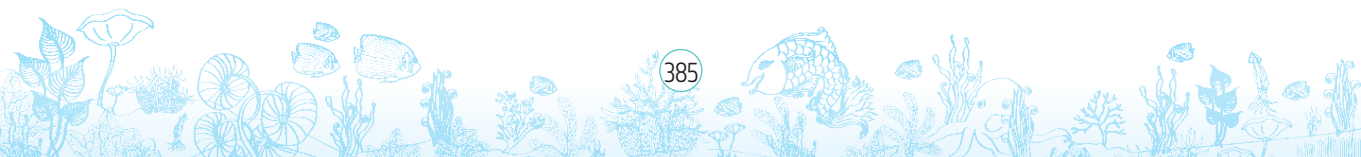
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A systematic review and synthesis of 77 peer-reviewed articles (2010–2020) on tropical finfish were conducted to understand their climate-related responses with implications for mariculture, with data extracted on study type, stressor variables, organismal taxa, and measured response parameters to generate quantitative trends and identify research gaps. The majority of studies were experimental (88.3%), followed by field investigations (3.9%) and other approaches (7.8%). The most frequently assessed parameters were ocean acidification (79.2%), temperature/warming (66.2%), behaviour (77.9%), growth/condition (71.4%), survival/mortality (46.8%), along with studies addressing metabolism (20.8%), reproduction (18.2%), otolith development (11.7%), hypoxia/oxygen limitation (11.7%), and range shifts (5.2%). Model organisms were largely coral reef-associated species, with repeated focus on *Acanthochromis polyacanthus*, *Pomacentrus amboinensis*, and *Amphiprion percula*, while mariculture-relevant taxa such as *Lates*, *Seriola*, *Rachycentron*, and *Hippocampus* also featured. The synthesis highlights that combined warming and acidification most consistently depress early-life performance (growth/survival) and alter anti-predator behaviour. Behavioural disruptions under high CO₂ were consistently reported across taxa, warranting hatchery screening and conditioning. Thermal stress and oxygen limitation jointly constrain physiological performance, highlighting the importance of selective breeding for heat tolerance and maintaining high dissolved oxygen. Limited but promising evidence for parental or early-life conditioning suggests potential for assisted acclimation. Responses were strongly species- and life stage-specific, underlining the importance of targeted research for candidate mariculture species. Collectively, this body of work provides key insights to shape climate-smart mariculture strategies in tropical regions, emphasizing that selective breeding for thermal and dissolved oxygen robustness, carbonate-system management (alkalinity control) to buffer pH, early-life protection and behaviour-informed husbandry, integration of multi-trophic aquaculture, and forecast-guided operations during seasonal heat or low-oxygen risk are critical components

Keywords

Coral reef-associated species, Hypoxia, Ocean acidification, Systematic review, Tropical regions, Warming



Thermal tolerance of ornate goby *Istigobius ornatus* acclimated to four temperatures

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Ornamental aquaculture is an important commercial activity and is one of the most popular hobbies globally. Many valuable marine ornamental fish species inhabit the ecologically sensitive coral reef ecosystems of tropical and subtropical regions, which have experienced episodes of elevated sea surface temperatures in recent years. Despite this, research on the thermal tolerance of marine ornamental species remains limited. Recently, the ICAR–Central Marine Fisheries Research Institute (ICAR-CMFRI) successfully standardised the captive seed production of a new marine ornamental fish species, the ornate goby *Istigobius ornatus*. Understanding the thermal tolerance and acclimation responses of such species is crucial for ensuring sustainable aquaculture, evaluating their adaptability to new geographical regions, and assessing their vulnerability to climate change. Therefore, a thermal tolerance study was conducted using hatchery-produced *I. ornatus*. Critical thermal maximum (CTMax) was estimated following acclimation to four temperature regimes: $24 \pm 0.5^\circ\text{C}$, $27 \pm 0.5^\circ\text{C}$, $30 \pm 0.5^\circ\text{C}$, and $33 \pm 0.5^\circ\text{C}$ for a period of 30 days. A total of 24 fish (mean total length, 46.2 ± 1.9 mm; mean body weight, 1.18 ± 0.15 g) were randomly distributed to twelve thermostatically controlled 50 L tanks, maintained at the four treatment temperatures in triplicate using heaters, chillers, and thermostats. At the end of the acclimation period, fish from each group were individually transferred to 50 L glass tanks and left undisturbed for 3 h to alleviate handling stress. Each fish was then subjected to a constant rate of temperature increase ($0.5^\circ\text{C min}^{-1}$) until loss of equilibrium (LOE). The CTMax values of *I. ornatus* were found to increase significantly ($p < 0.05$) with acclimation temperature. The CTMax of *I. ornatus* was $39.5 \pm 0.26^\circ\text{C}$, $40.28 \pm 0.17^\circ\text{C}$, $41.2 \pm 0.137^\circ\text{C}$ and $43.22 \pm 0.165^\circ\text{C}$ at $24 \pm 0.5^\circ\text{C}$, $27 \pm 0.5^\circ\text{C}$, $30 \pm 0.5^\circ\text{C}$ and $33 \pm 0.5^\circ\text{C}$ respectively. These findings suggest that *I. ornatus* exhibits a high capacity for thermal acclimation and is a promising marine ornamental species for aquaculture in tropical regions

Keywords

Acclimation responses, Critical temperature maximum, Loss of equilibrium, Marine ornamental fish



From embryos to adults: How temperature influence the different life stages and thermal tolerance of marine medaka *Oryzias dancena*

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The Indian rice fish *Oryzias dancena* was selected as a model to decipher the effect of temperature on the different life stages of a marine teleost. Eggs were collected from broodstock (0.6-0.9 g) reared in 300 L aquarium (30 ppt). Newly spawned eggs ($n=72$) were incubated in 500 ml plastic containers placed within thermostatic tanks (50 l) and maintained at four constant temperatures: $24\pm0.5^{\circ}\text{C}$, $27\pm0.5^{\circ}\text{C}$, $30\pm0.5^{\circ}\text{C}$ and $33\pm0.5^{\circ}\text{C}$ (in triplicates). The embryonic development was recorded at 24 h intervals at different temperatures for a period of 9 to 23 days. The hatched larvae from each of these treatments were pooled together based on days post-hatch (DPH) and growth as well as survival of the larvae were evaluated at 10, 20, 30, 60 DPH in triplicates. Reproductive parameters such as age, size of broodfish at first spawning, fecundity, egg diameter and inter-spawning intervals were also studied. The critical thermal maxima (CT_{max}) were studied using fish reared from embryos in the four thermostatic environments ($n=6$). Relative to 24°C , higher incubation temperatures significantly ($p<0.05$) shortened the duration of the embryonic period (by 60%, 40%, and 11% at 33°C , 30°C , and 27°C , respectively) and reduced the age at first reproduction (by 27%, 20%, and 9% at 33°C , 30°C , and 27°C respectively). Despite lower age, the size at first spawning was greater at higher temperatures ($p>0.05$). Fecundity at different temperatures ranged between 4.6-7.6 per fish per spawning. Significantly higher ($p<0.05$) growth rate was observed at higher temperatures. The CT_{max} showed significant increase ($p<0.05$) in fish reared at higher temperatures. These findings demonstrate that thermal environments exert a significant influence on developmental, growth, and reproductive parameters across the different life stages of *O. dancena*, and significantly impact the thermal tolerance capacity of the species

Keywords

Embryonic development, Fecundity, Larvae, Reproduction, Rice fish, Spawning



Effect of water temperature and phosphorous levels on growth, nutritive profile and quality of the marine microalga *Isochrysis galbana*

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Marine microalgae are important live feed for larval fish, crustaceans, and bivalves owing to their small size, high digestibility, and rich nutrient profile. *Isochrysis galbana*, a haptophycean flagellate, is particularly valued for its high levels of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), making it suitable for aquaculture and as a sustainable alternative to fish oil. This study investigated the combined influence of temperature (22°C and 30°C) and phosphorus concentrations (40, 60, 80 mg l⁻¹) on the growth, pigment content, proximate composition, and fatty acid profile of *I. galbana* in indoor cultures using a 2×3 factorial design. Cultures were grown in modified Walne's medium under controlled aeration and light (2000 Lux; 8:16 h light:dark) for 10 days, and analysed for growth performance, pigment levels, nutrient composition, fatty acids, and fatty acid quality indices. The highest cell density (14.85±0.51 million cells ml⁻¹), specific growth rate (0.27±0.008 μ max day⁻¹), and biomass yield (0.035±0.00153 gDW l⁻¹) occurred at 30°C with 60 mg l⁻¹ phosphorus (HT/P60). Ferric chloride flocculation achieved >90% biomass recovery at ≥0.3%, with regression analysis identifying 0.47% as the optimum dosage for harvesting. Pigment concentrations (chlorophyll a, b, total carotenoids, total pigments) peaked in HT/P60, except chlorophyll b, which was highest in LT/P60. Lipid content was greatest in HT/P40 (15.12 ± 0.43%), while protein and ash contents remained unaffected. The EPA (5.11±0.06%), DHA (10.45±0.14%), polyunsaturated fatty acids (PUFA; 31.91±0.71%), and total unsaturated fatty acids (UFA; 56.23±0.47%) were highest at 22°C with 60 mg l⁻¹ phosphorus (LT/P60), which also yielded the most favourable fatty acid quality indices such as hypocholesterolemic, atherogenic and thrombogenic indices. Higher water temperature (30°C) with moderate phosphorus (60 mg l⁻¹) was found to support maximum biomass production, whereas lower temperature (22°C) with moderate phosphorus enhanced PUFA and fatty acid quality. These findings provide insights into optimising *I. galbana* culture for aquaculture and nutraceutical applications, particularly under changing climatic conditions and for sustainable PUFA and long-chain n-3 fatty acids production without competing for arable land.

Keywords

Chlorophyll, Docosahexaenoic acid, Eicosapentaenoic acid, Fatty acid quality indices, Marine flagellates, Specific growth rate



Study to assess the impact of higher temperature on seaweed *Ulva fasciata*

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Ulva fasciata is an economically important native edible green seaweed which is distributed along the coastal areas of south Tamil Nadu. It has been gaining significant interest due to its potential for use in animal feed, human food, medicinal value, bioactive compounds, biofuel and also in wastewater bioremediation. It is an edible seaweed and is also used as a bait for fishing. *Ulva fasciata* is considered a strong candidate for tank-based cultivation due to its fast growth rate, high nutrient uptake capabilities, robust nature, and suitability for high stocking densities. These characteristics make it ideal for large-scale aquaculture. The present study was carried out to assess the impacts of higher temperatures on the growth and spore formation in *U. fasciata*. The seaweed was grown in two sets of FRP tanks of 300 L capacity, holding seawater of 35 ppt salinity. In the treatment group, water temperature was raised to 30°C using thermostat controlled submersible heaters and in the control group, ambient temperature (28°C) was maintained. The seaweeds maintained at ambient temperature (28°C) showed better growth performance than the group maintained at higher temperature (30°C). Spore formation of *U. fasciata* was observed only at 28°C. The thallus structure of *U. fasciata* was shrunken in treatment (30°C) whereas thallus structure was normal in control (28°C). Results of the present study indicated that higher temperature imparts adverse impact on growth and spore formation in *U. fasciata*. Further research is needed to identify potential strategies for mitigating the negative effects of warming on this valuable marine resource

Keywords

Green seaweed, Growth assessment, Spore formation, Tank-based cultivation, Thallus structure



Polymorphic transformations and elemental dynamics in *Purpura bufo* shells: Indicators of environmental variability and ocean carbon chemistry

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Molluscan shells are primarily composed of calcium carbonate, and these structures play a critical role in the protection of the organism. These biogenic structures are highly sensitive to changes in environmental conditions and can act as indicators of ecological variability. In this study, three various size classes of *Purpura bufo* were used for understanding the elemental composition (ICP-MS), functional properties (ATR-FTIR), thermal stability (TGA), and crystalline structure (XRD) during the growth phase. The elemental composition revealed that calcium is the predominant element in the shell matrix from 175606.9 - 269036.9 ppb, followed by Sodium (150.065 - 231.165 ppb), Magnesium (61.1 - 89.605 ppb), and trace elements Strontium (1433.67 - 2199.275 ppb), along with other minor elements detected in varying concentrations across the three size classes. Functional groups such as C-O (indicative of aragonite and calcite), CH₃ (organic matrix components), and C-H (organic compounds) were observed. TGA showed weight loss at ~270 °C (organic matrix/moisture) and ~47% loss above 650 °C, indicating the thermal decomposition of calcium carbonate to calcium oxide and carbon dioxide. CaCO₃ polymorphs were identified using XRD. They are Aragonite and calcite, of which aragonite is the major distributed polymorph among the three size classes of the shell. The calcite is mainly found in the large shells of *P. bufo*. These results demonstrate growth-dependent variations in composition and polymorph distribution of CaCO₃, providing a baseline for future studies on ocean carbon chemistry

Keywords

Biomineralisation, CaCO₃, Molluscan shell, Ocean acidification



Adaptations in molluscan shell architecture: A Micro-CT study of climate resilience

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Marine molluscs are key ecosystem engineers, with their shells providing not only structural protection and ecological function, but also valuable geochemical records of past and present environmental conditions. Their shell formation, controlled through species-specific biomineralisation pathways, is highly responsive to changes in ocean carbonate chemistry and temperature making them important biological indicators of climate resilience. This study utilised high resolution micro-computed tomography (micro-CT) to analyse shell microarchitecture across four molluscan classes including Polyplacophora, Gastropoda, Bivalvia, and Cephalopoda. Key shell parameters such as shell mineral density (SMD), microstructural layer thickness, calcified shell volume, and porosity were quantified across three anatomical shell regions (apical, medial, posterior) and three ontogenetic stages (juvenile, sub-adult, adult). Class and region specific differences in shell architecture were evident. Polyplacophorans and gastropods exhibited consistently high SMD, particularly in the posterior region, suggesting a mineral based strategy for maintaining mechanical strength under environmental stress. In contrast, bivalves and cephalopods displayed greater variability in SMD, indicating a more plastic or adaptable biomineralization response. Juvenile shells showed the highest closed porosity, which declined with maturity as shell layers compacted and thickened. Notably, adult gastropods and cephalopods demonstrated significant increases in both shell volume and microstructural layer thickness, enhancing overall shell robustness during growth. These findings highlight the diverse resilience strategies employed by molluscan taxa ranging from increased mineral density to architectural reinforcement to cope with environmental variability. The application of micro-CT offers a non-destructive and quantitative approach to understanding how molluscs modulate their shell structures in response to shifts in ocean carbonate chemistry. As such, molluscan shells represent promising biological archives for assessing climate related impacts on marine ecosystems

Keywords

Biomineralisation, Carbonate chemistry, Climate resilience, Geochemical records



Socio-ecological perspectives on climate change, adaptation, and mitigation among marine fishing communities in coastal Karnataka

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Climate change poses serious risks to India's coastal ecosystems and livelihoods, with marine fishing communities highly vulnerable due to their reliance on climate-sensitive resources. Examining fishers' perceptions of climate impacts, adaptation pathways, and mitigation measures is important for assessing their vulnerabilities, identifying locally relevant strategies, and designing policies that strengthen resilience in climate-sensitive coastal communities. The present study done along Karnataka's Karavali coast using an ex-post facto survey of 312 respondents from Dakshina Kannada, Udupi, and Uttara Kannada districts show high awareness, with 94% reporting observable climate changes and concern over hazards such as shoreline erosion, cyclones, and heat waves. Reported impacts included asset losses and an average reduction of 28 fishing days annually. Adaptation strategies emphasised mangrove conservation, saving, changing fishing locations, and indigenous knowledge, while capacity-building and livelihood diversification were identified as priorities. Mitigation was seen as a medium priority, with support for renewable energy (solar panels, 88.8%) and cleaner fuels (LPG, 43.3%), though structural measures like fleet restrictions received little backing. Institutional responses were rated weak except for weather communication. The findings highlight the need for participatory, locally relevant policies that blend ecological restoration, livelihood diversification, and disaster preparedness with stronger institutional support to build resilience among Karnataka's marine fishing communities.

Keywords

Capacity-building, Coastal community, Ex-post facto survey, Livelihood diversification, Mangrove conservation



Effect of climate change on variability of rainfall in coastal Kerala

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Climate is a complex system governed by multiple variables such as rainfall, temperature, atmospheric pressure, and humidity. The impacts of global warming have brought about notable shifts in climate patterns worldwide. As a result, studying long-term changes in climatic variables has become crucial for detecting and understanding climate change. The study was carried out in Ernakulam District in the central part of Kerala (9°57' N; 10°19' N and 76°12' E; 76°36' E), which lies in the "Humid Tropical Agro-Climatic Zone" of India. Ernakulam District, covers an area of about 3,068 sq. km and has a coastline of approximately 46 km along the Arabian Sea. Recent research indicates that global climate shifts can alter rainfall patterns, influencing water availability, increasing the risk of floods and droughts, as well as affecting fisheries along with other dependent sectors. With this in view, the rainfall data of Ernakulam District was analysed, with emphasis on the long-term annual rainfall, rainfall for different months, and normal seasonal rainfall across winter (January-February), pre-monsoon (March-April-May), monsoon (June-July-August-September) and post-monsoon (October-November-December) seasons. The meteorological data were collected from IMD and were processed at decadal (ten years) and annual scales. The long-term variability of rainfall for the Ernakulam District was studied by evaluating the mean and coefficient of variation on monthly, seasonal and annual timescales. Different approaches were applied to monthly and seasonal climatic data to assess variability and to identify trends during the periods 1995-2005, 2005-2015, and 2016-2024. The climate of Ernakulam is warm and humid throughout the year, with heavy rainfall during the southwest monsoon season from June to September. The summers are hot and humid, with maximum temperatures in March and April, while December and January are relatively cooler and more pleasant

Keywords

Climate change, Decadal and annual scales, Global warming, Rainfall variability



Coastal pollution studies in India: Knowledge gaps and the need for integrated approaches

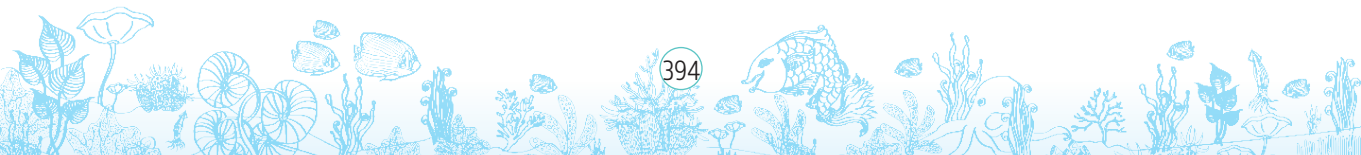
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Coastal systems provide vital ecosystem services and are central to achieving Sustainable Development Goal (SDG) 14: Life Below Water. India's diverse and economically important coastline, however, faces increasing pressures from emerging pollutants, compounded by climate-driven threats. This study systematically reviewed peer-reviewed literature published between 1990 and 2023 in the Web of Science and Scopus databases to identify threats, assess impacts on marine biota, and evaluate technological advances in coastal pollution studies. In total, 219 threats were documented and classified following the International Union for Conservation of Nature (IUCN) framework. The majority of threats ($n = 107$) were categorised under Pollution. Within this, Industrial and Military Effluents were most frequently reported ($n = 51$), largely involving heavy metals, petrochemicals, fertilizers, and pigments. Agricultural and Forestry Effluents accounted for 13 threats, primarily linked to nutrient enrichment, herbicides, and pesticides. Heavy metal contamination was the most common pollution type, followed by marine litter and microplastics. In contrast, relatively few studies addressed climate-related drivers, emerging contaminants, or the combined "cocktail effects" of multiple pollutants on coastal biota. Traditional monitoring approaches, such as field surveys and routine chemical analyses, continue to dominate coastal pollution studies, while only a limited number of investigations have adopted advanced methods. Future research should focus on the application of emerging tools including remote sensing, high-resolution chemical analyses, genomic approaches and AI/ML-based platforms to enhance the detection, prediction, and management of coastal pollution. This review highlights the urgent need for holistic frameworks that combine ecological indicators with advanced analytical and computational tools to strengthen coastal monitoring and management

Keywords

Climate change, Coastal threats, eDNA, Integrated approach, Remote sensing



Marine conservation under climate stress: Socio-economic and perceptual drivers in Indian fishing communities

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Climate change, coupled with escalating human pressures, threatens the sustainability of marine capture fisheries, emphasising the need for adaptive, inclusive management strategies. This study used a random sample of 103 fishers operating motorised and mechanised vessels in Ernakulam, Kerala state in India to examine the socio-economic, cognitive, and policy dimensions influencing sustainable fisheries. Demographic data were integrated with perceptions of biodiversity conservation, marine protected areas (MPAs), and climate change to assess stakeholder views on governance and policy effectiveness. The results indicate an average daily fishing effort of 3.8 h, with fishing grounds located approximately 133 km offshore, yielding a mean annual income of ₹161000 per fisherman. Nearly all participants (~100) relied primarily on fishing as their livelihood, yet only around 40% perceived economic activities as conflicting with conservation goals. A notable 85% of respondents perceived that conservation efforts have diminished in recent years. Overfishing (73.8%), habitat destruction (59.2%), pollution (70.1%), and climate change (80.6%) were cited as the foremost threats to marine ecosystems. All participants observed climate-driven changes in fish populations, most often linked to rising sea surface temperature (78.6%), coral bleaching (100%), sea-level rise (67%) and ocean acidification (54.4%). Lack of community-level awareness regarding biodiversity conservation was identified as a significant impediment to sustainable resource management. To address these challenges, the study findings highlight the need for adoption of community-based conservation initiatives and the integration of technological innovations into fisheries management practices. Although many fishers acknowledged the benefits of MPAs, only 15% of respondents expressed strong support for their expansion, signalling an urgent need for enhanced stakeholder engagement and targeted educational interventions to strengthen conservation outcomes

Keywords

Biodiversity conservation, Climate change, Community-based conservation, Socio-economic profile, Sustainable fisheries



Decoding mussel heartbeats: Electrophysiological insights into cadmium and acidification stress in *Perna viridis* L.

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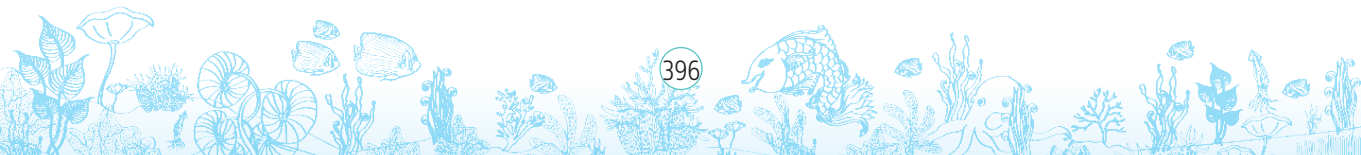
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Marine ecosystems are increasingly subjected to multiple anthropogenic stressors, including land runoff, ocean acidification, and heavy metal contamination, which compromise the health and resilience of ecologically essential bivalves. Among these, the Asian green mussel (*Perna viridis* L., 1758) is not only a keystone species in coastal ecosystems but also of high economic value in aquaculture. Understanding its physiological stress responses is therefore critical for predicting the impacts of environmental change and safeguarding shellfish resources. This study employed extracellular electrophysiological recordings to evaluate the interactive effects of cadmium (Cd) and pH perturbations on cardiac activity in *P. viridis*. Specimens (69–84 mm valve length) were acclimatised under controlled laboratory conditions, with salinity maintained at 28.2 ppt following APHA guidelines. Silver wire electrodes were surgically implanted near the posterior hinge to monitor cardiac rhythms using a differential amplifier system: AC/DC differential amplifier, extracellular A-M System, Inc., USA and PowerLab AD Instrument, Australia. Baseline heart rates ranged between 18 and 28.5 beats min^{-1} , with signal quality optimised at ~ 1 mm electrode depth. Experimental trials across four distinct pH regimes (4.5, 5.5, 6.5, and 7.5), in combination with cadmium exposure, revealed significant deviations in heart rate and rhythm, demonstrating that cardiac physiology in *P. viridis* is highly sensitive to combined chemical and acidification stressors. These findings underscore the utility of electrophysiology as a powerful biomonitoring tool for detecting early, sub-lethal stress responses in marine bivalves. By linking organismal physiology to environmental stressors, this approach provides valuable mechanistic insights into the vulnerability of aquaculture species under scenarios of climate change and coastal pollution, with direct implications for ecosystem management and sustainable fisheries.

Keywords

Cardiac physiology, Electrophysiology, Green mussel, Heavy metal contamination, Ocean acidification



Impact of cadmium on physiological and cellular responses in silver pompano *Trachinotus blochii*

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The silver pompano, being a euryhaline species is suitable for farming in brackish and marine environments and can get exposed to heavy metal toxicity during farming or in the wild environment. Studies on assessment of toxicological responses of this species to cadmium toxicity is scanty and hence the present study was taken up where in both acute toxicity as well as chronic toxicity was evaluated. After preliminary range finding assay, the 96 h LC_{50} was determined (33.5 ppm) by following standard protocols. A sublethal concentration of 3.35 ppm (one-tenth of LC_{50}) was used for chronic exposure studies for a period of 45 days. Periodical sampling was carried out during the chronic exposure from treatment group and control group to study the changes in growth, histopathology, scanning electron microscopy (SEM) and serum factors. The study revealed that growth was not significantly affected due to the sublethal level exposure of Cd, whereas changes were noticed in histopathology, SEM and serum factors of the fishes exposed to Cd, in comparison to that of control group. The histopathology of liver, kidney and gills showed progressive structural damage in all treatment groups. In case of liver, moderate to severe fatty changes and necrosis were observed initially, which intensified later on with the addition of vascular congestion, indicating circulatory disturbances possibly due to metal-induced oxidative stress. The changes in kidney include mononuclear cell infiltration, tubular necrosis, degeneration of proximal convoluted tubules, and enlargement of melano-macrophage centres. The gills of Cd exposed fishes showed structural modifications such as hypertrophy of the medullary cavity, severe necrosis, and clubbing of secondary lamellae. The SEM study of the gills revealed damages to the gill epithelial cells, fusion of secondary lamellae, folding of lamellae, reduced micro ridges, and chloride cell modifications. Quantitative SEM analysis showed reduced distance between secondary lamellae and decreased lamellar width in cadmium-treated fish. The average distance between secondary lamellae in treatment and control group was 21.77 μ m and 15.57 μ m respectively and the average lamellar width in treatment and control group was 4.03 μ m and 2.50 μ m respectively. The closer spacing between lamellae suggests tendency for lamellar fusion, a defence mechanism commonly observed in fish exposed to irritants or pollutants. The serum analysis of the Cd exposed fishes showed elevated levels of total proteins, albumin:globulin ratio and reduction in serum glutamic oxaloacetic transaminase (SGOT/AST) and serum glutamic pyruvic transaminase (SGPT/ALT).

Keywords

Cadmium toxicity, Histopathology, Mariculture, SEM, Serum factors, Sublethal concentration



Lead-induced oxidative stress and physiological impairment in fish: Implications for coastal ecosystem health

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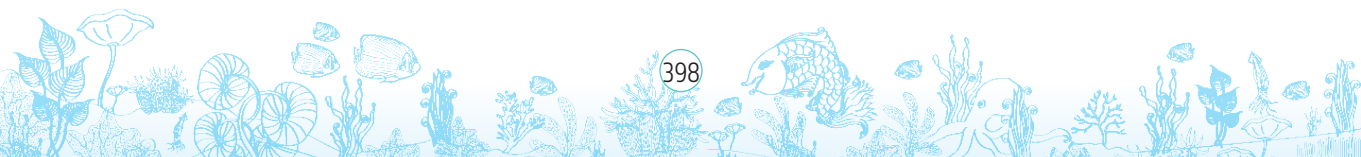
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Heavy metal contamination has emerged as a critical threat to marine and coastal ecosystems, especially in rapidly industrialising regions. India, the world's third-largest fish producer and second-largest aquaculture producer, is experiencing rising metal inputs into its coastal waters, posing risks to biodiversity, fisheries productivity, and food security. Lead (Pb), a non-essential and persistent heavy metal, readily bioaccumulates in aquatic organisms and is known to induce oxidative stress and physiological dysfunction. This study aimed to evaluate the toxicological effects of environmentally relevant concentrations (ERC) of Pb, obtained from published data from the Nellore coast (Andhra Pradesh, India), on the liver, gill, and muscle tissues of fish to assess its sublethal impacts on fish health. Molly fish (*Poecilia spheonops*, $n \approx 200$) were acclimated for 15 days and then exposed under controlled laboratory conditions. Acute exposure (96 h) included Pb at 0.648, 1.458, and 3.2805 mg l⁻¹, while sub-acute exposure (21 d) included 0.324, 0.648, and 1.296 mg l⁻¹. Behavioural responses were recorded during the exposure period, and post-exposure, tissues were analysed for oxidative stress biomarkers including superoxide dismutase (SOD), glutathione peroxidase (GPx), lipid peroxidation (LPO), and total protein content. Pb exposure caused significant ($p < 0.05$) alterations in SOD, GPx, LPO, and protein levels compared to controls, along with pronounced behavioural abnormalities. These effects were evident even at low Pb concentrations, indicating impaired antioxidant defense, cellular damage, and physiological stress. The findings underscore the urgent need for stricter industrial effluent regulation and continuous monitoring of coastal waters to safeguard fish health and marine biodiversity.

Keywords

Antioxidant enzymes, Heavy metals, Lead toxicity, Marine pollution, Oxidative stress



Radiological footprints in coastal diets: A case study from the Kollam high background radiation area

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This study investigated the presence of natural radionuclides in edible fish species from the Kollam coast of Kerala, India, an area known for its high background natural radiation (HBNRA). As a significant fishery resource supporting local livelihoods and nutrition, the coastal ecological sensitivity raises important concerns about the potential accumulation of radionuclides in aquatic food webs. Previous research has indicated both natural geogenic contributions and anthropogenic influences as sources of radioactive contamination in such environments, with implications for long-term human health risks through dietary exposure. The collected fish specimens were oven-dried, ground, and homogenised for the determination of naturally occurring radionuclides: Uranium-238 (^{238}U), Thorium-232 (^{232}Th), Polonium-210 (^{210}Po), and Lead-210 (^{210}Pb). Radiochemical separation and deposition techniques were employed, followed by alpha spectrometric analysis to ensure precise quantification. Quality control measures and standardised protocols were followed throughout the analytical process. To evaluate health impacts, radiological risk indices such as the annual effective dose (AED), ingestion dose, and hazard indices were calculated and interpreted against international radiological safety benchmarks. The results indicated marked differences in radionuclide accumulation between pelagic and demersal fish species. Demersal species, inhabiting sediment-rich environments, exhibited higher concentrations of ^{238}U and ^{232}Th , likely due to direct interaction with sediment-bound radionuclides. In contrast, pelagic species demonstrated elevated levels of ^{210}Po and ^{210}Pb , reflecting bioaccumulation through dietary intake and trophic dynamics. The estimated AED for adult consumers of these fish remained within permissible international limits. However, demersal fish posed relatively higher potential health risks due to their higher radionuclide burden. Despite these differences, overall radiological hazard indices did not exceed recommended safety thresholds. The findings establish a valuable radiological baseline for edible fish in the HBNRA and suggest that, under current conditions, fish consumption does not present significant health hazards. Nonetheless, the study underscores the need for species-specific and continuous biomonitoring, especially in ecologically vulnerable and high natural radiation areas. Such monitoring is crucial for supporting sustainable fisheries management and ensuring the long-term health safety of local communities dependent on aquatic resources.

Keywords

Edible fishes, Health risk assessment, Kollam coast, Natural radioactivity, Radionuclides



Behavioral studies of *Dotilla blanfordi* Alcock, 1900 with special emphasis on sunlight-driven distribution and phototactic response

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This study investigated the ecological dynamics of the *Dotilla blanfordi* Alcock, 1900, a prominent burrowing species inhabiting the intertidal mudflats along the Gujarat coastline, India. Conducted at Dandi Beach from December 2024 to March 2025, the research addressed the limited understanding of this species' burrowing behaviour, time budgeting, and responses to environmental stimuli in Indian coastal systems. The primary objectives were to examine burrow distribution and architecture, analyse time allocation across behavioural activities, and assess phototactic responses to sunlight direction. Methodology included extensive field surveys using three transects perpendicular to the shoreline, with 0.25 m² quadrats placed at 10 m intervals to count burrows and measure opening diameters. Burrow architecture was studied through 33 casts created with unsaturated resin, cobalt, and catalyst, later excavated and categorised into J-shaped, Single Tube (ST), U-shaped Double Opening (UDO), and bulb-shaped forms, with ST being most common. Temperature and moisture profiles at varying depths revealed increasing moisture with depth, creating favourable microenvironments. Behavioural observations were conducted by video-recording 18 randomly selected crabs for 15 minutes each, categorising activities into feeding, walking, standing, fighting, burrow use, and courtship. Phototactic responses were tested by manipulating sunlight direction with mirrors and cardboard sheets. Results showed that burrow density was highest in the mid-intertidal zone, where conditions were optimal. Burrow architecture correlated with carapace size, with larger crabs constructing wider entrances. Activity analysis revealed a clear diurnal rhythm, dominated by foraging and burrow maintenance during low tide. Phototaxis experiments demonstrated significant positive phototaxis, as crabs consistently oriented and moved toward sunlight, underscoring the importance of light cues for navigation and habitat utilisation. This study provides key insights into the ecological and behavioural adaptations of *D. blanfordi* in intertidal environments. The species acts as an ecosystem engineer, with burrowing and feeding activities influencing sediment structure and nutrient cycling. Its strong phototactic response, intricate burrow architecture, and specialised physiological adaptations highlight its evolutionary success. These findings enhance the understanding of intertidal crab ecology and establish a foundation for future research on coastal biodiversity and environmental adaptation.

Keywords

Activity budget, Ecosystem engineering, Intertidal zone, Sediment dynamics, Spatial distribution



Observations on the benthos of coastal waters of Northern Andhra Pradesh

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Benthic organisms (Macro and Meio benthos), which inhabit the seabed, play a crucial role in maintaining the ecological equilibrium of marine coastal productivity and fish faunal distribution and assemblages. The primary objective of this study was to identify, characterise and assess the ecological significance of benthic organisms in a natural sea bed condition in regular fishing habitat zones. By doing so, we aim to contribute to the understanding of biodiversity, ecosystem functioning, and environmental health along the Andhra Pradesh coastline. For the study, sediment samples were collected from various coastal regions of Northern Andhra Pradesh, including Yendada, Yarada and Jalaripeta in Visakhapatnam District and Budagatlapalem in Srikakulam District. The samples were analysed with respect to the benthic fauna and we attempted to understand its relevance to coastal fisheries. Amphipods, nematodes, polychaete worms and copepods dominated the fauna in the study region. The sediment from Budagatlapalem showed higher species richness and abundance than the sites in Visakhapatnam District. These regions offer an opportunity to investigate unexplored or less-studied areas of the northeast coast of Andhra Pradesh

Keywords

Amphipods, Benthic diversity, Coastal sediments, Copepods, Faunal distribution, Nematodes, Polychaete worms



Distributional shifts of fish parasites in Indian coastal waters: The role of climate change and El Niño

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Fish parasites are integral to biodiversity restoration and the stability of aquatic food webs, functioning as regulators of host populations and indicators of ecosystem health. In wild, fish biodiversity and aquaculture can be significantly affected by fish parasites both in terms of ecological impacts and economic consequences. Parasitic infections may weaken fish, making them more vulnerable to predation, environmental stress or other diseases. Parasites can affect the balance of predator-prey relationships in aquatic ecosystems. In recent decades, significant shifts in the distribution of ectoparasites among Indian marine fishes have been observed, correlating with changes in water currents, increasing salinity, and rising global temperatures which are the factors influenced by recurrent La Niña events. Water currents, salinity, and global temperature changes, especially driven by El Niño events, significantly affect marine fish parasitic distribution in Indian waters. El Niño alters oceanographic conditions by changing sea surface temperatures (SST) and water currents, bringing waters from other regions that shift local environmental parameters. Increased SST and altered salinity levels enhance parasite infection rates and intensity by improving parasite survival, reproduction, and transmission potential. These environmental changes also influence host fish distribution and susceptibility, often leading to higher parasite loads and changes in which parasite species dominate. This results in distributional shifts of fish ectoparasites, which can impact marine biodiversity and fish health, posing challenges for fisheries and aquaculture in affected regions. By analysing nearly thirty years of secondary data alongside recent primary observations, this study elucidated the impact of parasite distribution on marine fish. Isopod parasitic species like *Nerocila orbignyi*, *Norileca triangulate*, *Cymothoa frontalis* and *Nerocila exocoeti* are first report to Indian marine waters

Keywords

Climate change, Isopods, Parasitic infestations, Species distribution, Water current



Climate driven transboundary flooding and pathogen transport: Evidence from the Punjab cholera outbreak

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Benthic organisms (Macro and Meio benthos), which inhabit the seabed, play a crucial role in maintaining the ecological equilibrium of marine coastal productivity and fish faunal distribution and assemblages. The primary objective of this study was to identify, characterise and assess the ecological significance of benthic organisms in a natural sea bed condition in regular fishing habitat zones. By doing so, we aim to contribute to the understanding of biodiversity, ecosystem functioning, and environmental health along the Andhra Pradesh coastline. For the study, sediment samples were collected from various coastal regions of Northern Andhra Pradesh, including Yendada, Yarada and Jalaripeta in Visakhapatnam District and Budagatlapalem in Srikakulam District. The samples were analysed with respect to the benthic fauna and we attempted to understand its relevance to coastal fisheries. Amphipods, nematodes, polychaete worms and copepods dominated the fauna in the study region. The sediment from Budagatlapalem showed higher species richness and abundance than the sites in Visakhapatnam District. These regions offer an opportunity to investigate unexplored or less-studied areas of the northeast coast of Andhra Pradesh

Keywords

Amphipods, Benthic diversity, Coastal sediments, Copepods, Faunal distribution, Nematodes, Polychaete worms



Functional trait signatures of benthic macrofauna and habitat-specific responses to disturbance in mangrove ecosystems

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Mangrove ecosystems are critical coastal habitats that provide essential ecological functions yet face growing anthropogenic threats. Benthic macrofauna are central to mangrove ecosystem functioning, contributing to sediment stabilisation, bioturbation, and nutrient cycling. Functional trait analysis of benthic communities provides a robust method for evaluating habitat condition and anthropogenic influence. In this study, we compared benthic communities from relatively undisturbed mangrove patches and anthropogenically disturbed coastal patches of the Netravathi estuarine complex. Sediment cores were collected from four stations per habitat. 18 macrofaunal species were identified in their functional group in the undisturbed transects, and only 7 in the anthropogenically active transects. Functional traits such as feeding mode, mobility, burrow depth, and bioturbation potential were observed and noted in the field and then later assigned to all taxa. Community composition and trait data were analysed using multivariate ordination and clustering methods to assess specific patterns along both habitats. The present study reveals that mangrove patches exhibited higher functional diversity, dominated by tube-building polychaetes like *Prionospio* sp., and suspension-feeding bivalves like *Meretrix casta*, while disturbed patches were characterised predominantly by opportunistic polychaetes and oligochaetes like *Dendronereis aesturica* and *Capitella* sp., with lower functional redundancy. These findings underscore that benthic functional composition is a reliable indicator of habitat quality, offering a rapid and practical approach for monitoring mangrove ecosystem health and guiding conservation efforts

Keywords

Environmental indicator species, Functional diversity, Habitat disturbance, Macrofaunal composition,



Carbon sequestration potential and economic valuation of mangroves in Korapuzha Estuary, South India

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This study assessed tree density, biomass, carbon stocks, and sediment carbon in the mangrove ecosystems of Korapuzha Estuary, Kerala, India. A total of 135 live mangrove stems were recorded across 0.06 ha, with *Avicennia officinalis* exhibiting the highest tree density (916 nos. ha⁻¹), followed by *Kandelia candel* (550 nos. ha⁻¹) and *Avicennia marina* (383 nos. ha⁻¹). Diameter at breast height (DBH) ranged from 1.97 ± 0.14 cm (*Aegiceras corniculatum*) to 8.04 ± 0.59 cm (*A. officinalis*). Biomass analysis revealed *A. officinalis* as the dominant species, contributing the highest total biomass (45.71 ± 4.76 t ha⁻¹), while *Bruguiera cylindrica* had the lowest (1.82 ± 1.64 t ha⁻¹). The mean above-ground biomass (AGB) and below-ground biomass (BGB) across all quadrats were 75.74 ± 11.61 t ha⁻¹ and 38.73 ± 5.90 t ha⁻¹, respectively, with a T/R (AGB: BGB) ratio of 1.96. Carbon stock assessments showed *A. officinalis* as the largest carbon sink (22.85 ± 2.38 t C ha⁻¹), while sediment carbon averaged 28.78 ± 4.21 t C ha⁻¹. The total carbon stock (biomass + sediment) was estimated at 86.02 t C ha⁻¹, equivalent to 315.69 t CO₂ ha⁻¹. With a mangrove cover of 12.66 ha, Korapuzha Estuary sequesters approximately 1,089 t C (3,996.63 t CO₂), valued at ₹75.5 million based on the social cost of carbon (SCC) at \$220 per ton CO₂. These findings highlight the critical role of Korapuzha mangroves in carbon sequestration and climate change mitigation, emphasising the need for their conservation

Keywords

Biomass analysis, Blue carbon, Carbon storage, Climate change, Mitigation, Tree density



Understanding sediment organic carbon and resilience of the coastal seagrass ecosystem, Chinnapalam, Gulf of Mannar, Tamil Nadu

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This study was carried out to evaluate the carbon sequestration capacity of seagrass ecosystem of Chinnapalam, in the northern part of the Gulf of Mannar. Experimental design, sample collection and analysis were carried out based on standard procedures. The area is mostly muddy with dense population of seagrasses. Five species of seagrasses, dominated by *Thalassia hemprichii*, and *Cymododcea rotundata* supported the seagrass population. Availability of other species such as *Enhalus acroides*, *Halophila stipulacea* and *Halodule uninervis* are sparse and form small intermittent patches. The estimated soil organic carbon (SOC) was 319 t h⁻¹, with a total SOC of around 8,770 t for the 27.6 ha study area. This indicates exceptionally high SOC potential of Gulf of Mannar Biosphere Reserve, which harbour several wide seagrass meadows. The findings indicated large carbon sequestration and storage potential for seagrasses, providing high resilience to environmental challenges. Further, analysis suggests that inputs from a freshwater channel transporting nutrient-rich sediments and terrestrial carbon, combined with human intervention also, partly contributed to higher SOC rates. This ecosystem also supports a rich diversity of resident organisms, and serves as refuge and nursery ground for a wide range of marine fauna. Seagrass meadows serve as important fishing grounds for both invertebrates and finfish, supporting subsistence and commercial fisheries and contributing significantly to human well-being. These findings highlight the importance of maintaining ecosystem health and implementing policies to prevent degradation and promote seagrass restoration.

Keywords

Carbon sequestration, Nursery ground, Refuge, Seagrass meadows, Soil organic carbon



Seaweed cultivation for climate resilience: Building sustainable livelihoods in Lakshadweep

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The Lakshadweep Archipelago, a biodiversity hotspot in the Arabian Sea, is highly vulnerable to climate change and anthropogenic pressures. Rising sea surface temperatures, coral bleaching, coastal erosion, and declining fish stocks pose severe challenges to marine ecosystems and the livelihoods of local communities. Addressing these challenges requires sustainable and community-driven solutions that enhance ecosystem resilience while providing socio-economic benefits. Seaweed cultivation offers a promising nature-based solution within the broader framework of the blue economy. Species such as *Gracilaria edulis* and *Ulva lactuca* not only contribute to climate mitigation through carbon sequestration but also improve water quality by absorbing excess nutrients. Moreover, seaweed farming diversifies livelihoods for fisherfolk and self-help groups, reducing dependency on declining reef fisheries. Value addition in seaweed-based products such as agar and biofertilizers creates new economic opportunities, linking conservation with development. This study highlights the critical challenges facing Lakshadweep's marine ecosystems and examines seaweed farming as a sustainable, climate-resilient livelihood option. Case studies from community engagement initiatives illustrate its ability to support ecological restoration while promoting socio-economic empowerment. Positioning Lakshadweep as a hub for sustainable seaweed cultivation can significantly contribute to India's blue economy vision, offering a scalable model for other small island ecosystems facing similar vulnerabilities.

Keywords

Anthropogenic pressures, Blue economy, Community engagement, Marine ecosystem challenges



Habitat-enhanced recirculating aquaculture systems improve post-transport recovery and survival of *Scylla serrata* (Forsskål, 1775)

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The potential of mud crab aquaculture is constrained by high mortality rates linked to post-transport stress and suboptimal rearing systems. In addition, the sector often relies on wild seeds, contributing to overexploitation of natural stocks, while disease outbreaks make farming practices environmentally and economically unsustainable. The industry's reliance on prolonged transport and clear-water recirculating aquaculture systems (RAS) is fundamentally misaligned with the physiology of *Scylla serrata*. This study evaluated a habitat-enhanced RAS designed to mimic estuarine conditions through the use of mud substrate, turbid water, and shelters. Crabs subjected to transport durations of 0 h, 24 h, and 48 h were reared in either conventional clear-water or naturalised RAS. Extended transport significantly increased *Vibrio* spp. loads in haemolymph and tissues, induced gill damage, and suppressed immune function. In contrast, naturalised RAS substantially improved outcomes, achieving 80% survival even after 48 h of transport. These systems also enhanced key health indicators, including immune parameters (total haemocyte count, phenoloxidase) and antioxidant capacity (superoxide dismutase, glutathione peroxidase), while simultaneously increasing moulting frequency and growth rates compared with clear-water controls. Kaplan-Meier analysis further confirmed a significantly lower mortality risk in naturalised systems. Collectively, these findings demonstrate that habitat-enriched, species-specific RAS offer a breakthrough approach for mud crab aquaculture, reducing environmental pressures while enhancing survival, welfare, and long-term sustainability. By aligning aquaculture design with ecological principles, this study positions habitat-enhanced RAS as a climate-resilient pathway for the future of mud crab farming

Keywords

Climate resilience, RAS, *Scylla serrata*, Transport stress, *Vibrio*



Beneficial aspects of Better Management Practices on *Penaeus (Litopenaeus) vannamei* culture ponds with special reference to climate change

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Aquaculture has emerged as one of the fastest-growing food production sectors, providing nutritional security and livelihood opportunities worldwide. India has experienced significant growth, positioning the country as the second-largest fish producer globally. Among cultured species, the Pacific white shrimp *Penaeus (Litopenaeus) vannamei*, has emerged as the cornerstone of India's aquaculture industry, contributing significantly to rural livelihoods and national export earnings. However, shrimp culture is becoming increasingly vulnerable to the impacts of climate change, including fluctuating rainfall, temperature variations, and water quality deterioration. This study examines the role of Better Management Practices (BMPs) in sustaining semi-intensive shrimp farming under climate change, with a case study conducted in Alluru Village, Prakasam District, Andhra Pradesh during the period 2024–25, spanning both pre- and post-monsoon seasons. Four *P. (L.) vannamei* grow-out ponds with 0.8 ha each was taken for this study. PL12 of *P. (L.) vannamei* were stocked at 60 m² which resulted in survival over 80%, with FCR below 1.5 and yield above 7.68 t per pond during all seasons. This study found that BMPs interventions encompassed optimised stocking densities, water quality monitoring, biosecurity protocols, aeration management, sediment and season-specific feed management. The results showed that adoption of BMPs led to an improvement in average daily growth rate and reduction in FCR compared to conventional practices. It also strengthened the resilience of shrimp culture to climate-induced stressors. Post-monsoon crops, benefiting from stable salinity and reduced thermal stress, recorded higher survival rates and yields, while pre-monsoon crops faced greater environmental variability but still achieved notable gains under BMPs.

Keywords

Climate-induced stressors, FCR, Pond culture, Seafood, Shrimp farming, Seasonal variation



Transforming Tamil Nadu's hypersaline landscapes: A sustainable *Artemia*-based model for biodiversity and climate-aligned land use

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Tamil Nadu's hypersaline landscapes such as coastal salt pans and saline wetlands have long been relegated to traditional salt production, despite their critical ecological roles and vast untapped potential. Recent findings reveal that these habitats now harbour well-established populations of *Artemia franciscana*, introduced in the 1980s for aquaculture, which have successfully naturalised and replaced native parthenogenetic strains. Studies across Kelambakkam, Marakkanam, Vedaranyam, and Tuticorin demonstrate that Indian strains of *A. franciscana* exhibit high cyst viability, superior carotenoid and essential fatty acid content, and competitive hatching efficiencies compared to imported stocks. Additionally, salinity stress studies show that these strains display adaptive biochemical responses such as increased trehalose and PUFA synthesis and elevated *ArHsp22* gene expression, conferring resilience under extreme hypersaline conditions. Leveraging these traits presents a sustainable, climate-aligned opportunity: to reimagine Tamil Nadu's saline tracts as eco-industrial bioproduction zones centred on *Artemia* cyst harvesting. Such an integrated model could support biodiversity conservation, providing vital habitats for migratory birds while bolstering local livelihoods and reducing dependency on costly *Artemia* imports. By coupling *Artemia* harvesting with strategic investments in centralised processing units, community sensitisation, and environmental safeguards, this model promises enhanced productivity without compromising ecological integrity. Ultimately, it aligns with Tamil Nadu's broader biodiversity and climate resilience goals, offering a replicable blueprint for saline land transformation across India. This *Artemia*-based model demonstrates how a once-exotic species can be responsibly harnessed to generate socioeconomic and ecological value from underutilised landscapes, establishing Tamil Nadu as a national leader in saline resource management

Keywords

Artemia franciscana, Biodiversity conservation, Hypersaline ecosystems, Salinity stress, Sustainable aquaculture



Fish value chains in a changing climate scenario in India: Impacts and challenges

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This study investigated the impact of climate change on the resilience and sustainability of fish value chains in India's major coastal states. While existing research often focuses on the direct effects on fish populations and catch, this study provides a comprehensive analysis of the fish value chain from pre-harvest fishing activities to post-landing stages. We employed a multi-stakeholder survey-based approach to gather empirical data across the coastal states, capturing diverse perspectives and experiences. Using Confirmatory Factor Analysis (CFA), the latent factors driving the observed changes in the value chain were identified. The findings reveal a complex interplay between the negative and positive impacts. On the one hand, climate change-induced phenomena, such as rising sea temperatures, ocean acidification, and extreme weather events, lead to detrimental outcomes. These include increased variability in fish landings, shifts in species composition, higher incidence of non-target species and bycatch, emergence of non-conventional/invasive species, damage to fishing gear and infrastructure, loss of fishing days and increased operational costs due to unpredictable weather patterns, with greater risks and vulnerability for fishers posed by extreme weather events. The study also highlights certain positive adaptations and innovations that are emerging within the sector. These include shifts by fishers towards more resilient, climate-adapted species, together with the adoption of new post-harvest technologies and practices to minimise spoilage and waste. These results underscore the urgent need for targeted, evidence-based policy interventions to build resilience and ensure the long-term sustainability and economic viability of India's vital fisheries sector. This research provides a crucial framework for policymakers, industry stakeholders, and coastal communities to proactively address the challenges posed by climate change on marine fish value chains.

Keywords

Coastal communities, Extreme weather events, Pre-harvest, Post-landing, Risks and uncertainties



Jellyfish research in a changing ocean: A global bibliometric study of research priorities and emerging frontiers

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The present study was conducted to understand the bibliometric map of scientific studies on jellyfish. The study aims to map publication trends, key contributors, and research alignment with sustainable development goals. Based on literature review, a broader search strategy was developed with the refinement criterion "articles in English". A total of 1341 articles having 49,680 citations were retrieved from the OpenAlex database. Importantly, 67.7% (908) of the articles were open access, which provides accessibility to jellyfish research. The highest number of publications was from the United States of America (530) followed by Germany (104) and Australia (103), while India ranked 21st position with only 19 publications. The first publication on jellyfish as per this study was in 1969, and a gradual increasing trend was reported from 1995 with peak publications in 2019 and 2022 (87 publications). Further, mapping the publications to United Nations' Sustainable Developmental Goals (SDGs) revealed, 1239 publications were aligned to SDG-14 (Life below water) and 3 publications with SDG-13 (Climate action). This indicates future research needs to explore the aspects of jellyfish in connection with other SDGs, specifically SDG-13. Moreover, prominent contributors with the highest publications were identified; highest was Virginia M. Weis (33 nos.) followed by Mark Q. Martindale (31 nos.). Institutions such as King Abdullah University of Science and Technology (17 nos.) and Centre National de la Recherche Scientifique (12 nos.) are positioned at 1st and 2nd position, respectively. To strengthen research on jellyfish in India, it would be advisable to collaborate with these institutions and researchers, thereby filling the gaps in the global jellyfish research. These findings underline the growing global interest in jellyfish research and emphasize that there must be increased contributions from under-represented countries like India, particularly in the context of climate resilience, marine ecosystem health, and biotechnology.

Keywords

Bibliometric Analysis, Jellyfish, OpenAlex database, Publication trends, SDGs



Unprecedented observation of dual pigmentation (xanthism and erythrism) in *Diagramma pictum* from Palk Bay, India

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A fish specimen exhibiting unusual pigmentation was collected from Palk Bay on 16th March 2023 and identified as *Diagramma pictum* through molecular analysis. The individual displayed a rare combination of xanthism (yellow pigmentation) and erythrism (red pigmentation), which represents the first documented instance of such colouration in *D. pictum* worldwide. Morphologically, the specimen showed only minor deviations from typical individuals, and genetic testing confirmed over 99% similarity to existing *D. pictum* sequences. The specimen measured 660 mm in total length, 560 mm in standard length, and weighed 3.25 kg. No gross or microscopic tissue anomalies were observed in the liver, kidneys, or gonads of either the abnormal or the control fish. Radiographs of both specimens confirmed the absence of skeletal abnormalities, with all major anatomical structures, including vertebrae, fin rays, jaws, girdles, skull, and operculum, appearing structurally normal. The abnormal female fish has developed gonads that are in the spent stage. These findings suggest that the pigmentation variation is not associated with any detectable anatomical or physiological defect, indicating a possible genetic or molecular basis. This exceptional case has attracted scientific interest and indicates that there must be further investigation into the genetic and environmental mechanisms contributing to rare pigmentation phenotypes, which may provide insights into the species' adaptability and phenotypic diversity in natural environments

Keywords

Histology, Molecular analysis, Radiograph, Red pigmentation, Yellow pigmentation



Theme 4

Product, Value Chains and Livelihoods (PVL)

Oral Presentations



Exploring mesopelagic fishes for sustainable fish meal production and quality assessment

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Mesopelagic fishes represent an unexploited fisheries resource, rich in proteins and lipids, with significant potential for industrial, pharmaceutical, and nutraceutical applications. With the rapid expansion of aquaculture, demand for sustainable protein sources for fish feed formulation has increased. To ensure long-term sustainability of fish meal and fish oil production, it is essential to explore deep-sea and mesopelagic resources as alternative raw materials. In the present study, nine mesopelagic fish species such as, Indian spotted coffin fish (S1), Sickie fin chimaera (S2), Pelagic cusk (S3), Pike conger (S4), Blackfin roughy (S5), Occasional toothfish (S6), Bristly catshark (S7), Conger eel (S8) and Cusk-eel (S9) were collected from Mangalore coast at depths ranging from 200 to 1000 m and evaluated for their suitability in fish meal production. The proximate composition analysis revealed that the protein content of the mesopelagic fishes ranged from 10.37 to 16.94%, while fat content varied between 0.23 and 0.67%. Fish meal was prepared by conventional steam cooking method, with yields ranging from 10.19 to 15.83%. The fish meal prepared contained 2.8 to 9.66% moisture, 7.38 to 70.51% protein, 3.02 to 19.72% fat and 9.9 to 68.04% ash. The total volatile base nitrogen (TVB-N) content of all samples remained within the permissible limits, except for S1 and S6. All samples contained essential amino acids, and histamine levels were within permissible limits. Mineral analysis indicated calcium and phosphorous as the predominant minerals present, followed by sodium, magnesium, potassium, iron and zinc. *Staphylococcus aureus*, *Escherichia coli* and *Salmonella sp.* was absent in all samples. Fish meal prepared from S1, S4, S5, S6 and S9 met the standard requirements for protein content. Findings of the study suggests that mesopelagic fishes can serve as promising alternative resources for sustainable fishmeal production.

Keywords

Microbial quality, Mineral analysis, Protein content, Proximate composition

AI-driven conversational assistant for fisheries data analysis and decision support

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The sustainable management of marine fisheries requires timely access to reliable data and actionable insights. We present the *Chatbot Fisheries Advisor*, an AI-powered conversational platform designed to transform three decades of Indian marine fisheries catch data from the National Marine Fisheries Data Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) into an interactive knowledge system for fishers, policymakers, researchers, and students. Leveraging natural language processing and generative AI, the system enables users to query historical records, explore catch trends by species and region, generate summaries, and simulate policy scenarios intuitively. Core functionalities include natural language querying (e.g., "What was the tuna catch in Tamil Nadu in 2015?"), automated data summarisation with visualisations, policy evaluation through scenario modelling, market price insights, and sustainability alerts for overfished stocks. Built on a robust AI stack comprising open-source large language models connected to fisheries databases (PostgreSQL with FAISS indexing), the platform is deployed across web and mobile applications with multilingual support. Future enhancements will include generative forecasting using advanced models such as LSTM and Prophet to predict species-wise catch potentials, and integrated advisory services combining fisheries data with oceanographic and meteorological inputs to provide localised recommendations on fishing seasons, zones, and safety conditions. By bridging complex datasets with user-friendly AI-driven insights, the *Chatbot Fisheries Advisor* empowers fishers with actionable information, assists policymakers in evidence-based governance, accelerates research, and enhances student learning. This approach demonstrates the transformative potential of artificial intelligence in promoting sustainable fisheries management and informed decision-making in marine ecosystems.

Keywords

Artificial intelligence, Chatbot, Generative AI, Data-driven marine fisheries, Governance, Sustainable fisheries management



Anticancer potential and *in-silico* immunogenicity of type-II *Bacillus altitudinis* L-asparaginase from *Charybdis lucifera*: Towards a bio-better drug for blood cancer treatment

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Acute lymphoid leukemia (ALL), a common childhood blood cancer, is treated with L-asparaginase, which is listed as an Essential Medicine by the WHO. However, the widely used L-asparaginases from *Escherichia coli* and *Dickeya chrysanthemi* are often associated with severe adverse reactions due to immunogenicity and allergenicity. To address these limitations, alternative enzyme sources with improved clinical properties are being explored. This study evaluated the cytotoxic and anticancer properties of a type-II L-asparaginase from *Bacillus altitudinis* ICAR-CMFRI/Bal-02 (BAL-ASNase), isolated from the gut of the crab *Charybdis lucifera*. In our previous work, this enzyme was identified through biochemical assays as a promising candidate with clinically favourable traits. Here, the enzyme was purified from the culture supernatant and characterised as a homotetramer with a monomeric molecular weight of 40.83 kDa and a specific activity of 149.61 U mg⁻¹ protein. The kinetic parameters were determined as $K_m = 14.5 \mu\text{M}$ and $V_{max} = 2.5 \times 10^3 \mu\text{mol min}^{-1} \text{ml}^{-1}$. Anticancer activity was assessed against the leukemic MOLT-4 cell line, yielding an IC_{50} of 0.24 $\mu\text{g } \mu\text{l}^{-1}$. Phase-contrast microscopy confirmed cytotoxic effects, while flow cytometry revealed 90.4% apoptotic cells at the IC_{50} concentration, demonstrating potent anticancer potential. The immunogenic profile was further analysed using computational tools. MHC-II T-cell epitope densities were predicted for eight common alleles (HLA-DRB1*01:01, *03:01, *04:01, *07:01, *08:01, *11:01, *13:01, and 15:01). BAL-ASNase displayed similar or lower epitope densities compared with clinical L-asparaginases from *E. coli* and *D. chrysanthemi*. Notably, for HLA-DRB1*07:01, an allele strongly linked to hypersensitivity, BAL-ASNase showed a lower allergenic epitope density (0.492) than *E. coli* (0.692) and *D. chrysanthemi* (0.617). The enzyme was also predicted to be non-allergenic and free of toxic motifs. In summary, BAL-ASNase exhibited potent anticancer activity against leukemic cell lines and demonstrated a more favourable *in-silico* immunogenicity profile than currently used clinical L-asparaginases, supporting its potential for future *in vivo* studies to develop a safer bio-better candidate for ALL treatment.

Keywords

Allergenicity, Bioinformatics, Cytotoxicity, Epitope density, Kinetic parameters, MHC-II, T-cell epitopes, Toxic motifs

Seaweed polysaccharides as novel prebiotic sources for synbiotic functional food development

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In recent years, synbiotic functional foods have attracted considerable attention as consumers increasingly seek products that support both nutrition and health. Synbiotics are a combination of probiotics (beneficial live microorganisms) and prebiotics (non-digestible compounds that stimulate the growth and activity of probiotics in the gut). While most dietary prebiotics are derived from terrestrial plant sources, marine seaweeds represent an underexplored but promising alternative. Seaweed polysaccharides, in particular, exhibit strong prebiotic potential by serving as substrates for probiotic bacteria, thereby contributing to improved gut health. The present study investigated the potential of sulfated polysaccharides from the brown seaweed *Sargassum wightii*, as a novel prebiotic source for synbiotic food applications. The extraction yield of polysaccharide was 9.1%, with colour values of L^* 67.34 $\pm$ 2.1, a^* 4.8 $\pm$ 0.55, and b^* 18.84 $\pm$ 1.05. FTIR spectra showed a peak at 1246 cm^{-1} , confirming the presence of sulfate ester groups, characteristic of fucoidan. Scanning electron microscopy (SEM) analysis revealed a porous, sponge-like microstructure, and cytotoxicity assays using RAW 264.7 macrophages indicated that the polysaccharide was non-toxic. Probiotic *Lactobacillus plantarum* was microencapsulated via lyophilisation with seaweed polysaccharides and compared to the commercial prebiotic, inulin. The prebiotic score of seaweed polysaccharide (0.82) was comparable to inulin (0.88). Survival rates of *L. plantarum* in synbiotic microcapsules exceeded 95% across all wall materials tested, demonstrating that both inulin and seaweed polysaccharides play a key role in improving probiotic stability. These findings highlight the potential of seaweed polysaccharide-based synbiotic microcapsules for the development of functional foods.

Keywords

Lactobacillus plantarum, Macrophages, Probiotic, *Sargassum wightii*



Jellyspray: A novel spray formulation for managing jellyfish stings and its evaluation

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About 35 species of scyphozoan and 5 species of cubozoan jellyfishes have been reported from the Indian Ocean. These jellyfish pose significant health risks to recreational tourists and fishermen due to their stings. The extensive coastline of India, spanning about 11,099 km increases the likelihood of human-jellyfish interactions, particularly during bloom seasons, which are most common in the summer months. Traditionally, fishermen faced skin irritation caused by common scyphozoan jellyfish as an occupational hazard. However, the increasing occurrence and spread of more potent box jellyfish in Indian waters have intensified the risks, highlighting the need to develop a specific spray formulation to treat their stings. Historically, the use of 3-4% commercial vinegar has been recommended for managing jellyfish stings. This method is generally effective against most scyphozoan stings; however, it provides limited protection against cubozoans due to the higher potency and complexity of their venom. A three-pronged approach is generally recommended for managing jellyfish stings: first, carefully remove nematocysts from the affected area by gentle scraping; second, apply vinegar or a specialised jellyfish spray to inactivate any remaining nematocysts; and finally, use a calamine-based lotion to soothe and condition the skin. In this study, a vinegar-based spray formulation with nematocyst-disabling properties was formulated under the name "Jellyspray." This formulation comprises active ingredients viz., copper gluconate, urea, magnesium sulphate, lidocaine hydrochloride and vinegar, which together inactivate discharged nematocysts and prevent further nematocyst firing. This formulation was evaluated at a primary health centre under the supervision of a medical professional during a box jellyfish envenomation incident at Mandapam, Ramanathapuram District, Tamil Nadu, which provided marked relief to the affected individual. Prior informed consent was obtained from all sting victims participating in the field evaluation of "Jellyspray". Further multi-location clinical evaluation is planned to validate "Jellyspray" as an effective first-aid and cosmetic formulation for management of jellyfish stings.

Keywords

Box jellyfish, Cubozoan, Fishermen, Nematocysts, Scyphozoan, Sting management



Total factor productivity growth in the fish processing industry of India

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In 2024, India earned about US\$7.0 billion from seafood exports, with productivity growth in the processing sector playing a key role in enhancing global competitiveness. The present study estimated the partial and total factor productivity growth of fish processing industries in India using data from Annual Survey of Industries (ASI), for the ten-year period from 2011 to 2020. The study estimated the growth of both partial factor productivities (labour and capital productivities) and total factor productivity (TFP) for the entire processing sector and its six constituent sub-sectors. The Levinsohn-Petrin (LP) method was used to estimate TFP. In addition, the study identified potential correlates of TFP growth to aid the management of fish processing industries to enhance productivity performance. The results indicate that during 2011-2020, the number of fish processing industries in India increased at a compound annual growth rate (CAGR) of 3.86% per year, with performance varying across different industry typologies. As of 2020, about 43% of the firms operated as private limited companies, while 38% were registered under partnerships. Over the years, the partnership is increasing with a decline in the case of private limited companies. Over the study period, the gross value added (GVA) of the fish processing industry increased at a CAGR of 16.4%, capital at 16.67% and labour at 11.87%. The mean labour productivity was approximately ₹3.26 lakh per worker growing at a CAGR of 1.05%, while the capital productivity averaged ₹23, showing a growth rate of 23%. Considerable variation was observed across sub-sectors and partial productivity growth exhibited mixed trends. TFP growth ranged from 0.30 to 1.29% with an average annual rate of 0.85%. The results were compared with that of global experiences. Variables like imports by the firms, number of operational days, social security contributions as a proportion of salaries, and the capital-labour ratio were found to be highly critical. Based on these findings, the study offers policy leads for improving the productivity in the fish processing sector.

Keywords

CAGR, Fish value addition, GVA, Labour productivity, Levinsohn-Petrin method, Policy implications



Grab the crab: (in)equity in blue swimming crab value chain in Palk Bay region

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The blue swimming crab (BSC) (*Portunus pelagicus*) is a commercially important and a high value marine species, sustaining small-scale fisheries and global seafood exports. In the Palk Bay region, the BSC fishery contributes substantially to the livelihoods and local economic development, with crabs forming a considerable share in Indian and Sri Lankan crustacean exports. Owing to high export demand, especially in the USA market, the actors up in the value chain, the processor-exporters, have taken initiatives and are driving the fishery towards sustainability. Thus, the Crab Meat Processing Association (CMPA), a consortium of a dozen BSC exporters in India, and the Seafood Exporters' Association of Sri Lanka (SEASL) are jointly implementing a market-driven fishery improvement plan (FIP) in the Palk Bay region, aligning with growing market demands for responsible sourcing and sustainability certification. While the business interests, in terms of premium market value, is the primary driver here, it is often claimed that a considerable share of this 'premium' gets passed on to the fishers. This is an assumption that remains untested, given the lack of transparency in product pricing and value realisation across the actors in the value chain. Concerns remain regarding the equitable benefit sharing along the chain as small-scale fishers, including women active in BSC harvest and processing, often complain of traders/exporters profiting at their cost. By mapping the actors in the BSC value chain in the Palk Bay region, this study dives deep to reveal the value added and value (benefit) realised by each actor, and its (in)equity. It also documents the significant role of women in BSC value chain and their economic contribution. By highlighting existing gaps in value realisation and inclusivity, the study seeks to provide recommendations for equitable benefit-sharing, strengthening women's participation, and ensuring sustainable BSC fishery and trade.

Keywords

CMPA, Livelihoods, *Portunus pelagicus*, Small-scale fisheries, Sustainability



Assessment of socio-economic impact of artificial reefs deployed in coastal villages of Tamil Nadu

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Fisheries sector plays a vital role in Indian economy, serving as potential source of income, livelihood, nutrition and forex earnings. Marine fish production in India fluctuated from 3.94 million t in 2012 to 3.53 million t in 2023, and currently stands at 3.46 million t in 2024. Tamil Nadu contributed about 16% (6.79 lakh t) of the national marine fish catch in 2024. With the gradual decline in marine capture fisheries production, several fishery management measures have been introduced to enhance biomass in coastal waters. In this context, the Government of Tamil Nadu, with technical support from ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), implemented an artificial reef deployment programme across 17 coastal villages between 2012 and 2017 to rebuild fish stocks and rejuvenate coastal fisheries. The present study assessed the impacts of this initiative. In the study villages, the proportion of fishermen in the younger age group (0-35 years) was slightly higher (48.7%) than those in the middle-age group (36-55 years). Fishing remained the primary occupation (95.2%), followed by fishery-related activities (4.5%) and non-fishery occupations (0.3%). The literacy level was 76.85% and fishing experience ranged from 9 to 27 years. Forty-seven per cent of fishers were of small family (family size 4). Single-day and multiday fishing were in practice with fishing duration ranging from 4-5 h to 22 h. The average fishing depth ranged from 15 to 28 m and fishing distance varied between 16-18 miles. Impact analysis was carried out in three villages viz., Mamallapuram, Pudukuppam and Arangankuppam, during 2021-2022. Following deployment of the artificial reefs, there was a noticeable increase in fishing frequency, diversity of gears used, number of active fishermen and overall income. Species composition varied across sites with grouper, carangids, seerfish and barracudas dominating the catches at Arangankuppam; snappers, sardine, mackerel and cephalopods abundant at Pudukuppam; while *Nemipterus* spp., *Siganus* sp. and crustaceans dominant at Mamallapuram. Post-deployment of artificial reefs, the average monthly income of fishermen showed a notable rise across the study villages. In Mamallapuram, income increased by ₹4,000 from a baseline of ₹15,026; in Pudukuppam, by ₹1,800 from ₹14,901; and in Arangankuppam, by ₹1,500 from ₹16,830. This enhancement in earnings has significantly contributed to improving the socio-economic status of the fishing communities. Therefore, it is recommended to expand the deployment of artificial reefs in ecologically suitable areas to further enhance the income and standard of living of traditional and marginal fishermen.

Keywords

Fishing, Income, Livelihood, Standard of living



Efficiency, emissions and economics: A comparative study of longline and gillnet fisheries along the Tamil Nadu Coast

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Fisheries play a vital role in global food security but are increasingly scrutinised for their environmental footprint, particularly the greenhouse gas emissions associated with fuel-intensive operations. Understanding the comparative performance of gillnet and hook-and-line fisheries in terms of vessel design, catch composition, fishing efficiency, fuel consumption, CO₂ emissions and economic viability is crucial for promoting sustainable marine resource management. The present study was carried out at Thengapattinam Fishing Harbour, Tamil Nadu during August 2022 to May 2024. Vessels were categorised into three types based on construction and engine capacity: wooden vessels (Type A: 16-18 m; 120-140 hp), fibre-reinforced plastic (FRP) vessels (Type B: 18-20 m; 140-160 hp) and steel vessels (Type C: 20-22 m; 160-180 hp). Hook-and-line vessels exhibited distinct spatial variation in catch composition, with nearshore operations dominated by skipjack tuna (71.4%), while offshore fleets landed a more diverse assemblage comprising yellowfin, albacore, bigeye tuna, dogtooth tuna and billfishes (19%). In contrast, gillnetters consistently landed skipjack tuna (28-40%) as the dominant catch, followed by bullet tuna, yellowfin tuna, sailfish and mahi-mahi. Despite a significantly higher catch efficiency evidenced by a soaking-hour CPUE of 97.9-106.7 kg h⁻¹ for longliners compared to 7.25-8.99 kg h⁻¹ for gillnetters, longline operations were substantially more fuel-intensive. Longliners consumed 1,126-5,000 l of fuel per trip (emitting 2.97-13.20 t CO₂), with vessel transit alone accounting for 50-66% of total fuel consumption. Gillnetters demonstrated better fuel economy, consuming 1,626-3,584 l per trip (4.29-9.46 t CO₂). Profitability was closely linked to both fishing gear and vessel type. Nearshore longliners (Type A) were profitable (BCR: 1.08-1.94), while Types B and C were economically non-viable (BCR: 0.37-0.65). Gillnetters exhibited mixed economic performance, with Type A vessels operating at a loss (BCR: 0.46-1.32), whereas Types B and C achieving seasonal profitability (BCR: 0.72-1.38). Although longliners demonstrated higher catch efficiency, they were more fuel-intensive and less profitable in offshore operations. In contrast, gillnetters were more fuel-efficient but less productive, with variable economic outcomes. These findings highlight the need for gear and vessel specific management strategies that optimise efficiency, profitability and carbon emissions within the fisheries sector of Tamil Nadu.

Keywords

BCR, CPUE, Fuel consumption, Gillnetters, Longliners, Offshore fleets, Profitability



Adaptive co-management of winter migratory bagnet fisheries in Indian Sundarbans: Strengthening coastal livelihoods in changing climate

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Winter Migratory Bagnet Fisheries (WBNF) in the Indian Sundarbans are among the most important fishing activities for local food security and livelihoods, yet they face escalating threats from climate change, including rising sea levels, declining fish stocks, and frequent cyclones. This study aims to (i) document species diversity in the winter bagnet fishery of the Indian Sundarbans, (ii) evaluate the multifaceted environmental and socio-economic vulnerabilities affecting WBNF, and (iii) assess coping mechanisms and adaptive strategies employed by stakeholders to address these challenges. Data were collected from 2019 to 2024 across Fraserganj, Bakkhali, Kalisthan, and Lalganj in South 24 Parganas, West Bengal, using semi-structured interviews (SSIs), focus group discussions (FGDs), and participatory rural appraisal (PRA) techniques. Vulnerability assessment applied a driver-filtered approach based on fisher perceptions, complemented by historical data, and utilised the Livelihood Vulnerability Index framework recommended by the Intergovernmental Panel on Climate Change. Fish species composition varied with fishing intensity and prevailing hydrometeorological conditions. A total of 65 finfish species, representing 25 families and 13 orders, were recorded in WBNF catches during 2019–2024. Findings indicate that WBNF provides a stable income by directly employing over 4,000 seasonal workers, while also supporting local fresh and dry fish retailers and allied livelihoods. In post-harvest activities, women represent 70-80% of the total workforce. Livelihood Vulnerability Scores ranged from 0.253 at Kalisthan to 0.402 at Fraserganj, reflecting high-risk conditions, particularly for women engaged in post-harvest activities, who face considerable economic losses from climate-induced disruptions. Key drivers affecting fishery sustainability include sea level rise, declining species richness, reduced Catch Per Unit Effort (CPUE), shifts in spawning seasons, changing rainfall patterns, and dependency on middlemen. Adaptive management approaches highlighted by the study emphasize community participation, livelihood diversification, institutional support, and targeted policy interventions, including enforcement of seasonal regulations, gear specifications, fair pricing, credit access, cold storage, digital marketing, small-scale fish processing, and fair wages. Adoption of environmentally sustainable technologies, such as selective nets and solar dryers, coupled with community education and social media engagement, can further strengthen resilience. This study provides actionable insights for policymakers, practitioners, and stakeholders to enhance resilience, safeguard livelihoods, and promote the long-term sustainability of Winter Bagnet Fisheries in the Sundarbans

Keywords

Economics, Gender perception, Policy recommendation, Resilience, Vulnerability



Theme 4

Product, Value Chains and Livelihoods (PVL)

Poster Presentations



Enzymatic and biosurfactant potentials of psychrotrophic bacteria isolated from Arctic sediment samples

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Polar environments harbour diverse microorganisms that have adapted to extreme cold habitats, representing an untapped resource for novel bioactive compounds, like enzymes and biosurfactants that can be used for scientific and industrial purposes. The present study investigated the ability of bacterial strains to co-produce cold-active enzymes and biosurfactants, which were isolated from the Arctic sediment samples. A total of 150 bacterial strains were isolated and analysed for their hydrolytic enzymatic activities, including amylase, urease, cellulase, lipase, and protease. Besides, the production of bioactive secondary metabolites like biosurfactants was also investigated. The biosurfactant production was screened by various methods, like the drop collapse test, oil displacement test, microplate assay, emulsification activity, and CTAB methylene blue assay. The screening tests showed positive results, and biosurfactant production was confirmed. The most abundant enzymes detected were urease, followed by proteases, amylase, cellulase, and lipase. Four isolates showed good biosurfactant activity, with E24 values up to 72.8%. Additionally, the antibiotic resistance test of these isolates was assessed using standard disc diffusion Kirby-Bauer methods to evaluate their resistance profiles against commonly used antibiotics. The test results demonstrated that most of the strains were resistant to Erythromycin, Streptomycin, Amoxicillin, Nalidixic acid, Vancomycin, and Ciprofloxacin. These findings highlight the biotechnological potential of Arctic bacteria as promising candidates for the production of cold-adapted enzymes and biosurfactants with sustainable industrial applications.

Keywords

Antibiotic resistance, Bioactive compounds, Extracellular enzyme, Microorganisms, Secondary metabolites



Gelatin-chitosan based edible coatings enriched with *Psidium guajava* leaf extract to enhance the shelf-life of Indian white shrimp (*Penaeus indicus*) during chilled storage

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Psidium guajava (guava; GUV) is a widely cultivated fruit tree valued for its fruits and leaves, which are rich in bioactive phytochemicals with notable antioxidant and antibacterial properties. Quantitative analysis of the guava leaf extract revealed high levels of total phenolics, flavonoids, alkaloids, and tannins. Antioxidant activities assessed by DPPH and ABTS assays showed strong radical scavenging, with 97 and 74% inhibition at 20 and 40% extract concentrations, respectively. Antimicrobial testing demonstrated that 20% GUV extract produced significant inhibition zones against Methicillin-Resistant *Staphylococcus aureus* (MRSA, 34.00±0.00 mm), *S. aureus* (27.00±3.00 mm), and *Bacillus cereus* (17.00±2.00 mm), but did not show antimicrobial effects against Gram-negative bacteria. High-Resolution Mass Spectrometry (HRMS) profiling identified three major compounds with potent antimicrobial and antioxidant activities, such as neochlorogenic acid, gallic acid, and D-(–)-quinic acid. GC–MS/MS analysis also detected dominant sesquiterpenes including α-copaene (6.72%), caryophyllene (6.65%), caryophyllene oxide (6.49%), and humulene (3.89%). In application, peeled un-deveined shrimp (*Penaeus indicus*) coated with gelatin–chitosan (1% each) composite enriched with 20 and 40% GUV extract stored at 4°C exhibited an extended shelf-life of 18 days, compared to control samples (6 days), as determined by mesophilic and psychrophilic bacterial counts and biochemical analyses (TMA, TVBN, TBARS, pH). The combined effect of a gelatin-chitosan coating incorporated with guava leaf extract significantly delayed microbial spoilage and lipid oxidation in shrimps, resulting in improved sensory qualities during chilled storage. These findings confirm that guava leaf extract could be a potent, natural biopreservative as a sustainable alternative to synthetic additives in food applications

Keywords

Antimicrobial testing, HRMS profiling, Psychrophilic bacteria, Radical scavenging

CIFTEQ Staphage formulation: A phage consortium for the biocontrol of methicillin-resistant and sensitive *Staphylococcus aureus* in seafood

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Staphylococcus aureus is a significant pathogen causing food-borne illnesses and is increasingly being detected in seafood and processing environments. The rise of antimicrobial resistance (AMR), along with the ability to form robust biofilms, poses significant challenges in its control using conventional antibiotics or disinfectants. Bacteriophages serve as eco-friendly alternatives for the biocontrol of *S. aureus* owing to their host-specificity, wide host range, and effectiveness against antibiotic-resistant bacteria, thereby enhancing seafood safety. The present study aimed to develop a safe and effective phage cocktail for the reduction of *S. aureus*, including Methicillin-resistant *S. aureus* (MRSA) and Methicillin-sensitive *S. aureus* (MSSA) prevalent in seafoods and aquaculture settings. The CIFTEQ_Staphage formulation is a cocktail of ten lytic phages, active against MRSA and MSSA hosts prevalent in seafood and aquaculture settings. The lytic phages were isolated from the water samples collected from different aquatic environments by the multiple host enrichment procedure. The distinct plaques were purified, and the host range was assessed. The phages were subjected to whole genome sequencing and screened for the presence of resistance genes, lysogeny, and toxin genes. The phages were formulated into a cocktail in Saline-Magnesium buffer based on their effective multiplicity of infection and evaluated for their biofilm disruption ability, effectiveness in seafood surface decontamination, and their stability. The stability of the phage cocktail was assessed for 1 hour at the temperature range of -80 to 70°C, salinity of 0.85-10%, disinfectant level of 2-100 ppm, and pH range of 3-12. The biofilm disruption ability was checked using the crystal violet-based microtitre plate assay. The genome sequencing and analysis indicated that the phages harboured a linear double-stranded DNA, which was around 140 kbp and belonged to the genus *Silviavirus*. The phages were strictly lytic and free from lysogeny, virulence, and AMR determinants, making them safe for biocontrol applications. The phage cocktail exhibited good stability at a temperature range of -80 to 50°C, pH range of 7-9, salinity up to 10% NaCl, and disinfectant level up to 50 ppm, indicating their effectiveness in a wide range of environmental conditions. The seafood-based trials using MRSA spiked samples, also indicated a significant reduction of MRSA load in seafood. The phages exhibited antibiofilm activity and indicated the presence of putative depolymerases and lytic enzymes. The lytic phage cocktail tailored at ICAR-CIFT can be a promising strategy for the biocontrol of MRSA and MSSA in seafood supply chains, with profound implications in food safety and security

Keywords

Biofilm disruption, MRSA, MSSA, Phage cocktail, Putative depolymerases



Transforming abandoned FRP fishing boats into circular economy products for marine waste mitigation

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Fiberglass Reinforced Plastics (FRP) are extensively used in the construction of small-scale fishing boats owing to their strength, durability, and resistance to corrosion. However, the non-recyclable nature of thermosetting composites and the high cost of disposal have resulted in widespread abandonment of end-of-life FRP boats along India's coastal regions. This poses serious environmental concerns, particularly in the form of persistent marine litter. The present study, assessed the extent, distribution, and environmental impact of abandoned FRP boats across 23 beach landing centers in Kerala, covering the northern, central, and southern zones. A standardised methodology was developed to categorise FRP debris, from whole boats to mega, macro, meso, and micro fragments. The survey recorded 572 abandoned boats across these sites, with an average density of 22 boats km⁻¹. All of the abandoned boats were FRP sheathed over plywood/wood, estimated to be 45000 kg of FRP debris (Resin + glass). Various forms of abandonment were documented, including sunken boats in water or sand, boats left in vegetated areas, and remains from open burning. Analysis revealed high concentrations of plastic debris and microplastics around these disposal zones. The study also highlighted the increased environmental hazards posed by FRP debris, which differs from conventional thermoplastics in terms of density, degradation patterns, and toxicity. To address this growing issue, ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) developed three innovative strategies for upcycling FRP waste within a circular economy model: (i) converting FRP debris into cementitious composites, (ii) transforming it into thermoplastic-like material suitable for recycling streams, and (iii) incorporating FRP waste into bituminous products for pavement applications. These approaches not only mitigate the environmental burden of marine plastic pollution but also unlock the potential for sustainable resource recovery and value creation from otherwise persistent and hazardous waste. This study contributes to national and global efforts on marine litter reduction and promotes scalable, science-based interventions for circular economy transition in coastal fisheries sectors.

Keywords

Bituminous products, Cementitious composite, Circular economy, Marine debris



Sulfated galactofucan from *Turbinaria ornata*: A natural anticoagulant targeting coagulation and thrombin signalling in human umbilical endothelial cells

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Thrombosis, arising from dysregulated coagulation, underscores the need for novel and safe anticoagulants. This study evaluated TOP-3, a sulfated galactofucan isolated from the brown seaweed *Turbinaria ornata*, a resource widely available in tropical coastal waters and traditionally harvested by coastal communities. Structural characterisation revealed a backbone of sulfated α -(1 $\rightarrow$ 3)-fucopyranose and β -(1 $\rightarrow$ 3)-galactopyranose units. In vitro assays demonstrated that TOP-3 (25 μ g ml⁻¹) markedly prolonged activated partial thromboplastin time (aPTT, 100.49 s) and prothrombin time (PT, 77.57 s), confirming activity on both intrinsic and extrinsic pathways. In human umbilical vein endothelial cells, TOP-3 downregulated phospho-MARCKS (80%) and factor Xa expression (89%), while platelet aggregation assays showed ~87% inhibition compared to ADP-induced controls. Moreover, TOP-3 exerted five-fold stronger suppression of thrombin-catalysed fibrin polymerisation than heparin, attenuated thrombin-induced Ca²⁺ mobilisation (~33%), and reduced total thrombin generation by 33%. In *silico* molecular modeling highlighted high polarisability and polar surface area, indicating strong hydrophilic and protein-binding interactions mediated by sulfate groups. These findings establish *T. ornata* as a high-value marine bioresource with significant pharmaceutical potential. Harnessing such seaweed-derived bioactives not only contributes to the development of natural anticoagulant products but also strengthens marine value chains and supports coastal livelihoods, particularly where women play central roles in seaweed collection and processing.

Keywords

Prothrombin time, Seaweed, Structural characterisation, Sulfated polysaccharide, Thromboplastin time,



Physicochemical profiling of nacre isolated from the green mussel (*Perna viridis* L.)

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Mariculture has emerged as a rapidly expanding sector within global aquaculture, contributing substantially to food security and sustainable resource utilisation. Among molluscan resources, shells constitute nearly 65-90% of the total body mass, representing a largely underutilised reservoir of biomaterials. The nacreous layer, or mother of pearl, is a hierarchically structured biocomposite composed primarily of aragonite ($\approx 95\%$) integrated with an organic matrix (1 - 5%). Owing to its exceptional mechanical strength, bioactivity, and multifunctionality, nacre has garnered increasing attention for biomedical and industrial applications, including antimicrobial, antioxidant, and anticancer potentials. Here, we report the isolation and systematic characterisation of nacre from the indigenous Asian green mussel *Perna viridis*, an ecologically and economically significant species distributed across the Indo-Pacific. Nacre powders were extracted through optimised chemical and thermal protocols and subsequently characterised using a suite of advanced analytical platforms, including light and fluorescence microscopy, X-ray diffraction (XRD), thermogravimetric analysis (TGA), X-ray fluorescence spectroscopy (XRF), Fourier-transform Raman spectroscopy, and field emission scanning electron microscopy (FE-SEM). Furthermore, the water-soluble matrix of nacre was extracted and subjected to comparable analyses to explore its physicochemical properties. This study provides one of the first comprehensive insights into nacre from *P. viridis*, native to Indian waters. By valorising an otherwise discarded biomaterial, our findings highlight its prospective roles in bone and tissue engineering, regenerative medicine, and sustainable biomaterial innovation. These results position *P. viridis*-derived nacre as a promising platform for translational research at the interface of marine biotechnology, materials science, and environmental sustainability.

Keywords

Biomaterial, Mother of pearl, Mussel shell, Nacreous layer, Valorisation



Evaluation of functional and nutraceutical potential of dried jellyfish *Acromitus flagellatus* (Maas, 1903)

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Jellyfish are emerging as a promising alternative source of various marine-derived compounds. The present study investigated the dried form of *Acromitus flagellatus*, a jellyfish species native to Southeast Asia, to evaluate its nutritional composition, functional properties, and potential applications in the nutraceutical sector. Samples were collected from various areas of Ernakulam District, separated into bell and oral arm portions, and subsequently subjected to drying using a mechanical dryer. Proximate analysis of the species revealed high protein content (20.0-35.0 g 100 g⁻¹ dry weight⁻¹), minimal fat content (<2.0 g 100 g⁻¹), and good ash/mineral fractions (~20-55 g 100 g⁻¹). Amino acid analysis showed essential amino acids in significant amounts, and collagen content constituted approximately half of the total protein, with oral arms showing slightly higher levels. Mineral analysis (ICP-MS) indicated appreciable levels of macro elements (Na, K, Mg) and trace elements (Zn, Si), contributing to the high ash content. Furthermore, the functional properties of jellyfish were studied, including their water- holding capacity, oil-holding capacity and solubility, which are key indicators of their suitability for application in functional food and nutraceutical formulations. The study suggests that dried *A. flagellatus* is a nutritionally rich, low-fat resource with potential for development into various dietary supplements and collagen-based nutraceutical products. Findings of the study supports the value of marine jellyfish as a sustainable nutritional resource that aligns with zero-waste management principles.

Keywords

Collagen, Essential amino acids, Functional food, Marine protein, Oral arms



Sustainable utilisation of mussel mariculture waste as a reusable biomaterial for water purification

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Mussel byssus thread is a resilient, protein-based natural fibre known for its remarkable strength and adhesion properties. Although its unique mechanical and adhesive properties have been widely explored, the byssus thread is often treated as a waste product in mussel mariculture. While extensive research has focused on utilising mussel shells for industrial purposes, limited attention has been given to the potential applications of byssus threads. The present study investigated the capacity of mussel byssus threads to remove dyes and metal ions, highlighting their potential as an eco-friendly biomaterial for water purification. Byssus threads were collected from the indigenous mussel species *Perna viridis* and *Perna indica* and used for adsorption analyses of dyes and metal ions. The study examined the adsorption efficiency of the byssus threads under varying pH conditions (pH 2-10) and different concentrations. Maximum metal ion removal occurred at pH 6.0, while dye removal efficiency was influenced by the chemical nature of the dye (anionic or cationic). Adsorption of dyes and metal ions produced minimal changes in the thermal and mechanical characteristics of the byssus threads. In addition, the dye and metal ion removal potential of mussel shell waste materials was also evaluated to compare their adsorption efficiency. The findings indicate that mussel byssus threads can serve as a robust and reusable adsorbent for the removal of dyes and metal ions from water, offering superior performance compared to mussel shells. The adsorption process is governed primarily by selective chemical coordination bonding, ensuring that the treated water quality remains unaffected. The use of byssus threads represents an eco-friendly, green chemistry approach to water treatment.

Keywords

Adsorption efficiency, Adhesive properties, Biomaterial, Bivalves, Byssus thread, *Perna perna*, *Perna viridis*



Indian seaweeds for third-generation bioethanol production: Problems and prospects

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India is the third-largest consumer of the world's primary energy. In the country, there has been an urge for biofuels in recent years as there has been a constant rise in fossil fuel prices, which affects the economy. There are pollution issues due to increased combustion of fossil fuels, and they are predicted to be exhausted by half the century. The Indian government had shifted to green fuels and had made it mandatory to blend biofuels with fossil fuels. India is rich in seaweed resources, and they contain enough carbohydrates for bioethanol production. Seaweed offers advantages over terrestrial crops for bioethanol production because it grows rapidly without requiring arable land, freshwater, or fertilisers, and contains easily fermentable sugars with low lignin content. India has a vast coastal area along with a strong coastal community that provides ideal opportunities for large-scale seaweed collection and cultivation. At present, India's contribution to global seaweed production remains relatively small as well, and the production of bioethanol from seaweeds is not cost-effective because of the high cost of cultivation and conversion. The technologies are progressing, and their commercialisation has to overcome several obstacles to address the futuristic needs. A critical evaluation of the largely untapped potential of Indian macroalgae across its different regions as a sustainable source for bioethanol production is necessary. The major approaches for identifying suitable seaweeds for bioethanol production include evaluating their carbohydrate content and composition, assessing biomass productivity and seasonal availability, and analysing pretreatment efficiency and fermentable sugar yield. The major steps of seaweed bioethanol production are seaweed harvesting, post-harvest handling, pretreatment methods, fermentation, bioethanol recovery processes, and holistic seaweed-based biorefineries. India had made several advances at each step to meet its energy demand. Challenges encountered in the bioconversion and possible solutions, like advanced hydrolysis techniques and genetically modified strains of both seaweed and microbes that will improve the efficiency of the process, are introduced. Major Indian research institutions that contribute towards the development of the seaweed-based bioethanol industry are CSMCRI, CSIR-NIO, NIOT, ICAR-CMFRI and ICT. Commercial production of seaweed bioethanol in India will emerge once the efficiency and scale of the production process are increased. There is a necessity for different government policies for the advancement of the seaweed bioethanol industry. There should be sustainable management of seaweed resources without disrupting the ecosystem. India has the potential to emerge as a global leader in sustainable seaweed-derived bioethanol, significantly contributing towards its own and the world's bioenergy goals.

Keywords

Bioenergy, Carbohydrates, Fermentation, Hydrolysis, Macroalgae



Oil spill remediation: An innovative lipopeptide biosurfactant-based approach for environmental clean-up

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Crude oil is a complex mixture of aliphatic and polyaromatic hydrocarbons (PAHs), along with various other toxic components. Environmental contamination arising from oil spills, biomass burning, coal combustion and industrial discharges leads to elevated PAH levels in soils, which impede natural degradation processes and pose serious carcinogenic risks to humans. Traditional bioaugmentation strategies have shown limited success; therefore, the use of biosurfactants, owing to their low surface tension emulsifying properties offers a promising approach to enhance oil removal, flowability, and enhance PAH degradation. In the present study, a biosurfactant (BS) was isolated from *Lysinibacillus* sp. MW444883, characterised as a lipopeptide using FTIR, GC, LC-HRMS, and ¹H NMR spectroscopy. The biosurfactant demonstrated a strong surface tension reducing property and effectively lowered the viscosity of 50% crude oil at 25, 35, and 45°C. It also exhibited excellent stability over a wide range of pH values (3-11), salt concentrations (0.5-5%) and temperature (27-45°C) conditions. The ability of the biosurfactant to fragment oil into smaller droplets enhances the availability of hydrocarbons as a utilisable substrate for microbial degradation. The oil dispersion efficiency, evaluated through RGB image analysis, ranged from 56.4 to 86.6%, indicating the biosurfactant's strong potential for crude oil remediation and environmental clean-up applications.

Keywords

Biosurfactant, Crude oil, FTIR, LC-HRMS, *Lysinibacillus* sp., Oil dispersion, PAHs, Stability



Automated identification of deep-sea marine fishery resources through neural networks

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Deep-sea marine fishes represent one of the most diverse and least explored groups of organisms, playing a crucial role in maintaining ocean ecosystems and offering significant potential for scientific research and biotechnological applications. Their identification, however, is often challenging due to limited accessibility, morphological similarities among species, and the reliance on specialised taxonomic expertise. To overcome these challenges, this study explores the application of deep learning algorithms for the automated identification of deep-sea marine fishes using images collected from multiple sources. The proposed approach combines intelligent detection techniques to handle images containing multiple fish with advanced classification methods for species-level recognition, leveraging curated biological datasets to enhance accuracy and provide descriptive insights. The developed system successfully identifies 25 deep-sea fish species with promising classification performance.

Keywords

Artificial intelligence, Deep learning algorithms, Image classification, Species identification



DeepDATA (Deepsea Digitally Automated Taxonomy Assistant): An Android application for displaying key identification features of deep-sea fish species

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Documenting deep-sea fish species is essential for biodiversity conservation, ecological research, and sustainable fisheries management. Traditional methods, which rely on physical records, taxonomic expertise, and manual verification, are time-consuming and often inaccessible to a broader audience. To address these challenges, we developed *DeepDATA*, an Android-based mobile application that digitises comprehensive deep-sea fish species data from authoritative sources into a structured and searchable database. Built with a Flutter-based interface and an SQL database for efficient data storage and retrieval, *DeepDATA* provides rapid access to verified species information for researchers, students, and marine conservationists. The application emphasises key identification features, making it a valuable tool for education, field studies, and biodiversity assessments. Future developments aim to integrate image recognition, interactive taxonomy tools, and species distribution visualisations to further enhance deep-sea biodiversity research.

Keywords

Biodiversity database, Data storage, Mobile application, Searchable database.



Comparative analysis of antibacterial and antibiofilm effects of seaweed extracts

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Biofilm-forming bacteria initiate marine biofouling by colonising submerged surfaces and by secreting extracellular polymeric substances that facilitate the subsequent attachment of higher organisms. This progressive process of biofouling leads to increased fuel consumption, structural corrosion and higher maintenance costs. Marine macroalgae are rich in biogenic compounds with antifouling potential, which represent promising eco-friendly alternatives to toxic biocides. In the present study, crude extracts of three tropical macroalgal species, *Sargassum wightii*, *Gracilaria corticata*, and *Ulva fasciata*, collected from Thirumullavaram beach, Kollam, were evaluated for their antibacterial and antibiofilm activities against three strong primary colonisers in the early biofilm of different submerged panels identified in our previous work (*Micrococcus luteus*, *Brevibacterium casei*, and *Acinetobacter junii*). Extracts were prepared using five organic solvents, viz. methanol, chloroform, ethyl acetate (EA), acetone, and dichloromethane (DCM). Antibacterial (AB) score was quantified based on the minimum inhibitory concentration (MIC) of each extract against the test bacteria, in which scores 5, 4, 3, 2, 1 and 0 were assigned to extract concentrations <50, 50-100, 100-250, 250-500, 500-1000 and >1000 mg ml⁻¹, respectively. The final AB score for each extract was calculated by adding the scores against all three indicator bacteria. Antibiofilm (AF) score was assessed by determining the minimum concentration required to inhibit the bacterial adhesion compared to an untreated control (bacteria without seaweed extracts), in which scores 5, 4, 3, 2, 1 and 0 were assigned to extract concentrations <25, 25-50, 50-100, 100-250, 250-500 and >500 mg ml⁻¹, respectively. The final AF score for each extract was estimated by adding the AF score against each indicator bacterium. To provide an integrated assessment, a composite score was calculated by combining AB and AF scores. Among the 15 evaluated extracts acetone extract of *S. wightii* showed the highest AB score (12). The strongest AF score (11) was recorded for *G. corticata* (chloroform, EA, and acetone extracts), *S. wightii* (acetone extract), and *U. fasciata* (EA and DCM extracts). The maximum composite score (23), reflecting both antibacterial and antibiofilm activities, was achieved by the acetone extract of *S. wightii*. These findings underscore the potential of seaweed-derived compounds as dual-action agents capable of suppressing bacterial growth as well as initial adhesion, thereby offering an effective strategy to mitigate biofouling. Further purification and characterisation of the active constituents are warranted to advance their application in environmentally sustainable antifouling coatings and marine infrastructure protection.

Keywords

Acetone extract, Biofilm bacteria, MIC, Seaweed-derived compounds, Tropical macroalgae

Aloe vera peel extract edible coating for extending the shelf-life of Indian Mackerel (*Rastrelliger kanagurta*) under iced storage

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Aloe vera is a medicinal herb, and its peels are generated as waste following the extraction of gel for pharmaceutical and cosmetic applications. The present study evaluated the potential of Aloe vera peel waste for developing an edible coating for seafood applications and investigated the efficacy of Aloe vera peel extract (AVP) coating on the quality and shelf-life of Indian mackerel under iced conditions. Fresh Indian mackerel were divided into five groups and coated with Aloe vera peel extract (AVP) edible coatings at varying concentrations: 0.5, 1, 1.5, and 2% (w/v), along with an uncoated control (C). The sensory, biochemical, and microbiological quality of the samples was evaluated over 12 days under iced storage conditions. By the end of the 6th day of storage, free fatty acids (FFA) and peroxide value (PV) were significantly higher ($p < 0.05$) in the control and AVP 0.5% samples, whereas AVP coatings at 1, 1.5, and 2% maintained significantly lower levels. By the end of the 9th day, control samples showed significantly higher ($p < 0.05$) values of pH, drip loss, total volatile basic nitrogen (TVB-N), trimethylamine nitrogen (TMA-N), and total viable plate count (TPC) compared to AVP-treated samples. Aloe vera peel extract demonstrated antioxidant properties, and among the treated groups, AVP 1 and 1.5% achieved higher sensory scores compared to the control. The study demonstrates that AVP 1% can serve as an effective natural edible coating for extending the shelf-life of Indian mackerel under iced storage conditions. Valorising Aloe vera peel waste for the development of edible coatings and their use as natural seafood preservatives offers a sustainable alternative to synthetic additives, promoting both food safety and environmentally responsible practices.

Keywords

Food safety, Natural antioxidant, Seafood spoilage, Waste valorisation



***Bacillus aryabhatai*: A promising agent for eco-friendly and sustainable marine fish waste management**

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Marine fisheries and seafood processing industries generate substantial quantities of fishery waste, and improper disposal of such nutrient-rich organic waste contributes significantly to coastal pollution, eutrophication, and greenhouse gas emissions, posing serious environmental and public health concerns. Further, the demand for sustainable circular economy practices also necessitates efficient, cost-effective, and eco-friendly waste management strategies. In this context, composting using beneficial microbes is a promising alternative to conventional methods such as landfilling and incineration. Accordingly, twenty-five bacterial strains, which were originally isolated from marine fish waste, were screened in the present study for their metabolic competence in marine fish waste management. Among the tested 25 isolates, one isolate, named F25B, showed very good activities in the screening assays for sulphur oxidation, fish protein hydrolysis (enzyme index value 1.2), and chitin degradation (enzyme index value 2), which are the three key properties required in marine fish waste management. The identification of the bacterium by, polyphasic taxonomic approach showed that the isolate was *Bacillus aryabhatai*, and the isolate was deposited in the Microbial Type Culture Collection and Gene Bank (MTCC) under the unique ID. Laboratory-scale composting experiments demonstrated that inoculation with *B. aryabhatai* CMFRI/F25B accelerated the degradation of marine fish waste (*Saurida tumbil*), resulting in a significant reduction in waste volume and faster stabilisation. Further, there were 3.39 g of sulphate production and 66.97 g free amino acid release per kg of fish waste using this isolate under aerobic degradation conditions within 10 days. Application of the bacterium in unprocessed crab shell waste (*Charybdis lucifera*) resulted in 60% of weight loss of the shells, with 220 mg kg⁻¹ reducing sugar release. In conclusion, the results showed that *B. aryabhatai* holds a significant promise as a key agent in microbial bioremediation strategies for marine fish waste composting, supporting eco-friendly waste management and resource recovery in the marine sector. Further, the result warrants future research into genetic improvement of *B. aryabhatai* CMFRI/F25B and formulation of a consortium incorporating the strain for targeted biodegradation applications.

Keywords

Bioconversion, Composting, Microbial degradation, Organic fertilizer, Waste composting



Liquid smoke: A new approach to food preservation

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Liquid smoke is a smoke concentrate that adds a smoky flavour without traditional smoking methods. It is practical, cost-effective, easy to apply, and has less environmental impact than conventional techniques. To assure food safety, liquid smoke is manufactured utilising techniques that remove hazardous compounds such as polycyclic aromatic hydrocarbons (PAH) from the finished product. Liquid smoke has antibacterial and antioxidant characteristics, due to its phenolic components, organic acids, and carbonyls, preventing microbial growth and lipid oxidation. These characteristics improve food safety, preserve sensory attributes, and increase the shelf-life of fish products. Additionally, the controlled use of liquid smoke ensures consistency in processing and adaptability for a variety of fish species and products, including smoked fish, fillets, and surimi. This paper examines the sources and production of liquid smoke, its antimicrobial, therapeutic benefits, with a focus on its function in sustainable and consumer-friendly food preservation.

Keywords

Antimicrobial, Antioxidant, Food safety, Polycyclic aromatic hydrocarbons (PAH), Preservation



Attenuation of dyslipidemia by a microalgal sulphated polysaccharide: Mechanisms of cholesterol regulation in a Caco-2 cell model

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Dyslipidemia, characterised by elevated cholesterol and triglyceride levels, is a key risk factor for cardiovascular diseases. Although statins and synthetic lipase inhibitors are effective in lipid control, their long-term use is associated with side effects and reduced patient compliance, highlighting the need for natural, safe, and sustainable therapeutic alternatives. Microalgae are gaining global attention as sustainable sources of bioactive compounds with applications in functional foods and nutraceuticals. *Arthrospira platensis* (Spirulina), a well-known edible cyanobacterium, produces sulphated polysaccharides with diverse biological activities, including potential lipid-regulatory effects. Microalgae-derived polysaccharides represent an untapped resource for the development of cholesterol-lowering formulations. Investigating their mechanisms of action could enable the discovery of multifunctional bioactives that align with the growing demand for natural health products. The study aimed to isolate and characterise a sulphated polysaccharide from *A. platensis* and evaluate its antidyslipidemic activity through enzyme inhibition and cellular assays, with a focus on key pathways involved in lipid regulation. A sulphated polysaccharide, designated as APP-3, was isolated from *A. platensis* initially showed potent inhibition of HMGCR (IC_{50} : 0.92 mg ml⁻¹) and pancreatic lipase (IC_{50} : 37.25 µg ml⁻¹). In oleic acid-induced Caco-2 cells, APP-3 (6.25–25 µg ml⁻¹) downregulated HMGCR expression by 11–31% and significantly reduced intracellular triglycerides by 6–42% ($p < 0.05$). Confocal imaging revealed a 2–44% reduction in cholesterol uptake, closely comparable to the standard. Additionally, administration of APP-3 significantly decreased ApoB expression by 10.75 to 6.98-fold in a dose-dependent manner. These outcomes highlight that APP-3 interacts with lipid regulatory pathways through its sulphate moieties and distinct monosaccharide composition, promoting multiple lipid-lowering mechanisms. APP-3 represents a sustainable, microalgae-derived sulphated polysaccharide with strong potential for functional food and nutraceutical applications in dyslipidemia management. Future work on *in vivo* validation, formulation optimisation, and scalable production will support its translation into commercial products, contributing to global preventive healthcare and the management of lifestyle-related metabolic disorders

Keywords

Antidyslipidemic activity, ApoB expression, *Arthrospira platensis*, Functional food, Spirulina



A promising (1→4)-linked glucuronoglucan from *Perna indica* Kuriakose & Nair, 1976, as a therapeutic nutraceutical for managing inflammation and dyslipidemia

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Native to the southwest coast of India, the brown mussel *Perna indica*, is harvested for its high nutritional content and potential health benefits. The present study focused on the potential of PIP-1, a (1→4)-linked glucuronoglucan composed of repeating β -D-glucose (GlcP) and α -D-glucuronic acid (GlcAp) units, isolated from the brown mussel *P. indica*, in alleviating chronic diseases. PIP-1 exhibited strong anti-inflammatory effects by suppressing 5-lipoxygenase (5-LOX) and cyclooxygenases (COXs), showing an IC_{50} of ≤ 1.5 mg ml⁻¹. It demonstrated a preference for COX-2 and also reduced nitric oxide levels in lipopolysaccharide-induced macrophages with an IC_{50} of 2.9 μ g ml⁻¹. In animal models, a higher dosage of PIP-1 led to a 91% reduction in acute carrageenan-induced paw edema within 5 h, and a 77% reduction in chronic formalin-induced paw edema by the tenth day. PIP-1 exerted its potent anticholesterolemic activity by blocking 3-hydroxy-3-methylglutaryl-CoA reductase (IC_{50} 0.86 mg ml⁻¹) and reducing triglyceride levels by 8-54% in experiments using Caco-2 cells. In dyslipidemic rats, PIP-1 produced a rapid 68% reduction in total cholesterol and a 25% reduction in triglycerides within 48 h. During a 45-day chronic study, the reductions were 19% for cholesterol and 46% for triglycerides. PIP-1's therapeutic potential stems from structural features like its electronegative groups and large polar surface area, which enable it to interact with receptors through van der Waals forces and modulate metabolic pathways. These properties confer potent anti-inflammatory and anti-dyslipidemic effects, highlighting its potential as a promising source for nutraceuticals aimed at alleviating chronic diseases.

Keywords

Anticholesterolemic effect, Chronic ailments, Edible brown mussel, Functional foods, Therapeutic potential

Storage stability and predictive shelf-life modelling of IQF dusted squid rings

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Standardising processing protocols for frozen seafood products is essential to ensure consistent quality, safety, and extended shelf-life. The shelf-life of frozen fish products is influenced by processing methods, packaging, storage conditions, and species-specific characteristics. To address exporters' demand for reliable shelf-life evaluation of frozen commodities, the present study focused on individually quick frozen (IQF) dusted squid rings, procured from a commercial seafood processor in Kochi. Samples were stored under frozen (-18°C and -8°C) and chilled (2°C and 12°C) conditions to evaluate quality attributes through both conventional and accelerated storage studies. Proximate composition analysis indicated moisture ($75.21 \pm 0.31\%$), protein ($9.68 \pm 0.00\%$), fat ($0.14 \pm 0.09\%$), and ash ($1.51 \pm 0.02\%$) contents. Lipid oxidation, assessed by thio barbituric acid (TBA) values, was more pronounced at 12°C compared to 2°C , though values remained within acceptable limits. Total volatile base nitrogen (TVBN) and trimethylamine (TMA) concentrations were also within permissible levels. pH declined from 6.36 to 5.25 (2°C) and 6.46 to 4.77 (12°C), reflecting microbial spoilage, while colourimetric analysis revealed increased lightness (L^*) and yellowness. Microbiological assessment confirmed spoilage progression, with sensorial acceptability retained up to 13 days at 2°C , whereas samples stored at 12°C were rejected on the 6th day. Predictive modelling studies were further undertaken to estimate shelf-life under commercial storage scenarios. The findings highlight the utility of combining accelerated storage studies with predictive modelling to generate baseline data, optimise storage conditions, and develop standardised protocols for commercially important frozen seafood products.

Keywords

Accelerated storage, Individually quick frozen, Predictive modelling, Shelf-life prediction, Storage stability



Isolation and physicochemical characterisation of natural pigments from the Asian green mussel *Perna viridis*

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Marine organisms are increasingly recognised as reservoirs of bioactive compounds with considerable ecological, industrial, and biomedical relevance. Among these, natural pigments from molluscan species have attracted attention as sustainable, eco-friendly alternatives to synthetic dyes. Mussels, representing one of the most abundant molluscan groups, are not only valuable as aquaculture resources but also as sources of structurally diverse biomolecules. The present study reports the isolation, purification, and physicochemical characterisation of a natural pigment extracted from the bivalve *Perna viridis* (Linnaeus, 1758), an economically and ecologically important species distributed throughout the Indo-Pacific waters. Pigments were extracted using an alkaline-based protocol and subjected to purification steps before a comprehensive analytical investigation, including UV-VIS-NIR, FTIR, TLC, GC-MS, LC-MS, and HPLC, which provided both qualitative and quantitative characterisation. Together, these methods established a robust physicochemical profile of the *P. viridis* pigment, revealing unique spectral and compositional attributes that distinguish it from other molluscan pigment sources. This investigation represents one of the first systematic efforts to characterise bio-pigments from indigenous *P. viridis*, thereby contributing to the expanding chemical knowledge of marine invertebrate metabolites. By focusing on rigorous isolation and multimodal characterisation, this work establishes a foundation for subsequent studies into the bioactivity, functional roles, and potential applications of *P. viridis* pigments in pharmaceuticals, nutraceuticals, and sustainable biomaterials. Ultimately, the study underscores the value of indigenous marine resources as renewable reservoirs of natural compounds and strengthens the basis for their future exploration within marine biotechnology and biomaterial innovation.

Keywords

Analytical investigation, Biomolecules, Eco-friendly alternatives, Marine biotechnology, Renewable reservoirs



Development of a nanoengineered bioink from processing discards for electromagnetic shielding

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The increasing proliferation of wireless technologies and radiation-based therapies has intensified the need for sustainable electromagnetic interference (EMI) shielding materials. Conventional metallic shields, though effective, are limited by weight, corrosion, and poor environmental compatibility. Marine processing industries generate substantial volumes of biological wastes such as skis, scales, shells, and pigment-rich residues, that remain largely underutilised despite their richness in functional biomolecules and pigments. In this work, we demonstrate the valorisation of such marine waste into a printable bioink with intrinsic electronic and dielectric functionalities. The formulated bioink exhibits tunable conductivity and strong EMI shielding performance across broad frequency ranges, supported by multiple mechanisms including absorption, interfacial polarisation, and minimal reflection. The conjugated structure of functional moieties not only enhanced shielding but also provided low cytotoxicity and favourable cutaneous tissue compatibility, making it suitable for both environmental and biomedical applications. By transforming marine waste into high-value functional bioinks, this study establishes a circular bioeconomy approach for green, lightweight, and adaptable EMI shielding solutions with relevance to environmental protection and radiation therapy.

Keywords

Circular bioeconomy, EMI shielding, Environmental protection, Marine biomolecules, Valorisation



Discovery and characterisation of efficient phosphate-solubilising bacteria for enhanced soil fertility

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Phosphorus is an essential macronutrient in plant energy transfer, signal transduction, and macromolecular biosynthesis. Marine fish waste is a rich source of organic and inorganic phosphorus derived from bones, scales, and tissues. When properly processed, this waste can be transformed into a valuable phosphorus-rich biofertiliser for agricultural use, for which the use of phosphate-solubilising bacteria (PSB) is required. PSBs enhance phosphorus bioavailability from marine fish waste by secreting organic acids and enzymes that convert insoluble phosphate into plant-accessible form, supporting sustainable agriculture and promoting a sustainable, low-cost, and eco-friendly marine fish waste recycling approach. In this context, the present study aimed to evaluate the metabolic potential of selected bacterial strains from the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) marine microbial culture collection for their phosphate-solubilising capacity. Screening on Pikovskaya's agar identified four PSBs based on the formation of clear halo zones, indicating the release of soluble phosphate. The enzymatic index was recorded as 1.25 to 1.8. Quantitative evaluation by the molybdenum blue method showed the isolates could produce soluble phosphorus at a rate of 162 to 1300 mg l⁻¹ in Pikovskaya's broth within seven days. It is worth mentioning that one isolate termed as CMFRI/AH21 could produce 795 mg l⁻¹ soluble phosphorus within 24 h of incubation. When the strains were screened for indole-3-acetic acid (IAA) production using Salkowski's reagent, the isolates were able to produce 40 to 100 µg ml⁻¹ even without tryptophan supplementation. The production was increased up to 140 to 730 µg ml⁻¹ with tryptophan supplementation (1 mg ml⁻¹). Production of IAA, a key auxin by PSB, further emphasises their potential in sustainable and low-input agriculture by enhancing root development and stress tolerance of the plants. Polyphasic taxonomic characterisation identified the isolates as *Bacillus subtilis*, *Bacillus amyloliquefaciens*, and *Priestia megaterium*. Genetic analysis by targeted gene PCR approach revealed the presence of key phosphate metabolism genes (*phytase* and *phoD*) in these isolates, supporting their functional potential in phosphorus solubilisation. The findings highlight the promise of these bacterial strains as candidates for biofertiliser development and sustainable fish waste management. Further research is required to optimise their application in marine fish waste management.

Keywords

Biofertilizer, CMFRI/AH2, Fish waste management, Phosphate metabolism



Green conversion of *Perna viridis* shell waste into monetite (dicalcium phosphate): Advancing circular bioeconomy initiatives

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The global reliance on calcium phosphate biomaterials in orthopedics, dentistry, and regenerative medicine has intensified the demand for sustainable and low-cost production strategies. Among the various phases, dicalcium phosphate anhydrous (monetite) is particularly valued for its osteoconductivity, bioresorbability, and ability to serve as a precursor for advanced bone graft substitutes. The conventional synthesis of monetite often relies on high-purity precursors and energy-intensive processes, raising concerns about cost, scalability, and environmental impact. Marine shell waste, generated in vast quantities by the aquaculture and seafood industries, represents an underutilised reservoir of biogenic calcium carbonate. In this study, discarded shells of the green mussel *Perna viridis* were upcycled into monetite via a straightforward and low-energy reaction between shell-derived CaCO_3 and phosphoric acid. Structural and morphological characteristics were investigated using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), FT Raman spectroscopy, scanning electron microscopy (SEM), and thermal analysis, which confirmed the phase purity and crystallinity. The findings highlight mussel shells as an abundant, renewable, and cost-effective source of calcium that can replace conventional raw materials for the synthesis of calcium phosphate. Beyond producing high-performance biomaterials, this approach simultaneously addresses the pressing issue of molluscan shell waste management through a circular bioeconomy framework. By coupling environmental remediation with value-added material production, this work establishes a scalable green route for monetite synthesis with direct implications for sustainable materials science, biomedical engineering, and industrial ecology.

Keywords

Biomaterial, Calcium phosphate, Circular bioeconomy, Green mussel, Molluscan shell



Predictive modelling of growth in farmed *Penaeus (Litopenaeus) vannamei* using machine learning approaches

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Shrimp farming is a central component of India's aquaculture economy; however, challenges in feed efficiency, stocking density, and growth variability hinder its sustainability. This study applied machine learning to predict the average body weight (ABW) of *Penaeus (Litopenaeus) vannamei* using real farm datasets from Kerala. Eight models were evaluated, with XGBoost providing the best trade-off between accuracy and interpretability. Growth drivers, including days of culture, cumulative feed, and stocking density, were identified as key predictors. To translate results into practice, we developed *Growvannamei*, a prototype web-based application integrating XGBoost to predict shrimp growth and optimise feeding schedules. This demonstrates the role of AI-driven decision-support systems in improving farm productivity and sustainability.

Keywords

Average body weight, Shrimp growth, Stocking density, Web-based application, XGBoost



A promising marine microbe as a source for enzymatic seaweed saccharification

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Bioethanol production from seaweed represents a sustainable and eco-friendly alternative to fossil fuels, meeting growing energy demands while mitigating environmental challenges. Unlike land-based crops, seaweed cultivation requires neither arable land, freshwater, nor fertilizers, making it a promising feedstock for next-generation bioethanol production. A critical step in this process is the enzymatic saccharification of seaweed biomass, where marine microbes offer significant potential due to their unique enzymatic collections. In this study, marine sediment samples were collected from 100 m depth in the continental shelf to the upper slope of the Lakshadweep region (10°06.569" N; 075°40.189" E) using a sterile grab sampler and transported at 4°C for immediate processing. Samples were serially diluted and cultured on Zobell Marine Agar (3.5% NaCl, 7.5 to 8.0 pH, 28±2°C) to mimic the natural environmental conditions of the sampling site. Morphologically distinct colonies were isolated and purified. Nine isolates exhibited clearance zones on agar plates supplemented with algal polysaccharides (xylan, cellulose, carrageenan, laminarin, starch, sodium alginate), suggesting potential seaweed-saccharifying activity. Culture supernatants of these nine strains were then evaluated for their ability to hydrolyze tropical seaweed biomass. Six species representing major tropical seaweed groups, *Ulva lactuca* (green seaweed), *Kappaphycus alvarezii*, *Dawsoniolithon conicum*, and *Gratulopia* sp. (red seaweeds), as well as *Padina crassa*, and *Sargassum* sp. (brown seaweeds), were tested, and reducing sugars were quantified by the dinitrosalicylic acid assay. Among them, isolate CMFRI/LA100-11 exhibited the highest hydrolytic efficiency, achieving biomass conversion of 34.12% (*P. crassa*), 33.02% (*Sargassum* sp.), 31.64% (*Gratulopia* sp.), 29.60% (*K. alvarezii*), 26.79% (*D. conicum*), and 25.90% (*U. lactuca*), all surpassing previously reported values. The enzymatic index of this isolate on polysaccharide-embedded agar plates was recorded as: xylan (2.0), cellulose (3.33), carrageenan (0), laminarin (1.05), starch (2.71), and sodium alginate (3.4). The strong activity of sodium alginate correlated with the high conversion efficiency observed in brown seaweeds. Molecular identification using 16S rRNA sequencing confirmed the isolate as belonging to the genus *Stenotrophomonas*; species-level identification is in progress. This study highlights *Stenotrophomonas* sp. CMFRI/LA100-11 is a promising marine bacterium for the enzymatic saccharification of seaweed, offering potential for efficient and sustainable bioethanol production.

Keywords

Bioethanol, Brown seaweed, Enzymatic activity, *Stenotrophomonas* sp.

Development and optimisation of pearl millet and fish-based extruded snack food, using Response Surface Methodology

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The rising preference for convenient, healthy, and functional foods has accelerated innovation in extruded snack development. Millets, declared as “Nutri-cereals” by FAO, are high in dietary fibre, protein, and bioactive compounds with a lower glycaemic index (GI-55) than rice (82.57) and wheat (64.25), making them suitable for those with diabetes and celiac diseases. In contrast, seafood contains high-quality proteins, necessary amino acids, and polyunsaturated fatty acids (PUFAs). Their integration into extruded snacks offers a sustainable approach to enrich nutrition, diversify the value chain, and address Sustainable Development Goal (SDG-2), providing safe and protein-rich products for children and nutritionally vulnerable populations. The present study employed a D-optimal mixture response surface design to optimise feed composition and process variables. Independent variables included pearl millet (50–70%), fish mince (5–20%), rice (10–25%), maize (10–20%), barrel temperature (110–150 °C), and screw speed (300–400 rpm). Their effects on the product quality were evaluated through response parameters (dependent variables) such as expansion ratio (ER), bulk density (BD), texture (shear strength), protein content, overall acceptability (OA), and water solubility index (WSI). Optimisation revealed that a formulation containing 70% pearl millet, 20% fish mince, 5% rice, and 5% maize, extruded at 400 rpm screw speed and 150°C barrel temperature with 14% moisture, yielded superior product quality attributes with an expansion ratio of 3.54 mm, bulk density of 0.094 g cm⁻³, protein content of 17.67%, overall acceptability score of 8.27, water solubility index of 35.69%, and an overall desirability of 0.966. Validation outcomes closely aligned with predicted values, confirming model adequacy. The developed products represent a promising value-added option with high protein content, favourable expansion, and acceptable texture. It highlights their potential as functional, ready-to-eat snacks that strengthen millet and seafood value chains while addressing nutritional security challenges in line with SDG-2.

Keywords

High-quality proteins, Low glycaemic index, Nutritional security, SDG-2

Brown seaweed-derived cellulose nanocrystals as a renewable nanofiller for fish fillet packaging

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The escalating environmental crisis caused by petroleum-based plastics has intensified the search for sustainable alternatives to packaging. This study explored the potential of brown seaweed *Sargassum myriocystum* harvested from the Gulf of Mannar region, Tamil Nadu, as a renewable resource for deriving high-value nanomaterials such as cellulose nanocrystals (CNC). The extracted CNC exhibited good thermal properties with a T_{on} of 134°C and reaching a T_{max} value of 248.4°C, indicating its thermal resistance and a high negative zeta potential of -37.5 mV, confirming excellent colloidal stability to enhance its mechanical and barrier qualities, serving as nanofillers in the food packaging sector. A nanocomposite film was prepared via the solution casting method by incorporating seaweed-derived CNCs as nanofillers. The mechanical performance of the nanocomposite film was evaluated and compared to a control film without CNCs. The tensile strength surged from 8.29±3.2 kgf cm⁻² to 10.91±2.4 kgf cm⁻² when it was incorporated with 1% (w/w) CNC. This improvement demonstrated that the seaweed CNC particles are superior reinforcing nanofillers, greatly enhancing the film's ability to withstand pulling forces. By maintaining freshness, particularly for fish and shrimp products, these reinforced nanocomposite films improve the critical properties to prevent moisture loss and microbial spoilage, showing great promise for seafood packaging. This adoption of nanomaterials from sustainable resources not only promotes waste valorisation and circular economy goals but also strengthens the marine and natural resource value chain for sustainable livelihoods.

Keywords

Colloidal stability, GTensile strength, Nanocomposite film, *Sargassum myriocystum*



Application of chitin and chitosan extracted from the shells of marine bycatch brachyuran crabs for water treatment in aquaculture

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Brachyuran crab shells serve as a valuable yet underutilised resource for chitin extraction, which can be further converted into chitosan, a biopolymer with wide-ranging applications in agriculture, biotechnology, and pharmacology. The present study aimed at the extraction and estimation of chitin and chitosan from shell waste of certain marine bycatch brachyuran crab species, and to prove its efficacy in the treatment or purification of used water in aquaculture, aiming to promote it as an environmentally friendly approach to waste utilisation and its sustainable environmental application in water treatment. The extraction of chitin from discarded crab exoskeletons yielded 35.76%, whereas chitosan yield was 66.56% from the previously extracted chitin. The chitosan that was extracted underwent a comprehensive assessment to determine its efficacy in the treatment of used water from brackishwater aquaculture. A spectrum of concentrations (ranging from 5 g l⁻¹ to 25 g l⁻¹, designated as CS1–CS5) was systematically evaluated, indicating substantial enhancements in water quality metrics concomitant with elevated doses of chitosan. The concentration of dissolved oxygen (DO) increased from 3.1 mg l⁻¹ in the untreated wastewater to 5 mg l⁻¹ at CS5, which can be attributed to a reduction in organic load and an augmentation of microbial activity. The pH values exhibited a decline from 8.16 in the untreated samples, progressively diminishing with increased chitosan concentrations, thus implying acid-base neutralisation processes and potential protonation effects associated with chitosan. Nutrient contaminants, including ammonia, nitrite, phosphate, and nitrate, were observed to decrease significantly. Ammonia levels decreased from 4.96 mg l⁻¹ (NWW) to negligible concentrations in CS5, accompanied by a corresponding rise in removal efficiency. Concentrations of nitrite and phosphate were markedly diminished, with CS5 exhibiting the most pronounced reduction (over 50% for nitrite and a substantial decrease in phosphate levels). Notably, nitrate concentrations were reduced to below detectable limits (BDL) in all samples treated with chitosan, thereby illustrating the pronounced affinity of chitosan for nitrogenous species. Total dissolved solids (TDS) and electrical conductivity (EC) exhibited moderate reductions. Chitosan application markedly enhances water quality by elevating dissolved oxygen levels, reducing pH, and eliminating critical contaminants such as ammonia, nitrite, phosphate, and nitrate; thus, enhancing the quality of used water from aquaculture.

Keywords

Acid-base neutralisation, Biopolymer, Total dissolved solids, Waste utilisation



Impact of PEGylation on cupric oxide nanoparticles: Modulation of anticancer activity with unaltered antimicrobial properties

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Previous studies have suggested that polyethylene glycol (PEG) coating enhances the antibacterial and anticancer properties of nanoparticles. However, no proper research evidence is available comparing cupric oxide nanoparticles (CuO-NPs) and cupric oxide bulk particles (CuO-BPs) with PEG coating. Therefore, in the present study, CuO-NPs, CuO-BPs, PEGylated CuO-NPs, and PEGylated CuO-BPs were synthesised by the sol-gel method, and the nano and bulk size was confirmed by various nanotechnological techniques such as UV-spectra, Dynamic light scattering (DLS), Fourier Transform Infrared (FTIR), and scanning electron microscopy (SEM). Their antibacterial activity was checked by minimum inhibitory concentration (MIC). Anticancer and cytotoxic effects were then evaluated in MCF-7 and L-929 cell lines, respectively. The study revealed that there is a clear distinction in the antibacterial and anticancer activities between CuO-NPs and CuO-BPs, with CuO-NPs exhibiting stronger antimicrobial and anticancer properties. Ironically, PEG coating had no impact on antibacterial activity; in addition, it notably reduced anticancer effects by lowering cytotoxicity. This result contradicts earlier studies that reported PEG-enhanced anticancer activity. The study highlighted that discrepancy arises because PEG's benefits are primarily reported *in vivo*, where it aids nanoparticles in evading phagocytosis, allowing them to stay longer in the body and boosting anticancer effects. In contrast, *in vitro* assays do not involve phagocytosis, so the enhanced anticancer activity could not be observed in this study.

Keywords

Antibacterial activity, Anticancer effects, Nanotechnological techniques, Phagocytosis, Polyethylene glycol



Optimisation of extraction conditions for protein hydrolysate from pink perch head waste generated during surimi processing using Response Surface Methodology and its characterisation

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The study aimed to optimise the enzymatic extraction conditions using response surface methodology (RSM) to maximise fish protein hydrolysate (FPH) from pink perch head waste during surimi processing, which is commonly used for fish meal production. Central composite design (CCD) was employed to explore the direct and combined effects of four input variables: enzyme concentration (0.25, 0.63, 1%), extraction time (60, 90, 120 min), temperature (45, 55, 65 °C), and pH (6, 7, 8) on yield (dry weight basis). A quadratic model was fitted to the protein yield, achieving an R^2 value of 0.97. Based on the fitted model and predicted response values, the optimal conditions for maximum yield were an enzyme concentration of 0.80%, an extraction time of 110 min, a temperature of 55°C, and a pH of 6.11. Under these conditions, the predicted FPH yield was 7.97% on dry weight basis from pink perch head waste. The proximate analysis revealed $17.79 \pm 0.15\%$ protein and $0.133 \pm 0.005\%$ fat (on wet weight basis), indicating high quality. The amino acid profile showed that FPH contained 17 amino acids, with essential amino acids constituting about 41% of the total. Mineral analysis indicated that Na ($3,869.00 \pm 11.89$ ppm) was the primary mineral. Structural analyses, including SEM, DSC, MALDI-TOF, and XRD, alongside assessments of functional properties such as solubility, emulsifying activity index (EAI), emulsifying stability index (ESI), foaming characteristics, and water and oil absorption capacities, were conducted. Additionally, antioxidant properties, including DPPH, FRAP, and total phenolic content, were evaluated. The findings demonstrated that FPH derived from pink perch head waste during surimi processing could serve as a valuable source of protein supplements or functional ingredients in the development of high-value products.

Keywords

Antioxidant properties, Central composite design, Functional properties, Proximate analysis



Role of seaweeds as functional additives in aquaculture

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Seaweeds or macroalgae, are nutrient-rich marine resources classified into three groups: Rhodophyta (red), Chlorophyta (green), and Phaeophyceae (brown). They are dense in proteins, vitamins, minerals, polyunsaturated fatty acids, polysaccharides, and antioxidants, yet low in calories. Seaweeds also offer valuable bioactive compounds, such as polyphenols and pigments, making them important in the food, pharmaceutical, aquaculture, and biofuel industries. In aquaculture, they function as feed additives, immune boosters, water purifiers, and bioremediation agents. Brown seaweeds, such as kelps, are the most widespread and are characterised by the presence of the pigment fucoxanthin. Red seaweeds, rich in phycoerythrins, predominantly occur in marine environments, whereas green seaweeds, dominated by chlorophyll, are typically found in coastal and shallow waters. Global seaweed production reached 38 million t in 2022, with 97% derived from aquaculture, marking a threefold increase since 2000. Asia dominates, with China producing 60%, Indonesia 25%, the Republic of Korea 5%, and the Philippines 4%. India ranks as the second-largest fish producer globally, contributing 8% of total output, with production estimated at 18.40 million t in 2023-24. The country harbours 844 seaweed species, around 60 of which have commercial importance, highlighting potential for seaweed-based industries. Fish species commonly studied for seaweed supplementation include rainbow trout, channel catfish, tilapia, and common carp, due to their global cultivation, nutritional requirements, and economic relevance. The advantages of seaweed supplementation in fish feed include enhanced digestion and nutrient absorption, improved feed efficiency, immune stimulation, antimicrobial and antiviral effects, antioxidant protection, and gut health benefits. They also provide essential nutrients, reduce cholesterol, and serve as sustainable feed alternatives to fishmeal. Additionally, seaweed improves water quality and reduces environmental impact in integrated aquaculture. However, gaps remain, including variability in species composition, optimal inclusion levels, anti-nutritional factors, long-term health effects, supply limitations, and economic feasibility. Addressing these challenges requires further research on sustainable large-scale cultivation and the formulation of feed. The potential of seaweed in aquaculture is significant for promoting fish growth, boosting disease resistance, providing nutritional enrichment, minimising environmental harm, and reducing feed expenses. Its incorporation into aquafeeds represents a sustainable approach to achieving global food security and advancing marine biotechnology.

Keywords

Fish feed, Growth, Immune stimulation, Integrated aquaculture, Macroalgae, Sustainability



Robustness of mixture experiments against missing observations: A case study from fish nutritional trials

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Mixture experiments are widely used in fisheries and aquaculture research to study how varying proportions of feed ingredients, nutrient supplements, or culture conditions influence biological outcomes and product quality. Traditional approaches, such as One-Factor-at-a-Time (OFAT), are limited, as they fail to capture component interactions and explore only narrow experimental regions. While factorial experiments can identify main and interaction effects, they do not provide optimal factor settings for desired responses. Mixture experiments overcome these limitations by treating factors as proportions of components in a mixture, with Simplex Lattice, Simplex Centroid, and Extreme Vertex designs being the most common. However, fisheries trials often face missing observations due to resource constraints, infeasible factor combinations, or high experimental costs. Missing data alters the design matrix structure, affecting analysis of variance and reducing efficiency. A design that maintains reliability under such conditions is considered robust to missing observations. This study investigates the robustness of augmented Simplex Centroid designs against missing observations and quantifies efficiency loss when observations are absent at different design points. Results highlight the importance of adopting robust design strategies in fisheries nutrition trials, where experiments are frequently resource-limited and prone to data loss.

Keywords

Augmented Simplex Centroid Designs, Design robustness, Loss of design efficiency, Mixture designs



Evaluation of thermal, physical, and nutritional characteristics of ready-to-drink multi-millet soup incorporated with tuna (*Thunnus albacares*) chunks

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This study focused on the development of a shelf-stable, ready-to-drink multi-millet soup, prepared using pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*), and sorghum (*Sorghum bicolor*) in the ratio 3:1:1, respectively. The soup was thermally processed in retort pouches at F_0 values 6, 7, 8, and 9 to analyse the effect of sterilisation on the physical and nutritional quality of the soup. Additionally, the flour-to-water ratio was maintained at 1:16, 1:18, and 1:20 for each F_0 value. The sample processed at an F_0 value of 8 with the flour-to-water ratio, 1:18 was identified as sensorily more acceptable, possessing the desirable consistency of a thick, creamy soup. The protein content of the soup was enhanced by the incorporation of tuna (*Thunnus albacares*) chunks at levels of 0, 10, 25, and 50% into the optimised control formulation. The four different formulations were named as S_0 , S_{10} , S_{25} , and S_{50} , respectively. The lowest total process time was for the control sample, S_0 . The viscosity of the samples was affected by retort processing and the addition of tuna meat. The control sample (S_0) recorded the highest viscosity at 280 cP before processing, which slightly decreased to 220 cP after retorting. A decrease in the lightness value of the samples was observed before and after thermal processing. All processed samples were found to be commercially sterile, confirming product safety and shelf stability. The study demonstrates the potential for producing a high-protein, ready-to-drink, multi-millet soup using retort processing, offering a healthy and convenient meal option.

Keywords

Flour-to-water ratio, Lightness value, Process time, Retort processing, Viscosity



Metagenomic insights into microbiome shifts in air-packed and vacuum-packed Indian mackerel stored at different temperatures

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Metagenomics, a culture-independent approach, employs a faster and more comprehensive understanding of spoilage microbiome composition and dynamics of fish under various conditions. To develop an effective strategy to mitigate microbial spoilage in fish and fishery products, it is essential to identify and characterize both the dominant and subdominant microflora responsible for spoilage. Thus, in this study, microbiome variations in both air packed (T1M, T2M, T3M) and vacuum-packed (T4M, T5M, T6M) Indian mackerel (*Rastrelliger kanagurta*) stored at three different temperature such as $0\pm 2^{\circ}\text{C}$ (iced), $5\pm 2^{\circ}\text{C}$ (chilled) and $30\pm 2^{\circ}\text{C}$ (abused) were analysed by employing metagenomics with Oxford Nanopore Technologies (ONT) covering V1-V9 region of 16S rRNA. Followed by the packaging and storage at different temperatures, samples were drawn for DNA extraction on the day they surpassed the threshold limit of spoilage by microbial analysis. Based on the microbiological count for mesophilic, psychrotrophic and psychrotrophic-anaerobic bacteria and physicochemical parameters such as Total Volatile Base Nitrogen (TVB-N) and Thiobarbituric Acid (TBA) values, the best shelf-life was observed in T4 (Vacuum+Iced), where fish remained acceptable up to 17 days, followed by T5 (Vacuum+Chilled) with a shelf-life of 15 days. Alpha diversity analysis of the bacterial community in Indian mackerel during spoilage highlighted the influence of storage conditions on bacterial composition. Beta diversity analysis using NMDS revealed a scattering pattern among the samples, indicating differences in microbial compositions across treatments. By comparing the bacterial diversity, the genus *Shewanella* sp. was predominant in both samples T1M, T3M, T4M, and T5M, whereas *Staphylococcus* sp. outnumbered in sample T2M, and *Cetobacterium* sp. in T6M. The comparative analysis of bacterial diversity revealed dominance of genera such as *Shewanella*, *Pseudomonas*, *Cetobacterium*, *Citrobacter*, *Burkholderia*, *Vibrio*, *Staphylococcus*, *Psychrobacter*, *Pseudoalteromonas*, and *Photobacterium*, while the predominant species were *Shewanella arctica*, *Shewanella aquimarina*, *Shewanella baltica*, *Shewanella glacialis*, *Gilliamella apicola*, and *Cetobacterium ceti*. Summing up, vacuum packaging combined with low-temperature storage was the most effective in preserving the biochemical quality and extending the shelf-life of Indian mackerel. The species distribution and abundance among the samples indicated the changes in bacterial flora contributing, spoilage at different temperatures, and it further signifies the chance of exploration in developing methods to control the predominant spoilage flora and thereby to extend the shelf-life of Indian mackerel.

Keywords

Bacterial community, Indian mackerel, Packaging, Shelf-life, Spoilage flora

Development and shelf-life assessment of surimi gel-based fish bait for longline fishing

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This research focused on developing surimi gel-based fish baits and assessing the shelf-life of the ideal developed bait viz., surimi gel-based fish bait with 5% grouper bio-attractant (SGB-GB). The study evaluated the alterations in its physiochemical structure and microbial changes of the SGB-GB during both refrigerated and ambient storage. It was observed that moisture content, water holding capacity (WHC), and folding test grades exhibited a decline, while the expressible moisture content (EMC) of SGB-GB demonstrated an upward trend as the duration of frozen storage increased. The total plate count (TPC) of SGB-GB significantly rose in baits stored at ambient temperature compared to those kept in refrigeration. Atomic Force Microscopy (AFM) illustrated the structural changes in the baits during frozen storage, indicating that the baits became irregular and loosened, resulting in a less smooth structure. This suggests that as the storage duration extends, the Ra value increases, thereby enhancing the rigidity of the bait and its hook holding capacity. The physical changes of the SGB-GB were assessed, revealing that weight loss and shrinkage (%) significantly increased in open conditions compared to closed conditions at ambient temperature. In contrast, baits stored under refrigeration showed no changes. Acceptability tests of surimi gel-based fish baits under frozen storage indicated a strong negative correlation among fish; however, baits stored at ambient temperature yielded poor results, spoiling within two days. The study concludes that although refrigerated stored surimi gel-based fish baits exhibited physiochemical changes in SGB-GB, it did not negatively affect the acceptability rate of the baits. Therefore, surimi gel-based fish bait with grouper bio-attractant (SGB-GB) can serve as an effective fish bait.

Keywords

Bio-attractant, Frozen storage, Hook holding capacity, Microbial analysis, Structural analysis



Seasonal variability in fatty acid and amino acid composition of the deep-sea shrimp *Penaeopsis jerryi* Pérez Farfante, 1979 from the Arabian Sea

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The fatty acid and amino acid composition of the deep-sea shrimp *Penaeopsis jerryi* from the Arabian Sea was investigated with emphasis on seasonal and sex-specific variations. A total of 18 fatty acids were detected in pre-monsoon specimens, whereas only 11 were present during the post-monsoon season. Palmitic acid (16:0), oleic acid (18:1n-9), and docosahexaenoic acid (22:6n-3, DHA) were the predominant saturated, monounsaturated, and polyunsaturated fatty acids, respectively, in both sexes across all seasons. Distinct seasonal changes were observed in the fatty acid composition of muscle tissue. Among saturated fatty acids, stearic acid exhibited a marked increase from pre- to post-monsoon in both males and females. Similarly, pentadecanoic acid and palmitic acid showed elevated levels in the post-monsoon season for both sexes. Among unsaturated fatty acids, palmitoleic acid, oleic acid, and eicosapentaenoic acid (EPA) increased from pre- to post-monsoon in males and females, whereas DHA levels declined in both sexes during the post-monsoon period. Seventeen amino acids, encompassing both essential and non-essential types, were identified in muscle tissue. Glutamic acid and lysine were the dominant non-essential and essential amino acids, respectively, and occurred at higher concentrations in both sexes during the pre-monsoon season. In contrast, post-monsoon males exhibited arginine and leucine as the most abundant non-essential and essential amino acids, while glycine and phenylalanine predominated in females. The amino acid composition demonstrates that *P. jerryi* is a protein-rich species with a favourable balance of essential to non-essential amino acids. These findings underscore the nutritional significance of this deep-sea shrimp, highlighting its potential as a valuable source of high-quality seafood

Keywords

Amino acids, Fatty acids, Seafood nutrition, Seasonal variation



Development of chickpea flour cookies enriched with spirulina as a novel functional snack

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The increasing demand for functional foods has prompted the incorporation of nutrient-dense ingredients into traditional bakery products. Spirulina (*Arthrospira platensis*), a blue-green microalga, is recognised for its high protein content, essential amino acids, vitamins, minerals, and bioactive compounds, while besan or chickpea (*Cicer arietinum*) flour is gluten-free in nature as well as rich in protein and fibre. The present study aimed to develop and evaluate besan–spirulina cookies as a novel, protein-enriched, and health-promoting bakery product. Different formulations were prepared by incorporating spirulina powder at varying concentrations (0, 2, and 5%) into besan-based cookie dough and the developed products were named as BC0, BC2, and BC5. The physiochemical, sensory, and nutritional properties were analysed, including proximate composition, baking loss, spread ratio, spread factor and consumer acceptability. Sensory evaluation revealed that cookies with 2% spirulina incorporation achieved the best balance of nutrition and palatability, whereas higher concentrations slightly affected flavour and colour acceptance. The incorporation of spirulina significantly enhanced the protein content and overall consumer acceptance. Cookies with 2% spirulina had a protein level of $12.101 \pm 0.05\%$, compared to $10.9 \pm 0.10\%$ in the control sample. The control sample exhibited higher spread ratio and spread factor values compared to spirulina-enriched cookies, as spirulina possesses water-holding capacity. Colour evaluation revealed noticeable differences between the besan cookies with 2% spirulina incorporation and the control cookies. The control cookies exhibited the typical golden-yellow appearance of baked besan products. In contrast, the addition of spirulina imparted a characteristic greenish hue to the cookies. This shift in colour attributes, due to the natural pigments present in spirulina, mainly chlorophyll and phycocyanin. Overall, besan–spirulina cookies demonstrated potential as a functional snack with improved nutritional value, offering a sustainable and innovative approach to address protein and micronutrient deficiencies. This study highlights the scope of utilising spirulina in gluten-free, legume-based bakery products to promote health and sustainability.

Keywords

Arthrospira platensis, Bakery products, Besan, Microalgae, Palatability, Spread ratio



Integrated extraction of agar and nanocellulose from *Gracilaria crassa* for eco-friendly packaging and shelf-life enhancement of fresh fish fillet

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The sustainable utilisation of seaweed biomass offers dual benefits of obtaining valuable hydrocolloids and valorising residual biomass into high-value materials suitable for sustainable seafood packaging and preservation. In the present study, agar was extracted from the red seaweed *Gracilaria crassa* via methods involving hot water extraction with and without alkali pretreatment and ultrasonication methods. Comparative evaluation revealed that the alkali pretreatment yielded more refined agar with superior physicochemical and functional properties, making it suitable for film development. Further, to maximise biomass utilisation, residual seaweed after agar extraction was valorised for the isolation of nanocellulose. The extracted nanocellulose was characterised for its crystallinity, structural, and morphological attributes and was subsequently incorporated into the agar-chitosan (CS) matrix as a reinforcing nanofiller. The resulting agar/CS-nanocellulose films demonstrated improved mechanical and barrier properties, highlighting the synergistic role of nanocellulose in enhancing film performance. Further, the packaging efficiency of the films was investigated by analysing the biochemical and shelf-life parameters of fresh fish fillets kept under refrigerated conditions. This integrated approach demonstrates a sustainable biorefinery strategy that contributes to the circular bioeconomy while advancing the development of eco-friendly food packaging solutions.

Keywords

Biorefinery approach, Circular bioeconomy, Nanofiller, Sustainable fish packaging



Effect of storage temperature on the quality characteristics of marinated *Penaeus* (*Litopenaeus*) *vannamesi*

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Shrimp is one of the major seafood export items from India, and it shared 40.19% in total export during the year 2023-2024. It is rich in essential nutrients beneficial for human health. In recent years, there has been a growing demand for value-added products from shrimp, such as ready-to-eat or ready-to-cook products. Among these, marinated shrimp is gaining commercial importance due to its unique flavour and consumer acceptance. However, limited information is available on the quality and shelf-life of marinated shrimp products. In the present study, frozen (Individually Quick Frozen) marinated vannamei shrimps (*Penaeus* (*Litopenaeus*) *vannamesi*) were procured from a seafood factory in Kochi and stored at two different temperatures (2°C and 12°C), and their qualities were analysed during storage. The moisture content showed an increasing trend (79.17-84.72%) during storage. The initial K value of the sample was 17.30%, which exceeded the acceptable limit on the 13th day (60.51%) at 2°C and on the 5th day (60.80%) at 12°C. The initial pH of the sample was 6.93, and it showed a decreasing trend during storage. TVB-N and TBA values were within the limit. Textural analysis revealed a decreasing trend in Hardness values (35.05N to 33.50N), while colour analysis showed an increase in b* values (13.44 to 18.57). Based on sensory and microbiological quality analysis, the shelf-life of marinated shrimp was found to be up to 8 days at 2°C and 4 days at 12°C. These findings suggest that marinated shrimp can be stored at 2°C up to 8 days without compromising quality, whereas storage at elevated temperatures resulted in significant quality deterioration.

Keywords

Chilled storage, Elevated temperature, Microbiological quality, Shelf-life, Textural analysis



Enhancing the nutritional profile of cephalopods with Lycopene

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Cephalopods like cuttlefish and squid are excellent sources of protein, healthy fats (DHA and EPA), and vitamins. These benefits, coupled with a growing consumer demand for healthy “superfoods” and value-added seafood products, present a significant opportunity. This study investigated the incorporation of lycopene, a potent antioxidant with established anti-inflammatory, anticancer, and cardioprotective properties, into cuttlefish (*Sepia spp.*) and squid [*Uroteuthis (Photololigo) duvaucelii*] to develop novel value-added seafood products. Lycopene was extracted from fresh tomato pulp following standard methodology and incorporated into cephalopod rings using two distinct methods: a marinating and blanching technique and a quick blanching method. Cuttlefish and squid samples were sourced from fish landing centres, processed, and then treated with lycopene. The stability of the incorporated lycopene was evaluated over a 30-day refrigerated storage period, with the sample tested at fixed intervals. Results showed that the marinating and blanching method was more effective, yielding higher lycopene concentrations in both cuttlefish (4.16 mg 100 g⁻¹) and squid (4.00 mg 100 g⁻¹) compared to the quick blanching method (3.52 mg 100 g⁻¹ in cuttlefish and 3.10 mg 100 g⁻¹ in squid). The findings of the study suggest that incorporating lycopene into cephalopods is a viable method for developing health-enhancing seafood products. This research provides a foundational step toward creating nutritionally fortified seafood that meets the demands of health-conscious consumers.

Keywords

Antioxidant, Essential vitamins, Refrigerated storage, *Sepia spp.*, *Uroteuthis (Photololigo) duvaucelii*, Value addition



Investigation of formalin presence in selected edible fish species from Thrissur market, before and during the trawl ban period

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The use of formalin for fish preservation poses a serious threat to human health. The present study investigated the presence of formalin in edible fish samples collected at random from fish markets in Thrissur, Kerala, during two periods: before the trawl ban (March-April 2025) and during the trawl ban (June-July 2025). Analysis of fish samples for formalin detection was done using UV-Vis Spectrophotometry. Comparative analysis revealed a slight, but noticeable increase in both formalin concentration and pH values in fish samples collected during the trawl ban period (June, 2025) compared to those collected before the ban (March, 2025). Formalin traces were observed in 43% of fish species collected before the trawl ban period and 62% of fish species collected during the trawl ban period, but all within the permissible limits. The slightly elevated formalin levels observed during the trawl ban period may be attributed to the illegal use of formalin as a preservative in fish transported from neighbouring states to prolong storage and transport time when the availability of fresh catch is limited; however, this requires further confirmation. The slightly elevated pH levels observed in the June samples further support the likelihood of delayed spoilage resulting from formalin treatment. The present findings highlight serious concerns regarding post-harvest handling practices and food safety during the trawl ban period. The study strongly recommends regular fish quality inspections by the Food Safety Department and the Department of Fisheries, Government of Kerala, to detect any illegal use of banned preservatives such as formalin, sodium benzoate and ammonia. Strengthening monitoring measures is essential to ensure consumer trust and confidence, particularly during the trawl ban season when the risk of adulteration is higher due to the large influx of fish transported from neighbouring and distant states.

Keywords

Fish preservation, Food safety, Permissible limits, Spectrophotometry



Chitosan edible coatings for quality preservation and shelf-life extension of dried anchovies

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Unhygienic handling, spoilage, and the use of synthetic preservatives negatively impact the quality and marketability of dried seafood products. In India, a substantial proportion of landed anchovies are preserved and marketed in dried form. Owing to its film-forming ability, as well as antifungal and antibacterial properties, chitosan has emerged as a key material for developing edible coatings and films for seafood preservation. In the present study, freshly landed anchovies (*Stolephorus indicus*) were divided into five groups and coated with chitosan at varying concentrations (CH0.25%, CH0.5%, CH 0.75%, and CH1%), with one group left uncoated as a control (C). A seven-week storage trial was conducted to evaluate the effects of chitosan coating on product quality and shelf-life. Sensory, biochemical, and microbiological analyses were performed on all coated and uncoated samples. The results indicated that the moisture content of the control samples gradually increased from $7.14 \pm 0.00\%$ to $11.6 \pm 0.40\%$ over the seven-week storage period, whereas all chitosan-coated samples maintained a relatively constant moisture level of $7.03 \pm 0.06\%$. The TMA and TVB-N values were lowest in CH0.75% and CH1%, while the highest values were observed in the control ($p < 0.05$) samples. TPC analysis over the storage period revealed that the bacterial load was lowest in chitosan-coated samples, with the minimum observed in the CH1% (2.45×10^4 cfu g⁻¹), whereas the highest bacterial count (1.25×10^5 cfu g⁻¹) was recorded in the control sample after seven weeks of storage. The study indicates that chitosan 1% edible coating is an effective approach for preserving the quality and extending the shelf-life of dried seafood. The adoption of chitosan-based natural edible coatings is recommended to minimise spoilage in dried fish, provide a safe alternative to synthetic or illegal preservatives, and enhance food safety across the dried fish supply chain.

Keywords

Biopolymer, Food safety, Illegal additives, Natural preservative, *Stolephorus indicus*



Technology development and dissemination for backwater cage culture of Indian pompano - An alternative option for livelihood empowerment of marginal coastal communities

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Estuaries and backwaters are important ecosystems that support the livelihoods of marginal coastal communities. The Indian pompano (*Trachinotus mookalee*) is an emerging candidate marine finfish species for mariculture, for which coastal cage farming technology has been standardised and demonstrated for effective dissemination. This study presents the results of a case study conducted in selected districts along the coastal region of Andhra Pradesh. Grow-out cage farming was initiated in galvanised iron (GI) cages of 5 x 5 x 3 m size. Indian pompano fingerlings were stocked in cages at an optimised stocking density of 20 nos. m⁻³ and reared for 7 months, feeding with a high-protein floating pellet feed. Growth parameters and economic performance were analysed to assess the feasibility of culture adoption. The fish attained an average weight of 663±50 g, with an average growth rate (AGR) of 2.7-3.0, and a feed conversion ratio (FCR) of 1.6 to 1.8. Economic analysis indicated a net profit of approximately ₹74,000 per cage, an annual rate of return on capital of 53.92%, and an operating ratio of 0.65, with a market price realisation of ₹330 per kg of produce. The developed technology was demonstrated at five different locations in Krishna backwaters, comprising a total of 70 units, following a cluster-based and two-tier farming approach to promote wider adoption. The technology was disseminated in other coastal districts, with varying levels of technical support and handholding. The impact assessment of the farming technology showed that more than 90% of the participating farmers have experienced improved livelihoods and enhanced income. Cage culture of Indian pompano thus proves to be a viable technology for estuarine ecosystems, offering an alternative livelihood option to enhance income opportunities for marginal coastal communities.

Keywords

Annual rate of returns, Economics, Growth, Impact assessment, Krishna Estuary, *Trachinotus mookalee*



Sustaining livelihoods and biodiversity through traditional mud crab (*Scylla* spp.) fishery in Pulicat Lake, India

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Pulicat Lake, recognised as the second-largest brackish lagoon along India's east coast, supports a vital mud crab (*Scylla* spp.) fishery that forms a crucial livelihood source for artisanal fishermen in Andhra Pradesh and Tamil Nadu. Covering an area of about 461 km², the lake exhibits fluctuating seasonal salinity levels (15–45 ppt), and nutrient conditions that influence crab populations and the overall fishery productivity. A study conducted between 2024 and 2025 at eight major landing centres revealed the widespread use of traditional fishing techniques, including bamboo traps (*koodu valai*), handpicking, and crab gillnets (*nandu valai*). On an average, fishers gather between 10 and 20 kg of mud crabs daily for each fishing unit, depending on seasonal changes, tidal conditions, and the intensity of fishing efforts. Operations using 90–100 mm mesh crab nets (5–6 km in length) is deployed for 18–20 h with 2–3 fishers, yielding a CPUE of 0.167–0.556 kg h⁻¹ fisher⁻¹. The pricing dynamics of live mud crabs fluctuated between ₹300 and ₹2500 per kg exerting a notable influence on household incomes. Peak fishing activity was noted during the post-monsoon (December-February) and pre-monsoon (April-June) periods, as the environmental conditions favoured recruitment and growth. Nevertheless, the fishery faces increasing challenges, stemming from the overexploitation of juveniles, inadequate gear regulation, and the degradation of mangrove and lagoon ecosystems. Improving community-based monitoring, regulating mesh size, and promoting pen-based crab fattening and restocking practices could lead to lasting ecological and economic sustainability. The Pulicat mud crab fishery exemplifies the successful integration of traditional knowledge with adaptive management, fostering biodiversity conservation while strengthening livelihood resilience.

Keywords

Artisanal fishermen, Brackish lagoon, Restocking, Salinity, Seasonal variation, Traditional practices



Coexistence of artisanal fishing, gathering and sea farming for livelihood diversification: A case study of Olaikuda, Tamil Nadu

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Coastal fishing communities rely on the marine environment for their sustenance and income. Over the last two decades, diminishing economic returns from small-scale fisheries have led to social-ecological shifts and co-adoption of mariculture in India. In this study, we have documented this transition and livelihood diversification in Olaikuda, a traditional fishing village in Ramanathapuram District of Tamil Nadu, through participatory rural appraisal. We documented the social and coastal ecology, resources and technologies, indigenous traditional knowledge, bioresource flow, seasonal calendar, time trends, gender disaggregated activities, linkages, livelihood analysis, problems and potential solutions. There were 270 households in Olaikuda with 976 male and 897 female population, belonging to the Christian Pattam Ketti Kadayar community. The primary occupation was fishing followed by seaweed farming and backyard livestock rearing. The coastal habitat had pristine water with less wave action and steep continental slope, and the intertidal zone had coral-rocky, rocky-sandy and sandy shores. Catamarans made of wood and/or thermocol and motorised vallams were the commonly used fishing crafts. Gill nets, squid jigs, traps and spears were used to catch perches, sardines, needlefish, barracudas, rays, cephalopods, crabs and shrimps in the coastal waters. Diving was traditionally practiced in this village for the collection of gastropod molluscs, sea cucumbers, anemones, starfish, sponges and corals. Likewise, from traditional gathering of wild green, brown and red seaweeds, they have transitioned to the culture of *Kappaphycus* sp. in floating rafts with coast division 'indigenous patta' system. Cage farming of marine finfishes have been demonstrated with active involvement of the fishers. Coastal shrimp farming was tried but not accepted due to ground water salination and eutrophication issues. Fish, seaweed and chanks were the major income sources, followed by crab and squid. Decreasing catch per unit effort and mean catch size, seaweed rot and loss of pigmentation, exploitation by middlemen, anthropogenic pollution and coastal erosion were the major problems faced by the village. Community based fisheries management, marine protected areas, artificial reef deployment, sea safety/insurance, improved varieties of seaweed for stress resistance and growth, crop rotation, optimised raft density/design, water quality monitoring, timely availability of fish seed and feed for cage culture, value addition of products, ecotourism, micro-credit and skill development programmes were identified as potential solutions to enhance the livelihood.

Keywords

Cage culture, Diving, Participatory appraisal, Seaweed farming, Traditional fishing



Empowering scheduled caste fishers through seaweed farming: Insights from SCSP and NICRA-SCSP programmes

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Seaweed farming is an environmentally sustainable and climate-resilient aquaculture practice that offers an alternative source of income for coastal communities. Unlike conventional agriculture, it does not require arable land, freshwater, or chemical fertilizers. It offers a sustainable income source for coastal fishing communities and contributes to carbon sequestration, enabling potential carbon credit benefits for India. Owing to the importance of seaweed farming as a national priority, the Mandapam Regional Centre of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) is promoting seaweed farming under the Scheduled Caste Sub-Plan (SCSP) and NICRA-SCSP programmes in Ramanathapuram, Pudukkottai, and Thanjavur districts of Tamil Nadu, since 2019. A total of 177 fisher families across 14 villages have been benefited through the distribution of 3,535 raft/monoline units. Initially, each family received 20 monoline units along with hands-on training, inputs (including seed), and technical guidance. A socio-economic impact study conducted in Ramanathapuram District compared the status of SCSP beneficiary households before and after adoption. Results revealed a remarkable improvement in income and savings, with average monthly earnings increasing from ₹8,400 to ₹21,000 (60%) and savings rising from ₹600 to ₹11,500 (95%). Majority of the families (62%) expanded their farming operations by an additional 10-20 units and nearly 90% of the families continuing the adoption with their own investment. Investments in housing, vehicles, and household appliances also increased, while social indicators such as children's higher education (supported by 70% of families), healthcare, and cultural participation improved significantly. Overall, seaweed farming has enhanced financial security, asset creation, and social well-being, while empowering fisherwomen through improved confidence and decision-making ability. The study reaffirms its potential as a scalable and sustainable livelihood diversification strategy for coastal communities.

Keywords

Coastal communities, Empowerment, Farming operations, Financial security, Fisherwomen, Livelihood diversification



A cross-regional analysis of *Penaeus* (*Litopenaeus*) *vannamesi* farming in the west coast of India with a focus on socioeconomics, production and constraints

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Shrimp aquaculture has expanded rapidly in India since the 1990s, with the introduction of *Penaeus* (*Litopenaeus*) *vannamei* boosting productivity and positioning the country as the world's second-largest producer. However, regional disparities and constraints continue to influence the sustainability of shrimp farming, particularly along the west coast of India. This study assessed farmer profiles, production economics, and constraints across Gujarat, Maharashtra, Goa, Karnataka, and Kerala states, using semi-structured interviews (n=60), adopting a multi-state approach to capture regional variation. Most farmers (~58%) were in the middle age group (36–50 years), with ~56% having less than five years of farming experience and education ranging from primary to post-graduation. Farm size averaged 1.84 ha, ranging from ~2.27 ha in Kerala and 2.05 ha in Gujarat to ~0.7 ha in Karnataka. Stocking densities ranged between 25–65 PL m⁻², with average survival of ~65%. Farms with lower stocking densities consistently achieved higher survival and better economic returns. Production per crop was highest in Karnataka (5.9 t acre⁻¹), followed by Kerala (3.7 t acre⁻¹), Goa (3.5 t acre⁻¹), and Gujarat and Maharashtra (2.5 t acre⁻¹ each). Economic analysis showed the Benefit–Cost ratio ranged from 1.50 in Kerala to 1.16 in Goa, with an overall average profit of ~₹8.48 ha⁻¹ crop⁻¹. Feed costs dominated operational expenses (~58%), followed by seed (~13%). Kerala farmers benefited from lower input costs and better market access, while Karnataka gained from larger farm sizes and higher gross returns. Constraints included disease outbreaks (75%), high feed costs (68%), seed quality issues (50%), and volatile market prices (47%). Regional differences were observed with Gujarat and Maharashtra highlighting lack of nearby hatcheries and high seed costs, Karnataka and Maharashtra citing electricity costs, and Goa reporting faced small farm sizes and weak infrastructure. In Kerala, promotion of paddy cultivation was viewed as indirectly suppressing shrimp culture, adding a unique policy-driven constraint. The study concludes that shrimp farming on India's west coast remains profitable, though region-specific constraints threaten long-term viability. Climate-resilient practices integrating biofloc/copefloc systems, insect meal-based feeds, shrimp-seaweed integrated culture, solar-powered aeration, water recycling, AI-powered disease prediction, weather-indexed insurance, climate-adaptive pond designs, regional hatcheries, and coastal zone management, are vital to reduce environmental dependency and enhance resilience. Together, these interventions can transform shrimp aquaculture on India's west coast into a resilient, efficient, and future-ready sector, optimising productivity, securing farmer livelihoods, and strengthening India's position in the global seafood economy.

Keywords

Penaeus (*Litopenaeus*) *vannamesi*, Regional constraints, Shrimp aquaculture, Socioeconomics, West coast



Transforming livelihoods of tribal (non-traditional) and coastal fisher women through innovative sustainable fishery practices, green technologies, and inclusive market integration

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The coastal and tribal fisherwomen of India, especially the Irula community in the Vellar-Pichavaram-Coleroon mangrove ecosystem and fisherwomen in Rameswaram Island, rely heavily on marine resources for their livelihoods. These communities face critical challenges, including unsustainable fishing practices, poor product quality, limited access to markets, and lack of value addition, which perpetuate economic vulnerability and low living standards. To address these issues, a comprehensive intervention was implemented combining sustainable fishery practices, eco-friendly technology adoption, and value chain strengthening. The initiative introduced mud crab fattening practices, enhancing the market value of crabs by improving size and quality through carefully designed fattening protocols. Simultaneously, hygienic dry fish production using tunnel solar driers provided a sustainable and energy-efficient alternative to traditional open-air fish drying. This technology significantly reduces biological contamination and accelerates drying cycles, enabling consistent, safe, and market-ready products year-round. A detailed baseline survey assessed fish and live feed availability, followed by community mobilisation through Focused Group Discussions (FGDs) and participatory action plans to encourage ownership and replication of technology. The intervention emphasised developing inclusive market linkages, creating a multiple-buyer system connecting women SHGs to local and export-oriented markets. This strategy ensured fair pricing, enhanced market reach, and minimised the role of exploitative middlemen. Key outcomes include increased *per capita* income, improved product quality, sustainable employment generation, and reduced seasonal migration. The study enabled fisherwomen to transform from subsistence-level fishers to micro-entrepreneurs by adding value to their catch and accessing structured market channels. This integrated model demonstrates that empowering marginalised tribal and coastal fisherwomen through innovative, sustainable fishery practices, supported by green technologies and market-driven value chains, can effectively enhance livelihood security, improve economic resilience, and promote environmental sustainability in vulnerable coastal ecosystems.

Keywords

Crab fattening, Dry fish production, Market integration, Technology adoption



Entrepreneurial ecosystem in fisheries - A study of the interdependent actors and factors of micro enterprise development by coastal women

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India is one of the best countries in the world to start a business and ranks second among 49 countries as per the latest Global Entrepreneurship Monitor (GEM) report. High levels of established business ownerships, indicative of long-term sustainability of enterprises and 'social and cultural norms' supportive of entrepreneurship in the country were major causes pointed out for this achievement. An ecosystem that fosters the rapid flow of talent, information, and resources nurtures entrepreneurs at every stage of growth. Entrepreneurs play a pivotal role in shaping the nation's economy by establishing new firms and driving innovation. While India as a whole has witnessed remarkable progress in entrepreneurship, this study attempts to examine the extent to which such growth is reflected among the fisherfolk in coastal villages. The study examined how technological advancements translate into livelihood opportunities through business development among fisherfolk and assessed the extent to which the country's entrepreneurial ecosystem supports them. The study was conducted across the coastal states of Kerala, Gujarat, Andhra Pradesh, and Maharashtra, with a particular focus on women respondents. It examined the network of interdependent actors, including entrepreneurs, technology institutions, government bodies and financial institutions along with enabling factors such as culture, policy and infrastructure that collectively shape the entrepreneurial ecosystem and foster productive entrepreneurship in these regions. The entrepreneurial ecosystem comprises several interrelated elements, which in this study were broadly categorised into six domains: culture, policies and leadership, finance, human capital, markets, and support systems. Women respondents with entrepreneurial intent, purposively selected for the study, were evaluated based on their level of awareness, access and outcomes related to these entrepreneurial components. The factors pertaining to micro, meso and macro levels of entrepreneurial ecosystem, as per the study framework, were also rated by the respondents. While many research studies on entrepreneurship point out entrepreneurial characteristics/potential of clients as reasons for the success/failure of entrepreneurs, this study results revealed the role of the external ecosystem factors in deciding the growing and perishing of an enterprise. A lack of adequate education and effective communication skills emerged as two major factors hindering even potential entrepreneurs. The study underscores the genuine need for a comprehensive audit of the entrepreneurial ecosystem in the fisheries sector.

Keywords

Communication skills, Education, Empowerment, Sustainability, Technology institutions



Dynamics of fisher well-being in marine fisheries sector: Insights from Indian marine fisheries

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Seasonal and long-term migration has become an essential livelihood strategy for fishing communities in India, largely influenced by the depletion of local fish stocks, fluctuating incomes, and regional disparities in marine resources. For many coastal households, migration is not simply a choice but a necessity to secure livelihoods, access sustainable fishing grounds, and seek alternative employment opportunities. This process reflects broader socio-economic and environmental transformations that are reshaping traditional fishing practices and community life. Migration provides fishermen with improved income, diversified opportunities, and enhanced living conditions, yet it also exposes them to vulnerabilities such as precarious employment, lack of social security, inadequate housing, health risks, and challenges of social acceptance in host communities. These trade-offs directly influence their overall well-being and long-term resilience. To capture these dynamics, this study develops and applies a Migrant Well-being Index (MWI) to assess the multidimensional well-being of migrant fishermen across India's coastal states. The index incorporates both objective and subjective indicators, focusing on five key dimensions: social status, economic well-being, health scenarios, proficiency, and futurities. This multidimensional framework offers a comprehensive understanding of how migration reshapes the lives of fishermen. Findings suggest that migration not only contributes to enhanced income stability but also facilitates improvements in health awareness, social recognition, and the adoption of new skills and technologies. Furthermore, many migrant fishermen were found to diversify into alternative avocations beyond fishing, reflecting livelihood adaptability and a greater likelihood of sustained migration in the future. The MWI highlights the dual nature of migration: it acts as a pathway to improved human development and resilience, while simultaneously generating social and economic vulnerabilities that require policy attention. The study identifies significant gaps in welfare and institutional support systems, underscoring the need for targeted interventions to protect fishermen for sustained livelihood. The findings provide a structured framework for evidence-based policymaking that not only aims to enhance the living and working conditions of migrant fishermen and foster inclusive growth in the fisheries sector but also contributes to a deeper understanding of the intersection between migration, livelihoods, and well-being, offering critical insights for strengthening resilience and fisheries governance in coastal India in line with broader sustainable development goals.

Keywords

Institutional support systems, Labour, Migration, Targeted interventions, Well Being Index



From hook to hyper local: Digitalisation and the restructuring of domestic fish value chains

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The COVID-19 pandemic and ensuing lockdowns precipitated a profound crisis across the nine coastal states of India, shattering traditional, multi-layered fish value chains and severing market access for fishing communities. This paper examines the subsequent grassroots digital transformation that secured livelihoods and forged a more resilient domestic fish market. It employs a comparative cohort analysis, segmenting 280 domestic traders from 14 districts across India's nine coastal states into distinct groups based on their digital adoption and business roles. The quantitative findings from this analysis were then validated and contextualised through qualitative stakeholder workshops conducted in four key maritime states: Kerala, Tamil Nadu, Andhra Pradesh, and Maharashtra. Prior to the pandemic, the sector was characterised by an opaque system of intermediaries that resulted in low price shares for fishers and significant post-harvest losses. The lockdown-induced collapse of this chain was rapidly filled by a spontaneous, technology-driven pivot using tools like WhatsApp, digital payments, and social media to create hyper local value chains. Findings from the cohort comparison reveal a substantial improvement in fishers' earnings, as producers who adopted digital tools retained a significantly larger portion of the final consumer price. Furthermore, the model empowered new entrepreneurial roles, particularly for women, enhancing their agency and financial control. While born of necessity, this "Hook to Hyperlocal" model presents a sustainable path forward. The paper concludes by recommending institutional support in digital literacy, logistics, and policy recognition to solidify this ad-hoc solution into a long-term, resilient framework.

Keywords

Cohort analysis, COVID-19 pandemic, Digital literacy, Fishing communities, Technology-driven



Cage farming of marine finfishes for the socio-economic empowerment of scheduled caste and scheduled tribe fishing communities in the Coromandel Coast: An impact assessment

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The SCSP and TSP projects implemented by Madras Regional Station of ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) endeavours to empower the downtrodden and elevate their socio-economic status, fostering their integration and active participation in the course of nation's development. With a vision to improve the livelihood of Kottaiakadu scheduled caste fisherfolks, six square cages were installed by three beneficiary groups in the year 2024. Each cage was stocked with 1000 Asian seabass fish fingerlings with an average length of 156 mm and average weight of 43 g. The fingerlings were fed with raw fish feed. The growth of fishes, its feeding patterns and monitoring of environmental parameters within the cages was carried out on regular basis. Around 2.5 t of healthy fishes were harvested, with a revenue generation of ₹8,89,471/-. In the same year under TSP project, 2 circular cages and 4 square cages were installed at Senjamman Nagar. The square cages (4 nos.) were stocked with 1,000 Asian seabass fish fingerlings with an average length of 146 mm and average weight of 72 g. Each circular cage (2 nos.) was stocked with 800 Asian seabass fingerlings with an average total length of 205.20 mm and average weight of 120 g. Around 2.75 t of healthy fishes were harvested, with a revenue generation of ₹9,80,500/-. The total gross revenue generated out of both the projects was ₹18,69,971/- during the year 2024. The impact realised on livelihood enhancement due to the technological interventions of cage culture demonstrations and training was documented. It could be understood that all the respondents (100%) have perceived that the cage farming interventions have ensured diversification and sustainability in their livelihood. Nearly three-fourth of them (75% each) either strongly agreed/agreed upon the parameters such as increased awareness, enhanced knowledge and increased income. From the focus group discussions, it was evident that several factors are crucial for enhancing the adoption of cage culture. These include clear policy guidelines on access to water bodies, availability of raw materials for cage construction, timely supply of seed and feed, market access and fair pricing for harvests, technical know-how and timely advisories, government support, access to institutional finance, efficient logistics and strong peer group support.

Keywords

Beneficiaries, Cage construction, Environmental parameters, Policy guidelines, SCSP, TSP



Socio-economic status and constraints faced by shrimp farmers of Raigad District of Maharashtra

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Shrimp aquaculture plays a vital role in the livelihoods of millions of people worldwide, providing employment to a large section of the population. Therefore, understanding the socio-economic conditions of shrimp farmers and the challenges they face is essential to identify appropriate solutions and improve their farming practices for sustainable development and livelihood enhancement. The present study aimed to assess the socio-economic status of shrimp farmers and identify the economic constraints they face in the Raigad region. A total of 70 shrimp farms from the talukas of Alibag, Murud, Shrivardhan, and Mhasala in Raigad District were surveyed using a pre-tested interview schedule. The study revealed that most shrimp farmers belonged to the middle-age group and had 1-5 years of experience in shrimp farming, with the majority practicing Hinduism. Most farmers were educated up to the graduate level, lived in pucca houses, and belonged to nuclear families with 1-5 members. The majority reported an annual income ranging between ₹6 and ₹10 lakhs. Feed technicians were the primary source of information for shrimp farmers (87.15%), while profit served as their main motivation. The major economic constraint identified was the high initial investment required for shrimp farming. Price fluctuations posed significant marketing challenges, whereas lack of experience emerged as the main socio-personal constraint. The absence of disease diagnostic laboratories was identified as a key technical limitation, and frequent disease outbreaks were reported as the major environmental constraint among shrimp farmers in the Raigad District of Maharashtra.

Keywords

Constraints, Disease outbreak, Initial investment, Livelihood, Price fluctuations, Shrimp aquaculture



Livelihood security and vulnerability of small-scale marine fisherfolk in Kerala: Insights from the sustainable livelihoods analysis

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Marine fisheries play a critical role in sustaining the coastal economy and food security of coastal population in Kerala State. The state has a total marine fisher population of 5,63,903, inhabiting the 220 marine fishing villages spread across the nine coastal districts. Despite Kerala's notable achievements in human development indicators, a significant number of its fishing community remains socio-economically vulnerable, with nearly 60% of the households falling below the poverty line (BPL). A livelihood assessment of the marine fisher households was undertaken in Ernakulam and Alappuzha districts of the state using the Sustainable Livelihoods Approach (SLA). Data were collected from households of active fishers operating across mechanised, motorised, and non-motorised fishing and allied sectors. The livelihood capital indices were developed based on five livelihood capital assets consisting of human, physical, financial natural and social capital derived from 41 sub-indicators. Livelihood diversification among fisher households was assessed using the Simpson Index of Diversity. Preliminary analysis revealed that, households engaged in fishing-allied activities in Alappuzha District and mechanised fishing crew in Ernakulam District exhibited higher livelihood diversification compared to other categories of small-scale fisher households. The education index of fisher households was developed by assigning scores to the educational status of each household member. In the Ernakulam District, mechanised crew, auctioneers, inboard owners, outboard owners, and outboard crew had education index values greater than 0.5. Climate change, sea incursion, high fishing costs and tidal flooding emerged as the top ranked livelihood challenges based on Garrett scores. The livelihood capital assessment showed imbalances with social and human capital assets with high scores, while critically low scores for physical and natural capital. Limited access to adequate infrastructure, and productive assets, alongside declining marine resources, place significant constraints on livelihood security. The livelihood assessment of small-scale fisherfolk highlights the need for integrated policy responses encompassing targeted livelihood enhancement programmes, investment in resilient infrastructure, sustainable fisheries management, and social protection measures for reducing the vulnerability and ensuring long-term sustainability of coastal livelihoods.

Keywords

Active fishers, Climate change, Diversification, Sustainable fisheries management, Tidal flooding



Techno-economic assessment of marine fishing operations in Andhra Pradesh

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An estimated 1.75 lakh t of marine fish were landed in Andhra Pradesh in 2024, accounting for 5.07% of all marine fish landings nationwide. To determine the economic efficiency, a techno-economic analysis of various fishing techniques in Andhra Pradesh was conducted. Due to the high cost of fishing, the increased time spent at sea and the need for advance funding and assistance, the combinations of fishing gear and craft have changed significantly over the years. The majority of mechanised vessels' operating costs (75.7%) were related to fuel. Fuel's share of operating expenses in motorised vessels varied from 11.9 to 33.2%. Crew wages constituted the largest portion of operating expenses in motorized crafts (67.8–84.2%), whereas they accounted for only 12.8% in mechanised crafts. In non-motorised vessels, crew wages comprised nearly the entire operating cost. Among the three categories, non-motorised fishing proved to be the most cost-effective, as reflected in the net profit margin and return on investment (ROI): 35.2% and 2.16% for mechanised operations, 37.5–44.3% and 0.91–2.77% for motorised operations, and 40.7–44.7% and 3.78–5.17% for non-motorised operations, respectively. Mechanised fishing activities had capital productivity and input-output ratios of 0.71 to 0.87 and 0.63 to 0.71, motorised fishing operations had 0.52 to 0.88 and 0.04 to 0.07, while non-motorised fishing operations had 0.51 to 0.54 and nearly zero. A substantial contribution to the economy, the Gross Value Added (GVA) of all fishing operations equalled around 50% of the Gross Revenue. Indian mackerel, penaeid shrimps, lesser sardines, tunnies, ribbonfish, catfish, carangids, and anchovies were the main fisheries resources that were caught throughout different fishing operations. The increased cost of fishing per trip, fewer landings, ocean pollution, climate change, and consequently lower gross returns per trip have all been identified by fishermen as major variables affecting the financial returns from different methods of fishing.

Keywords

Capital productivity, Costs, Gross value added, Input-output ratio, Returns



Stakeholder resilience in Kerala's marine fisheries value chain: Lessons from a covariate shock

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Marine fisheries form the backbone of livelihoods, nutrition, and local economies in many coastal regions, yet they remain highly vulnerable to covariate shocks, including pandemics, market disruptions, and climate-related events. Kerala, with its dense network of fishing communities and high socio-ecological exposure, offers a critical case for understanding resilience in such contexts. This study investigates adaptive strategies and resilience capacity across multiple stakeholder groups in the marine fisheries supply chain, boat owners, labourers, traders, market functionaries, women engaged in fishing and allied activities, and consumers. Data were drawn from 470 stakeholders through structured surveys and participatory workshops. Using factor analysis of mixed data and mixed principal component analysis, composite resilience capacity scores were developed to capture economic, operational, social, and behavioural dimensions of resilience. Regression modelling was applied to explore factors influencing these scores. The analysis also examined gendered labour contributions, informal support systems, and digital adaptation patterns that emerged during a recent large-scale disruption. Results show that diversified income portfolios, reliance on family labour, and access to informal credit strengthened adaptive capacity. Conversely, high dependency ratios and limited market linkages increased vulnerability. Social networks and community-level cooperation were key in sustaining supply chain continuity, particularly for small-scale operators. Women's roles in value-addition and household management contributed significantly to resilience, though their access to institutional support remained limited. The integration of digital tools for marketing and coordination was uneven, with adoption gaps linked to literacy and infrastructure constraints. The study's findings provide actionable insights for targeted policy interventions aimed at enhancing resilience in marine fisheries. These include strengthening social capital, improving credit accessibility, promoting gender-inclusive support measures, and investing in digital infrastructure. The approach offers a framework for mapping differential resilience profiles and can be adapted to other socio-ecologically vulnerable coastal systems.

Keywords

Adaptive capacity, Gender inclusion, Market disruptions, Pandemics, Resilience capacity



Men and women migrant workers in the post-harvest fisheries value chain: Analysing push and pull factors, socio-economic challenges and gendered livelihoods in Malpe Harbour, India

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Migration to coastal fishing hubs is a key livelihood strategy adopted by individuals seeking improved economic opportunities. However, research addressing the gendered dimensions of migration within small-scale fisheries remains limited. Most gender-disaggregated datasets focus predominantly on male fisherfolk, underrepresenting the experiences and contributions of migrant women. This study investigates the distinct roles and division of labour among male and female migrant workers who have relocated from neighbouring states to engage in various post-harvest nodes, such as sorting, peeling, grading, processing, and icing, at Malpe Fisheries Harbour in Karnataka. It also examines the principal push and pull factors influencing migration patterns. Primary data were collected from 50 migrant workers (20 women and 30 men) using a combination of simple random and snowball sampling techniques, supported by semi-structured interviews, key informant interviews, and field observations. Data were analysed using frequency and percentage calculations, the Mann-Whitney U test, and Garrett ranking to identify and prioritise the main push and pull factors. The findings indicate that improved wages, enhanced social status, and a higher standard of living are significant pull factors attracting migrants, while unemployment and social or gender-based discrimination at the place of origin act as major push factors. Women's active participation strengthens value addition through substantial labour contributions within the sector, yet they continue to face gender-based disparities in occupational roles, wages, and access to resources and services compared to their male counterparts. Although migration has expanded women's economic opportunities and improved livelihoods, migrant workers encounter conflicts with native fisherfolk, including socio-cultural tensions and environmental constraints, which result in unequal resource access and systemic discrimination. The study recommends the implementation of gender-responsive value chain interventions, along with targeted skill development and training programmes for women migrants, to enhance their participation in sustainable resource management within informal fisheries systems. Such measures are essential to strengthening livelihoods, improving fisheries value chains, and advancing an inclusive blue economy.

Keywords

Field observations, Gender, Migrant workers, Small-scale fisheries, Snowball sampling



Mapping labour dynamics in Indian marine fisheries: A labour mobility grid approach

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India's marine fisheries sustain millions of coastal households while strengthening national food security and economic growth. The sector supports nearly four million marine fishers directly and millions more in allied activities such as processing, trade, and transportation. Despite its economic and nutritional importance, the sector faces challenges of declining fish stocks, rising operational costs, and shifting livelihood aspirations of younger generations, many of whom move away from fisheries in search of education and alternative careers. These transitions have widened labour gaps in harvesting and post-harvesting operations, increasingly filled by migrant workers from both coastal and inland states. Understanding these complex labour flows is crucial for sustaining fisheries, ensuring equitable livelihoods, and strengthening policy frameworks. Against this backdrop, the present study applies a labour mobility grid to systematically analyse fishermen migration across India's marine fisheries sector, offering new insights into its drivers, patterns, and implications. The grid explains how, why, where, and to what extent fishermen migrate while highlighting key origin–destination linkages. A mixed-methods approach was employed and the study focused on the coastal states of India where data were synthesised within the labour mobility grid to identify patterns, adaptive strategies, and policy gaps, offering a comprehensive understanding of fishermen migration and labour dynamics across India's marine fisheries sector. The study reveals that labour migration in India's marine fisheries sector is highly dynamic and regionally differentiated. These movements are fluid, seasonal, temporary, or permanent, shaped by wages, employment opportunities, and risks. The labour mobility grid highlights how migration addresses critical labour shortages and sustains fisheries operations but also exposes workers to vulnerabilities including exploitation, inadequate housing, and health risks. The framework offers a replicable tool for understanding labour flows, origin–destination linkages, and occupational patterns. The study underscores the need for evidence-based policies that enhance migrant welfare, promote sustainable livelihoods, and strengthen fisheries resilience. Insights from this research can guide national fisheries governance, support poverty reduction, advance food security, and align with Sustainable Development Goals across India's coastal communities.

Keywords

Economic growth, Labour flows, Migration, Sustainable fishery livelihoods



Unrecognised contributions: Gender dynamics and evolving governance in small-scale marine fisheries of southeast coast of India

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Marine capture fisheries play a critical role in food and nutritional security, yet the contributions of women remain largely unrecognised. This study examines gender dynamics in small-scale fisheries along the southeast coast of India, with a focus on Chinnapalam Fishing Village, Ramanathapuram District, Tamil Nadu. Field observations revealed that approximately 250 women actively participated in marine capture fisheries. Both men and women engaged in multi-day fishing trips lasting 3–5 days, operating up to 2 nautical miles offshore, typically within family-based groups of four individuals. Gillnets and trammel nets were the predominant fishing gears, primarily targeting crabs and finfish species such as milkfish (*Chanos chanos*), barracuda (*Sphyraena* spp.), rabbitfish (*Siganus* spp.), grouper (*Epinephelus* spp.), red mullet (*Mullus* spp.), and blue swimmer crab (*Portunus pelagicus*). Each haul yielded an average catch of 20 kg, generating a net income of ₹3000 per trip. Decision-making authority, particularly regarding fishing ground selection, was predominantly held by men, highlighting gendered power asymmetries in resource use. Additionally, past regulatory challenges concerning access to island resources and the use of natural materials for fishing during activities were recorded, though such restrictions are no longer prevalent in recent times. Recognising the contributions of women and addressing persistent gender disparities in fisheries governance remains essential for equitable and sustainable resource management.

Keywords

Capture fisheries, Fisherwomen, Fishing ground selection, Resource ecosystem



Assessment of economic efficiency of marine fishing practices in Ramanathapuram District, Tamil Nadu

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Marine fisheries are vital for ensuring livelihood and nutritional security to coastal fishing communities in India. Ramanathapuram District, one of the prominent coastal districts of Tamil Nadu, is recognised for its substantial marine fish landings and diverse fishing gear systems. Analysing the economic performance of different fishing methods is essential for framing effective marine fisheries management strategies. Therefore, a study was conducted to assess the economic performance of marine fishing methods in Ramanathapuram District. This study evaluated the economic performance of mechanised, motorised, and non-mechanised craft–gear combinations operating in the district. Key performance indicators such as capital productivity, labour productivity, net operating income, gross value added, input–output ratio, and operating ratio were analysed over a ten-year period (2014–2024). Results indicate that mechanised single-day trawling for fish resources consistently outperformed other fishing methods, showing the highest productivity and economic returns. It recorded the lowest operating ratio (0.44) in 2020–21 and 2023–24, signifying higher economic efficiency. In contrast, motorised single-day fishing exhibited relatively lower net income per trip and overall economic performance. The findings emphasise the need for tailored fisheries management strategies to enhance profitability while ensuring sustainability of marine resources.

Keywords

Craft–gear combinations, Economic performance, Mechanised, Motorised, Non-mechanised



Sustaining fish and fishers: Optimising input-output controls for future-ready fisheries management

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Effective fisheries management requires a careful balance between ecological sustainability and socio-economic well-being. Input–output control measures provide a structured framework to regulate fishing pressure while safeguarding the livelihoods of coastal communities. Input controls, such as gear restrictions, seasonal closures, and effort limitations, directly influence the means of harvest, while output controls, including catch quotas, minimum size limits, and landing regulations, focus on the quantity removed from ecosystems. Together, these complementary approaches form the foundation of resilient fishery management regimes. The Bay of Bengal Programme (BOBP) project is currently working towards identifying, testing, and optimising such control measures across selected coastal regions. Preliminary insights suggest that when input-output controls are implemented through participatory mechanisms, fisherfolk not only comply more effectively but also contribute their local ecological knowledge, thereby strengthening co-management practices. This alignment of scientific tools with community-driven governance enhances both ecological outcomes and livelihood security. Furthermore, integrating these measures into broader blue economy frameworks highlights their role in ensuring food security, promoting equity, and building adaptive capacity in the face of climate and market uncertainties. Future-ready fisheries management thus depends on the ability to optimise input-output controls in ways that are inclusive, evidence-based, and adaptable. This paper emphasises the importance of designing balanced management regimes that sustain both fish populations and fisherfolk, showcasing the BOBP project as a pathway toward sustainable, inclusive, and economically viable fisheries governance.

Keywords

Adaptive capacity, Blue economy, Food security, Livelihoods, Participatory mechanisms, Sustainability



Gender dynamics in small-scale bivalve fisheries: Insights from Chinnapalam Creek and Athankarai Estuary, Tamil Nadu

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Women play a critical yet often under-recognised role in small-scale fisheries along the southeastern coast of India, particularly in bivalve collections. This study examines gendered contributions to bivalve resource utilisation at two key sites in the Ramanathapuram District: Chinnapalam Creek and Athankarai Estuary, both situated along the Gulf of Mannar. In Chinnapalam Creek, near Pamban on Rameswaram Island, fisherwomen manually harvest species such as *Gafrarium pectinatum* and *Donax* spp. during low tide using traditional handpicking methods. These activities provide essential livelihood support and supplement household income. The creek's estimated annual average production (2017-2024) is 182.5 t, with a catch per unit effort (CPUE) of 20 kg per person per day. Shell resources are dominated by *Donax* spp. (62%) and *Gafrarium tumidum* (38%), with varying proportions of live and semi-fossilised shells. Collected shells, valued at approximately ₹15 per kg, are supplied to the shellcraft industry, which further engages women in value-added production. In the Athankarai Estuary, seasonal exploitation of *Meretrix casta* occurs from March to September. While both men and women participate in harvesting, women primarily contribute to post-harvest processing, including sorting, cleaning, and drying of clams. During the non-harvest period (October–February), women shift to other artisanal fisheries or temporary occupations due to the influence of the northeast monsoon and freshwater inflow. The annual average harvest in Athankarai is estimated (2017-2024) at 1487 t, with a CPUE of 124 kg person⁻¹ day⁻¹. The lime and poultry industries primarily use harvested shells, yielding approximately 400 per 100 kg, to support seasonal community livelihoods. This study highlights the pivotal, yet marginalised, economic and social role of women in sustaining coastal bivalve fisheries. Recognition of their contributions, alongside capacity building and inclusive co-management frameworks, is essential for ensuring sustainable livelihoods and effective resource management.

Keywords

Artisanal fishing, *Gafrarium pectinatum*, Gender roles, Livelihood, *Meretrix casta*, Shellfish



Invasion of the non-indigenous mussel *Mytella strigata* (Hanley, 1843) in the Vellar Estuary and Pichavaram backwaters: Consequences for native mussel fisheries and responses of local fishing communities

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Introduction of invasive species poses serious ecological and socio-economic threats to coastal ecosystems. The charru mussel *Mytella strigata* (Hanley, 1843), has recently invaded the Vellar Estuary and Pichavaram backwaters on the southeast coast of India. Its rapid spread has displaced native mussels such as *Perna viridis* and *Crassostrea madrasensis*, altering community structure and impacting traditional mussel fisheries. Considering the dependence of local households on mussel collection, this study assessed the ecological dominance of *M. strigata* and the livelihood responses of fishing communities. Field surveys undertaken during June 2023–March 2024, used quadrat sampling to record mussel density and composition, while interviews with fishers, particularly women, explored changes in harvest practices, market value, and income. Results indicated that *M. strigata* formed over 70% of mussel biomass in several sites, causing sharp declines in native mussels. Fishers reported reduced catches and lower earnings, disrupting the established value chain. Although some communities began harvesting *M. strigata*, poor consumer demand and low prices limited its role in sustaining livelihoods. A few groups attempted to market the invasive species, reflecting initial adaptive strategies but with uncertain long-term benefits. The findings underline the dual challenge of ecological disruption and livelihood insecurity. However, opportunities exist for product diversification, value addition and aquaculture-based utilisation of *M. strigata*. Integrating ecological monitoring with community awareness and policy support can help transform this invasion into a managed resource, safeguarding both biodiversity and livelihood resilience in coastal fisheries.

Keywords

Adaptation, Charru mussel, Ecological disruption, Invasive species, Livelihood, Value chain



Perceived challenges of women fisheries students toward aquaculture in India

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Academic exposure and field visits in countries such as Vietnam and Norway have demonstrated how women play a leading role in aquaculture. Their active involvement in hatchery operations, broodstock management, disease monitoring and production supervision showcases remarkable expertise and commitment that propel the sector's growth. In contrast, the Indian scenario reveals a noticeable gap, as many women fisheries students remain hesitant to pursue careers in aquaculture. The barriers they face are not rooted in lack of competence or interest, but in deep-seated gendered perceptions and cultural biases that continue to frame aquaculture as a male-dominated domain. In the Indian context, aquaculture is still perceived as physically demanding, field-intensive, and socially inappropriate for women. Such attitudes restrict opportunities for female students, often denying them equal access to hands-on training, participation in decision-making, and long-term professional pathways within the sector. Evidence from global systems demonstrates that women often excel in tasks requiring meticulous attention to biosecurity, record-keeping, and hygiene compliance, all of which are critical for disease prevention and sustainable farm management. In short, leaving women out of the system, weakens aquaculture itself. This paper highlights the lived experiences of women fisheries students in India and emphasises the urgent need for cultural, institutional, and structural reforms. If women can excel in roles as demanding as aviation and space exploration, there is no reason to doubt their capacity to manage shrimp ponds or aquaculture enterprises. Moving beyond token representation toward inclusive training, equitable field access, and leadership opportunities is essential.

Keywords

Biosecurity, Farm management, Gender equality, Hygiene compliance, Record-keeping, Sustainability



Technological innovation, fishing efforts and trawl fisheries: Paradigm shifts in Munambam Fishing Harbour, Kerala

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Technology and modernisation have greatly transformed the fisheries sector especially with the rising human population, urbanisation and shifts in the country's macroeconomic conditions. Kerala, a prominent fishing-producing state in India, contributes about 20% of the country's fish landings and revenue. Trawling has acquired the status of an industry with incorporation of the technological advancements such as developments in craft technology and mechanisation of propulsion, gear and catch handling practices, developments in acoustic fish detection and satellite-based remote sensing techniques, less dependency on weather conditions, reduced working hours, wider social networks, advances in electronic navigation and position fixing equipment. This study focused on trawl fisheries at one of the major landing centres, Munambam Fishing Harbour located on Vypin Island in the Ernakulam District of Kerala. Trawl fisheries in the mechanised sector make up a significant portion of the landings at this centre. These mechanised trawlers have expanded both in terms of numbers and in size, largely as a result of locally-driven technological innovation and adaptations. There has been paradigm shift in the technological innovation and fishing efforts including labour endowments. In the case of multi-day operating vessels, the fishing effort duration varied from single days to multiday (8 to 12 days). The ownership regime include individual to community (shareholder) fishermen (shareholders). The crew size typically ranges from 6 to 16 labourers including the skipper, engine driver and other deckhands. Over the years, supply of local labour has decreased due to better opportunities elsewhere, leading to an influx of migrant workers into the industry. In addition to receiving a labour wage, fish labourers are typically paid a portion of the boats total catch commonly known as a crew share which was found to be 40%. As the economic benefits of trawling increased, the practice gradually spread along the coastline over the following decades. Several factors play a crucial role in enhancing fishing power, particularly in trawling, such as vessel size, engine power, net and gear design, fish-finding technology, catch-handling procedures and onboard chilling facilities. Mechanisation and the adoption of modern fishing techniques have significantly improved vessel efficiency, increased catch capacity and enhanced the socio-economic conditions of fishing communities. However, while technological advancement is inevitable, it is essential to implement effective fisheries management practices to ensure a balance between harvesting capacity and resource sustainability.

Keywords

Crew share, Crew wage, Fish labourers, Fisheries management practices, Trawling



Economic assessment of marine fishing methods in Odisha

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An estimated 1.54 lakh t of marine fish were landed in Odisha State in 2024, accounting for 4.5% of all marine fish landings nationwide. The proportional contributions from pelagic, demersal, crustacean, and molluscan resources were 60.9%, 29.7%, 7.7%, and 1.7% respectively. Mechanised, motorised and non-motorised sectors contributed 47, 52 and 1% of total marine fish production in the state respectively. To determine the economic efficiency, a techno-economic analysis of different fishing techniques in Odisha was conducted. In motorised crafts, crew wage accounted for 75.68 to 76.79% of the total operating cost. Whereas in non-motorised crafts, crew wage accounted for 89.17 to 90.32%. Fuel share of operating expenses in motorised crafts varied from 19.04 to 21.85%. For motorised fishing operations, capital productivity and the input-output ratio were 0.61 to 0.77 and 0.23 to 0.47, respectively, while for non-motorised fishing operations, they were 0.5 and nearly zero. Fishing operations contributed substantially to the economy, with the Gross Value Added (GVA) accounting for nearly 69% of the total gross income. The major fishery resources harvested across different operations included croakers, lesser sardines, anchovies, white sardines and penaeid shrimps. Fishermen identified several key challenges affecting financial returns from various fishing methods, such as rising operational costs per trip, declining catch rates, ocean pollution, climate change and the resulting reduction in gross returns per trip.

Keywords

Capital productivity, Gross value added, Input-output ratio, Returns, Techno-economic analysis, Total operating cost



Computer applications as catalysts in marine fisheries value chains: From net to network

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Marine fisheries are vital to global food security, trade, and the livelihoods of coastal populations, yet the sector faces persistent challenges including overfishing, climate change, inefficient post-harvest systems, and volatile markets. In this context, computer applications are emerging as catalysts of transformation, shifting marine fisheries from conventional “nets” to interconnected “networks” that integrate production, value addition, and livelihood security. At the harvest stage, Geographic Information Systems (GIS), Remote Sensing, and computer-based decision-support systems enable real-time resource mapping and identification of Potential Fishing Zones (PFZs). These tools help optimise fishing trips, reduce fuel consumption, and increase catch efficiency. Vessel Monitoring Systems (VMS), electronic logbooks, and onboard sensors contribute to responsible fishing by ensuring traceability and compliance with sustainability regulations. Post-harvest and value chain stages have been equally transformed. Computer-aided quality control systems, digital inventory management, and traceability platforms reduce spoilage, enhance standardisation, and build consumer confidence. Blockchain-based applications and QR-coded tagging improve market transparency and reduce the prevalence of Illegal, Unreported, and Unregulated (IUU) fishing. Simultaneously, e-commerce platforms and computer-driven auctioning systems link fishers directly to consumers and exporters, shortening the supply chain, improving price realisation, and ensuring equitable market participation. At the community level, digital literacy initiatives, e-learning platforms, and computer-based financial tools foster resilience and inclusivity. Mobile banking applications, credit access platforms, and digital cooperatives empower small-scale fishers to manage finances and invest in sustainable practices. Capacity-building modules delivered through computer applications enhance skill development, ensuring that fishers adapt effectively to evolving technologies and market conditions. Case-based evidence demonstrates tangible improvements in resource management, reduced post-harvest losses, increased income, and stronger community resilience. The shift “from net to network” signifies more than mere technological adaptation; it represents a fundamental paradigm shift in fisheries governance and livelihoods. Scaling these innovations requires strategic investment in digital infrastructure, targeted policy frameworks, and capacity development to ensure that marine fisheries remain sustainable, competitive, and livelihood-secure in the digital era.

Keywords

Digital infrastructure, Mobile banking applications, Potential fishing zones, Small-scale fishers, Vessel monitoring systems

India's shrimp success is also its weakness

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The fate of India's shrimp industry, which brings livelihood to millions, was decided in the boardrooms of Washington. The recent 50% tariff imposed by the US made a devastating impact throughout the value chain. The extent of impact becomes noticeable by considering the livelihoods behind the sector. In Andhra Pradesh, women, a major fraction of the workforce and Kerala's migrant workers who form the backbone of the peeling and processing sectors, were hit hard, losing their jobs overnight. Farmers keep on stocking seeds and feed on credit systems by integrators, hoping for recovery during the harvest season. But when exporters froze procurement and processors cut shifts, the very foundation of the industry was disturbed. *Penaeus vannamei*, ironically, an imported species, is the star export commodity of the world's second largest shrimp producer, India. India has its own high potential species like *Penaeus indicus* and *Penaeus monodon*, requiring comparatively less input cost and energy, but the focus on *vannamei* persists due to its fast production cycle. This singular focus, and lack of resilience has failed to secure a domestic market. High input costs made shrimp unaffordable for most Indians, resulting in an industry that is highly dependent on volatile international markets. It is time for India's shrimp industry to look beyond its limitations of one-species, one-market model. This study aims to provide strategic pathways for refining the Indian aquaculture sector, proposing ideas to export indigenous species and innovative methods for marketing them domestically, thereby building a more resilient and sustainable industry.

Keywords

International markets, Livelihood, Tariff, Value chain, Vannamei



Rebalancing India's shrimp export strategy amid the 2025 U.S. Tariff shock

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In India, shrimp contributed 92% of the total seafood export earnings, amounting to USD 7.38 billion in 2023–24. However, following the imposition of reciprocal tariffs under Executive Order 14257 in 2025, the effective duty on Indian shrimp exports increased to 58.26%, compounded by the continued enforcement of anti-dumping and countervailing duties. This paper discusses the evolution of India-U.S. shrimp trade disputes, the escalation of tariffs in 2025, and their broader economic, social, and geopolitical implications. Findings show that the tariff increase initiated steep declines in farm-gate prices in Andhra Pradesh, India's largest aquaculture centre, wiping out margins to 5-6% and threatening the livelihoods of almost 3-4 crore people relying on the sector. Exporters experienced a sudden liquidity crisis as almost 2,000 containers in transit were liable to new duties, while freight costs and collateral requirements also surged. Ecuador, with a lower tariff rate of about 15% and rapid growth of production capacity, has acquired a competitive advantage in the U.S. market, posing a long-term threat to India's share. Although the re-exports to China are growing, they are of lower margin as demand focuses on raw shrimp rather than value-added-shrimp. India has begun reorienting towards alternative markets such as the EU, Japan, West Asia, Russia, and BRICS allies, where the tariff burdens are low. Domestically, initiatives under PMMSY, concessional credit schemes, and rebranding campaigns are designed to sustain farmer confidence and stimulate local demand. Geopolitically, there are renewed discussions on joining the Regional Comprehensive Economic Partnership (RCEP) reflecting India's quest for deeper trade integration to offset U.S. protectionism. This paper emphasises that while U.S. tariffs pose a severe near-term threat, diversification, value addition, and strategic trade re-alignments can cushion risks, safeguard livelihoods, and re-position India as a resilient global seafood supplier.

Keywords

Anti-dumping duty, Aquaculture, Countervailing duty, Diversification, Trade policy



Masculinisation of technology: Nuanced understandings of fisherwomens' gains in the interplay of technology on intra-household dynamics and in workspaces

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World over and with special emphasis to the realm of small-scale fisheries, there is a constant refrain that women have largely borne the brunt of technological impacts leading to occupational displacements. This has fairly been true in the larger discourse and narratives on the impact of technological innovations on increasing the gender divide, particularly in the fisheries sector. However, we posit that, harnessing the benefits of technological innovations have also been viewed as positively impacting womens' livelihoods, improving their negotiating powers and intersectionality's for women at home and workspaces. The foregoing research discusses how men engaged in primary nodes of production in dolnet fishery of Gujarat, have opened up opportunities and spaces for their women counterparts in Rajpara, a major centre for dolnet fishery in Gir Somnath District of Gujarat. Dolnets in the past two decades have undergone a series of technological innovations in their craft and gear, contributing to increased economic efficiency and profitability. Apart from involving themselves in their traditional roles of fresh fish and dry fish trading, the capital accumulation which has stemmed up from technological innovations in dolnet fishery, have resulted in fisherwomen diverting loans on interest to fellow villagers, diversifying their livelihoods in to non-fishery avocations such as livestock and poultry keeping, to becoming proud owners of provision shops as well and a few being employed in the service sector too. Besides, this has strengthened social bonding, increased women's financial autonomy, espoused reciprocities in strengthening domestic ties and promoted women as agencies of savings, thrift and credit. In a less technology impacted village, i.e. Madhwad in the same district, predominantly a motorised gillnet fishery centre, it was observed that, fisherwomen lagged behind in their economic independence, decision making ability, and spouse reciprocities. Our study lends credence to feminist technological studies which expound on the theory that, technology are not givers but are points of influence which act in a circulatory pattern and are based on the context in which men and women are situated. The causal-comparative research design was used for the study covering a sample of 90 fisherwomen. The research methods employed for the study consisted of structured interview schedules, freewheeling focus group discussions and field observations. Descriptive statistics and non-parametric statistics such as Mann-Whitney U test were used for the study.

Keywords

Causal-comparative research design, Dolnet fishery, Livelihoods, Small-scale fisheries, Structured interview schedules

Fish-based gelatin as a sustainable alternative stabiliser in ice cream production

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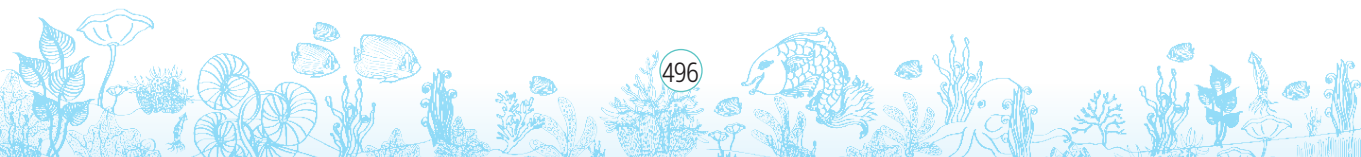
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Ice cream is a nutrient-dense dairy product and stabilisers play a pivotal role in enhancing its quality and shelf-life. This study explored the potential of fish-derived gelatin as a value-added ingredient in ice cream, offering a sustainable alternative to conventional mammalian sources. Fish gelatin, a protein obtained from the collagen present in fish skin, bones and scales, presents a promising substitute due to its compatibility with specific dietary and religious requirements. The gelatin used in this study was extracted from the bones and scales of Catla and Rohu, freshwater fish species rich in protein and well-suited for gelatin production. The primary objective of this study was to evaluate the efficacy of fish-derived gelatin in stabilising ice cream while ensuring desirable physicochemical and sensory attributes. A comprehensive comparative analysis was conducted, encompassing proximate composition, functional characteristics, viscosity and texture profiling of samples prepared with both commercial (control) and fish-extracted gelatin. Results indicated that the extracted gelatin exhibited higher fat, ash and moisture content compared to the control, though it demonstrated a lower protein concentration. Functional and textural evaluations revealed that the control sample generally outperformed the experimental samples; however, the fish gelatin still exhibited promising potential. Ice cream formulations with two different gelatin concentrations (5 and 10%) were assessed, and the findings demonstrated that increasing the gelatin concentration positively influenced the overrun and melting resistance of the final product. The findings highlight the feasibility of utilising fish-derived gelatin as a functional stabiliser in ice cream production.

Keywords

Catla, Rohu, Sensory attributes, Shelf-life, Texture profiling



Steps in harnessing *Bacillus* sp. for potential biocontrol of *Vibrio vulnificus*, in search of a panacea

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The aquaculture industry is known for its disease-based losses. Bacterial pathogens like *Vibrio vulnificus* play a major role not only in losses but also can cause zoonotic diseases. The increasing episodes of antibiotic-resistant strains necessitates the use of biocontrol methods. Bacteria of live fish origin can be used against the pathogenic *Vibrio vulnificus* and related species. In this study we isolated twenty spore forming bacteria from the live fish gut samples, of which seven were chosen with spot assay. From the seven, only 2 were selected for the co-culture assay by assigning a scoring method for the cross-streaking test. The isolates that give the minimum score were selected for further testing with the co-culture method. Two strains 1-5B (C) and 1-8B (D) with strong inhibitory activity on biofilm-forming *Vibrio* sp. were isolated from pooled fish obtained from marine water. These two strains were identified as *Bacillus* spp., using BD Phoenix M50 and Sanger sequencing. In addition, the probiotic strains 1-5B (C) and 1-8B (D) were found to produce spores and secrete extracellular enzymes. Using various *Vibrio* biocontrol assays, we qualitatively and quantitatively determined the efficacy of these two probiotic strains in controlling *Vibrio vulnificus*, principally the biofilm formers. Two strains of *Bacillus* spp. are showing promising activity against vibrios. The strains isolated have shown antagonistic activity against different strains of *Vibrio vulnificus* particularly targeting biofilm-forming isolates. Co-culture studies showed complete inhibition of *V. vulnificus* growth on selective media in 24 h. Both *Bacillus* strains exhibited spore-forming capability and produced extracellular enzymes such as protease, lipase and amylase. The extracellular and intracellular products were analysed in individual and co-culture extracts with LHRMS. Aquaculture has a dynamic environment in which the chemical treatments can be cumbersome. The biological treatments can be achieved by using the bacteria either as probiotic or as their product can be used as a postbiotic. Further research should focus on characterising the specific antimicrobial compounds responsible for the antagonistic effects and optimising their application in commercial aquaculture settings.

Keywords

Antibiotic resistance, Aquaculture, *Bacillus* sp., Biocontrol, Probiotics



Special Track

Research in Marine Mammals and Sea Birds

Poster Presentations



Navigating a shifting sea: Predictive habitat modelling for Indo-Pacific bottlenose dolphins in the Indian Ocean

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Marine mammals, a diverse group of warm-blooded species adapted to oceanic life, are vital to ecosystem functioning, contributing to nutrient cycling, energy transfer, and the stability of coastal food webs. Among them, the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), currently listed as Near Threatened on the IUCN Red List, is a key coastal cetacean widely distributed across the Indian Ocean. However, this species is increasingly threatened by fisheries interactions, habitat degradation, coastal development, and climate-driven environmental change. Despite its ecological importance, comprehensive assessments of its habitat preferences and distribution across the Indian Ocean are lacking. To address this gap, we applied an ensembled Species Distribution Modelling (eSDM) framework integrating georeferenced occurrence records with environmental predictors, including sea surface temperature, chlorophyll-a, primary productivity, bathymetry, and salinity. The models consistently highlighted productivity-linked variables, particularly chlorophyll-a and primary productivity, as dominant ecological drivers, while sea surface temperature and continental shelf depth further constrained distribution. Ensemble projections revealed extensive areas of suitable habitat in the Arabian Sea, Bay of Bengal, and along the Sri Lankan shelf waters. These findings provide the first region-wide assessment of *T. aduncus* habitat in the Indian Ocean, delivering a spatially explicit basis for conservation prioritisation, marine spatial planning, and the protection of critical habitats under accelerating climate change.

Keywords

Climate change, Conservation prioritisation, Critical habitats, Indian Ocean, *Tursiops aduncus*



Behavioural patterns and distribution of the short-finned pilot whale *Globicephala macrorhynchus* Gray, 1846 in the Indian EEZ

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The short-finned pilot whale *Globicephala macrorhynchus* is a highly social delphinid inhabiting tropical and subtropical waters. However, baseline knowledge on its behavioural ecology from Indian waters remains scant. Systematic cetacean surveys were conducted between November 2022 and March 2024 employing the line-transect distance sampling method through onboard Fishery Survey of India (FSI) research vessels operating across the Indian Exclusive Economic Zone (EEZ). Multiple sightings of short-finned pilot whales were documented, with detailed records of pod size and behavioural repertoire. Observed behaviours included spy-hopping, blow patterns, synchronised swimming, logging, peduncle arching, and breaching, along with physical indicators such as scarring, injuries, and body colour variation. Spy-hopping appeared linked to environmental awareness and navigation, while synchronised breathing and travelling reflected social cohesion and coordinated foraging. Logging represented periods of rest, often following long dives, and partial breaching was recorded more frequently than in earlier reports, suggesting a role in communication or social display. The presence of tooth rake marks and scars indicated intraspecific interactions as well as anthropogenic threats such as vessel strikes and fishing gear entanglement. Notably, variations in body colouration were observed among adult individuals, possibly linked to age, health, or skin conditions. This study provides a systematic account of short-finned pilot whale behaviour within the Indian EEZ, contributing valuable baseline data to understand species ecology in the region. The findings emphasise the ecological significance and highlight the need for continued long-term monitoring to assess potential impacts of fisheries, shipping, and climate-driven changes in the marine environment.

Keywords

Behavioural pattern, Cetacean surveys, Distribution, FSI, Indian Seas



Conservation threads: Cetacean populations, fishery lanes, and spatial management in Indian waters

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Cetacean distribution and abundance along India's territorial waters were investigated between 2023 and 2025 with a focus on their overlap with fishery vessel operations. Systematic line-transect surveys across six coastal states and union territories covered 78 transects and documented 526 individual cetaceans representing 14 species. Regional variation in species richness was evident, with Lakshadweep recording the highest diversity (four species) despite its limited area, followed by Tamil Nadu and Karnataka (three species each). The Indo-Pacific humpback dolphin (*Sousa plumbea*) was the most abundant and widely distributed species, comprising 67% of all records (355 individuals) and occurring across four states, with peak numbers in Kerala (156 individuals across 12 transects). Pantropical spotted dolphin (*Stenella attenuata*, 364), spinner dolphin (*S. longirostris*, 113), and Risso's dolphin (*Grampus griseus*, 100) were also frequently observed, while moderate sightings included Indo-Pacific bottlenose dolphin (*Tursiops aduncus*, 43), finless porpoise (*Neophocaena phocaenoides*, 28), and pygmy killer whale (*Feresa attenuata*, 19). Smaller groups consisted of common bottlenose dolphin (*T. truncatus*, 10), short-finned pilot whale (*Globicephala macrorhynchus*, 8), striped dolphin (*Stenella coeruleoalba*, 8), and Mesoplodon sp. (6), while rare encounters included blue whale (*Balaenoptera musculus*, 3), Bryde's whale (*Balaenoptera edeni*, 3), and killer whale (*Orcinus orca*, 2). To better understand habitat preferences, survey-based observations were integrated with abundance-density models and environmental predictors, including remotely sensed variables (sea-surface temperature, SST variability, chlorophyll-a, and sea-surface height) and static features (distance to land). In addition, vessel traffic density derived from Automatic Identification System (AIS) data was overlaid with cetacean occurrence, enabling spatial comparison between biological hotspots and fishery intensity. This analysis provides evidence on areas of high overlap along the coasts of India, highlighting potential risks from marine fishery tracks and habitat disturbances. The integration of survey data, environmental predictors, and vessel traffic layers provides a robust framework for identifying both ecological hotspots and conflict zones, offering valuable guidance for conservation strategies and marine spatial planning in India's biodiverse coastal and offshore waters. .

Keywords

Abundance, Fishery intensity, Management, Marine mammals, Spatial hotspots



Understanding marine mammal diversity and distribution in Lakshadweep waters, Northern Indian Ocean

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The Lakshadweep Islands, located on the Laccadive-Maldives-Chagos ridge in the southeastern Arabian Sea, are part of a mid-oceanic archipelago, characterised by steep island slopes, diverse habitats, and strong seasonal oceanographic variability. These features support a rich diversity of cetaceans (whales, dolphins, and porpoises), yet long-term studies in this region have been sparse. This study employed both visual surveys and passive acoustic monitoring to investigate species composition, temporal patterns, and habitat use of cetaceans around Kavaratti Island in Lakshadweep. Visual surveys conducted from 2015–2016 documented 139 cetacean sightings, confirming eight odontocete and one mysticete species. Sightings varied significantly by season and habitat features, including seafloor slope and proximity to land. From 2018 to 2020, passive acoustic recorders deployed on both the north and south sides of Kavaratti detected the presence of pygmy blue whales, extending the known range of the Central Indian Ocean acoustic population. These detections presented a clear seasonal pattern, with peak acoustic activity occurring during the inter-monsoon months. Additionally, continuous acoustic data from 2019 to 2020 revealed the presence of resident odontocetes, primarily spinner dolphins, whose vocal activity was influenced by diel and lunar cycles. Detection rates were highest during the northeast monsoon and new moon phases. This study highlights the importance of mid-oceanic islands as habitats for cetaceans and demonstrates the utility of acoustic tools in data-sparse, logistically challenging environments. Findings also provide a much-needed ecological baseline for the Lakshadweep region, which is facing increasing developmental pressures and a rapidly changing climate. The study highlights the importance of integrating long-term acoustic monitoring with seasonal and habitat-based variables to gain deeper insights into the ecology of marine mammals in the Indian Ocean.

Keywords

Cetaceans, Passive acoustics, Seasonal variability, Temporal patterns





Drone-based observations of the behaviour of Indian Ocean humpback dolphins (*Sousa plumbea*), off Kochi with special reference to courtship

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Understanding marine mammal ecology, behaviour, and interactions with fishing systems is crucial for assessing ecosystem dynamics, informing conservation strategies, and developing effective mitigation measures. In recent years, unmanned aerial vehicles (UAVs) have become an important tool in the study of marine mammals. Drone observations yield more authentic and reliable data compared to the conventional methods. Drone-based research in India is still in its early stages. Based on favourable atmospheric conditions, drone surveys were conducted off Kochi, on selected days during 2024–2025. Two sightings of Indian Ocean humpback dolphins were recorded, each involving a pod of four individuals. The first pod exhibited travelling and socialising behaviours, while the second displayed clear courtship activity, including a copulatory act lasting 24–29 seconds within a single cycle. This study represents the first UAV-based observation of courtship behaviour in Indian Ocean humpback dolphins within the Asian region. The findings highlight the area as a preferred habitat for this endangered species and demonstrate the value of drone-based observations as a non-invasive method to inform conservation strategies and management plans .

Keywords

Coastal dolphins, Mammal fishery interaction, Marine megafauna, Unmanned aerial vehicles



Marine mammals stock assessment survey in the Lakshadweep waters

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Marine mammals are widely recognised as indicators of ocean health, reflecting both ecosystem variability and anthropogenic impacts. Despite their ecological importance, knowledge of species diversity and their distribution in Indian waters remains limited. To address this gap, a marine mammal stock assessment survey was conducted across the Indian waters as part of the Marine Mammal Stock Assessment Program. This study focused on the waters of Lakshadweep, and surveys were conducted during 11 to 26 February 2025, covering the islands of Suhaili, Minicoy, Kalpeni, and Kavaratti. The survey employed a linear transect approach using a fishing vessel, with dedicated observer effort for visual detections. Standardised protocols were followed for recording GPS positions, group size, behaviour, and habitat features, complemented by oceanographic data collection, including water quality parameters. During the survey, we documented a total of eight marine mammal species, including spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), Risso's dolphin (*Grampus griseus*), Indian Ocean humpback dolphin (*Sousa plumbea*), pygmy killer whale (*Feresa attenuata*), Blainville's beaked whale and pilot whales (*Globicephala spp.*). The largest sighting was a group of 350 *S. attenuata* off Kalpeni, while *S. longirostris* were the most frequently encountered, observed in multiple locations in groups of 6–35. These findings provide baseline information on species occurrence, ecological behaviour, and habitat associations in the Lakshadweep waters, supporting efforts to strengthen conservation and management of marine mammals in Indian waters.

Keywords

Cetacean diversity, Megafauna, Standardised protocols, Stock assessment



Spatio-temporal analysis of marine mammal strandings along the coast of Karnataka

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Marine mammal stranding events are valuable indicators for understanding species ecology, distribution patterns, and overall ocean health. This research focuses on marine mammal strandings along the Karnataka coast from July 2023 to June 2025, serving as a baseline to understand species diversity, ecology, habitat, and threats to marine mammals in the region. During this period, a total of 61 individual stranding events were documented across 33 beaches along the three coastal districts: Uttara Kannada (49.2%), Udupi (39.3%), and Dakshina Kannada (11.5%). Reporting in Uttara Kannada was slightly higher, likely due to increased awareness of marine mammal strandings and the importance of documenting such events for research and conservation. The stranded animals included dolphins (73.8%), porpoises (14.8%), and whales (11.4%). Among them, 45.9% were identified as females, 18% as males, while 36.1% were undetermined due to advanced decomposition. Temporal analysis revealed a peak in strandings between May and September, aligning with the pre-monsoon and monsoon seasons, with the highest number recorded in 2024. Kernel density analysis identified beaches in the Udupi District as significant stranding hotspots, followed by those along the Uttara Kannada coast. All documented individuals were found dead, with most strandings occurring during the peak fishing seasons (pre- and post-monsoon). Approximately 56% of the deaths were linked to anthropogenic causes, primarily vessel collisions, fishing net entanglement, and ingestion of marine debris such as ghost nets and plastics. The study underscores the urgent need for enhanced conservation measures, including focused awareness programmes for fishing communities and stricter enforcement of existing regulations along the coast.

Keywords

Conservation, Fisheries interaction, Karnataka, Marine mammal stranding, Plastic ingestion, *Sousa plumbea*



Documentation of stranding of marine mammals along the coast of Maharashtra

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Marine mammals as keystone species in the oceans, play important role in maintaining the structure and function of marine ecosystems. They are the indicators of ocean health, therefore, monitoring their distribution and behaviour enhances our understanding of marine ecosystem dynamics. Studying marine mammal stranding is important because it provides critical, near-real-time insights into the health of oceans, identifies human and natural threats, enriches biodiversity records, and guides effective conservation and management strategies. The present study is a comprehensive analysis of cetaceans stranding along the Maharashtra coastline, based on compiled data from official records and citizen reports. During 2019 to 2025, a total of 87 cetacean stranding incidents were recorded along the coasts of Palghar, Mumbai, Raigad, Ratnagiri and Sindhudurg districts. The strandings predominantly involved small cetaceans, especially Indo-Pacific humpback dolphin (*Sousa plumbea*), finless porpoise (*Neophocaena phocaenoides*), and spinner dolphin (*Stenella longirostris*), with occasional records of baleen whale strandings such as Bryde's whale (*Balaenoptera edeni*). Temporal analysis revealed higher reporting during the southwest monsoon and immediate post-monsoon months, coinciding with rough seas, vessel strikes, and increased debris load. Spatial analysis showed that stranding reports were not evenly distributed, suggesting that region-specific management measures are needed. It also indicates recurrent hotspots near urbanised and industrial coastal areas along the Mumbai-Thane shoreline. However, a large proportion of these stranding cases remained "undetermined" due to advanced decomposition or limited necropsy access. The findings highlight the importance of systematic monitoring and emphasise the need for region-specific management strategies, and a dedicated stranding response network, especially in the southern coast of Maharashtra.

Keywords

Citizen reports, Conservation management, Ocean health, Stranding, Vessel strike



Seabird responses to fisheries discards and anthropogenic food sources along the southwest coast of India

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Fishery discards provide an important supplementary food source for seabirds, influencing their foraging ecology, behaviour, and diet composition. While global research has largely focused on bycatch mortality and mitigation, far less attention has been given to the behavioural dynamics of seabird–fishery interactions in Indian waters. This study examines seabird responses to discards from fishing operations and other anthropogenic food sources along India's southwest coast, with particular attention to adaptive foraging strategies and the associated conservation implications. Systematic field observations were carried out both offshore, in association with active fishing vessels, and onshore near animal feed processing units and fish drying areas. Seabird behaviours during net hauling, discard events, and coastal feeding opportunities were documented. Particular attention was given to generalist gulls, terns, and skuas. Seasonal variation in the occurrence of Lesser black-backed gulls (*Larus fuscus*) was monitored during their migratory period. At sea, seabirds aggregated around fishing vessels, displaying a strong affinity for discards during haul-back and sorting operations. Generalist gulls exhibited prey switching from natural prey to discards, minimising foraging efforts, despite the lower nutritional value of waste, consistent with the 'junk food hypothesis.' Facilitated behaviours, such as vessel-following, improved foraging efficiency, while competition and kleptoparasitism by skuas were frequently observed. Distinct species-specific feeding methods were also recorded, including pursuit plunging by terns and surface seizing by gulls. Onshore, *L. fuscus* relied extensively on dried fish material, often accessing it through protective nets, which led to ingestion of plastic fragments and occasional entanglement. The study demonstrates that fisheries discards and coastal food processing sites play a critical role in shaping the foraging ecology of seabirds in southwest India. While these resources reduce foraging costs, they also pose ecological and health risks. Findings highlight the adaptive plasticity of seabirds and emphasise the urgent need for integrated fisheries and coastal management to balance human resource use with seabird conservation.

Keywords

Foraging behaviour, Man-fishing-bird interaction, Seabird–fishery interactions



Avian biodiversity and interaction patterns associated with the selected fishing systems of Kochi, India

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Kochi is one of the major fishing sites in the state of Kerala, contributing more than half of the total catch of the state. Traditional fishing is mainly confined to a depth of 10–50 m. Trawlers, ring seines, gillnet setters and long liners, are the major fishing systems contributing to the fishery. Interaction of mammals and reptiles with fishing systems have been widely studied and reported in India. Whereas the interaction of the bird community with the fishing system is the least studied. Fishing activities may affect waterbird distribution, abundance, and diversity. In the present study, avian abundance and interaction were monitored from various locations in Kochi. The data collected from the sites represent major locations where different fishing systems operate. Interviews were held with fishermen to gather data on the diversity and interaction patterns of birds. Lesser crested tern (*Thalasseus bengalensis*), great egret (*Ardea alba*), little cormorant (*Microcarbo niger*), little egret (*Egretta garzetta*), Indian cormorant, Javan pond heron (*Ardeola speciosa*), black-headed Ibis (*Threskiornis melanocephalus*) are the major water birds observed interacting with the fishing systems. Besides waterbirds, terrestrial bird species such as house crow (*Corvus splendens*), large-billed crow (*Corvus macrorhynchos*), brahmyn kite (*Haliastur indus*), and black kite (*Milvus migrans*), were frequently observed assembling around coastal fishing systems. Fishing activities were found to enhance the abundance and distribution of bird species. The interactions were mainly in the form of perching, foraging, and scavenging. The gears act as a readily and easily accessible source of diet for the birds. Land birds mainly serve as scavengers. These findings highlight the significant influence of fishing activities on avian abundance and behaviour, emphasising the need for integrated management approaches to sustain both fisheries and bird populations

Keywords

Bycatch mitigation, Coastal birds, Conservation policy, Fisheries conflict, Seabirds



Status, distribution and threats to the seabird community of Muttukadu backwaters, east coast of India

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Seabirds are integral components of coastal ecosystems, acting as bioindicators of marine health and trophic dynamics. Compared to the west coast, studies on seabirds along the east coast of India remain limited. This study, conducted in the Muttukadu Backwaters which supports diverse migratory seabirds along the east coast of India, aimed to assess the spatial distribution, population status, and prevailing threats affecting the local seabird community. Field surveys were conducted between September 2021 to May 2025 using the direct visual count method. Observations were made during both low and high tides from a fishing boat, covering multiple vantage points along the backwater margins to ensure representative coverage of various microhabitats. Seabirds were photographed using a Nikon D3400 camera with a 55-300 mm lens, and species identification was carried out with the aid of standard field guides. Qualitative assessments of environmental threats were also conducted through field observations. A total of 20 seabird species were documented during the survey period, representing the families Laridae (gulls and terns), Phalacrocoracidae (cormorants), and Pelecanidae (pelicans). Spatial distribution patterns revealed the habitat preferences, with seabirds primarily foraging in open waters near the mouth of the backwaters and roosting on mudflats, marshy regions, and rocky surfaces. Threat assessments highlighted multiple stressors affecting seabird populations and habitat integrity, which include overfishing, plastic and heavy metals pollution, predation by feral dogs as well as disturbances from recreational activities such as boating and surfing. Additionally, effluent discharge from adjacent urban settlements and aquaculture units contributed to the deterioration of water quality. The study underscores the need for targeted conservation strategies to safeguard the seabird community of the Muttukadu Backwaters

Keywords

Bioindicators, Coastal ecosystem, Effluent discharge, Laridae, Pelecanidae, Phalacrocoracidae



Exploratory surveys on marine fishery resources and megafauna along the upper east coast of India, with emphasis on marine litter and seabird populations

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An exploratory survey was conducted employing MFV Matsya Darshini along the upper east-coast, of India during the month of February 2024 to assess demersal resources. In addition, marine mammal stock assessment, marine plastic pollution assessment, and sea birds' identification were undertaken during the survey. A total of 13 demersal finfish species were identified, with silverbellies being the most dominant group, accounting for 54.03% of the catch. Barracudas were the second most abundant, contributing 9.15%. Among cephalopods, squid species comprised 7.59% of the catch, while elasmobranchs, represented mainly by rays, contributed 3.57 %. Marine mammal sightings along the coast were dominated by *Stenella attenuata* (49.13%), followed by *Stenella longirostris* (34.23%) and *Tursiops aduncus* (8.72%). The marine plastic pollution assessment indicated a higher prevalence of Municipal macroplastics, while plastic bottles were found in comparatively lower concentrations. The sea birds identified during the survey included the flesh-footed shearwater, red-necked phalarope, and a few unidentified species. The findings from this study will contribute to future scientific efforts aimed at developing effective strategies for the conservation and management of marine biodiversity including that of marine megafauna, and for identifying marine plastic pollution hotspots to facilitate targeted mitigation measures

Keywords

Bycatch mitigation, Coastal birds, Conservation policy, Fisheries conflict, Seabirds



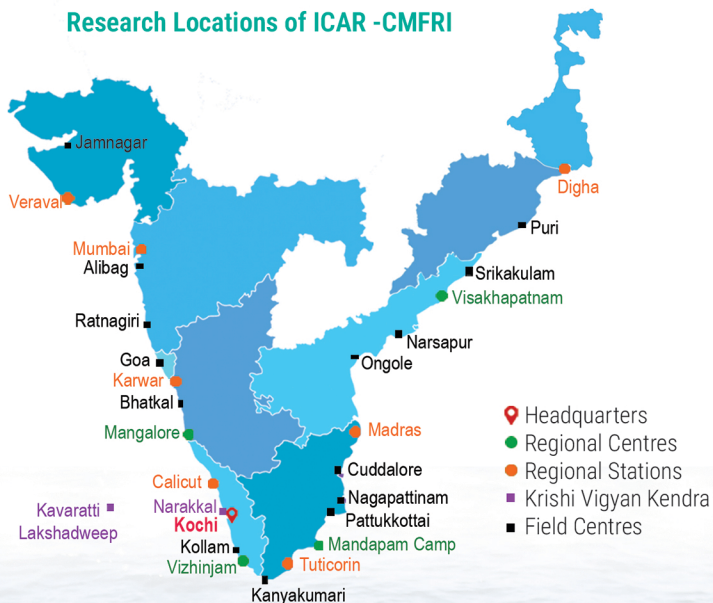


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