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The Marine Fisheries Information Service, Technical & Extension Series (MFIS) is a quarterly publication of ICAR-Central Marine Fisheries Research Institute disseminating latest research information on marine fisheries and mariculture in India. Research based technical articles, reporting significant new information, knowledge and understanding of marine fisheries and ecosystems as well as new concepts/technologies in marine fish nutrition, hatchery and larval rearing, fish pathology, fish health management, application of genetics in fish conservation and farming, sea farming technologies, seafood trade and fisheries governance are published. To see all issues since 1978, visit:

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Black pomfret landings at Digha Mohana, Purba Medinipur, West Bengal
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Marine Fisheries Information Service Technical and Extension Series envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers and transfer of technology from laboratory to the field.

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Marine Fisheries Information Service
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From the Editorial Board

Warm greetings to all our esteemed readers

Modern fisheries governance and seafood trade demands an efficient traceability system in the marine fisheries sector whereby there could be incremental gains in the aspects like seafood safety, supply chain efficiency, higher regulatory compliance leading to improvements in resource sustainability and market access to premium export markets. The launch of the National Framework on Traceability in Fisheries and Aquaculture 2025 by the Government of India is therefore a significant step in fast-tracking the development journey of the fisheries sector in India which is a significant contributor to the nation's economic development and food security. To capture the significant development, the lead article in this issue of MFIS explores the topic as applicable to marine fisheries. Also included are other interesting observations on the diversity of the fish landings, fish identification needs and market chains in the marine fisheries sector of India, to kindle the curiosity of our audience.



Marine Fisheries Information Service
Technical & Extension Series

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Traceability in India's Fisheries and Aquaculture: Concepts, practices and emerging pathways

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India's fisheries and aquaculture are entering a phase where market access is increasingly shaped by proof. For decades, competitiveness was largely associated with production growth, processing capacity and logistics. Today, however, both international buyers and domestic consumers are asking a more basic question: Can the origin, handling history and legality of a fish product be reliably verified when required? This shift is no longer limited to premium export destinations; it is also evident in India's expanding organized retail, cold-chain distribution and online seafood platforms, where consistent quality and safety assurances are becoming part of routine purchasing behaviour.

Globally, traceability has gained prominence as markets, regulators and consumers demand greater transparency in fish and aquaculture supply chains. Owing to high perishability, complex multi-stage marketing channels and diverse production systems, fish and aquaculture products are particularly sensitive to concerns related to quality, safety and authenticity. Issues such as species substitution, uncertain origin, improper handling and sustainability claims have reinforced the need for reliable traceability systems. Effective traceability strengthens trust among supply-chain actors and consumers, reduces public health risks and enables rapid, targeted recalls when contamination or non-compliance is detected. Consequently, in many international markets, traceability has become a prerequisite for meeting food-safety regulations and import requirements aimed at protecting consumer health and ensuring fair trade.

India, as one of the world's leading producers,

consumers and exporters of fish and seafood, is increasingly confronted with these expectations. Recurrent export rejections and recalls linked to antibiotic residues, concerns over disease outbreaks in aquaculture, growing scrutiny of fishing sustainability and rising domestic awareness of food safety have brought traceability to the forefront of fisheries discourse. Given the sector's critical role in livelihoods, employment and nutritional security, traceability has emerged as a key dimension of supply chain management and modernization. At the same time, rising domestic demand for safer, higher-quality fish products together with stringent compliance requirements in major export destinations highlights the need for coherent and inclusive traceability approaches that can serve India's diverse fisheries and aquaculture value chains. Against this backdrop, the present article outlines the basic concepts and operational logic of traceability in fisheries and aquaculture, with emphasis on its relevance to Indian conditions and emerging policy directions shaping fisheries governance, market access and sustainability.

Concept and scope of traceability in fisheries and aquaculture

Traceability in fisheries and aquaculture refers to the ability to systematically follow a fish or aquaculture product as it moves through defined stages of production, processing, and distribution. It enables access to information on the identity, origin, history and handling of a product, as well as its subsequent movement and destination within the supply chain. In

addition to this, traceability also provides details on the materials and ingredients incorporated at different stages of production and processing, thereby enabling verification of inputs used and their compliance with food safety and regulatory requirements.

stage of the supply chain. Equally important is the organization and secure storage of these data, so that information can be retrieved quickly and accurately when required. A unique identification code assigned

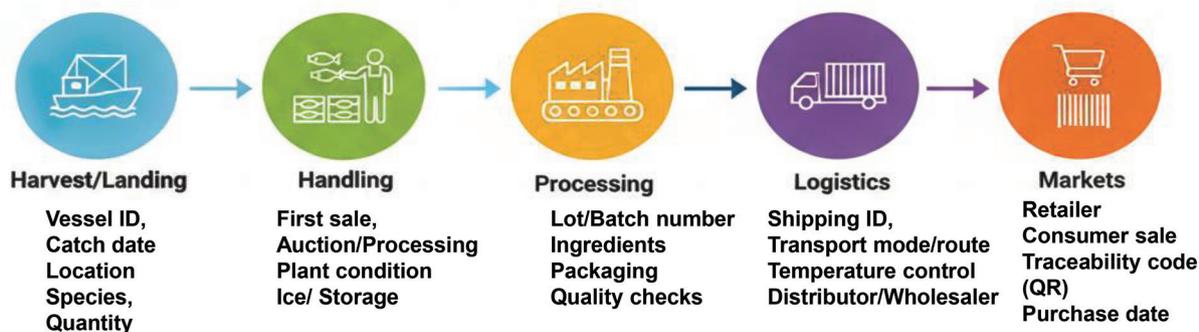


Fig. 1. Schematic representation of the key components of traceability in the capture fisheries supply chain

Traceability operates through two complementary processes: tracking, which follows the forward movement of a product from harvest or farm to markets and consumers, and tracing, which reconstructs the product's journey backward from the point of sale to its source (Fig. 1.). In the fisheries sector, traceability information is primarily used for food safety assurance, enabling operators and regulators to verify safe origin and to undertake timely withdrawal or recall actions when risks are identified. It also plays an important role in verifying the sustainability and legality of harvests, including compliance with conservation measures and catch certification requirements.

Operational logic of traceability systems

A functional traceability system is established through a disciplined operational logic that links the physical movement of fish or aquaculture products with reliable and verifiable records. The essential components include a unique product identity, continuity of information flow across supply chain nodes and proper record keeping and retrieval mechanisms when required.

A traceability system requires systematic recording of data related to inputs, production, batch separation, mixing or combination and outputs at each relevant

to each lot or batch is essential to maintain the link between the physical product and its associated records.

Input data: For all physical inputs, details such as the date of receipt, supplier identity, product description, quantity and batch or lot code must be systematically documented. In capture fisheries, primary input information generally relates to water and ice used during handling and storage, whereas in aquaculture systems, detailed records of seed, feed, medicines, and health interventions are required. Where processing is involved, input records must additionally include information on raw fish lots, ingredients, additives, and processing aids, ensuring that all components incorporated into the final product can be identified and traced back if necessary.

Production data: In capture fisheries, production data typically include vessel registration number, date of fishing, fishing location, gear used, and time of capture. In aquaculture systems, data relate to the location of production (pond or cage number), date of production, quantity and type of feed applied, and use of supplements or medicines. Where processing is involved, all processing steps must be recorded, including treatments applied, storage locations and conditions and quantities produced at each stage. Batch separation is essential to maintain traceability throughout production and processing and any mixing or combination of batches must be clearly documented.

All production, processing and batch mixing information should be linked to the original identification code to ensure continuity, traceability and retrievability of data across the supply chain. In marine capture fisheries, where fish may be derived from a large number of small-scale vessels and some degree of mixing is unavoidable, efforts should be made to preserve data integrity by limiting aggregation to a practical level, for example, by adopting landing centre-based identification and clearly labelling fish boxes or crates with appropriate traceability codes.

Output data: Output data must also be systematically recorded and linked to information collected in the earlier stages of the supply chain. Details of the receiver or customer, including identity and date of dispatch, should form an integral part of output data, ensuring that each outgoing consignment can be clearly linked to its corresponding batch or lot.

Data storage and retrieval: All traceability data generated across stages should be stored in an organised data retrieval system that allows rapid identification of both suppliers of inputs and receivers of outputs. At a minimum, the system should support “one-up, one-down” traceability, whereby each operator can identify from whom a product was received and to whom it was supplied. With advances in information technology and artificial intelligence-based tools, data storage and retrieval have become more efficient. However, records must be retained for appropriate durations depending on the shelf life, processing level, and regulatory requirements associated with the product.

Advanced traceability tools in fisheries and aquaculture: Advanced traceability systems increasingly rely on a combination of digital technologies to enable end-to-end visibility across fisheries and aquaculture value chains. A range of identification, location, and sensing technologies are commonly used to support traceability across fisheries supply chains. These include Radio Frequency Identification (RFID) systems, which use tags, readers, and scanners for data capture, along with barcodes and Quick Response (QR) codes for batch and product identification. Environmental monitoring tools such as time–temperature and humidity sensors are increasingly used to ensure cold-chain integrity. Location tracking is supported through Global Positioning Systems (GPS), while Near Field

Communication (NFC) and wireless sensor networks enable short-range data exchange and real-time monitoring. For data storage and management, digital platforms based on cloud infrastructure, blockchain, and standards such as Electronic Product Code Information Services (EPCIS) are being adopted to ensure secure, interoperable, and auditable records. Mobile applications, web-based services, and sensor-enabled Internet of Things (IoT) solutions facilitate data collection and exchange across different stages of the fisheries and aquaculture value chain. Tools such as blockchain-based ledgers can be used to securely record key transactions thereby reducing the risk of data tampering. In capture fisheries, GPS, vessel monitoring systems, and transponders facilitate spatial tracking of fishing activity and verification of compliance with fishing zones and regulations, while in aquaculture, geo-tagging and batch-wise digital documentation support farm registration and input traceability. QR codes act as simple yet powerful digital identifiers, linking physical products or batches to their traceability records and enabling access to information by regulators and consumers. More recently, artificial intelligence and machine-learning tools are being integrated to automate quality checks, detect mislabeling or anomalies, and improve logistics and decision-making, further strengthening the efficiency and credibility of traceability systems in the fisheries and aquaculture sector.

Importance of traceability for food safety, market access and sustainability

Fisheries and aquaculture value chains are inherently diverse and complex, involving multiple actors, products and marketing channels that link producers to both domestic and international consumers. Meeting the expectations of an increasingly discerning global and domestic consumer base therefore represents a significant challenge. Broadly, the importance of traceability in fisheries and aquaculture can be viewed in the following key dimensions, i.e., food safety and hygiene, market access and sustainable and responsible fishing and farming practices.

Traceability plays a critical role in strengthening both the forward and backward linkages of the supply chain. By enabling verification of product origin, compliance

with safety standards, and rapid action in the event of contamination or non-compliance, traceability directly addresses concerns related to food safety and hygiene. When safety issues such as contamination, residue violations, or quality failures occur, this enables rapid trace back to identify the source and track forward to locate affected products. This facilitates targeted withdrawal and precision recalls of specific lots or batches, rather than blanket removal of products from the market, thereby reducing economic losses and protecting the reputation of the sector. In addition, traceability contributes to improved process control, greater supply chain efficiency, and enhanced internal and external visibility across the value chain.

Adherence to internationally accepted standards is increasingly non-negotiable from a market access and buyer confidence perspective. In both domestic organized retail and international trade, buyers increasingly demand verifiable information on origin, handling, and compliance with food safety and sustainability standards. For Indian seafood exporters, compliance with global food safety management systems such as ISO 22000 and related certification schemes like FSSC 22000 is often a mandatory requirement for accessing major markets, including the European Union and the United States. Traceability underpins these standards by providing documented evidence and without these, certification and verification process becomes weak, exposing exporters to the risk of rejections, additional inspections or loss of market confidence.

A further dimension of traceability relates to sustainability and responsible fishing and farming practices. By linking products to documented harvesting or production activities, traceability supports verification of legality, adherence to conservation measures, and responsible resource use.

Global traceability practices and key stakeholders in the fisheries value chain

Globally, traceability systems in fisheries and aquaculture operates as coordinated information networks that link multiple stages of the value chain and a wide range of stakeholders. While the design and level of sophistication may vary across countries

and commodities, the core principle of reliable information flow across nodes of the supply chain remains the same. In many countries, traceability systems combine regulatory requirements, industry practices and technology enable data capture to achieve this objective.

Multiple stakeholders are involved across the value chain. At the production and harvest stage, the primary stakeholders are fishers, aquaculture farmers, and vessel or farm operators, who generate the first layer of traceability data. In marine capture fisheries, this stage often involves additional actors such as landing centre authorities and auctioneers, who play a critical role in aggregating catches and assigning lots. In aquaculture, hatcheries and input suppliers also form part of the upstream traceability ecosystem, as their records also influence the credibility of farm level data. The midstream segment of the value chain includes processors, cold storage operators, transporters and distributors. Globally, this stage is where traceability systems are often most rigorously implemented, as processing and export facilities are subject to formal audits and certification requirements. At the downstream end, wholesalers, retailers, exporters and food service operators are key stakeholders. Their role is to ensure that the traceability information is properly associated with the product until it reaches the consumer and can be retrieved when required. In many countries, retailers and large buyers act as strong drivers of traceability adoption by setting procurement conditions that require suppliers to demonstrate verifiable origin and handling practices. Consumers, although not direct data generators, increasingly influence traceability systems through demand for transparency and access to product information via labels and digital interfaces.

In addition, regulatory authorities, certification bodies, and research and extension institutions play a crucial enabling role in global traceability systems. Regulators establish minimum data requirements and compliance frameworks, certification agencies verify adherence to standards and research institutions contribute protocols, methodologies and capacity building. Effective traceability systems thus function as multistakeholder arrangements, where responsibility for data accuracy, continuity and use is shared across the fisheries and aquaculture value chain.

Traceability in India: Present status and policy direction

In India, traceability in the fisheries and aquaculture sector is presently at a transitional stage, evolving from fragmented and commodity-specific practices towards a more coordinated and digitally enabled approach. Recognizing the growing importance of traceability in the Indian capture fisheries and aquaculture sector, the Government of India has recently introduced the National Framework on Traceability in Fisheries and Aquaculture 2025. The framework responds to the urgent need for an integrated and unified digital traceability system that facilitates real-time tracking of product movement and transactions across the fisheries value chain. It aims to establish a national, IT-enabled traceability system covering both capture fisheries and aquaculture, ensuring product safety from catch/farm to fork and enabling continuity of food safety and quality assurance throughout the supply chain. The framework is envisaged as a transformative initiative benefiting a wide range of stakeholders, including small-scale fishers and farmers, processors, exporters, regulators, and consumers. Its objectives include strengthening regulatory compliance, accelerating certification and audit processes, enhancing product credibility, and promoting inclusive growth and sustainable resource management across the fisheries and aquaculture sector.

The traceability framework is structured around globally accepted traceability principles, particularly the concepts of Critical Tracking Events (CTEs) and Key Data Elements (KDEs). CTEs represent specific nodes in the supply chain where data must be captured to ensure traceability, while KDEs define the nature of information to be recorded at each stage. These concepts provide the operational backbone of the framework, ensuring that data capture is both systematic and relevant across diverse fisheries and aquaculture value chains.

Development of an IT-based traceability system is a core pillar of the framework and is proposed to be implemented through the National Fisheries Digital Platform (NFDP). The system is envisaged to leverage advanced digital technologies such as artificial intelligence and blockchain for risk

flagging, trend analysis, and creation of immutable traceability records. It proposes the use of digital tools including QR codes, GPS, IoT devices, cloud-based platforms, and blockchain protocols, and advocates a phased implementation strategy. Importantly, the framework emphasizes integration with existing digital systems such as the SHAPHARI certification by Marine Products Export Development Authority (MPEDA), digital vessel permits platforms, and related fisheries information systems to avoid duplication and ensure interoperability.

At the same time, the framework explicitly acknowledges key Indian challenges associated with traceability implementation. These include regulatory gaps and lack of data cohesion, multi-species fisheries and mixed marine landings, the dominance of a large number of small-scale fishers and fish farmers, variability in physical and cold-chain infrastructure, and the need for low-burden data capture mechanisms that do not exclude smallholders. The existing systems therefore require dedicated efforts towards standardization, interoperability, and integration with public digital infrastructure to make traceability workable at scale.

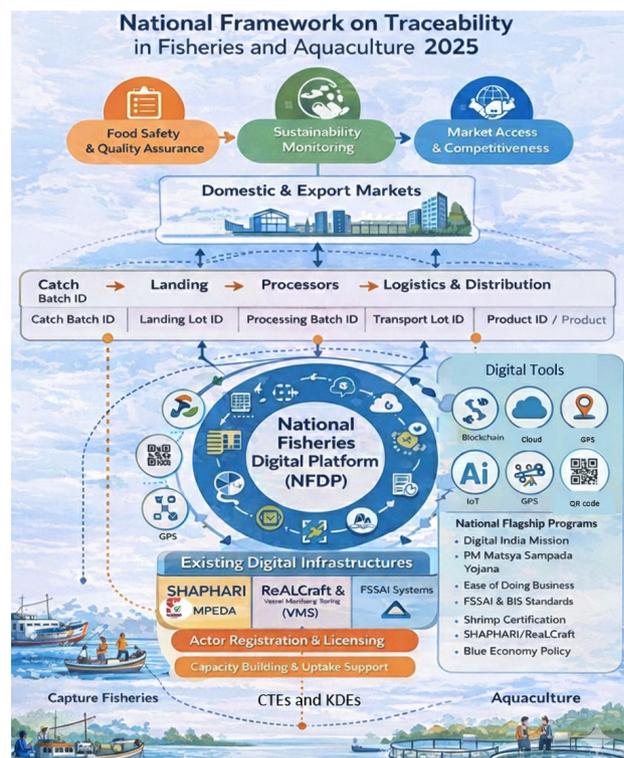


Fig. 2. National Traceability Framework for Fisheries and Aquaculture in India (2025)

The National Framework on Traceability in Fisheries and Aquaculture 2025 is strategically aligned with several national flagship programmes and policy initiatives, including the Pradhan Mantri Matsya Sampada Yojana (PMMSY), Digital India Mission, Ease of Doing Business, implementation of Food Safety and Standards Authority of India (FSSAI), Bureau of Indian Standards (BIS) standards, the Blue Economy policy, and existing shrimp certification schemes such as SHAPHARI implemented by MPEDA, along with Real Craft and Vessel Monitoring Systems (Fig.2). At the global level, the proposed traceability framework aligns India with international trade expectations and standards, positioning the country to meet evolving requirements of key export markets and international bodies. Successful implementation of the framework will, however, require active participation of stakeholders across fisheries and aquaculture value chains, supported by systematic registration and licensing, digital readiness, and sustained capacity-building efforts as a SWOT Analysis indicates (Fig. 3).

opportunities. Recent efforts towards digital governance in fisheries, including the proposal of a national traceability framework, reflect a broader recognition that transparent and reliable supply chains are central to sustainable fisheries management, biosecurity preparedness, and continued access to domestic and international markets. More importantly, traceability offers a practical pathway to ensure that claims related to quality, safety, and sustainability are supported by verifiable evidence, rather than assumption. By safeguarding livelihoods while strengthening the credibility of Indian fisheries and aquaculture in an increasingly demanding global marketplace. By strengthening confidence among regulators, buyers, and consumers alike, traceability has the potential to safeguard livelihoods, reduce avoidable risks, and enhance the credibility of Indian fisheries and aquaculture in an increasingly demanding and competitive global marketplace.

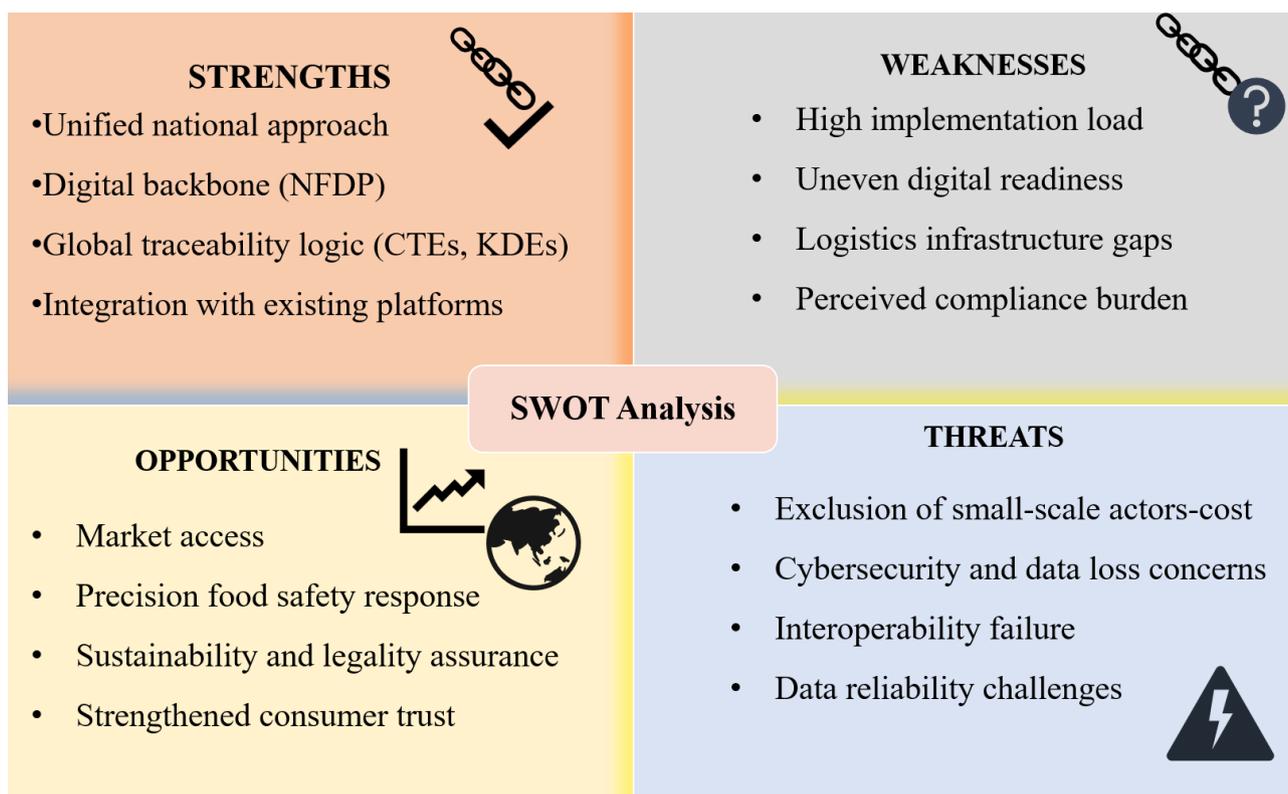


Fig. 3. SWOT Analysis of the Traceability initiative in Indian marine fisheries sector

Conclusion

For a country like India - with its diverse fisheries, large number of small-scale producers, mixed landings, and complex marketing channels - establishing effective traceability systems poses unique challenges as well as

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Rare landings of large-sized Bronze croaker in West Bengal that warrants sustainable management

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The Bronze croaker *Otolithoides biauritus* (Cantor, 1849) is found in shallow coastal waters and estuaries, with adults capable of entering rivers, while sub-adults primarily inhabit marine environments. The maximum recorded length of *Otolithoides biauritus* is 160 cm, though it is commonly observed up to 100 cm being targeted across its range using various fishing methods, including trawls, bag nets, purse seines, and longlines, and is also caught as bycatch. The species is assessed as Data Deficient globally on the IUCN Red List of Threatened Species (Chao *et al.*, 2020). Fish swim bladders, called as fish maw after being processed, are highly prized seafood delicacies in East Asian markets and ranked one among the "big four" traditional delicacies which includes sea cucumber, shark fin, and abalone. Limited information on the marketing channels and value chain analysis of commercially important finfish and shellfish species which hinders our understanding of how market structures influence the exploitation and sustainability of marine resources was addressed in the present study focused on *Otolithoides biauritus*, a high-value yet poorly studied sciaenid species. The emphasis on catch trends, size composition, value chain mapping, and constraints in exploitation and trade aims to provide baseline information to support sustainable fisheries management, conservation strategies, and policy interventions.

Fishery

Otolithoides biauritus, locally known as 'nede bhola' or 'lathi bhola' along the West Bengal coast, is a valuable resource with no specialized or targeted

fishery in the region. It is occasionally caught in coastal waters as by-catch in trawls, gillnets and bagnets. The estimated landings of this species along the West Bengal coast from 2007 to 2024 show a declining trend (Fig.1).

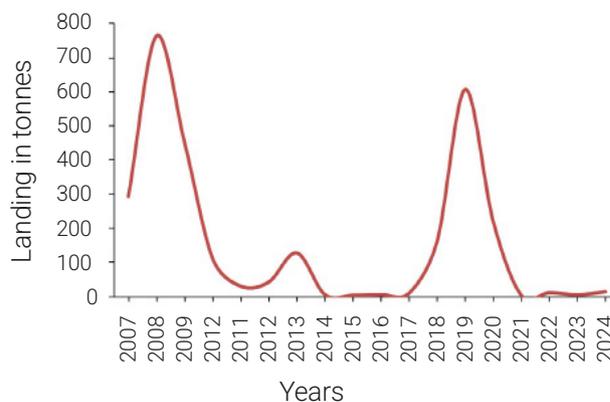


Fig. 1. Catch trends of large-sized Bronze croaker in West Bengal during 2007-2024

The highest estimated landings of 763 tonnes (t) were recorded in 2008, followed by a steady decline until 2017. A subsequent increase was observed, reaching 607 tons in 2019. However, the catch has recently decreased significantly, dropping to 14.5t in 2024. Among the various fishing gears used along the coast, trawl nets accounted for the largest share of the catch (40%), followed by gillnets (24%) and other combination gears (36%). Regular surveys conducted along the West Bengal coast from 2021 to 2024 revealed that the majority of landings comprised small-sized juveniles. The recorded specimens measured between 17.2 and 146.0 cm in total length (mean: 67.2 cm TL) and weighed from 0.050 to 12.0 kg (mean: 3.0 kg) during this period (Fig. 2 and 3).



Fig. 2. Adult and juvenile specimen of *Otolithoides biauritus* measuring 143.6 cm TL (A) and 39.8 cm TL (B)

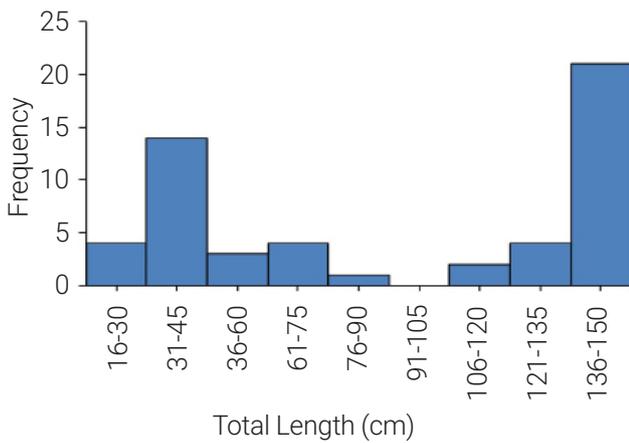


Fig. 3. Length-frequency distribution of *Otolithoides biauritus* along West Bengal coast during 2021-2024

On December 6th, 2024, 17 large specimens of *O. biauritus* were landed at the Digha Mohana Landing Centre, West Bengal (21°36'58.3272"N, 87°29'56.8644"E). These specimens measured 138–149 cm in total length (mean: 144 cm TL) and weighed 12.3–15.5 kg (mean: 13.8 kg). The total catch of 235 kg was auctioned at ₹ 730 per kg, yielding a total revenue of ₹1,71,331.



Fig. 4. Large-sized Bronze croaker *Otolithoides biauritus* landed at Digha Mohana Landing Centre, West Bengal

The fish were caught using a monofilament gillnet with a mesh size of 185 mm, operated from an inboard plank-built boat (OAL: 11.3 meters, engine capacity: 68 hp) by a nine-member crew. Fishing took place 8 km from the Subarnarekha River mouth, between the Kirtania and Talasari areas of the Odisha coast, at a depth of 9 meters. The species was captured as by-catch while targeting large threadfin species, namely *Eleutheronema tetradactylum* and *Leptomelanosoma indicum*. The typical two-day fishing trip began at around 8 am and ended early the following morning at approximately 4 am. Gillnets were set at a depth of 9–10 meters for a soaking time of 4 hours, with two hauls conducted per trip. Each trip required approximately 50 liters of diesel and 200 kg of ice. After the auction, wholesalers/supplier gutted the fish, filleted the meat, and transported it to the Howrah fish market at a rate of ₹300-400 per kg. Fresh air bladders were sold to processing plants or companies at ₹17,000–20,000 per kg, depending on the size and sex of the specimens. The air bladder of male individuals is larger, thicker, and of superior quality, fetching a higher price compared to

that of females. The processed air bladders are exported mostly to Southeast Asian countries and primarily China, at a price of ₹40,000–50,000 per kg

Marketing and Value Chain Mapping

The price trends of large-sized Bronze croaker in West Bengal (Small, medium and large- ₹/ kg) during the year 2024 were observed as 1-3 kg @ ₹150-200/kg, 3-5 kg @ ₹350-400/kg, 5-10 kg @ ₹600-650/kg and >10 kg @ ₹800-1500/kg. The marketing and value chain mapping of *Otolithoides biauritus* in West Bengal is given from the different channels the landings go through from Digha Mohana and indicates a price range of ₹300-400 at the level of wholesaler to ₹700-800 at the retailer level of marketing, per kg of meat. For the air bladder, the price range was ₹17,000/- to 20,000/- per kg of fresh air bladder at the level of wholesaler to ₹40,000/- to 50,000/- of dried air bladder at the export node (Fig. 5).

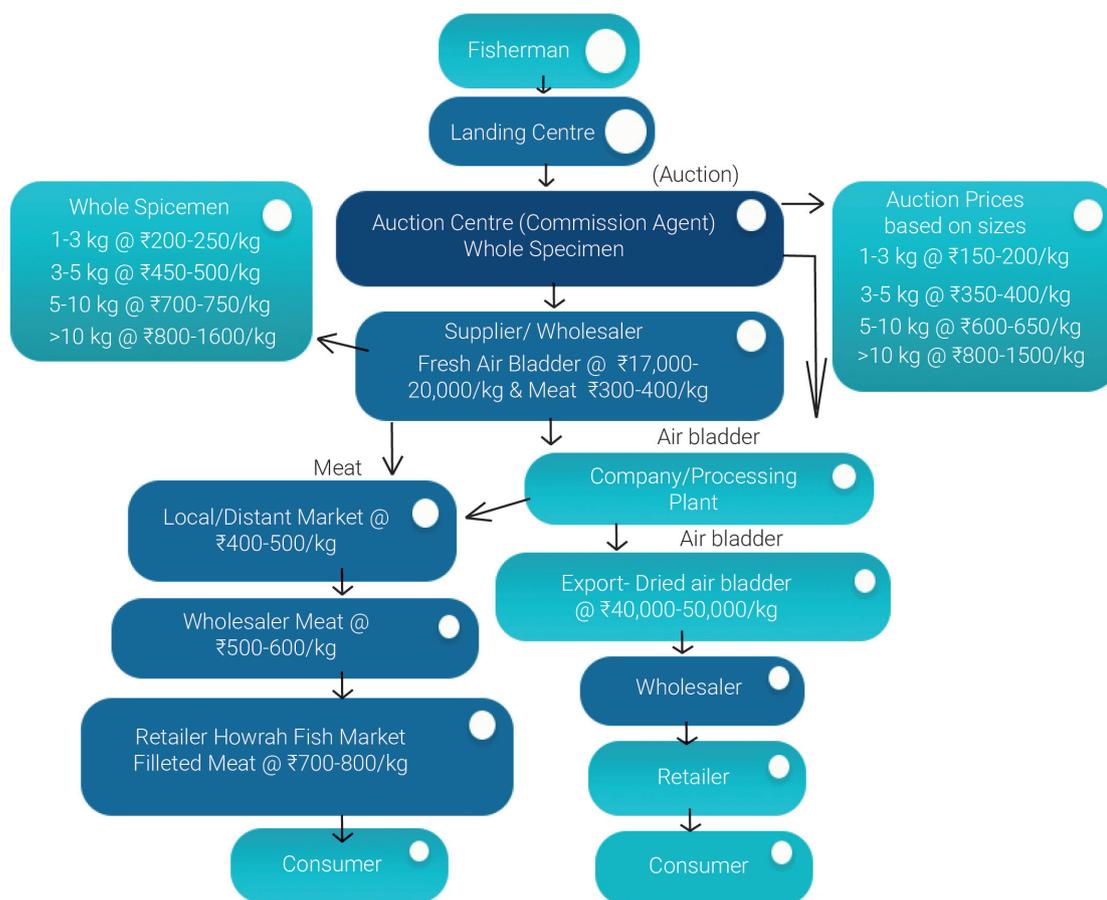


Fig. 5. Marketing and value chain mapping

From the focused group discussions with the various operators at the value chain, it could be assessed that 30 % of the catch goes to the local market and 10% to distant places, while 60% goes to the export market. The percentage source of arrival at and disposal of Bronze croaker, from Digha Mohana market is given in Table 1.

Table 1. Market arrivals and disposal of Bronze croaker in selected markets of West Bengal

Market	Arrival		Disposal	
	From	Percentage	To	Percentage
Digha Mohana	Paradeep Fishing Harbour	20	Howrah	60
	Bahabalapur	20	Kolkata	20
	Petuaghat Fishing Harbour	30	Sialda	20
	Shankarpur	20		
	Diamond Harbour	10		

The analysis of market access revealed that the distance from the market (Digha Mohana) to the nearest landing centre was 10 kms (Sankarpur); nearest railway station at 5 kms (Digha Railway Station); nearest airport at 210 kms (Dum Dum Airport) and the nearest seaport (Haldia Port) at 85 kms. The average quantity (t/yr) and value (₹/yr) traded and percentage distribution/sales at different levels in the value chain is given in Tables 2 & 3.

Table 2. Characteristics of the value chain for Bronze croaker

Value chain Point	Quantity (t/yr)	Value (₹/yr)
Fishers	14.0	56,00,000
Commission agent/Auctioneer	14.0	58,24,000
Wholesaler/Supplier	0.70	2,80,000
Local Market	0.70	3,50,000
Distant Market	0.70	4,20,000
Company/Processing Plant	11.2	56,00,000
Retailer	0.70	5,60,000

Table 3. Percentage distribution/sales to different value chain actors

Value chain actors	Wholesalers	Local Markets	Distant markets	Processing Units	Export Units	Vendors	Consumers
Fishers	5%	5%	5%	85%	0	0	100
Wholesalers	-	5%	90%	5%	-	-	100

The constraints in large-sized bronze croaker fishing were identified as: large-sized fish are primarily found in deeper waters, congregating in specific areas, with no available information on fishing grounds. Since the large-sized bronze croakers are often found in deeper waters, suitable, advanced fishing vessels and gears, fish storage facilities etc. are needed. In West Bengal, there are no specialized deep-sea fishing vessels capable of venturing into deep waters to capture these resources. The market for bronze croaker, particularly for its air bladder (used in Chinese medicine and cuisine), is also unpredictable. These fish exhibit shoaling behaviour and occasionally migrate toward the coast for breeding and feeding, making them vulnerable to being entirely caught. The species takes several years to mature, making it vulnerable to overexploitation. Probably, fishing pressure is also contributing to a significant decline in the population of large-sized bronze croakers, making them harder to catch.

The constraints in large-sized Bronze croaker marketing were perceived as: due to exceptionally high market prices, there are fewer buyers for this species; due to their large size, there is less demand in local markets; the demand for large-sized Bronze Croaker is inconsistent, especially since its main value lies in the air bladder, which is highly sought after in Chinese traditional medicine and cuisine; prices vary significantly based on market conditions, availability, and competition from alternative fish species; due to overfishing, fewer large specimens are available, making consistent supply difficult; the involvement of multiple intermediaries in the trade can reduce profit margins for fishermen and other stakeholders.

The problems in export as perceived by the producers were; since *Otolithoides biauritus* is a high-valued fish species, some countries like Vietnam listed this species in the National Red Book of Vietnam at the highest level of protection in year 2007, to prevent overfishing, which places restrictions or bans on its trade. A reduction in the availability of this species, is making it harder for traders to source sufficient quantities. Buyers demand high-quality, properly dried and preserved air bladders,

which can be challenging to maintain. The demand for fish air bladders (used in traditional Chinese medicine and cuisine) varies, affecting prices and export opportunities. The price of fish air bladders is highly volatile, making it difficult for producers to predict revenue. Fish air bladders require careful drying and packaging to prevent spoilage and loss of quality during transit. Some producers face issues with non-payment or delayed payments from international buyers. Exporters may suffer losses due to exchange rate fluctuations. The Garret ranking on the problems and constraints encountered in marketing is given in Table 4.

Most species within the 'greater sciaenid group' are characterized by long lifespan, larger maximum sizes, late maturity (in terms of both age and size), infrequent spawning and low relative fecundity which make them more susceptible to risks of overfishing. Targeting primarily large-sized fish reduces spawning stock biomass, increasing the risk of recruitment overfishing, while the by-catch of juveniles leads to growth overfishing. Therefore, continuous monitoring of these economically significant species for the impacts of fishing pressure, is crucial.

Table 4. Garret ranking of constraints in Bronze croaker market chains in West Bengal

Problem	Rank
High marketing cost	3
Lack of infrastructure and amenities	7
Lack of access facilities	8
Lesser number of buyers	4
Low market arrivals	1
High transportation cost	9
Competition among traders	6
Low product diversity	2
Price discrimination	5
Others	10

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Brief Communication

A case study on the harvesting of dead *Turbinella pyrum* along Thoothukudi coast

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Turbinella pyrum (Linnaeus, 1767), commonly known as the sacred chank (family Turbinellidae) holds cultural and religious significance, as well as used in handicrafts industries of South Asia. *T. pyrum* is considered endemic to the Indian subcontinent, distributed across the Gulf of Mannar, Palk Bay, and the Southeastern Arabian Sea and slightly, to the Sri Lankan waters. *T. pyrum* is ecologically significant and has been commercially harvested from the Gulf of Mannar region because of its ornamental shells and juicy meat (Hornell, 1914). It is generally distributed in sandy bottoms between 10 and 27 m in depth (Hornell, 1922; Nayar and Mahadevan, 1974). The

dead chank refers to the empty white shell of *T. pyrum*, which has lost both its soft tissues and periostracum, and remains buried in the seabed.

The dead chank resources were accidentally explored by fishermen during the deepening of the Harbour by V.O. Chidambaranar Port Trust in Thoothukudi. In 2009, dead chanks were exploited by skin diving. From 2011, the fishermen started diving using air compressors onwards for breathing to exploit this resource, allowing them to stay longer (average of 2-3 hours), with a maximum of 4 hours in the water at a depth of up to 18 m. Collection was

performed using aluminium scrapers/flippers worn on their legs to dig deeper using their legs at the sea bottom up to 2.0 m. The chank divers from the Therapuram coastal village of the Thoothukudi coast have started using water jet pumps for chank collection from the sea bottom, since 2023.



a) Live chank

b) Dead chank

In the Thoothukudi region, the major dead chank exploitation centre is the Therapuram coastal fishing village, while a limited number of boats are also involved in dead chank exploitation in the New Harbour Beach and Vembar coastal fishing villages of Thoothukudi District. In the Therapuram region, 2,250 divers and 1,350 helpers were involved in dead chank exploitation. In total, 450 motorised boats, including 430 "Vallam", a wooden plank-built boat and 20 FRP (Fibre-Reinforced Plastic) boats, were engaged in dead chank exploitation. The vallams had an overall length of 12-20 m and were fitted with a 40-80 hp engine. An FRP boat with an overall length of 10-15 m was fitted with a 20-40 hp (Horsepower) engine.

Equipment and accessories used by chank divers for dead chank exploitation include,

a) Compressor and Compressor hoses: Each craft was fitted with a 15-20 hp locally designed air compressor used to fill the air-storage cylinders with breathable air. Each compressor unit was connected to approximately 6-10 hoses, each 100 m long. The hose is flexible and allows the driver to move freely during the chank exploitation. The hose connected to the air cylinder is part of a breathing air supply system that delivers air directly to the driver.

b) Jet pump motor: Most boats were equipped with a single water jet pump motor, whereas a smaller percentage had two water jet pump motors. The number of water jet pump connections varied between four and ten per

boat, with an average of six connections in most cases.

c) Water intake suction line: Water intake is part of the jet pump that draws water from the surrounding area. This water is then pumped through the system at high pressure.

d) Discharge hose: The discharge hose or outlet line carries high-pressure water from the pump to the nozzle of the pump. The length of the hose is 30 m.

e) Water jet pump: A water jet pump, made of galvanised iron and approximately 1.2 meters in length, is a key accessory used to dislodge sand from the seabed during chank exploitation.

f) Regulator: The regulator, placed in the diver's mouth, ensures that the diver receives breathable air from the cylinder

g) Mask: It provides clear underwater vision and allows divers to breathe through a regulator.

h) Collection bag: A locally known kaccha net is used to store the collected underwater chank.

i) Iron rod: An iron rod (1.5–2 m) is used to anchor the diver in place during exploitation.



Water jet pump in use for dead chank exploitation

The dead chank collection process uses a water jet pump to dig into the seabed and collect the chanks buried in the sand. Divers tie a safety rope around their waist, connected to a boat on the surface for safety and communication. During the digging operation, a force of water from a water jet pump is used to excavate the seabed thereby allowing the chanks to be picked. The vertical digging process lasted between 1 and 2 minutes for a single dig, whereas the horizontal dig lasted between 4 and 5 minutes. After completing the chank collection, the process is repeated continuously for 3–4 hours during the first dive. Multiple digging and collection cycles contributed to the overall chank catch during this period. The water jet pump can dig down to 1.5 to 2 meters deep. After digging, the pits slowly start to close due to water movement and currents. Vertical digging creates round pits about 0.45 to 1 m wide and 0.3 to 0.7 m deep. Horizontal digging creates U-shaped pits about 1 to 3 m long and 0.5 to 1 m deep.

Although dead chanks have been collected since 2009, after the introduction of advancements in diving equipment such as compressors, the dead chank collection was 200t in 2013. In recent years, the exploitation of dead *T. pyrum* has increased to 420t by 2021, reaching a maximum of 1050t by 2023 on the Thoothukudi coast. Dead chank landings have substantially increased since the introduction of water jet pumps for dead chank collection. This modification increased the catch by more than fivefold, reaching a peak of 4,032t in 2024, with an estimated catch per unit effort (CPUE) of 62.5 kg/unit and 12.5 kg/person. The number of chanks collected by divers varies with age and the younger divers tend to collect more chanks, possibly due to greater physical strength and stamina. Divers in the 18–35 age group collect between 15 to 60 chanks (average 30). Those aged 35–50, collect around 10 to 40 chanks (average 25). Divers in the 50–70 age group collect fewer chanks, between 5 to 30 (average 17).



Dead chank exploitation by the water jet pump method



Dead chank landed from water jet pump operations

In the trading of dead chank in Thoothukudi region, the prices of chanks are determined by their size, quality, and condition. Currently, approximately 72 traders are actively engaged within this district and commonly traders are providing advance payments to boat owners to secure a steady supply of chanks. Most harvested chanks are now transported directly to Kolkata by local traders, where they are processed and used to make trumpets, bangles, and other shell crafts.

Table 1. Grades and pricing of dead chank shells

Shell diameter (mm)	Cost (₹)
65 to 70	50-100
70 to 80	200-300
80-90	400-500
90-100	600-800
100-110	800-1000
>110	1000-1500

Chank divers often take medication before diving to manage the physical strain and challenges associated with prolonged underwater work. Many of them use acid reflux tablets to prevent stomach discomfort, which is likely triggered by pressure variations and extended durations of working underwater. A few divers also take energy tablets to boost their stamina and strength before diving. Use of pain-relief tablets are common to manage body pain or muscle strain. Use of energy drinks are also common. Often, dead-chank divers / collectors face severe health and safety issues due to unsafe diving practices. They rely on air compressors connected to long hoses for breathing, which poses a serious risk to their lives in the event of equipment malfunction. Most of the equipment they use does not follow safety standards. Recently, with the introduction of water jet pumps, inexperienced divers have started participating in dead chank collection. Lacking proper skin-diving skills, they are unable to save themselves in the event of a compressor malfunction, putting their lives at serious risk. Divers, both young and old, suffer from joint pain, breathing problems and nerve-related issues. These health problems are likely caused by breathing in polluted air, skipping decompression steps, and doing heavy work underwater for prolonged period. One of the most dangerous problems is Decompression Sickness (DCS), which happens when gas bubbles form in the body during a fast rise to the surface. Every year, a few casualties occur during dead chank collection.



a) Bangles



b) Rings



c) Engraved shell

Ornaments from *Turbinella pyrum* and whole shell craft

Shining at Sea: Field Identification of Silver pomfrets in Indian waters

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Three species of *Pampus* (*P. chinensis*, *P. candidus*, and *P. griseus*) are sympatric in Indian waters, although they differ in their distribution range and relative abundance. *P. chinensis* is widely distributed along the entire Indian coastline, whereas *P. candidus* is restricted to the west coast and Tamil Nadu, and *P. griseus* occurs exclusively along the east coast. Among the three, *P. griseus* most closely resembles *P. candidus* in overall body form. Both *P. griseus* and *P. candidus* have an elongated anal fin that extends beyond the caudal peduncle. Their caudal fin is also long and deeply forked, with the lower lobe almost twice the length of the upper, a feature consistent across all size classes of these two species. Earlier studies have reported shortening of the lower caudal fin lobe with age, may be misleading, possibly due to breakage at the tip of the anal fin, a detail that may have been overlooked. Therefore, this characteristic should not be heavily relied upon to distinguish these cryptic species. Because pomfrets generally have long, thin, fragile and delicate fins that are highly prone to damage during fishing operations, post-harvest handling, or predator attacks, extreme caution must be exercised when conducting taxonomic investigations of such species. Such damage can easily lead to misidentification if not properly accounted for. This field identification guide will serve as a practical tool for fishery officers, fishers, students, researchers, and local scientists, helping them accurately identify *Pampus* species during routine sampling and fishery data collection. It will also enhance the precision of species-specific records and strengthen the reliability of fishery statistics, thereby supporting future research, monitoring, and sustainable management of *Pampus* resources along the Indian coastline.

Silver pomfrets and butterfishes

Family: Stromateidae Rafinesque, 1810

Diagnostic characters: The body is oval, laterally compressed, and notably deep, measuring about 31–55% of standard length. Eyes are relatively small to moderate in size, with the snout typically longer than the eye diameter; adipose tissue extends over the snout. The mouth is small, bearing minute, blade-like, uniserial laterally compressed teeth, sometimes with three cusps restricted to the jaws, with none on the vomer or palatines. The dorsal fin is either continuous or partially divided, consisting of 5–7 slender, flexible spines embedded in flesh and a total of 42–57 fin elements. The anal fin carries 2–3 spines and 33–48 total elements. Dorsal and anal fins are often falcate. Pectoral fins are fan-shaped or wedge-like, comprising 18–27 rays. Pelvic fins are absent in adult (pelvic bones present in some young). The caudal skeleton includes 4 hypurals and 2–3 epurals. Scales are tiny, cycloid, and easily shed; the top of the head and nape are typically scaleless, though small pores may be present. Branchiostegal rays number 5 or 6; gill rakers are slender, closely spaced, and range from 12 to 24. The vertebral count varies between 30 and 48.

Colour: Distinctly silvery in appearance, with a bluish sheen along the back; gill membranes and the interior of the mouth are darkly pigmented.

Habitat, biology, and fisheries: Adults are found both in demersal and pelagic zone on the continental shelf, generally down to depths of about 100 m, often forming small schools. Juveniles are epipelagic and commonly associate with jellyfish. The species holds commercial significance in certain regions and is

regarded as a high-quality food fish. Individuals of some species may reach a maximum total length of 40–60 cm. The group comprises three valid genera and 21 valid species, of which three species under the genus *Pampus* are recognized in the Indian coastline (Fricke *et al.* 2025).

Distribution: Distributed along coastal marine areas of the Americas (north and south), western African shores, and southern parts of Asia in the Indo-Pacific.

Habitat, biology, fisheries and distribution: Silver pomfrets are medium-sized, pelagic fishes that commonly form schools and are typically found in shallow coastal waters, occasionally extending into estuarine environments. Their diet mainly consists of soft-bodied coelenterates and free-swimming crustaceans. These fishes are primarily harvested through trawl fisheries and are highly valued as table fish. Within this group, three species *Pampus chinensis*, *P. candidus*, and *P. griseus* hold notable commercial significance in the Indian coast line.

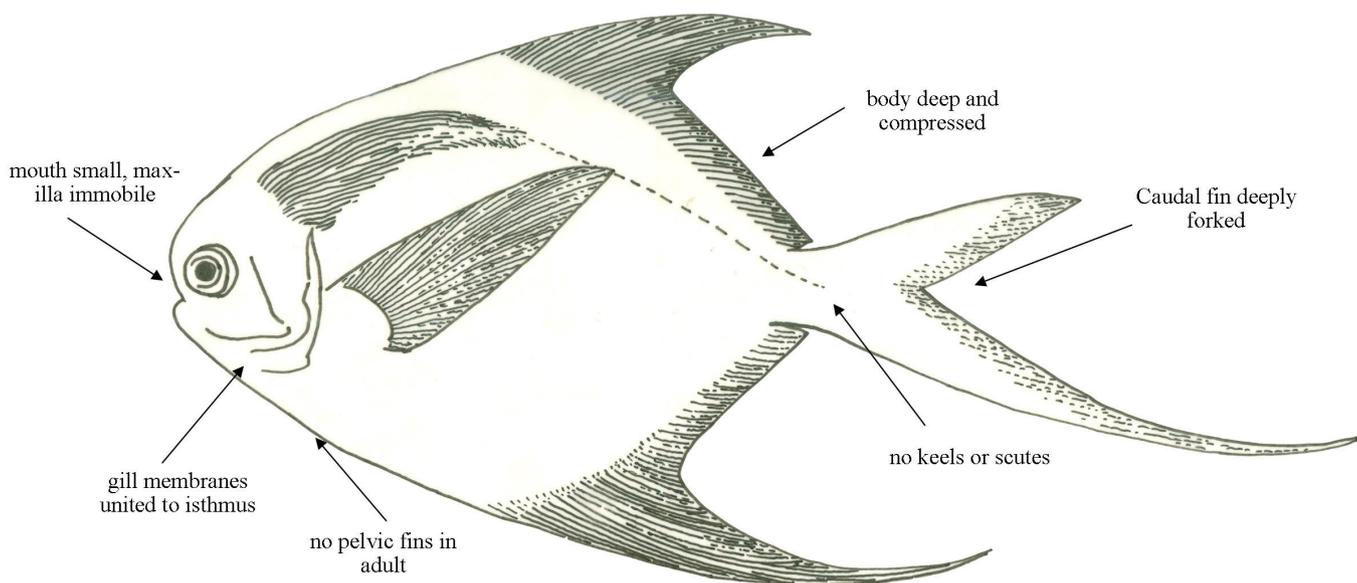


Fig. 1. General features of a typical stromateid fish species

Silver pomfrets

Genus *Pampus* Bonaparte, 1837

Diagnostic characters: The body is subcircular, very deep, and laterally compressed. The dorsal fin begins opposite the origin of the anal fin. Pelvic fins are absent, though the pelvic bone is elongated. Eyes are relatively small, and the gill opening is short, extending to the lower edge of the pectoral-fin base or slightly below. In most species, more than five sharp, blade-like spines are present before the sickle-shaped dorsal and anal fins, though these spines are lacking in *Pampus chinensis*. The lateral line is positioned high, running along the dorsal profile before curving onto the caudal peduncle.

Key to the species of *Pampus* occurring along the Indian coast

1a. Body has a diamond shape, very deep equal to standard length minus head length, forehead almost straight, short caudal peduncle, some jaw teeth having three cusps, both upper and lower lobes of caudal fin equal in length, anal fin and caudal fin not extended and no spines preceding the median fins; gill rakers slender and needle-like; transverse occipital canals of the ventral branches of lateral line slender, eyebrow-like, longer than dorsal branches, reaching base of dorsal fin and 2/3 of pectoral fin; total vertebrae, 32-33 (usually 33) (all along the Indian coast line)..... **Chinese silver pomfret *P.***

chinensis (Euphrasen, 1788) (see Fig. 2, Table 1).

1b. Body has an oval shape, depth smaller than standard length minus head length, forehead not straight, long caudal peduncle, jaw teeth without branched cusps, lower lobe of caudal fin larger than the upper, anal fin and caudal fin lower lobe greatly extended, and spines preceding the median fins; gill rakers short and tubercular-like spinules; transverse occipital canals of the ventral branches of lateral line longer than dorsal reaching base of dorsal fin and 2/3 of pectoral fin 2.

2a. Total vertebrae, 36–38 (usually 37–38) (entire west coast and Tamil Nadu coast of India) **Indian silver pomfret *P. candidus* (Cuvier, 1829)** (see Fig. 3, Table 1).

2b. Total vertebrae, 35–36 (usually 35) (entire east coast of India) **Bengal silver pomfret *P. griseus* (Cuvier and Valenciennes, 1833)** (see Fig. 4, Table 1).

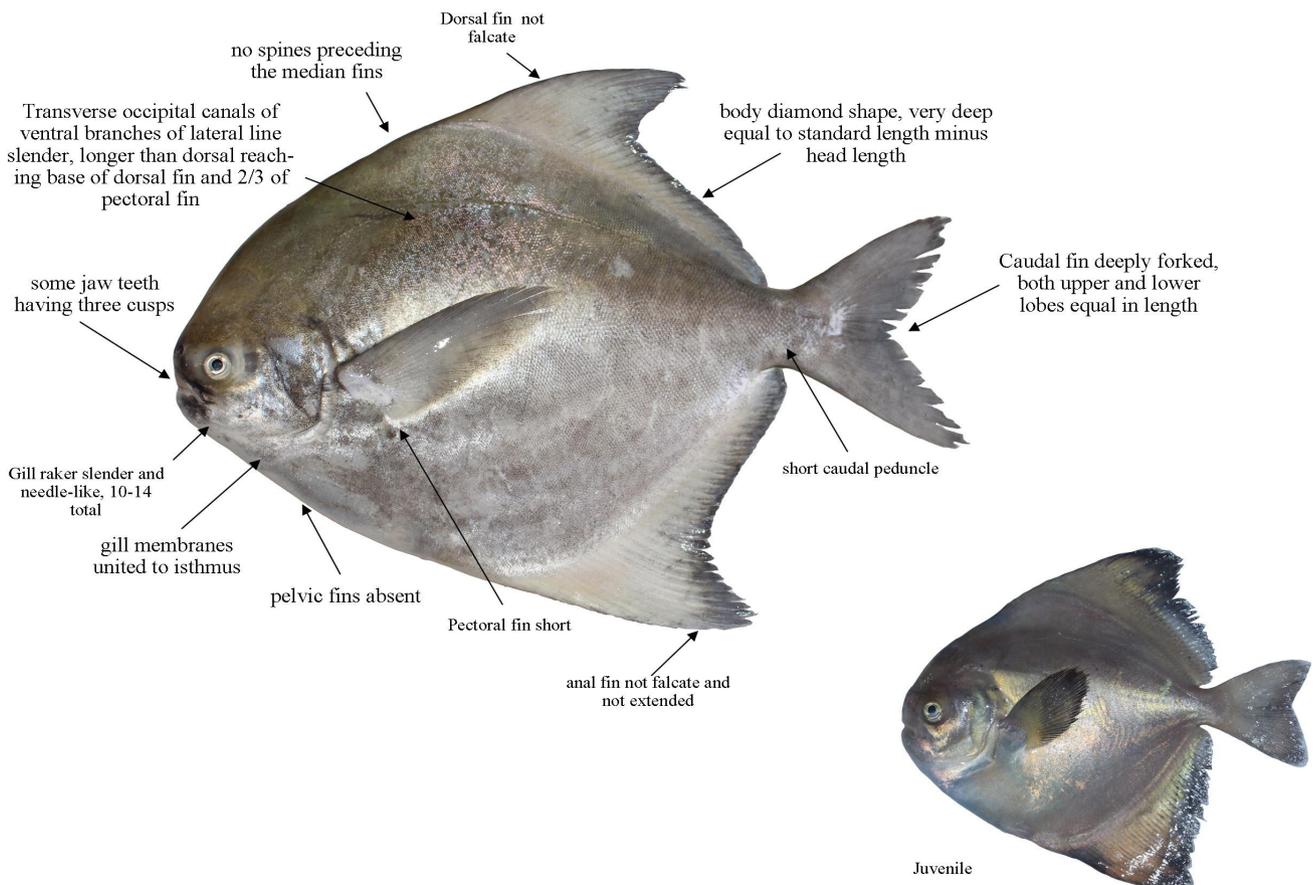


Fig. 2. Chinese Silver pomfret *Pampus chinensis* (Euphrasen, 1788)

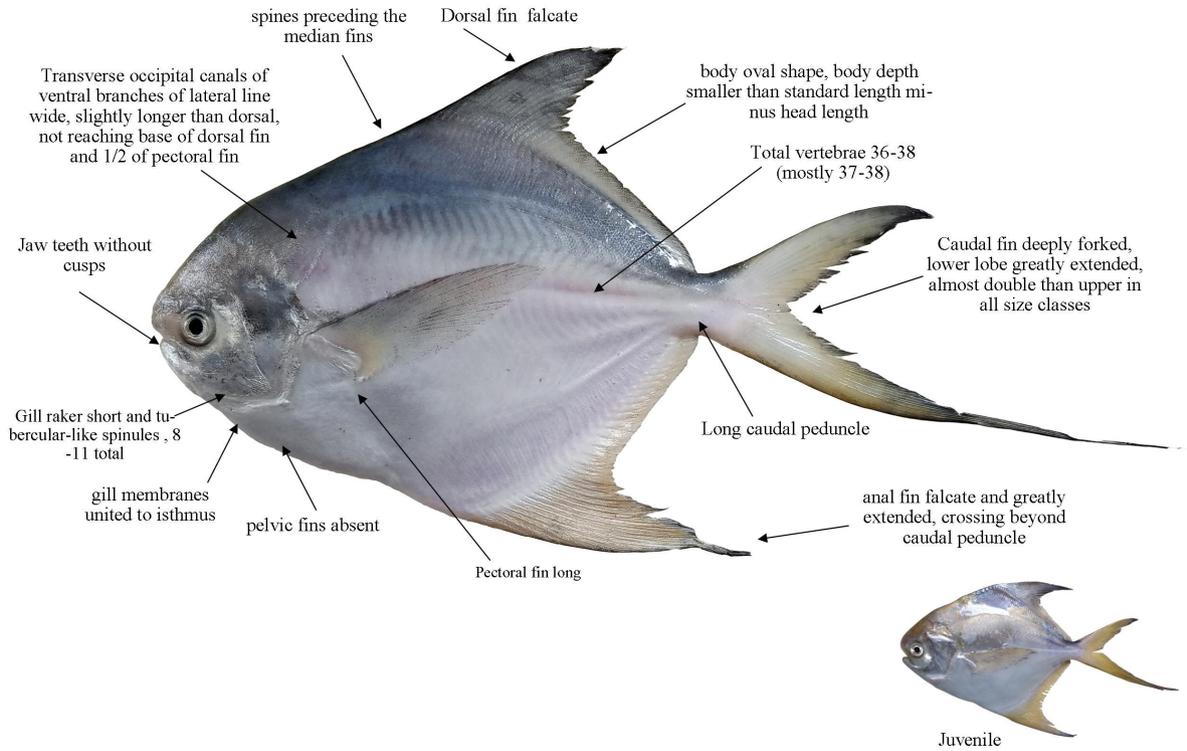


Fig. 3. Indian silver pomfret *Pampus candidus* (Cuvier, 1829)

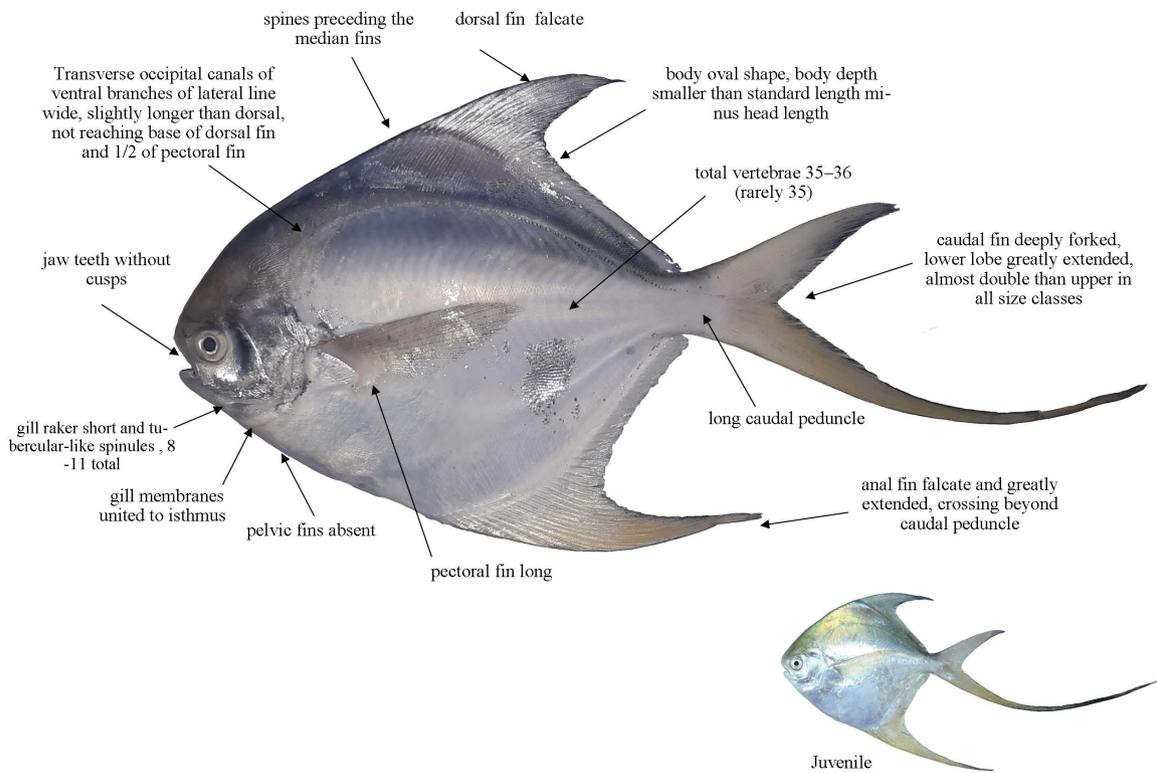


Fig. 4. Bengal silver pomfret *Pampus griseus* (Cuvier and Valenciennes, 1833)

Table 1. Comparison of the morphological characteristics of three species of *Pampus* from the Indian waters

Species/Features	<i>P. griseus</i>	<i>P. candidus</i>	<i>P. chinensis</i>
Overall body shape	Oval	Oval	Diamond
Body depth	Shorter than standard length minus head	Shorter than standard length minus head	Equal to standard length minus head length
Forehead	Not straight	Not straight	Straight
Caudal peduncle	Long	Long	Short
Spines preceding median fins	Yes	Yes	No
Jaw teeth	No branched cusps	No branched cusps	Some jaw teeth with three cusps
Gill raker shape	Short and rounded	Short and rounded	Slender and needle-like
Total gill rakers	8-11	8-12	10-14
Groove on lower ridge of gill cover	Absent	Absent	Absent
Transverse occipital canals of ventral branches of lateral line	Wide, eyebrow-like, slightly longer than dorsal branches, not reaching base of dorsal fin and 1/2 of pectoral fin	Wide, eyebrow-like, slightly longer than dorsal branches, and not reaching base of dorsal fin, 1/2 of pectoral fin	Slender, eyebrow-like, longer than dorsal branches, reaching base of dorsal fin and 2/3 of pectoral fin
Total Vertebrae	35-36 (mostly 36)	36-38 (mostly 37-38)	32-33 (mostly 33)
Eye	Small, diameter less than 1/2 of head length	Small, diameter less than 1/2 of head length	Small, diameter less than 1/2 of head length
Pectoral fin	Long	Long	Short
Anal fin	Greatly extended, crossing beyond caudal peduncle	Greatly extended, crossing beyond caudal peduncle	Not extended, never crossing beyond caudal peduncle
Lower-lobe caudal fin	Greatly extended, almost double than upper in all size classes	Greatly extended, almost double than upper in all size classes	Never extended

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Climate change and coastal fisherfolk: Impact of storms on marine fisheries

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A storm is a major atmospheric disturbance followed by sudden and often violent changes in weather conditions. It typically involves the rapid movement of air masses, leading to strong winds, heavy rain, lightning, thunderstorm, dust storm etc. Storms are caused by sudden changes in atmospheric pressure and can vary in intensity from mild to extreme. These disturbances arise from interactions between warm and cold air masses. Storm develops due to instability in atmospheric conditions. Depending on the geographic location and severity, storms can manifest in various types like tropical storms, cyclones, hurricanes or typhoons.

The effects of storms can range from localized weather changes to large-scale natural disasters, impacting both terrestrial and marine environments. In marine areas, storms disturb ocean surface conditions, influence wave patterns and significantly alter ecological dynamics. Storms generate strong surface winds, which transfer energy to the water, creating large waves and rough sea conditions. Storm winds mix the upper ocean layers, disrupting the stable stratification and causing upwelling and downwelling. Due to vertical mixing, heat from the surface spreads deeper, cooling the surface and consequently changes Sea Surface Temperature (SST). Low atmospheric pressure and strong winds create storm surges that raise sea level along coastlines. This can cause severe coastal flooding and erosion. When turbulence is high, it re-suspends sediments from the seabed, which reduces water clarity and negatively impacts coral reefs, seagrass beds, and various marine habitats. Storms play a significant role in altering local ecosystems. Storms significantly reshape local marine ecosystems by

overturning the water column. This process brings oxygen-rich water from the surface downwards and draws nutrient-rich water from the depths upwards.

Key drivers of storm development

1. Ocean warming

The primary factor driving the development and intensification of storms, particularly tropical cyclones (hurricanes/typhoons), is the high amount of energy they derive from warm ocean waters. Storms originate when sea surface temperature exceed 26.5°C, as warmer oceans supply more latent heat from evaporation and more moisture in the atmosphere and resulting in stronger and more intense storms. Warmer ocean temperatures are leading to a rise in Category 4 and 5 storms. These warmer waters sustain storms longer and can lead to rapid intensification. Ocean temperature directly influences storm strength. Intergovernmental Panel on Climate Change (IPCC) reports indicate that for every 1°C rise in sea surface temperature, storm intensity can increase by 3-5%. This correlation is supported by historical data, which shows that the strongest storms today are stronger than decades ago.

2. Moisture availability in the atmosphere

The term Moisture is used to describe the presence of water vapor in the air. Moisture in the air is crucial for formation of cloud and precipitation, and plays a significant role in the transfer of energy within the atmosphere. Water vapor is a key component

of the hydrological cycle. The level of moisture is commonly expressed as humidity. Higher moisture levels often make the air feel warmer and can significantly influence storm development along with other weather phenomena. The presence of moist air in the mid-troposphere (around 5 km altitude) is crucial for the development and strengthening of storm.

3. Low vertical wind shear

Wind Shear is the difference in wind speed and direction with height in the atmosphere. Low vertical wind shear allows the storm structure (tropical cyclones) to remain vertically organized; high shear disrupts storm formation by tilting or breaking apart storm clouds. When the difference in wind speed and direction between the ground surface and upper levels of the atmosphere is small, the developing storm can maintain its vertical alignment. This means the warm, moist air can rise directly upward, and the system can efficiently organize and strengthen.

4. Coriolis Effect

The Coriolis effect, resulting from Earth's rotation, it provides the necessary spin for the storm. The effect of Coriolis force is strongest near the poles and weakest at the equator. This is why tropical cyclones do not form near the equator (Coriolis is near zero there). Coriolis force causes the rotation of storms (anticlockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere) and also influences the direction of major currents.

Effects of Storms on Marine Fisheries

1. Fish breeding cycles

This refers to the reproductive strategies and seasonal breeding patterns of fish species throughout the year. These cycles are influenced by environmental, biological, and ecological factors like temperature, photoperiod (Day Length), salinity and water flow, food availability and environmental stability that regulate when, where, and how fish reproduce. Storms significantly disrupt fish breeding cycles because these cycles depend on stable environmental conditions Table 1.

Table 1. Effects and Impacts of storms on fish breeding cycles

Effects	Impacts
Disruption of spawning grounds	Storms disturb seabed habitats (coral reefs, estuaries, and mangroves), destroying eggs and nesting sites.
Changes in water temperature	Sudden fluctuations delay or inhibit spawning as many species require specific temperature ranges.
Altered salinity levels	Freshwater runoff lowers salinity, causing stress or mortality in eggs, larvae, and broodstock.
Reduced oxygen levels	Increased turbidity lowers photosynthesis, reducing dissolved oxygen and impacting reproduction.
Migration pattern disruptions	Altered currents and cues delay or prevent migration to spawning grounds.
Increased mortality of eggs and larvae	High-energy waves and sediments destroy eggs and increase larval mortality.

2. Fish population

Storms like tropical cyclones, can have a profound and often detrimental impact on fish populations (Table 2). These effects can be both immediate and long-term, influencing fish survival, behaviour, reproduction, and overall ecosystem health.

Table 2. Impacts of storms on fish population

Impact of Storms	Effect on Fish Population
Habitat Destruction	Damages coral reefs, mangroves, and seagrass beds; reduces breeding and feeding grounds.
Increased Mortality	Eggs, larvae, and juveniles killed by turbulence; adults suffer stress or oxygen depletion.
Changes in Water Quality	Runoff reduces salinity, increases turbidity, and introduces pollutants, harming fish health.
Disruption of Feeding & Breeding	Reduced food availability and interrupted spawning cycles, lowering recruitment.
Altered Distribution & Migration	Fish move to deeper or safer waters, changing population structure and availability.
Long-term Stock Decline	Repeated storms reduce population recovery and may cause commercial species collapse.

3. Fish habitats

Tropical cyclones and hurricanes can severely disrupt fish habitats, producing short and long term impacts on fish populations. These impacts is

primarily driven by intense winds, waves, rain, and storm surges Table 3.

Table 3. Impacts of storms on fish habitats

Impact of Storms	Explanation
Destruction of Physical Habitats	Strong waves and surges damage coral reefs, mangroves, and seagrass beds essential for fish life
Increased Turbidity	Sediment runoff makes water murky, reducing light available for photosynthesis and disrupts the food chains
Altered Water Chemistry	Heavy rainfall lowers salinity; runoff adds pollutants, degrading water quality
Loss of Shelter and Breeding Grounds	Breaking of reefs and uprooting of mangroves eliminates protective and spawning areas
Habitat Fragmentation	Storm surges disconnect estuaries and lagoons, disrupting fish migration and breeding

4. Marine food chain

Storms can have significant and complex impacts on marine food chains, sometimes triggering cascading effects that transform the entire ecosystem (Table 4). These impacts vary depending on the intensity of the storm, the specific marine environment and the season.

Table 4. Impacts of storms on marine food chain

Trophic Level	Impact
Primary Producers (Phytoplankton)	Increased turbidity reduces sunlight and photosynthesis; storm mixing may cause short-term nutrient boost
Zooplankton	Decline in food availability; turbulence disperses or kills delicate organisms
Small Pelagic Fish	Reduced zooplankton lowers food supply; alters migration patterns
Predatory Fish	Less prey availability causes feeding stress; forces migration and increases competition
Marine Mammals & Birds	Food scarcity affects feeding and breeding behaviour
Overall Food Web	Disrupted energy flow leads to imbalance; opportunistic species may dominate

5. Ecosystem imbalance

Intense and frequent storms can profoundly disrupt the delicate balance of ecosystems, triggering a chain of effects that modify community composition, energy dynamics, and overall ecosystem integrity. These disturbances can manifest in various ways, often with long-term consequences (Table 5).

Table 5. Impacts of storms on Ecosystem imbalance

Impact Area	Description	Examples
Physical Habitat Damage	Strong waves and storm surges damage habitats.	Coral reef breakage, mangrove uprooting
Coastal Erosion & Sediment Transport	Erosion of shorelines and sediment resuspension smothers benthic life.	Loss of beaches, seagrass burial
Disruption of Food Webs	Alters plankton communities, impacts fish larvae and recruitment.	Fish population decline
Oxygen Imbalance	Post-storm organic decay leads to hypoxia (low oxygen zones).	Fish kills, dead zones
Species Displacement & Mortality	Displaces or kills sensitive species.	Coral bleaching, shellfish mortality
Salinity & Temperature Changes	Freshwater runoff lowers salinity; surface cooling from mixing.	Stress on marine species
Pollution & Contaminants	Storm runoff brings chemicals, plastics, and sewage into marine areas.	Water contamination, bioaccumulation
Long-term consequences	Habitat loss and altered nutrient cycles reduce biodiversity and resilience.	Dominance of invasive species

Conclusion

Storms have profound and multifaceted impacts on marine ecosystems, disrupting critical habitats such as coral reefs, seagrass beds, and mangroves, which serve as breeding and nursery grounds for numerous fish species. Repeated storm events cause cumulative habitat degradation, risking long-term biodiversity loss and collapse of fish communities. Damage to artificial reefs and conservation zones further undermines marine protection efforts, while socioeconomic repercussions for coastal fisheries demand adaptive strategies in marine resource management.

Fishery for endemic marine clam *Sunetta solanderii* from Kadalundi, Kerala

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The marine clam *Sunetta solanderii* (Gray, 1825) is a venerid bivalve endemic to the southwest coast of India, particularly Kerala. The clam resources of the estuaries along the Kerala Coast have been traditionally exploited by coastal populations. The Kadalundi Estuary in Kozhikode District, supports a traditional clam fishery in the Kadalundi – Vallikkunnu Community Reserve (VKCR), declared in 2007. Spread across an area of 1.5 sq.km, this biologically productive estuary, drains directly into the Arabian Sea, and supports fauna and flora including a total of 13 species of molluscs from 13 genera, under 9 families and 7 orders.

The marine clam *Sunetta solanderii* locally referred to by the populace “Vella erunthu,” supports a small-scale lucrative local fishery. The seasonal fishery is observed during April to July in this estuarine system where extensive clam beds occur in the sandy deposits near the bar mouth adjacent to the Kadalundi Bridge (11°07'16.8" N; 75°49'39.0" E). About 5-10 fishermen fish these clams in Kadalundi, besides 20-50 residents who engage in the collection of clams primarily for their subsistence or household consumption. The clams are typically handpicked from the intertidal zone during periods of low tide, when they are fully exposed and easily accessible. The fishermen also employ scoop netting techniques, using a scoop net without a handle, and a mesh size of 22 mm, to sieve through the sediment at knee-depth to collect more clams. This fishery yielded an estimated 27.07t of *S. solanderii* during the 2024 season.

Morphological characteristics noted were a shell that is smooth and glossy, moderately elongated in shape. The hinge teeth are thin and narrow, and the tooth is in front of the cardinals. The lunule is long and narrow and deeply excavated. The locations

where the adductor impressions are marked by slight depressions, and the pallial line is deeply sinuate. The inner surface is uniformly whitish, and its margin is finely crenulated all around. Colouration of the external surface is characterized by a pale yellowish or fleshy white shade, while the internal surface is white or pale yellow (Fig. 1.)

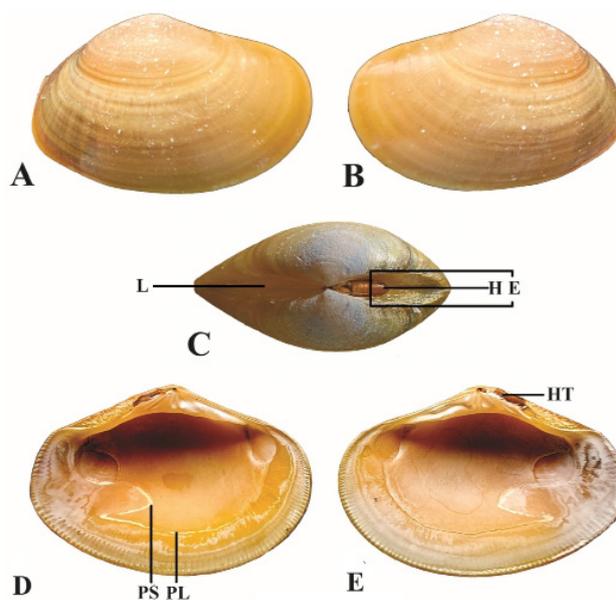


Fig. 1. External view of shell left (A), right (B), view of umbo region (C), internal view of left (D) and right (E) of *Sunetta solanderii* (scale bar= 2 cm); L=lunule; H=hinge ligament; E=escutcheon; PL=pallial line; PS=pallial sinus and HT=hinge teeth

Size of the clams from the fishery ranged from 23.2 to 38.9 mm (mean = 32.4 mm) and weight of the individuals ranged from 0.45 to 14.5 g (mean =5.6 g). Wet meat weight varied between 0.03 and 1.96 g (mean = 0.77 g). The wet meat weight as a percentage of total body weight ranged from 6.7% to 21.7%

(mean=12.6%). The substratum that constitutes the habitat of these clams was comprised by sand, silt and shell fragments. It inhabits the fine sandy substrate on the upper subtidal zone surrounding the mouths of expansive inner bays and is often found alive in the Thooval Theeram Beach (Malappuram District) and Munambam Beach (Ernakulam District) and its populations appear to be unevenly distributed. In India, clams support a small-scale fishery and in order of abundance, *Villorita cyprinoides*, *Meretrix casta*, *Paphia malabarica*, *Marcia opima*, and *Meretrix* are fished from estuaries in Kerala. However, the marine clam *Sunetta solanderii* contributes to a distinct marine clam component of the fishery from open coastal zone near the estuarine mouths.

Clam fishing effort intensifies during the monsoon season, particularly when weather conditions are not conducive for sea-fishing coinciding with mechanized fishing ban (June and July). A fishery for its congener, *Sunetta scripta* in the northern side of the entrance into the Cochin bar mouth and Azhikode areas during 1990s. The wedge clam, *Donax incarnatus* Gmelin, 1791 was fished in significant quantities in the Malippuram area in Vypeen Island, near Kochi (George 2000). However, there were no reports on marine clam fishing in the Kadalundi areas. More extensive and comprehensive studies are required to characterize the ecological role, reproductive biology,



and fishery potential of *Sunetta solanderii*, ensuring its sustainable utilization and conservation within the Kadalundi–Vallikkunnu ecosystem in particular and also along the Kerala coast.

Unearthing the Fossilised Bivalve fishery in Kulasekarapattinam: A Unique livelihood in Thoothukudi District

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Kulasekarapattinam, a coastal fishing village of Thoothukudi District, Tamil Nadu, has around 200 fishing families, with around 80 motorised crafts, actively engaged in marine fishing operations. While gill nets (Bottom set gill net and Trammel net) are the principal gear used in traditional fisheries here, the village is also known for a unique activity of the exploitation of fossilised bivalve shells by skin diving from the seabed, making it an important regional fishery of both livelihood and commercial significance.

Craft and gear

Around 25 Fiber Reinforced Plastic (FRP) boats are involved in the fossilised bivalve shell fishery. These boats typically measure 8 to 10 m in length and are powered by 10 hp outboard engines. The gear and tools used in the exploitation process are simple yet efficient: normal diving masks are used by the divers for underwater visibility. An empty tin oil container, is modified into a box for manually digging and loosening the buried shells on the seabed. A locally fabricated net bag called "Katcha Valai" is used for collecting and storing the fossilised shells during the dive. This gear setup enables efficient and sustainable shell extraction from the seabed without heavy mechanisation.

The boats venture out by 5.00 am into the southeast direction from the village, covering a distance of 3 to 5 nautical miles where at 3 to 5 meters depths in the shallow subtidal zones, fossilised bivalve shells are found. Each boat carries 7 to 10 individuals, including 3–4 divers and boat-based helpers. The method is fully manual and labour-intensive. Divers, equipped with mirror masks, dive into the water and identify the areas rich in fossilized clams. Breath-hold diving is practiced, with each dive lasting 50 seconds to 2 minutes, depending on their skill level. After each dive, they surface to breathe and quickly return to continue exploitation. Using the steel box, they dig the

seabed to collect fossilized. Shells which are transferred into the Katcha Valai, which can hold approximately 15 kg of shells. Once it is filled, the divers signal the boat crew, who then haul the bags aboard using ropes. This process is repeated over 2–3 hours per trip, typically yielding around 5–10t of shells per boat per day during the peak season, and 2–3t during the lean season. The boats return to shore by 10:30 am, and the harvested shells are transported from shore to land using net baskets.

This fishery operates year-round, except on Sundays and during rough sea conditions. The fossilised bivalve fishery has shown ups and downs from 2012 to 2024. The catch started at 6,518t in 2012 and reached a high of 7,991t in 2015. After that, it dropped to 6,127t in 2017 and further down to 5,366 tonnes in 2020. A strong recovery began in 2021 with 7,210.48t, followed by a sharp increase in 2022 to 12,894t, almost double the previous year. Although the catch slightly dropped to 9,557t in 2023, the highest catch was recorded in 2024, reaching 13,081t. The fossilised shell deposits are composed of a diverse range of species, including *Cardita* sp., *Brachidontes* sp., *Dentalium* sp., *Chlamys* sp., and other species. In addition, smaller gastropods such as *Cerithidium*, *Umbonium*, and small cowries are frequently collected. Which are segregated post-harvest and sold to the shellcraft industry.

Once the bivalve shells land, they are cleaned using sieving nets to remove sand and unwanted debris. Cleaned shells are sorted, and small gastropods are separated for ornamental and craft use. The market value of fossilised bivalves varies depending on demand and availability with 10 kg of shell fetching ₹20–₹25. The daily earnings per boat range between ₹3,000 to ₹25,000, and the average income is around ₹12,500 per boat per day. The shells are primarily sold to retailers and middlemen. The bulk of

the collected material is transported to Namakkal, Tamil Nadu, a major hub for poultry feed production. The shells are crushed and used in poultry feed formulation as a rich source of calcium. Additionally they are also supplied to lime factories for industrial use.

This fishery thus plays a vital role in supporting the coastal economy of Kulasekarapattinam. It provides year-round employment and the steady market demand from the poultry sector ensures sustained revenue for local fisherfolk, particularly during periods when fish catches are low.

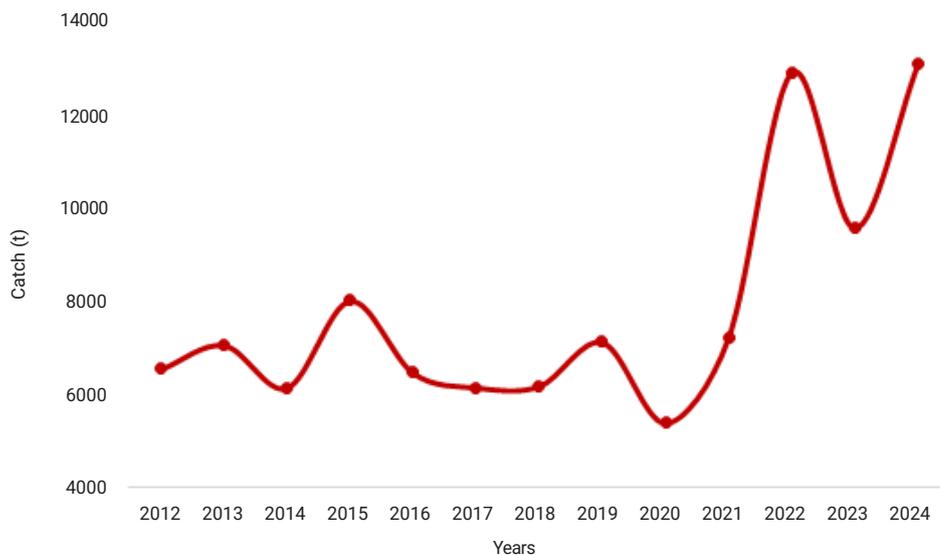


Fig. 1. Landing trends of fossilised bivalves from Kulasekarapattinam, Thoothukudi



Boat with exploited shells



Dumping the exploited shells on the shore



Sieving the collected shells to remove the sand particles

Reports on less known fishes occurring in trawl by-catch



Lalmohania velutina

The southwest coast of India is a region of significant marine biodiversity but certain ecosystems remain poorly documented and needs special attention. This report discusses some species collected as part of monitoring and identifying the resources landed in Kozhikode. Filefishes (Monacanthidae:

Tetraodontiformes) are small to medium size fishes with a highly compressed body. Around 23 species are reported from India. Velvet filefish, *Lalmohania velutina* Hutchins, 1994 was described from the Gulf of Mannar, India, and considered to be a species with a restricted distribution range.

However, the species is reported up to Visakhapatnam on the east coast of India, in the northern Bay of Bengal. Specimens were also collected from trawl bycatch at Beypore Fisheries Harbour, Kozhikode extending the known distribution range of *L. velutina* to the west coast of India. .



Parapercis clathrata

Sandperches (Pinguipedidae) are moderate sized benthic fishes occasionally forming a minor fishery along southern India. At least 17 species are known from Indian waters. Latticed sandperch

Parapercis clathrata Ogilby, 1910 is reported from Gulf of Mannar and since then there are no additional regional reports (Kannan *et al*, 2012). This report extends distribution of *Parapercis clathrata*

to the south west coast of India based on trawl bycatch landed at Beypore, Kozhikode.

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A note on the deep-sea shrimp *Glyphocrangon investigatoris*



Glyphocrangon investigatoris Wood-Mason & Alcock, 1891, is a deep-sea shrimp belonging to the family Glyphocrangonidae (Smith, 1884), order Decapoda, and the genus *Glyphocrangon* (A. Milne-Edwards, 1881), which comprises 101 species with a global distribution (WoRMS). Twenty-one female specimens were collected from the commercial fishing trawlers at Sakhikulangara Fisheries Harbour Kollam, Kerala during May 2025. The specimens exhibited a total length ranging from 43.43 to 102.98 mm. Carapace length varied between 19.52 and 43.06 mm, with a mean of 37.19 ± 5.08 mm. Body weight ranged from 0.62 to 18.17 g, with an average of 7.61 ± 3.77 g. Among the 21 females examined 16 were berried. Absolute fecundity ranged from 44 to 108 eggs, while relative fecundity varied from 4.83 to 7.5. The entire carapace and abdomen, excluding the rostrum, are densely covered with tubercles, giving the body a thick and rigid appearance. The rostrum

is dorsoventrally compressed and bears two pairs of lateral teeth—one pair situated medially and the other at the base. Rostrum is immovably fused to the carapace, shorter in length than the carapace, and curves downward. A well-developed median carina extends along its length. The carapace features a distinctly marked cervical groove. Both the orbital and branchiostegal spines are well developed and prominently visible. Carapace and thorax firmly interlocked. The carinae on the dorsal surface of the carapace are composed of tubercles, while those along the lateral margins are ridge-like in form. The sub-median carina of the carapace bears 6 blunt or broad tubercles anteriorly and 4 posteriorly. The lamina of the anterior fourth lateral carina relatively small, strongly divergent and weakly curved laterally. The antennal scale is broadly oval. The upper branchial region has about 30 blunt tubercles arranged in three rows. 2-4 supra-orbital

tubercles present. The abdomen is prominently curved dorsally, with the median gastric region exhibiting a row of approximately 10 tubercles. An anteriorly directed sub-acute tooth is present on the median carina of the first abdominal somite. Second to fourth somites possess a well-developed median carina. The fifth somite has a posteriorly directed tooth on the median carina. The pleura of the second to fifth abdominal segments each end in two recurved spines, while the pleura of the sixth segment terminates in a single spine. The telson bears three ridges, sharp dorsolateral and ventrolateral ridges, covered with tubercles, with the median ridge extending only up to one-fourth of its length. Appendix interna on the second pleopod of female well developed.

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Report on *Charybdis (Charybdis) riversandersoni* from southwest coast of India

The Portunid crab *Charybdis (Charybdis) riversandersoni* was recorded in multiday trawl landings at Munambam during January 2025, and at Neendakara and Sakthikulangara during February-March 2025. This edible crab is not a commercially targeted species in Indian marine fisheries and is very rarely encountered in fish landing centers. It is occasionally landed as by-catch, in the trawl fisheries of India. Notably, this species was earlier recorded in the regular landings from the Cochin Fisheries Harbour in 2013, but, there have been no reports of its commercial exploitation till now.

In its external characters, the carapace is very smooth and polished, a mix of orange and light lilac gives an attractive colour to the crab. The epibranchial region is very prominently swollen bordered with small white spots in a specific



pattern. On either branchial region is with a big creamish white spot near the middle of the postero-lateral border. More than half of the distal portion of propodus

and dactylus of chelipeds are in blood-red colour with the extreme tips milk-white. Other pereiopods are light violet except the dactylia, which are pale brown.



Ventral view of the male and female *Charybdis (Charybdis) riversandersoni*.

The size of the male crabs recorded in the landings ranged from 43 to 82 mm in carapace width (CW), 29 to 59 mm in carapace length (CL) and 10.64 to 63.0 g in total weight (TW). The size of the female crabs ranged from 44 to 87 mm in CW, 30 to 63 mm in CL and 11.2 to 88.0 g in TW. Among the females, three were ovigerous (CW -73/ 76/ 80 mm;

CL - 52/ 47/ 47mm and TW- 46/ 52/ 63g). The smallest male and female crabs were procured from the Munambam Landing Centre and all the rest from Sakthikulangara Landing Centre. A female specimen of the species has been deposited in the Designated National Repository (DNR) of ICAR- CMFRI, Kochi (ED: 5.5.1.10.2). The recent landings

highlight the continued presence of *Charybdis (C.) riversandersoni* in the region and a growing understanding of its distribution along the Indian coast.

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Photograph-based record of False catshark, *Pseudotriakis microdon* from India



Fig. 1. *Pseudotriakis microdon* landed at Thengaipattinam, Tamil Nadu

While looking at photographs of sharks by field staff an unusual shark was observed along with gulper sharks (Centrophoridae) and was identified as False catshark, *Pseudotriakis microdon* Capello, 1868 (Pseudotriakidae) Fig. 1. A second opinion on photograph-based identification was obtained from global shark expert Dr. David Ebert. This 130 kg, 9 feet female shark was from mechanized liner landing 19.05. 2023 at Thengaipattinam landing centre, Tamil Nadu. The fishing ground was located at a depth of 200m at a distance of 260km from the shore. This appears

to be first report of the species from Indian waters, which still harbours hidden deepwater diversity. This deep-sea shark can grow to a size of 300 cm TL, have a large, bulky, dark-brown, soft-bodied shark with elongated, catlike eyes and nictitating eyelids, large spiracles, a huge, wide, angular mouth, two large spineless dorsal fins and an anal fin. The low, long, keel-like first dorsal fin and a caudal fin without a strong ventral lobe are strong identification characteristics of the species.

Pseudotriakidae (Carcharhiniformes) in India was formerly known based

on only single species *Planonassus indicus* Ebert, Akhilesh & Weigmann 2018 which was based on material from India and currently known from India and Sri Lanka only. *Pseudotriakis microdon* though known as a cosmopolitan deepwater species Indian Ocean records are poor. This report fills a gap in the distribution range of species and could be more widespread. The deepwater fisheries of India is providing more faunal diversity to India.

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A note on the biogenic honeycomb like reef structures by Sandcastle worms



Fig.1. *Sabellaria alveolata* Dorsal view

Unusual honeycomb-like structures were observed along Majali Beach (Karnataka) and Talpona Beach (Goa) during field visits in the month of January 2026. The formations were identified as biogenic reefs constructed by sandcastle worms, commonly referred to as honeycomb worms (family Sabellariidae). These reef-like structures represent a remarkable example of ecosystem engineering in the intertidal zone, where small invertebrates significantly modify their physical environment. The Majali Beach, Karnataka (14°53'53.9"N 74°05'44.4"E) is an exposed sandy beach influenced by strong wave action and abundant sediment supply. Talpona Beach, Goa (14°58'25.1"N 74°02'35.5"E) is a relatively undisturbed beach with a mix of sandy substrate and scattered hard surfaces suitable for organism

attachment. Both sites fall within the intertidal to shallow subtidal zone, providing ideal conditions for reef-building organisms due to the availability of suspended sand particles and firm anchoring substrates.

The observed structures appeared as tightly packed, hexagon-like tubular formations, and extended over several meters in length in certain areas. Each visible cell represented an individual tube constructed by a single worm. The reefs were composed of sand grains and shell fragments, bonded together using a protein-based bio-adhesive secreted by the worms. The coloration of the structures varied from pale brown to grey, reflecting the local sediment composition of each beach. Notably, these reef structures were recent formations, as no such features

had been documented during earlier visits, suggesting a possible recent colonization or environmental shift favouring reef development.

The colonies of sandcastle worms (*Sabellaria alveolata*) where each polychaete worm constructs its own tube and the close proximity of individuals results in a collective reef-like structure that provide protection and survival for the colony is remarkable. When submerged by the tide, the worms extend feathery tentacles to filter feed of floating particles of plankton and detritus from the water column. The worms can seal the entrance of their tubes with a shield-like operculum when the tide is out, trapping seawater inside to prevent dehydration. These honeycomb reefs also function as microhabitats and biodiversity hotspots that supports various



Fig. 2. Colonies of sandcastle worms

associated organisms, including small crabs, bivalves, sponges, molluscs, juvenile fish and other invertebrate marine organisms. By transforming loose sandy environments into structured habitats, sandcastle worms act as ecosystem engineers, enhancing local biodiversity and stabilizing sediments. The recent appearance

of these reefs at Majali and Talpona beaches may indicate changes in sediment availability, wave dynamics, or larval recruitment patterns. Such biogenic structures play a crucial role in coastal ecosystems, yet they are often overlooked due to their cryptic nature. Their presence highlights the dynamic and responsive nature of intertidal ecosystems, where even

small organisms can create large-scale ecological impacts.

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