Brief Communication

Significance of Green tiger shrimp fishery in Palk Bay, Tamil Nadu

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The Green tiger shrimp, *Penaeus semisulcatus* De Haan, 1844, is an important commercial penaeid shrimp in capture fisheries and culture practices due to its large size and fast growth rate. It is known as '*Mandapam flower* or *Flower shrimp*' in the international market. *P. semisulcatus* contributes over three-fourths of the shrimp landings in Palk Bay and the Gulf of Mannar. Palk Bay (9° 55′ to 10° 45′ N and 78° 58′ to 79° 55′ E), situated in Tamil Nadu on the southeast coast of India, has a coastline of approximately 296 km spanning from Point Calimere in the north to Dhanushkodi in the south. The coastline comprises five revenue districts: Nagapattinam (58 km), Thiruvarur (19 km), Thanjavur (29 km), Pudukkottai (49 km), and Ramanathapuram (141 km). Palk Bay's muddy bottom and seagrass ecosystem supports shrimp fishery, particularly *P. semisulcatus.* It is extensively distributed in the Indo-West Pacific region, the Red Sea, eastern and southeastern Africa, Japan, Korea, the Malay Archipelago, and northern Australia. In India, it is distributed on both the east and west coasts, forming a fishery in the Palk Bay and Gulf of Mannar with its abundance gradually reducing south to north on the east coast. On the west coast, it forms a fishery only along the Gujarat coast, from October to November.

P. semisulcatus is a carnivorous species that primarily feeds on smaller molluscs, crustaceans, and polychaetes. In addition to these, the diet included digested matter, unidentified sand particles, foraminiferans and traces of fish scales, remains of echinoderms, cirripeds, algae, seagrass, seaweed, diatoms, mysids, and radiolarians. The spawning season is most active during the post-monsoon and monsoon periods, with a minor peak during the pre-monsoon period. Males mature earlier than females, and they do not have specific seasons or cyclic changes. Females were consistently present in larger numbers.

Habitat and ecology

Nursery grounds and distribution

Juvenile Green tiger shrimp primarily inhabit shallow waters because these areas provide the ideal environment for early life stages. The shallows are typically nutrient-rich, supporting the availability of food and other essential resources. Muddy bottoms, offer a stable substrate for the shrimp to anchor themselves and hide from predators. Abundance of organic matter, which serves as food and shelter for the juvenile shrimp. Seagrass beds are vital for the juvenile Green tiger shrimp as a nursery ground where shrimp can grow safely. Seagrass beds are also critical for the health of the ecosystem because they maintain water quality and offer food sources such as detritus and small invertebrates. Adult *P. semisulcatus* shrimps prefer sandy areas available up to 130 m depth.

Fishery

Mechanised fishing crafts with an overall length (OAL) of 13.0–25.0 m, equipped with 110–240 hp engines, operate bottom trawls in the Palk Bay for shrimp fishing. The fishing grounds are located between Sri Lanka and India at 5-13 m depth. Fishing is permitted three days a week: Monday, Wednesday, and Saturday by the Tamil Nadu Fisheries Department. The department issues tokens at 6 am on the morning of the fishing days. Fishing begins at 6 am and ends the next day at 6 am. The power of the engines may vary according to the size of the craft and gear, and the length of the trawl net also varies from 30-32 m. The cod end mesh size used is 25 mm. Each haul lasts for 3 hours, and there are 6 hauls for a single-day fishing operation The number of hauls depends on the season and the quantity of catch. Fishing is year-round, except for the monsoon trawl ban. The crew members involved in fishing varies from 5 to 6 people. Eight fish landing centres in Palk Bay operate trawls with 1538 trawl units engaged in shrimp fishing, 996 in the Ramanathapuram district, 375 in the Pudukottai district, and 167 in the Thanjavur district.

Motorised FRP (fibre-reinforced plastic) boats with OAL of 11-14 m operates mini-trawls. The boats use sails and wind energy to operate mini-trawls, while the motor facilitates reaching the fishing grounds. The fishing typically commences at 3 pm and concludes at 3 am the next day, operating at depths ranging from 3 to 5 m, usually within a radius of 3 nautical miles. The cod end measures 18 mm. The net is operated from one of the boat's lateral sides depending on the wind direction. Outrigger poles are used to spread the net's opening. The dragging may commence for 1 hour at a 1 km/hr speed. Fishing operations continue throughout the year, except the trawl ban period. Fifty fishing villages in Palk Bay are involved in mini-trawl fishing. There are 1239 mini-trawl units engaged in shrimp fishing, with 546

Green tiger shrimp landings from the mechanised trawl in Palk Bay

Green tiger shrimp landings from the mini trawl in Palk Bay

Green tiger shrimp landings by trammel net in Palk Bay

units located in the Ramanathapuram district, 323 in the Pudukottai district, and 370 in the Thanjavur district.

Motorised FRP boats with OAL of 11-14 m also operate the disco net, also known as the trammel net. These nets operate throughout the year, peaking during the monsoon trawl ban period when the mini-trawls are not in operation. Two crews engage in fishing in a single boat at a depth of 5-7 m within the territorial waters. The fishing begins at 2 pm in the evening, and by 3 am the following morning, the net is brought to the shore with the catch. The outer and inner mesh sizes of the gear are 120 and 34 mm, respectively. Thirteen fishing villages in Palk Bay are operating disco gill nets for shrimp fishing. There are 1007 disco gillnet units engaged in shrimp fishing in Palk Bay, with 52 of these units located in the Ramanathapuram district, 630 in the Pudukottai district, 170 in the Thanjavur district, and 155 in the Thiruvarur district.

Species composition

In total, twenty-two species constitute the shrimp landings in Palk Bay. *P. semisulcatus* contributed 57.6% followed by *P. indicus* (8.9%), *P. monodon* (8.3%), and *P. merguiensis* (5.9%). Surprisingly, when Palk Bay is taken as a single unit for study, the top three landed species were *P. semisulcatus*, *P. indicus*, and *P. monodon* whereas when the same ecosystem is studied region-wise, the top three shrimps were considerably changed. This inference plays a crucial role in planning the management of this regional fishery. Apart from these penaeid shrimps, finfish, cephalopods, molluscs, crustaceans, sponges, bivalves, seagrass, and seaweeds are also part of the bycatch in bottom trawls, with the crustaceans being dominant. Mini-trawls capture fish, crustaceans, cephalopods, molluscs, bivalves, and seagrass, with seagrass dominating the bycatch. *P. semisulcatus* and *P. pelagicus* are the major constituents of the mini-trawl catch. The disco gill net does not register a substantial catch since it is selective. Few shrimps, cephalopods, crabs, and fish are encountered in the catches of the disco gill net, and shrimp (*P. indicus, P. semisulcatus, P. monodon, and P. merguiensis*) are the major constituents among them.

Catch and effort

The average annual landings of *P. semisulcatus* in Palk Bay was 6286±1108 t from 2007 to 2022. The species alone made

up 61% of the penaeid shrimp caught in the area. The average landings of *P. semisulcatus* from single-day mechanised bottom trawl was 5043±954 t, 894±333 t from mini-trawl and 283±300 t from disco gill nets. The percentage, catch per hour, catch per unit effort and size range of *P. semisulcatus* caught in different gears are given in Table 1.

Population parameters and stock status

It was observed from the Thompson and Bell bioeconomic model, that increasing fishing pressure to F = 1.4 and F = 1.6 for males and females, respectively, would achieve MSY, but cannot result in a higher financial return. In contrast, reducing current fishing effort (F = 0.8) for males and increasing (F = 1.2) for females results in maximum economic yield. SB/SB_0 or SPR by both Thompson and Bell and LB-SPR analysis indicated the stock to be healthy and sustainable (Thompson and Bell SPR 24.83% for males and 32.08% for females and LB-SPR 0.21 for males and 0.31 for females).

Trade and processing

The shrimps were auctioned collectively on the shore (closed auctions, in which the quoted price is known only to auctioneers). The highest bidder wins the auction. The

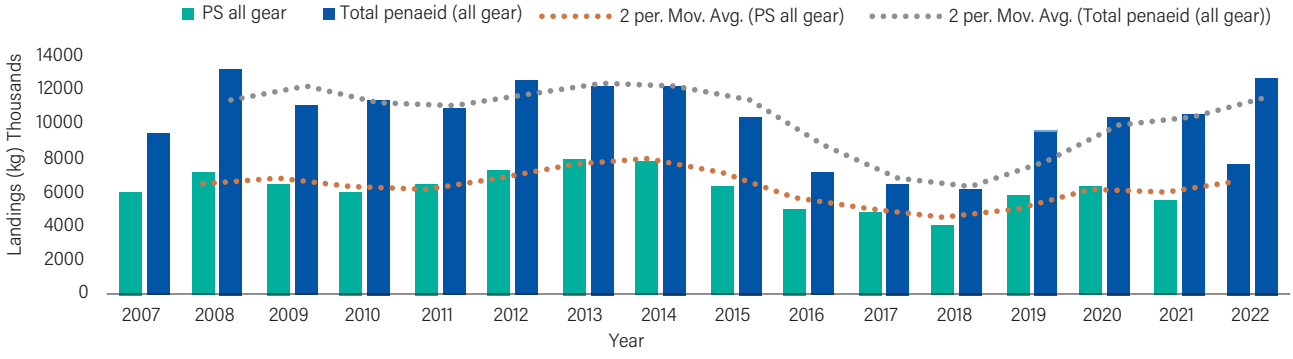


Fig. 1. Temporal change in the landings of *Penaeus semisulcatus* (PS) and penaeid shrimp in Palk Bay from 2007 to 2022

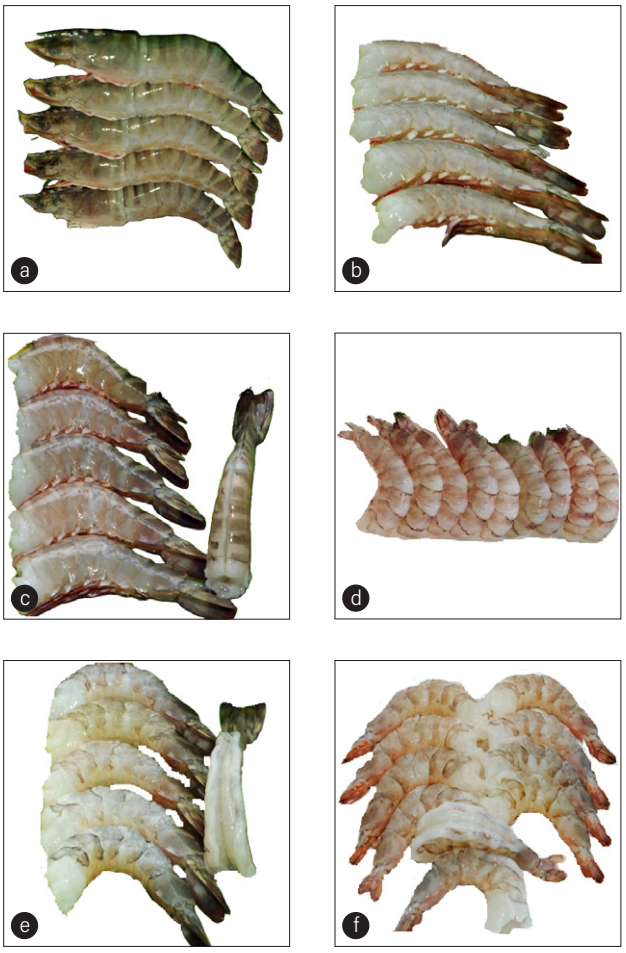
Table 1. Details of the landing of *P. semisulcatus* in Palk Bay

Gear	C/h (kg/h)	C/unit (kg/u)	% in total penaeid shrimp landings	Size range (mm)
Mech. bottom trawl	1.9±0.5	30.7±6.6	57	51-251
Mini-trawl	1.2±0.21	8.4±1.09	98.7	50-172
Disco gill net	0.05±0.04	0.57±0.49	74.1	59-190

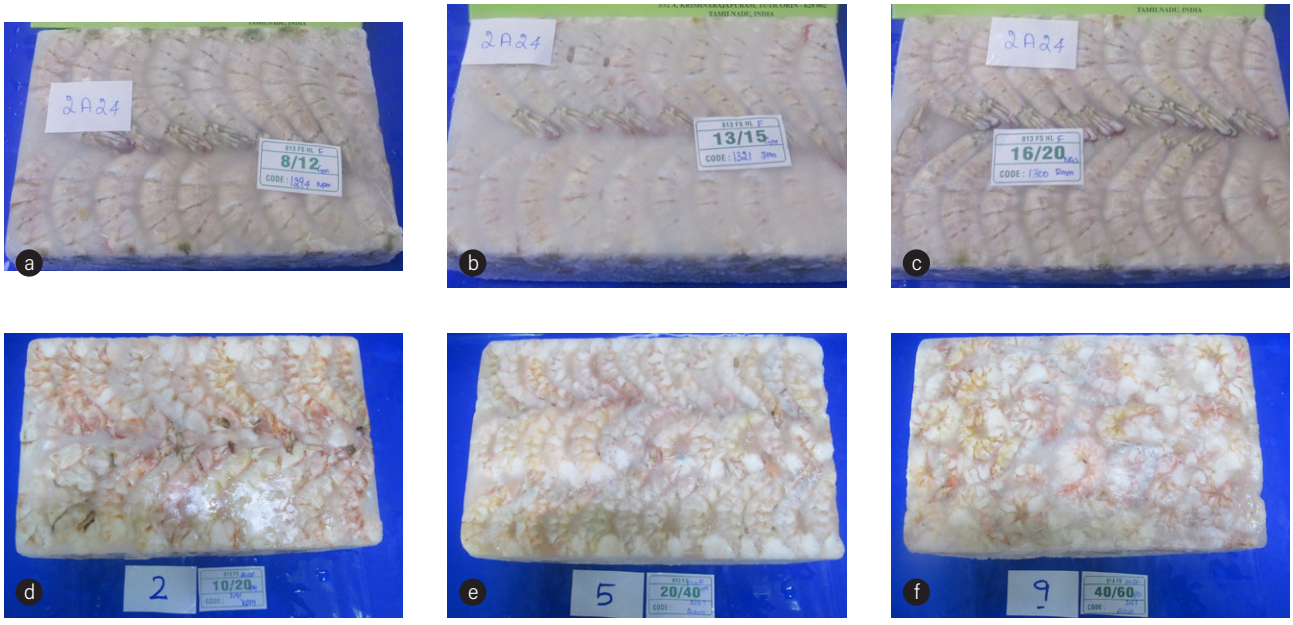
Table 2. Life history parameters estimated for *P. semisulcatus* from Palk Bay

Parameters	Male	Female
L_∞	229.3 mm	270.4 mm
K	1.24 y^{-1}	1.14 y^{-1}
Z	5.301 y^{-1}	5.474 y^{-1}
M	2.214 y^{-1}	2.002 y^{-1}
F	3.087 y^{-1}	3.265 y^{-1}
E	0.582	0.634
MSY	1594.1 t	6437.5 t
Potential yield	2557 t	11206 t

auction price ranged from ₹180 to ₹900 depending on the size grade. The species were sourced by the processing companies in Thoothukudi. The processed Green tiger shrimp include HON (head-on), HL (headless), HL-EZP (headless easy peel), PUD (peeled undeveined), PD-TON (peeled, deveined tail-on), and PD (peeled, deveined). The final packing is carried out according to the grades. *P. semisulcatus* is exported under various labels to eighteen countries, namely Japan, the USA, China, Vietnam, Belgium, France, Germany, Greece, Ireland, the Netherlands, Spain, the United Kingdom, Hong Kong, Saudi Arabia, Dubai, Qatar, Canada, and Kuwait. Major exports from Tamil Nadu were to Japan, the USA, and European countries. There was a steady decline in India's exports of *P. semisulcatus* from 2015-16 (4410 t) to 2022–23 (2260 t). The average annual export of *P. semisulcatus* was 3532±746 t, with a value of 30.9±9.3 million US dollars.



Varieties of processed green tiger shrimps from Palk Bay. A. HON – head-on, B. HL – headless, C. HL-EZP – headless easy peel, D. PUD – peeled undeveined, E. PD-TON – peeled deveined tail – on, F. PD- peeled deveined.



Some of the grade-wise packing of green tiger shrimp. A. HL (8/12), B. HL (13/15), C. HL (16/20), D. PUDF (10/20), E. PUDF (20/40), F. PUDF (40/60)

Brands of Palk Bay green tiger shrimp exported.

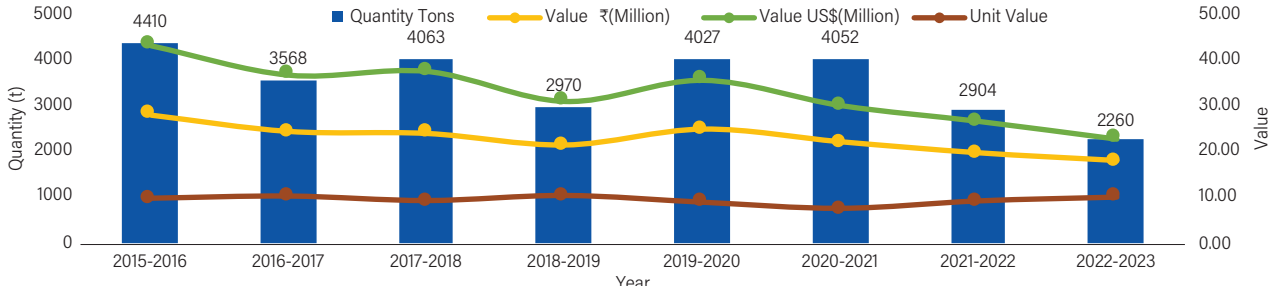


Fig. 2. Export of *Penaeus semisulcatus* from India to other countries

Fishery enhancement programme

The Green tiger shrimp fishery in Palk Bay at the present level is healthy and sustainable (Rajkumar, 2024); however, considering the importance of this fishery for the livelihood of this region, ICAR-CMFRI is implementing a sea ranching programme through the project entitled "Sea ranching of Green tiger shrimp (*Penaeus semisulcatus*) Post Larvae (PL) in Palk Bay and Gulf of Mannar, Tamil Nadu" with funding support from the PMMSY as a proactive measure. The project aims to release 200 million shrimp seeds in the Gulf of Mannar and Palk Bay during 2022-2026.

Conclusion & Recommendations

To ensure the long-term sustainability of the Green tiger shrimp fishery, a seasonal ban on shrimp fishing should be imposed during the peak breeding season, regardless of the gear used. This ban will help protect shrimp during their critical reproductive period. Shallow, muddy areas with seagrass beds and bays are vital for the survival, growth, and reproduction of Green tiger shrimp. These habitats provide essential shelter, abundant food, protection from predators, and optimal growth conditions, forming the foundation of the shrimp's life cycle from juvenile to adult. The preservation of these environments is crucial for maintaining healthy shrimp populations. Without them, the survival and productivity of the shrimp fishery could be jeopardized. Additionally, artificial propagation in protected waters could serve as a viable alternative for enhancing shrimp stocks and supporting fishery sustainability.

Palk Bay is the primary spawning ground for *P. semisulcatus*, and fishing during the spawning season reduces reproductive output. Overexploitation of a spawning stock will most likely decrease reproductive output, becoming a limiting factor for fishery production. Based on these findings, we recommend imposing a seasonal ban on shrimp fishing in Palk Bay during peak breeding season, irrespective of the gear, through a fleet cut-off to use the resource sustainably. The muddy bottom and seagrass beds encourage *P. semisulcatus* recruitment to sustain fishing pressure in Palk Bay. The intense fishing pressure on juveniles by mini-trawl and adults by mechanised trawlers has affected the spawning stock/spawning potential ratio. Even though the resource is sustainable, appropriate management measures to avoid overfishing are required. The peak spawning periods should be declared as closed seasons to maintain biologically sustainable levels (SSB_{20-30}) of Spawning Stock Biomass.