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Feeding Ecology of Red Spotted Swimming Crab, *Portunus sanguinolentus* (Herbst, 1783) along Mangaluru Coast, Karnataka

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ABSTRACT

Background: Crabs are one of the major marine fisheries resources in India and they are among the most valuable seafood species due to their delicious taste, nutritional value and economic importance. The knowledge of the feeding ecology of these crabs is particularly important to understand their ecological interactions, since the abundance of preferred prey organisms strongly affects their distribution, growth, reproduction, behavior and migration.

Methods: The study was conducted along the Mangaluru coast, with fortnightly crab samples gathered from the Mangaluru fish landing centre from March 2021 - February 2022. Random sampling ensured the inclusion of all size categories and samples were analyzed for weight, morphometric measurements, sex and food and feeding habits. The level of stomach fullness was assessed visually and the contents were examined using Point's volumetric method, identifying food items at the lowest taxonomic level and grouping them into dietary categories. The vacuity index and Gastro-somatic index (GaSI) were calculated to describe the trophic behaviour of *Portunus sanguinolentus*.

Result: Gut content analysis revealed that *P. sanguinolentus* fed predominantly on crustaceans (31.45%), fish (22.84%), molluscs (18.70%) and larger quantities of sand and debris (20.29%) and unidentified matters (6.68%). The presence of debris and unidentified matter in the foregut suggests that *P. sanguinolentus* is a bottom-feeding omnivore which feeds on fresh and decaying matter. Size-wise analysis of gut contents revealed that juveniles (<80mm CW) preferred miscellaneous items followed by crustacean remains as their diet, sub-adults (80-100 mm CW) crustaceans (42.65%) and miscellaneous (50.07%) and adults (>100mm CW) had a solid preference for crustaceans and molluscs.

Key words: Crustaceans, Feeding, Food, *P. Sanguinolentus*, Swimming crab.

INTRODUCTION

Marine crabs are valuable seafood animals because of their esteemed delicacy, nutritive content and the significance of the fishery they support (Sudhakar *et al.,* 2012). Crabs play a significant role as a marine fishery resource in India, accounting for an average of 9.6% of the overall crustacean landings between 1975 and 2020 (Madhubala and Selvamohan, 2023). *Portunus pelagicus* formed the dominant species in Karnataka, followed by *P. sanguinolentus* (Josileen *et al.,* 2019). The various authors investigate the crab's food and feeding habits, its status and potential (Dana *et al*., 2024), the physico-chemical environment and management strategies (Mandal *et al*., 2017), as well as the carapace (Sanjay *et al*., 2024).

Red-spotted swimming crabs*, Portunus sanguinolentus,* are found throughout the Indo-Pacific region, from the eastern coast of South Africa to the coasts of Hawaii. They usually live on muddy or sandy bottoms that are between 10 and 30 meters deep. Compared to male, female crabs prefer higher salinities. For this reason, they frequently live in deeper waters (Campbell and Fielder, 1986).

Understanding a species dietary habits is crucial to comprehending their ecological interactions, according to Biswass (1993). The availability of preferred prey organisms has a significant impact on crab distribution, growth, reproduction, behaviour and migration rate (Sánchez-Paz *et al.,* 2006; Vinagre *et al.,* 2007). The present study aims to study food composition, feeding behaviour and variation among the different size groups of *P. sanguinolentus*.

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MATERIALS AND METHODS

The current research was conducted along the Mangaluru coast. Fortnightly samples were gathered from the commercial catch at Mangaluru fish landing centre (12.9141°N, 74.8560°E) from March 2021 to February 2022 as a result of the fishing prohibition period (June 1st to July 31st 2021) on the West coast; collecting samples in June and July was not feasible. Random sampling was undertaken to ensure the inclusion of all size categories in the study. Samples were brought to the laboratory for recording weight, morphometric measurements (carapace width and carapace length), sex and to study food and feeding habits (Sukumaran and Neelakantan, 1997; Dineshbabu *et al.,* 2007).

Only foregut was used to study the dietary patterns and consumption behaviors of *P. sanguinolentus*. The degree of stomach fullness was visually evaluated based on categories including full, three-quarters full, half full, one-quarter full and empty, following the method outlined by Muthiah (1994). Crabs with full and ¾ full were considered active feeders and ½ were considered moderate feeders. Similarly, stomachs with ¼ and empty full were supposed to denote poor feeding.

The frequency of food items' occurrence was accomplished by counting every foregut containing at least one specimen or part of the specific item (taxon) (Manooch and Mason, 1983; Williams, 1982). The contents of the stomach were transferred to a Petri dish and analyzed using Point's volumetric method, taking into account the level of fullness, following the approach described by Hynes (1950). A qualitative analysis identified all the food organisms present in the stomach. Food items were identified to the most specific taxonomic level possible and subsequently categorized into five dietary groups: crustaceans, fish, molluscan remains, sand and debris and miscellaneous.

Since a predator's diet cannot be fully described by a single technique for analyzing stomach contents (Hyslop, 1980), the trophic behavior of the species was described by the calculation of the vacuity index and the gastro-somatic index (GaSI).

$$GaSI = \frac{\text{Weight of the gut}}{\text{Weight of the crab}} \times 100$$

Vacuity index, the number of empty stomachs encountered during the study period was calculated by vacuity index (Biswass, 1993).

$$\text{Vacuity index} = \frac{\text{Number of empty}}{\text{Total number of stomachs}} \times 100$$

RESULTS AND DISCUSSION

Five hundred ninety-six (596) specimens of *P. sanguinolentus*, ranging in size from 77.3 mm to 165.2 mm carapace width (CW), comprising 294 males and 302 females, were assessed.

Diet composition

Gut contents analysis by points method revealed that crustaceans 31.45% was the top food preference of *P. sanguinolentus*(which included appendages, telson, other body parts of prawn, chelipid of crabs, stomatopods), fish (scales, bones, eyeball, vertebrae) formed the secondary preferred food 22.84%, subsequently by mollusc remains (squid tentacles, bivalves, gastropods)18.70% and a large quantities of sand and debris (sand, mud, mesh and plastics) 20.29% and miscellaneous items (algae filaments and unidentified matters) 6.68% (Fig 1, 2, 3, 4).

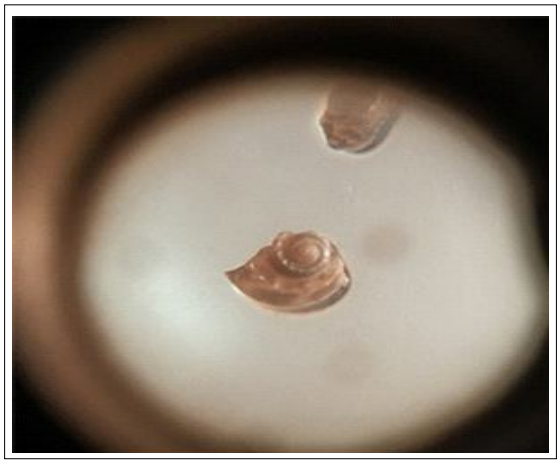


Fig 1: Mollusc remains (Gastropod).



Fig 2: Crustaceans remnants(crabs chilipids).



Fig 3: Debris (Mesh).

According to the occurrence method, the top food preference was crustaceans, which contributed the most in January (24.76%), followed by November (24.28%) and the least in August (10.71%). Fish remains were recorded maximum in December (19.45%), March followed subsequently (19.393%) and minimum in August (11.6%). Mollusc presence was significantly elevated in quantity during May (22.52%) and less in October (12.65%). Substantial amounts of sand and debris were detected throughout the study period, forming the highest in September (28.04%), followed by August (26.78%) and most down during December (17.64%). Miscellaneous food groups practically occurred in all the stomachs with food particles, with a peak in August (33.03%) and the lowest in May (12.61%) (Fig 5).

Food items in relation to size group

It was observed that juveniles (<80 mm CW) favoured miscellaneous items, with crustacean remains as the next most common component of their diet. In sub-adults (80-100 mm CW), the primary food source categories were crustaceans and miscellaneous. Adults (>100 mm CW) strongly preferred crustaceans and molluscs (Fig 6).

Feeding intensity

Based on the condition of the foregut, crabs were categorized into three groups. Crabs with full and ¾ full

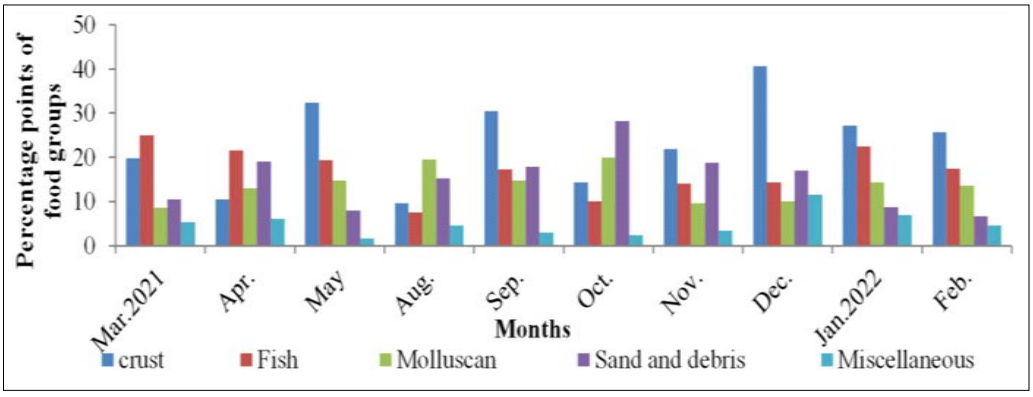


Fig 4: Percentage points of food groups during different months for *P. sanguinolentus*.

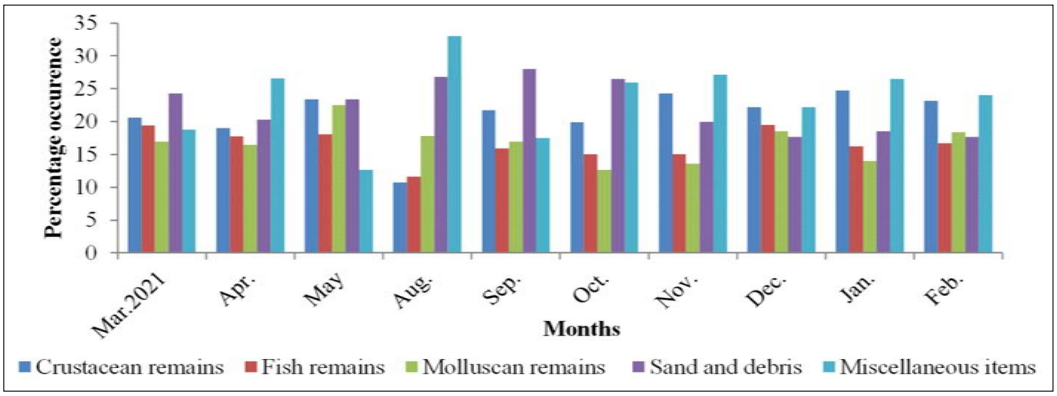


Fig 5: Percentage frequency of occurrence of major food groups during different months for *P. sanguinolentus*.

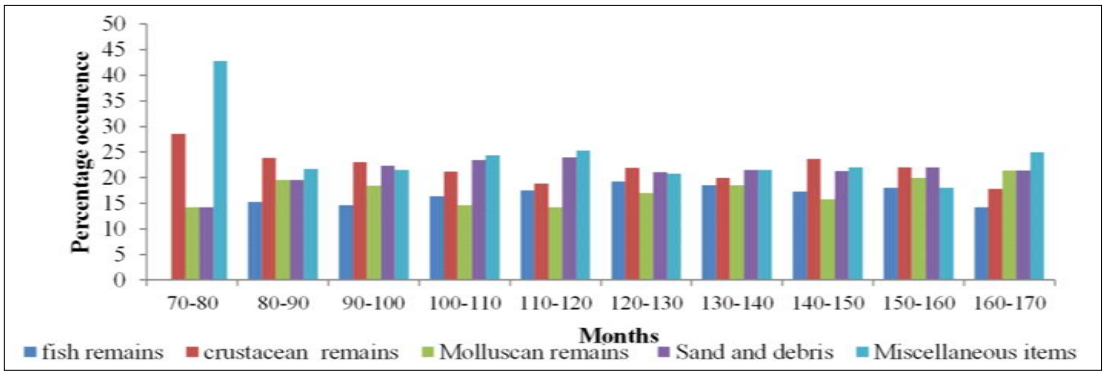


Fig 6: Percentage frequency of occurrence of major food groups during different size groups of *P. sanguinolentus*.

were considered active feeders and ½ were considered moderate feeders. Similarly, stomachs with ¼ and empty full were considered to denote poor feeding. Out of 596 stomachs (21.94%) were in full condition, (13.82%) were in 3/4th full, (19.59%) were in ½ full, (18.13%) were in 1/4th full and (26.50%) were in empty stomach. The majority of the actively fed crabs (full stomach) were recorded as being highest during December (24.59%), followed by September (22.72%) and least in August (8.46%). Moderately fed crabs were found maximum during October (32.25%), November (22.03%) and minimum in December (11.47%). Poorly fed crabs were recorded highest in August (33.07%), followed by March (30.90%) and lowest during October (16.12%) (Fig 7).

Feeding intensity in relation to size

Actively fed crabs (Highest feeding intensity) were discovered in the size group of 70-80 mm (49.9%) followed by 80-90 mm (26.47%) and least in 160-170 mm (11.53%). Moderately fed crabs were observed maximum in the size group of 100-110 mm (21.25%),140-150 mm (18.18%) and minimum in 150-160 mm. Crabs with empty stomachs were observed across all size groups except the 70-80 mm range, with the majorly occurred in the 130-140 mm (39.68%) and 160-170 mm size group (Fig 8).

Gastro-somatic Index

Gastro-somatic index of *P. sanguinolentus* varied from 1.708 to 2.617. The highest value was observed in May (2.617) and minimum in August (1.708) (Fig 9).

Vacuity index

Out of 596 stomachs examined, 159 had empty stomachs (27.10%). The frequency of stomachs being empty was also analysed every month, where August had the most elevated number of empty stomachs (43.07%), followed by November (33.89%), April (32.25%) and May (30.43%) and the most downward was observed in December (14.75%) (Fig 10).

A comprehensive study of aquatic animals' habits of food and feeding is important to understand their biology, such as growth, reproduction, migration patterns, etc. An organism's diets vary considerably at different stages of life and the habitat they live in (Khan *et al.*, 2018). Based on qualitative and quantitative analyses, this research confirmed that *P. sanguinolentus* (Fig 11 and 12) is a predator of faunal slow-moving benthic macroinvertebrates like crustaceans and molluscs, miscellaneous items consisting of algal filaments, polychaetes, fish remains and other items such as sand and debris. These findings

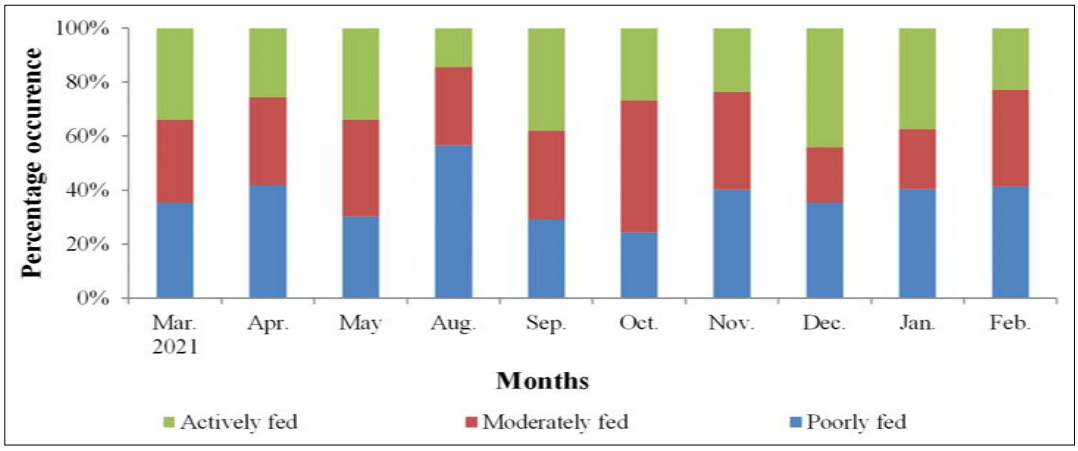


Fig 7: Feeding intensity in different months of *P. sanguinolentus.*

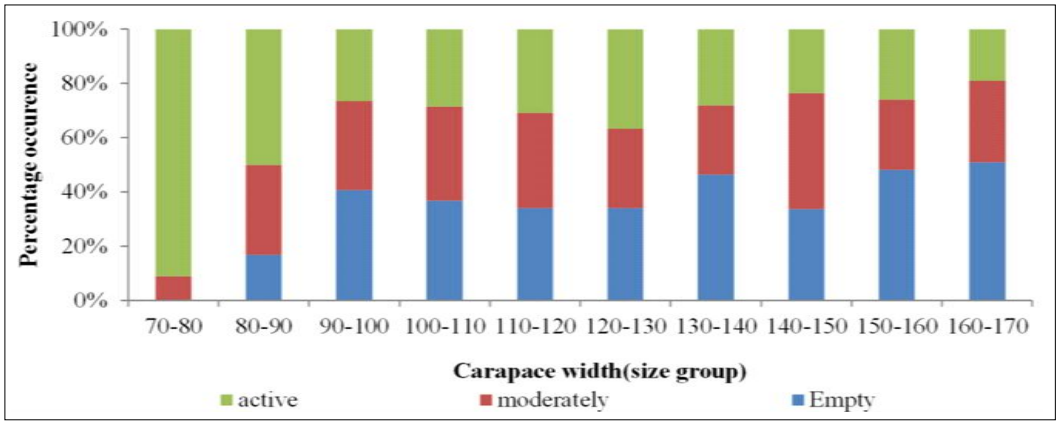


Fig 8: Feeding intensity in different size groups of *P. sanguinolentus.*

in this study support those of Rasheed and Mustaquim (2018). The most common food items found in their study were crustaceans (small crabs) and fish. Molluscs (gastropods and bivalves) remains were found to be a minor food in this study. Comparable findings have been noted by Chande and Mgaya (2004) for *P. segnis* in Tanzania. The occurrence of fish remains in the gut load of portunids confirms that they exhibit scavenging behaviour that feeds on dead fish (Prasad and Neelakantan, 1988; Cannicci *et al.,* 1996).

Pooled data revealed the percentage occurrence of feeding habits across various months; crustacean remains formed major food items (20.22%), subsequently by fishre mains (16.93%) and large quantities of sand and debris (23.3%) and mollusc remains (16.5%) and miscellaneous items (22.96%). These observations agree with the study of Prasad and Neelakantan (1988) on *Scylla serrata* from the Karwar region, which showed that portunid crabs mainly fed on crustaceans, detritus, molluscs, fishes and miscellaneous items from Karwar waters (Prasad and Neelakantan 1988).

Josileen (2011) observed that crustaceans constituted a prominent food group, molluscs constituted the second dominant group and teleost fish were the 3rd most significant food item for *P. pelagicus* from the Mandapam coast in India. *Portunus segnis's* diet mainly depends on local food availability, making it an opportunistic predator. Hamida (2019) stated that the biological aspects of an organism, such as growth and reproduction, largely depend on the presence of favourite food items or prey organisms.

The blue crab Portunus segnis's dietary makeup was observed by Tadi Beni *et al*. (2019) from Iran, who reported 34.4% of empty stomachs. They concluded that the frequency of empty stomachs varied throughout the study period. In this study, the prevalence of an empty stomach fluctuated across different months, averaging 27.10% overall. The dietary patterns of portunid crabs have been previously studied (Ropes, 1968; Patel *et al*., 1979; Williams, 1982) and they reported that portunid crabs are opportunistic omnivores and rarely feed on motile forms like fish and shrimp species in their diets.

This study noticed fluctuations in dietary patterns concerning different size groups and juveniles strongly preferred miscellaneous and crustaceans. In subadults, crustaceans and other miscellaneous items were the predominant components. Adults showed a clear inclination for crustaceans and molluscs. This conforms to reports of Sukumaran and Neelakantan (1997) in *P. sanguinolentus.*

Khongngain *et al.* (2017) and Sarkar *et al.* (2017) noted that feeding activity varies seasonally due to changes in the availability of preferred food items, maturity stages and spawning seasons. In this investigation also, feeding intensity varied among different months; crabs with full stomachs were observed highest in September (33.33%), 3/4 stomach in December (27.86%), ½ full in October (32.25%), 1/4 full in January (26.75%) and empty stomachs in August (43.07%). Same outcomes have been reported by

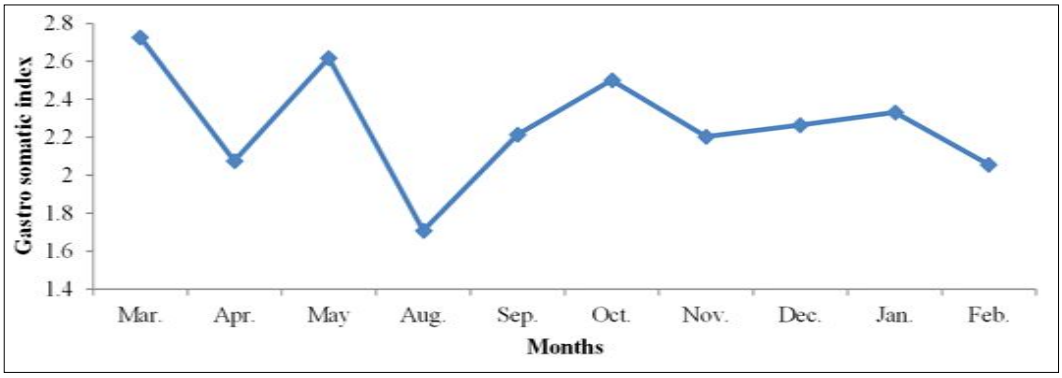


Fig 9: Gastrosomatic index in different months of *P. sanguinolentus.*

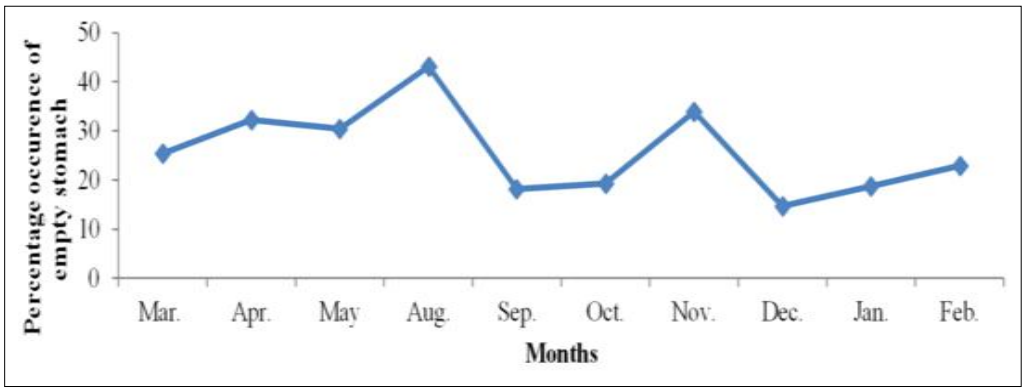


Fig 10: Vacuity index in different months of *P. sanguinolentus.*



Fig 11: *Portunus sanguinolentus.*



Fig 12: Samples of *P. sanguinolentus.*

Khan *et al*. (2018), where the feeding intensity was less during the spawning season in *S. serrata.*

Whereas in size groups, full stomachs were dominant in the size group of 70-80 mm CW (66.66%) and empty stomachs were highest in the size group 130-140mm CW (39.68%), followed by 160-170 mm CW (38.46%). These observations agree with Wenner *et al*. (1974), who noticed that the preying utility is less in adults and relatively more among juveniles. Freier *et al*. (1996) state that the impact of larger chela size and muscle mass is probably responsible for the variance in the propensity for food items among crab sizes.

CONCLUSION

The study confirmed that *P. sanguinolentus* predominantly preys on infaunal, slow-moving benthic macroinvertebrates like crustaceans and molluscs, with the occasional inclusion of fish remains, sand and debris, indicating a scavenging behaviour. The diet composition varied across different size groups, with juveniles preferring miscellaneous items and crustaceans, sub-adults favouring crustaceans and miscellaneous items and adults strongly preferring crustaceans and molluscs. Feeding effort was also seasonal and size-related; the highest feeding intensity was observed in juveniles and lower feeding activity during breeding season. These results add to our understanding of the ecological role and especially the trophic importance, of this crab. This function concerning the crab combining with other species to interact in the ecosystem deserves more attention and to be studied in a wider range about ecological equilibrium.

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Conflict of interest

Authors declare no competing or conflicting interests.

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