



Food and feeding habits, gastro-somatic index and gonado-somatic index of *Scylla serrata* from Hooghly-Matlah estuary of West Bengal, India

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Original Article

Abstract

Food and feeding habits, gastro-somatic index and gonado-somatic index of *Scylla serrata* (Forsskål, 1775) were studied for a period of one year from the Hooghly-Matlah estuary. It was found that the crab mainly feeds on animal matters and categorized as carni-omnivore. The gut contents analysis showed that crustacean contributed maximum share with 41.93%, followed by fishes (32.94%), molluscs (12.56%), detritus (7.84%) and miscellaneous items (4.73%). Gastro-somatic index of male crab was varied from minimum of 0.984 (May) to maximum of 5.561 (January) and that of female crab varied from 0.642 (May) to 5.621 (February). There was significant variation ($P < 0.05$) in GaSI values in both the sexes and in different months. The gonado-somatic index (GnSI) was varied from 2.53 to 8.35. Two dominant peaks of gonado-somatic index were recorded during April-May and September-October. There was significant variation ($P < 0.05$) in GnSI values between two sexes.

Keywords: *Scylla serrata*, food and feeding habits, gastro-somatic index, gonado-somatic index.

Introduction

The knowledge on food and feeding habits of aquatic animals is quite important to understand its biology like growth, reproduction, migration etc. It varies considerably from habitat to habitat in time and space as well as at different stages of life. The analysis of the gut contents of the individuals collected from their habitats should be carried out to know the type of food consumed and the feeding habits. Studies on food and feeding habit are an important aspect of biology and management of fishes (Chakraborty *et al.*, 2016). In general, the feeding intensity varies with seasons, availability of preferred food items, maturity stages and spawning season (Khongngain *et al.*, 2017 and Sarkar *et al.*, 2017). There is need of bio-monitoring of foraging of commercially important species at regular intervals to develop suitable management measures for fisheries. Studies on the reproductive biology of any species are essential in evaluating the commercial potential of the stocks. Gonado-somatic index value gives clear cut idea regarding spawning season of any species and necessary management measures to promote the fisheries in the concerned localities (Vahneichong *et al.*, 2017).

Scylla serrata is a decapod crustacean locally known as 'nona kankra' belonging to the suborder Brachyura. In India,

it abundantly occurs in all the maritime states of East and West coasts, *viz.* West Bengal, Odisha, Tamil Nadu, Andhra Pradesh, Andaman & Nicobar Islands, Goa, Maharashtra, Karnataka, and Gujarat (Chondar, 1999). It inhabits muddy bottoms in brackish water along the shoreline, mangrove areas and river mouth, hence known as mud crab or mangrove crab (Motoh, 1979). It has good demand in the export market for its large size and high-quality meat. Crabs are opportunistic omnivores, eating on a variety of foods, with a preference for animal food. Their animal food usually consists of crustaceans especially amphipods and decapods, fish as well as bivalve, molluscs etc. Small gastropods, copepods, and polychaete worms also form an appreciable part of the food of several crabs.

Several works have been carried out on crabs by various researchers like Sukumaran and Neelakantan (1997); Raman and Srinivasagam (1978); Joel and Sanjeevraj (1986); Prasad *et al.* (1988); Nandi and Pramanik (1994); Chondar (1999); Kizhakudan (2002); Ghosh (2003); Mamun *et al.* (2008) and Paul *et al.* (2018). But works on food and feeding habits and other biological aspects of mud crabs in Hooghly-Matlah estuarine system are scarce. So, the present study was carried out to bridge the gap of selected biological aspects of the crab in the locality. It will be helpful for biological management of fisheries of the species.

Material and methods

The present work on food and feeding habits of *Scylla serrata* was conducted for a period of 12 months (September 2007 to August 2008). A total of 325 numbers of *Scylla serrata* (155 male and 170 female) with length ranged from 44 to 120 mm and weight 20 to 210 g were examined during the period of investigation. The collected mud crab individuals were identified with the taxonomic keys of Nandi and Pramanik (1994) (Fig. 2). They were collected from different areas of Hooghly-Matlah estuarine system *viz.*, Sagar Island, Bokkhali and Kakdwip (Fig. 1). The collected specimens were usually captured by fishing line locally known as haar suti or doan; gulta suti or thupa suti;



Fig. 1. Study area and sampling stations in Hooghly-Matlah estuarine system



Fig. 2a & b. Matured mud crab of *Scylla serrata* (dorsal and ventral view)

chhankan jal; khancha; ganjia, collection from holes by a bent 'sik' or iron rod locally known as kanpi.

To study the food and feeding habits, crab samples were dissected and foreguts were preserved in 6% formalin for further study of gut contents. The weight and condition of guts were recorded by electronic balance and eye estimation respectively. The percentage of various food items in the foregut contributed by each food group was determined. Gut contents were analyzed following the points method (Hynes, 1950). The unidentified materials were grouped under miscellaneous group.

The gastro-somatic index and gonado-somatic index were calculated by the following formulae:

$$\text{Gastro-somatic Index} = \text{Weight of gut/weight of body} \times 100.$$

$$\text{Gonado-somatic index} = \text{Weight of gonad/weight of body} \times 100.$$

Significant difference among mean of different biological parameters was tested employing standard statistical tools like Student's "t"-test and analysis of variance technique.

Results and discussion

Food and Feeding

The gut contents analysis showed that crustacean group

contributed maximum share followed by fishes, molluscs, detritus and miscellaneous items which resembles with the other earlier works of Kathirvel (1981), Prasad *et al.* (1988) and Sukumaran and Neelakantan (1997). The monthly trend of variations in food items of *Scylla serrata* is provided in the Fig. 3. The study has indicated that the crustaceans were the most favored food items which include body parts of penaeid prawns, crabs, stomatopods etc. It was observed that penaeid prawns and crabs accounted for more than 85% of gut contents of some samples during the months of December and February. It indicated that crab also exhibits cannibalism occasionally. Various body parts of fish like fins, scales, bones, and vertebrae accounted for the second important item in the food of the crab. The detritus, mud and sand contents in the guts indicated that crabs are bottom dwellers and scavengers. The spectra of food items in the gut indicate the species is a carni-omnivore. It bears similarity with earlier works of Kathirvel (1981) who found that the food of *S. serrata* in Cochin backwaters of India consists mainly of crustaceans followed by fishes, molluscs, detritus and sand. Joel and Sanjeevraj (1982) observed that the mud crab of Ennore estuary and Pulicate Lake of Tamil Nadu, India subsists mainly on crustaceans followed by molluscs, fishes, detritus and sand and unidentified food materials for both water bodies. Joel and Sanjeevraj (1986) reported that the natural food of two important edible crabs *Scylla tranquebarica* (Fabricus) and *S. serrata* (Forsk.) in the Pulicate lake mainly constituted of two shallow water gastropods (*Cerithidea cingulatus* and *Cerithida fluviatilis*), prawns and fish. It was noticed that both of them feed on a wide variety of fishes and prawns, polychaetes, jellyfish and submerged aquatic weeds. In both South African and Australian crabs, 50% of the identifiable materials in the foreguts were molluscs followed by crustaceans,

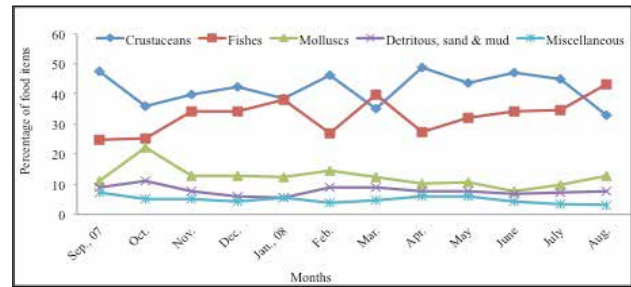


Fig. 3. Monthly trend of variations in food items of *Scylla serrata*

and the remaining comprised of small amounts of plants and debris. It differs from the present work which might be due to spatial food availability and local conditions. According to Xiao *et al.* (2004), there is no significant variation in the comparison of food items in *S. serrata* in relation to size. Small sized crabs fed mostly on small invertebrates while the larger crabs fed largely on detritus. This difference in the diet may be related to the activity of the crabs.

In the present study, active feeding intensity was observed during the months of November to February with the peak during January-February and lowest feeding intensity was noticed during April-June and September to October. The lowest feeding intensity during the months of April-June and September to October coincides with the highest GSI values of the species, which might be the spawning season of the species.

According to Hill (1976) the gut contents of crab *Scylla serrata* mainly consists of molluscs followed by crustaceans and fish. Prasad and Neelakantan (1988) opined that the principal diets

Table 1. Comparative study of food and feeding habits of *Scylla serrata* by various researchers

Author(s)	Food composition	Location
Kathirvel, 1981	Crustaceans-38.5%, gastropods-3.9%, fish-19.2%, detritus-19.2%, sand-19.2%.	Hooghly-Matlah estuary, India
Kathirvel, 1981	Crustaceans-78.40%, gastropods-3.50%, fish-15.20%, sand-2.50%, miscellaneous items (misc.)-0.40%.	Cochin backwater, India
Prasad and Neelakantan, 1988	Detritus-35.70%, fish-23.57%, crustaceans-18.37%.	Karwar waters, India
Prasad <i>et al.</i> , 1988	Crustaceans-6.00%, gastropods-8.30%, fish-33.00%, detritus-41.30%, misc.-11.40%.	Karwar waters, India
Jayamanne <i>et al.</i> , 1992	Crustaceans-50.70%, gastropods-7.12%, fish-3.06%, bivalves-32.93%, sand-9.95%.	West coast of Srilanka
Kathirvel and Srinivasagam, 1992	Crustaceans-46.6%, gastropods-20.3%, fish-21.2%, detritus-0.5%, sand-9.2%, misc.-2.2%.	Pulicate Lake, India
Mohapatra <i>et al.</i> , 2005	Crustaceans-10.19%, molluscs-51.85%, fish-22.22%, molluscs and fish-5.56%, plant materials-4.63%, sediments-3.70%	Chilika lagoon, India
Mamun <i>et al.</i> , 2008	Crustaceans-44.48%, gastropods-26.67%, fish-15.20%, detritus-10.11%, unidentified-2.87%, plant materials-0.67%.	South-West coastal area of Bangladesh
Nayak <i>et al.</i> , 2014	Crustaceans-22-55%, gastropods-8-35%, fish-18-35%, detritus-0.5-8.3%.	Chilika lagoon, India
Paul <i>et al.</i> , 2018	Crustaceans-38.49%, gastropods-4.66%, fish-1.70%, bivalves-21.37%, detritus-15.67%, sand-8.09%, misc.-10.07%.	North of Sundarbans, Bangladesh
Present study	Crustaceans-41.93%, fishes-32.94%, molluscs- 12.56%, detritus-7.84%, misc.-4.73%.	Hooghly-Matlah estuary, India

of mud crab *Scylla serrata* were crustaceans, detritus, molluscs, fishes and miscellaneous items from Karwar waters, India. Viswanathan and Rafii (2015) reported that other species of mud crab *Scylla olivacea* despite their length groups and moths predominantly feeds on crustaceans, molluscs, fishes, detritus, mud and sand and miscellaneous items from the Pichavarm mangroves of India. Paul *et al.* (2018) observed that, the gut content analysis of mud crab *Scylla serrata* mainly consists of crustaceans followed by bivalves, detritus, gastropods, fish, sand and miscellaneous items.

The higher feeding intensity was observed during January-February and lowest during the month of May for both the sexes based on gastro-somatic index. The feeding intensity was found less during the spawning season of the species. Comparative study on food and feeding habits of *Scylla serrata* observed by other workers presented in Table 1.

Gastro-somatic index (GaSI)

Gastro-somatic index of male *S. serrata* varied from 1.084 to 5.561 during the period of investigation (Fig. 4). It showed maximum value during January (5.561) and gradually declined in May (0.984). The corresponding value in female was recorded during February (5.621) and minimum value during May (0.642). There was significant variation ($P < 0.05$) in GaSI values in both the sexes ($F = 30.2137$, $df = 1, 11$) and in different months ($F = 3.0070$, $df = 11, 11$) which might be due to variations in feeding due to season/environment, maturation, growth, food availability etc. Sukumaran and Neelakantan (1997) opined that the sex wise, size wise and seasonal variability of diet in crabs may be largely due to the relative abundance of prey species in the habitat or related to change in chelipeds strength and foraging behaviour. Seasonal fluctuation of the feeding intensity and dietary composition in fishes were influenced not only by the maturation of gonads but also due to non-availability of food in the habitat. According to Satapathy and Mishra (2007), gastro-somatic index of crab is more in the month of December and February and minimum in the month of May-June in Chilka Lake which resembles with the present studies. Gastro-somatic index (GaSI) exhibited an inverse relationship with the Gonado somatic index (GnSI).

Gonado somatic index (GnSI)

The mean monthly variations in gonado-somatic index for both the sexes are presented in Fig. 5. In case of male the mean monthly GnSI values varied from 2.53 (January) to 4.63 (October) and in the female it was varied from 2.55 (January) to 9.31 (May). The study also showed that few samples exhibited well-developed gonads throughout the year. Mohanty (2006) reported that breeding period of mud crab *Scylla serrata* is found year-round in Chilika Lake but the maximum GnSI values were found in the month of October (6.3) and minimum in the month of January (1.7). He also stated that instead of two peak breeding seasons, breeding period remained nearly for seven months with the peak season from August to November in the Chilika Lake. According to Joel and Sanjeevraj (1982), breeding period of mud crab in the Pulicat Lake was found throughout the year but peak season was found in the month of March-April and September-October and such works bear resemblance with the present study. It was found during the present work that there were two dominant peaks of GnSI values coinciding with the period of April-May and September-October. There was significant variation ($P < 0.05$) in GnSI values between two sexes ($F = 11.0261$, $df = 11, 1$). Mohapatra *et al.* (2010) reported GnSI of *S. serrata* varied from 2.6 ± 1.1 (March) to 6.2 ± 3.7 (October) with peak during September to November in Chilika Lagoon. Satapathy (2007) also reported GSI values of *S. serrata* varied from 1.5 to 6.3 with higher values during the month of September to November. Lee (1992) also mentioned that there are two peaks of the breeding season in mud crab of *S. serrata* in the months of March and September-October in Queensland. Lalitha Devi (1985) observed two peak breeding seasons in the mud crab in Kakinada region with one in the month of May-June and other in October. All such studies bear resemblance with the present work. However, Ali *et al.* (2004) reported a single peak of GnSI in *S. serrata* during the month of May to July in Sundarbans mangrove ecosystem in Khulna region of Bangladesh. Delahunty and DeVlaming (1980) found that the dynamics of increasing gonad weight in proportion to body weight may change from year to year depending on environmental factors such as food availability and temperature.

The mud crab *Scylla serrata* occurring in Hooghly-Matlah estuary of West Bengal was found highly carnivore in food and feeding

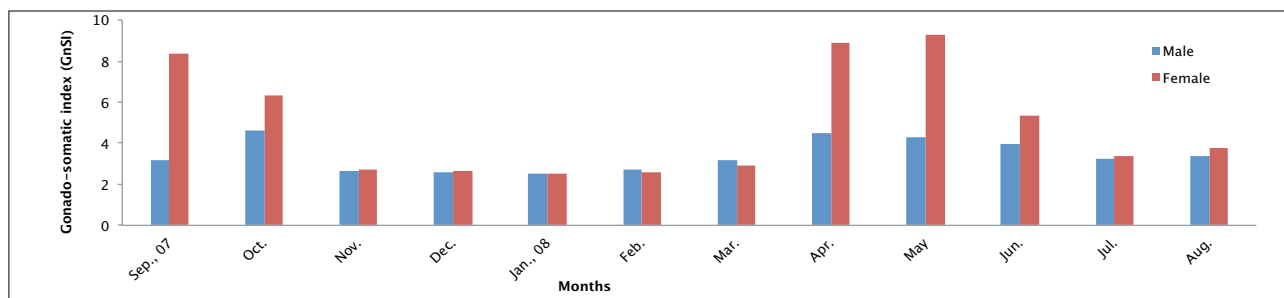


Fig. 4. Monthly variations in mean gonado somatic index of *Scylla serrata*

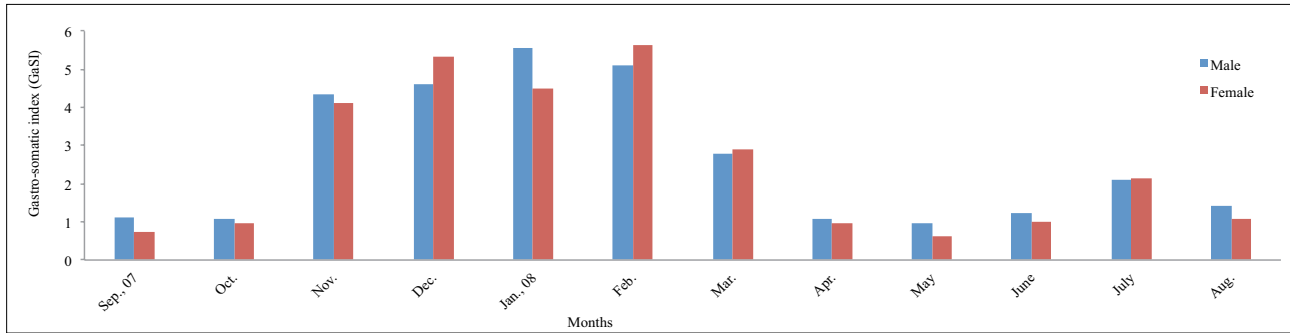


Fig. 5. Monthly variations in mean gonado somatic index of *Scylla serrata*

habits and predominantly feeds on crustaceans, fishes, and molluscs. The higher feeding intensity was observed during January-February and lowest during the month of May for both the sexes based on gastro-somatic index. The feeding intensity was found less during the spawning season of the species. The details knowledge on food and feeding habits as well as organic indices of the species will be useful to adopt proactive measures for biological management of fishery in the locality.

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References

- Ali, M. Y., D. Kamal, S. M. M. Hossain, M. A. Azam, W. Sabbir, A. Murshida, B. Ahmed and K. Azam. 2004. Biological studies of the mud crab, *Scylla serrata* (Forsk.) of the Sundarbans Mangrove ecosystem in Khulna region of Bangladesh. *Pakistan J. Biol. Sci.*, 7(11): 1981-1987.
- Chakraborty, R., S. K. Das and D. Bhakta. 2016. Food and feeding habits of *Channa punctatus* (Bloch, 1793) from water bodies of Nadia district, West Bengal. *J. Inland Fish. Soc. India*, 48(2): 88-92.
- Chondar, S. L. 1999. Biology of fin and shell fish. SCSC Publishers (India), Howrah. 514 pp.
- Delahunty, G. and V. L. DeVlaming. 1980. Seasonal relationships of ovary weight, liver weight and fat stores with body weight in the gold fish, *Carassius auratus* (L.). *J. Fish Biol.*, 16: 5-13.
- Ghosh, S. K. 2003. Diversifying coastal Aquaculture through mud crab fattening. *Aquaculture authority News*, p. 22-24.
- Hill, B. J. 1976. Natural food and fore gut clearance rate and activity of the crab *Scylla serrata* from Australia. *J. Mar. Biol.*, 34 (2): 109-116.
- Hynes, H. B. N. 1950. The food of freshwater sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. *J. Anim. Ecol.*, 17: 36-58.
- Jayamanne, S. C. 1992. The mud crab fishery in Srilanka. In: Seminar on the mud crab culture and trade. Angell C. A. (Ed), Bay of Bengal Programme for Fisheries Development, Madras, India, p. 41-48.
- Joel, D. R. and P. J. S. Raj. 1982. Taxonomic remarks on two species of the genus *Scylla* De Haan (Portunidae: Brachyura) from Pulicat lake. *J. Inland Fish. Soc. India*, 12(2): 38-50.
- Joel, D. R. and P. J. Sanjeevaraj. 1986. Food and feeding of the two species of *Scylla* (De Haan) (Portunidae: Brachyura). *J. Mar. Biol. Ass. India*, 28 (1&2): 178-183.
- Kathirvel, M. 1981. Present status of taxonomy and biology of *Scylla serrata* (Forsk.) Proc. Symp. on coastal Aqua. *Mar. Biol. Ass. India*, Abs. No. 94: pp. 45-49.
- Kathirvel, M. and S. Srinivasagam. 1992. Taxonomical status of mud crab, *Scylla serrata* (Forsk.) from India. In: Seminar on the mud crab culture and trade. Angell C. A. (Ed), Bay of Bengal Programme for Fisheries Development, Madras, India, p. 127-132.
- Khongngain, O., S. K. Das and D. Bhakta. 2017. Study on Food and feeding biology of *Trichogaster fasciata* Bloch & Schneider, 1801 from a wetland of Nadia district of West Bengal. *J. Inland Fish. Soc. India*, 49(2): 03-09.
- Kizhakkudan, J. K. 2002. Fishery of the blur swimming crab, *Portunus pelagicus* (Linn.) in Gujarat. *J. Mar. Biol. Ass. India*, 44(1&2): 97-106.
- Lalitha Devi, S. 1985. The fishery and biology of crabs Kakinanda region. *Indian J. Fish.*, 32(1): 18-32.
- Lee, C. 1992. A brief overview of the ecology and fisheries of the mud crab *Scylla serrata* in Queensland. In Angell, A.C. (Ed.), The Mud crab, p. 65-70.
- Mamun A. A., M. Begum, M. Y. Mia and M. J. Alam. 2008. Food and feeding habits of mud crab *Scylla serrata* (Forsk.) in Bangladesh. *J. Bangladesh Soc. Agric. Sci. Technol.*, 5(3-4): 141-144.
- Mohanty, S. K., A. Mahapatra and A. K. Pattnaik. 2006. Occurrence and biological outlines of two species of *Scylla* (De Haan) in Chilika lagoon, India. *Indian J. Fish.*, 53(2): 191-202.
- Mohapatra, A., R. K. Mohanty, S. K. Mohanty and S. K. Dey. 2010. Carapace width and weight relationships, condition factor, relative condition factor and gonado-somatic index (GSI) of mud crabs (*Scylla* spp.) from Chilika Lagoon, India. *Indian J. Mar. Sci.*, 39(1): 120-127.
- Motoh, H. 1979. Studies of the fisheries biology of the mud crab *Scylla serrata* in the Philippines, Tech. Rep. No.3, SEAFDEC, Aquaculture Dept., p. 79-85.
- Nandi, N. C. and S. K. Pramanik, 1994. Crabs and crab fisheries of Sunderban. Hindustan publishing corporation, Delhi, 192 pp.
- Nayak, L., R. Mohapatra, P. Padhi and S. D. Sharma. 2014. Food and feeding habit of *Scylla serrata* and *Scylla tranquebarica* from Chilika Lagoon, East coast of India. *Journal of International Academic Research for Multidisciplinary*, 2(10): 467-478.
- Paul, A. K., M. M. Alam, M. S. Islam, M. A. Hussain, and S. K. Das. 2018. Feeding behaviour of mud crab *Scylla serrata* in North of Sundarbans, Bangladesh. *AACL Bioflux*, 11(3): 701-708.
- Prasad P. N. and B. Neelakantan. 1988. Food and feeding of the mud crab *Scylla serrata* (Forsk.) (Decapoda: Portunidae) from Karwar waters. *Indian J. Fish.*, 35(3): 164-170.
- Prasad, P. N., R. Sudharshana and B. Neelakantan. 1988. Feeding ecology of the mud crab *S. serrata* (F.) from the Sankar Backwaters. *J. Bombay Nat. Hist. Soc.*, 85(1): 79-89.
- Raman, K. and S. Srinivasagam. 1978. On new records of the Deep Sea portunid crab, *Podophthalmus vigil* (Fabricius) from the Ennore and Pulicat estuaries, Madras. *J. Inland Fish. Soc. India*, 10: 171-173.
- Sarkar, S., S. K. Das and D. Bhakta. 2017. Length weight relationship and relative condition factor of Indian shad, *Tenulosa ilisha* from Hooghly estuary system, West Bengal. *J. Inland Fish. Soc. India*, 49(1): 22-26.
- Satapathy, D. 2007. Fishery of mud crab *Scylla serrata* with reference to its growth and maturation in Chilika lagoon, east coast of India. In: Lakes and Coastal Wetlands Conservation, Restoration and Management (E.D.) Mohanty, P.K., Capital Publishing Company, New Delhi, p. 45-51.
- Satapathy, D. and S. K. Mishra. 2007. Growth of mud crab, *Scylla serrata* in Chilika Lake, East coast of India. *J. Inland Fish. Soc. India*, 39(2): 72-75.
- Sukumaran, K. K. and B. Neelakanta. 1997. Food and feeding of *Portunus sanguinolentus* and *Portunus pelagicus* (Linnaeus) (Brachyura: Portunidae) along Karnataka coast. *Indian J. Mar. Sci.*, 26: 35-38.
- Vahneichong, E., S. K. Das and D. Bhakta. 2017. Foraging and bio-indices of *Labeo calbasu* (Hamilton, 1822) from wetlands of South 24 Parganas district of West Bengal. *J. Aqua Trop.*, 32(3-4): 353-360.
- Viswanathan, C. and S. M. Rafii. 2015. The natural diet of the mud crab *Scylla olivacea* (Herbst, 1896) in Pichavarn mangroves, India. *Saudi J. Biol. Sci.*, 22(6): 698-705.
- Xiao, Y., S. Venema, and G. Hooper. 2004. Studies of mud crab in Adelaide, Australia. South Australian Aquatic Science Centre. p. 55-65.