Rajiv Gandhi Chair Special Publication - 2008

GLIMPSES OF AQUATIC BIODIVERSITY

Editors

Prof. (Dr.) P. Natarajan
Rajiv Gandhi Chair Professor, CUSAT, Cochin - 682 022

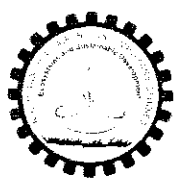
Prof. (Dr.) K.V. Jayachandran
College of Fisheries, Kerala Agricultural University
Cochin 682 506, Kerala, India

Prof. (Dr.) S. Kannaiyan
Former Chairman - National Biodiversity Authority
Chennai-600 041

Dr. Babu Ambat
Executive Director, Centre for Environment and Development
Trivandrum-695 013

Arun Augustine
Research fellow, Rajiv Gandhi Chair, CUSAT, Cochin-682 022

Published by



RAJIV GANDHI CHAIR IN CONTEMPORARY STUDIES
SCHOOL OF ENVIRONMENTAL STUDIES
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
Kochi - 22

Glimpses of Aquatic Biodiversity - Rajiv Gandhi Chair Spl. Pub., 7 : 103 - 110 (2008).

MOLLUSCAN BIODIVERSITY AND RESOURCE CONSERVATION

K.K. Appukuttan
Anuradh, Akshaya Nagar-20, Kadappakada P.O., Kollam - 8
akkakuttan@yahoo.co.in

The phylum Mollusca is currently the second most diverse animal group with origin date back before Cambrain. These animals are soft bodied heterogeneous group with great antiquity and are extremely diversified in shape and colour. This animal group include coat-of-mail shell (Ampheneura), snails (Gastropoda), clams, oysters and mussels (Bivalvia), octopuses, squids and cuttlefishes (Cephalapods), less obvious animals such as slugs and sea slugs (which have an internal shell), and elephant tusk shells (scaphopod). The majority of molluscs inhabit marine biotopes and they occur from the backwater zone, mangroves, intertidal area , shelf and deeper waters. There are various estimates of number of total species of molluscs varying from 80,000 to 1,35,000 numbers (Appukkuttan, 2008). A summary of published data indicate that there are 31463 marine molluscs, 24,503 terrestrial and 8765 freshwater.

Since the dawn of human civilization, molluscs have a tremendous impact on Indian tradition and economy. They have been in good demand as ornaments, currency, as a popular panacea for illness and mascot to ward off evil spirits. Shell handicraft is an age old industry in India especially chank bangle industry of Bengal. Gastropods (chanks) and bivalves (pearl oysters, mussel and oysters) were exploited from the country from time immemorial. Several species of gastropods and bivalves are traditionally fished for edible purposes, for industrial raw material and as ornamental shells for handicraft. Commercial exploitation of cephalopods (squids, cuttlefishes and octopuses) began very recently in India, only after the large scale operation of mechanized trawlers and subsequent export demand. The exploitation rate of molluscs for all these purposes is increasing day by day. Due to excessive fishing pressure and over exploitation in recent years, there are management problems for conservation of the resource. With an extensive coast line of 6100 km and Exclusive Economic Zone (EEZ) of 2.1 million km^2, the molluscan biodiversity along our main land and Islands are rich and varied, especially in the coral reef and intertidal ecosystem. It is reported that 3271 species of molluscs coming under 220 families and 591 genera with 1900 species of gastropods, 1100 bivalves, 210 cephalopods, 41 polyplacophores and 20 scaphopods are recorded from Indian waters.

A review of literature reveal that number of studies have been taken up to describe the taxonomic details, ecology and distribution of Indian molluscs. Melvill and Abercrombie (1892) have described the molluscs from Bombay. Annadale and Kemp (1915) listed the gastropods and bivalves from Chilka lake. Hornell (1927; 1941) who can be considered as the pioneer in Indian molluscan research has described the common edible molluscs that are available in South India. Chrichton (1941) also has documented the marine sea shells of Madras. Gravely (1941; 1942) has listed the molluscan fauna available in the intertidal littoral area and described the important characters of common gastropods and bivalves from Madras. Satyamurti (1952; 1956) collected and described molluscs from Krusadi Island, Gulf of Mannar, especially from reef habitat and intertidal areas. Kundu (1965) and Menon *et al.* (1967) collected intertidal molluscs from Gujarat and described the characters and habitat details. Appukuttan (1972; 1973) studied the coral - boring bivalves of Gulf of Mannar and Palk Bay and described the taxonomic features and distribution pattern in detail and also the occurence and abundance of these groups from different parts of India. Rao and Sundaram (1972) gave the ecological details and distribution pattern of molluscs of

Gulf of Mannar and Palk Bay. Nair and Rao (1974) in their book on commercial molluscs of India documented the taxonomic features, distribution and utility of commercially important edible and ornamental molluscs from India. Pillai and Appukuttan (1980) studied the distribution of molluscs of Gulf of Mannar and Palk Bay. A team of scientists from the Central Marine Fisheries Research Institute, Kochi made an investigation on Mariculture potential of Andaman and Nicobar Islands through an indicative survey in 1983 and described the distribution pattern of pearl oysters, edible oysters, mussel, giant clams, trochus and turbo. Again in 1985 the CMFRI has published the bionomics, fisheries and resource characteristics of cephalopods from Indian waters. Through another indicative survey Appukuttan *et al* (1989) have documented the molluscs available in the intertidal and reef habitats of 12 Islands of Lakshadweep. Pinn (1990) collected commercially important snails from Pondicherry and described the major characters and habitat. Narasimham (1993) reviewed the status of molluscan resources of India and gave suggestion for improvement of cephalopod, bivalve and gastropod fishery. Phillip and Appukuttan listed 29 gastropods (29) collected from the trawl by catches off Kollam, Kerala. Deepak Apte (1998) described the taxonomic features and distribution of common Indian molluscs. Zoological survey of India have conducted many surveys on the intertidal molluscs of mainland of India and Andaman and Nicobar Islands and documented the distribution and abundances in detail (Subba Rao, 1991). Appukuttan and Shoji (2005) dealt in detail conservation and management aspects of reef associated molluscs for sustainable utilization. Biju Kumar and Deepthi (2006) studied the trawling and bycatch composition with implications on marine ecosystem and observed the molluscan biodiversity in the trawl grounds of Kerala.

Biodiversity Studies on Indian Molluscs

Gravely (1927; 1941; 1942) has listed almost 700 species of molluscs from Madras with brief ecological details. Satyamurti (1952) described the taxonomic details and distribution of Scaphopods, pelecypoda and cephalopods of Krusadi Island, Gulf of Mannar and listed 209 species, of which 4 were scaphopods coming under a single family, 156 pelecypods under 30 families and 9 cephalopods from 4 families. Most of the specis were collected from coral reef and intertidal rocky and sandy areas. Venerid bivalves ranked first in abundance and occurrence. Satyamurti (1956) studied amphineura and gastropod molluscs from same area and recorded 8 species of amphineura under 3 families and 249 species of gastropods coming under 63 families, out of which 206 species were prosobranchs (48 families), 30 were opisthobranchs (12 families) and 4 pulmonates (3 families). Cypraidae (cowries) contributed maximum number of species followed by Conidae (cone shells). Appukuttan (1973) recorded 22 species of coral boring bivalves from mainland and Islands of India and indicated that all the 22 species are available in the east coast, where as only 8 species are found in the west coast. Pillai and Appukuttan(1980) studied the distribution pattern of molluscs in the reefs of south east coast and listed 112 species of which 3 were Amphineura, 57 gastropods and 52 bivalves collected from raised reefs, sand stone, eulittoral boulders, submerged shingle, unvegetated sand, sea grass, algae, mangrove, reef crest, massive and branching corals. Fred Pinn (1980) described 210 species of gastropods from Pondicherry with note on the occurrence of each species in different habitat. Appukuttan *et al.* (1989) made an indicative survey of molluscan resources and reported 125 molluscs from 12 Islands of Lakshadweep giving distribution and abundance in each Island. There were 92 gastropods recorded under 25 families, 29 bivalves from 18 families, and 4 cephalopods under 2 families. Conidae contributed the maximum number of 24 followed by 13 species from Cypraidae. Babu Phillip and Appukuttan (1995) listed 29 species of gastropods as by-catch of shrimp trawlers from southwest coast of India and shown the magnitude of abundance. Deepak Apte (1998) has documented 262 gastropods, 3 scaphopods and 48 bivalves in his book on Indian Sea Shells. Cowries (36 species) ranked first in abundance followed by conus (33 species). He has also listed 60 species as uncommon, rare and endangered. Chakravarthy *et*

t (2005) described the molluscs of Mangrove ecosystems in India and listed 34 spcies with 14 milies (23 species) from gastropods, 6 families (10 species) bivalves and 1 family (1 species) om cephalopods. Biju and Deepthi (2006) studied the impact of trawling and biodiversity in the arine ecosystem of trawl grounds and listed 140 species of molluscs from Kerala Coast.

olluscan Distribution in Various Ecosystem

Sandy Shore: A large number of molluscs inhabit this habitat including *Cerithium, mbonium, Dentalium* and *Donax.* Other molluscan species recorded from this habitat are *Murex apa, Buforaria echinata, Cronia margariticola, Cerithium sp., Aplysia lineolata, Cerithidea cingulata, erithium trailli* and *Atactodea glabrata.* The protected island beaches of the coral reefs with a high alcreous content in this area form a favourable habitat for these molluscs especially *Atactodea abrata.*

Sandstone: Structurally, these are conglomerate of sand grains of different sizes with olluscan shells, predominantly of *Cerithium sp.* It is reported that in the absence of any rocky tcrops in this area, the typical rocky shore animals occupy the sandstones. The molluscs ported from these areas include *Littorarina undulata, L. krausi* and large individuals of *Nodilittorina ramidalis* and *N. leucostica.* Below the zone of littorinids (eulittoral zone) occur the limpets ellana rota. *Craspidochiton, Saccostrea cucullata, Purpurea, rudolphi, Thais carnifera, Drupa argariticola* and *Cerithium trailli.*

Mangroves: The molluscan fauna of mangroves in general, includes a limited number of stropods and bivalves. The molluscan fauna associated with mangroves can be broadly divided to those that actually live on the vegetation and those that live around. The molluscan fauna ported in association with the mangroves are *Planaxis sulcatus,* Littorina melanostoma, *Littorania abra, L. undulata, Cerithidea cingulata, C. obtusa, Gafrarium tumidum, Isognomon, Saccostrea, odiolus sp.* and *Teredo,. Nerita articulata, N. smithi, Neretina violacea, umbonium vestiorium, ssiminae brevicula, A. francessiae, Architectonica perspectiva, Telescopium telescopium, Natica rina, N. vitellus, Nassarius spp., Ellobium sp., Onchidium spp., Crassostrea spp., Solen sp., nax sp., Meretrix meretrix, Gluconema sp. and Sepia aculeata*

Eulittoral Boulders: Semi fossilized loose lying corals: The semi-fossilized loose lying ral boulders having a coating of green algae are found to be an ideal ground for many algal azing gastropods. Among the molluscs reported, *Planaxis sulcatus* is the dominant species nd in abundant numbers showing the tendency of crowding together in small crevices and pressions of the coral boulders. Other common species of molluscs reported are *Onchidium rruculatum* under the stones, *Cerithium trailli, Nerita maura, N. albicilla* and *N. chamaeleon.* Four ecies of *Gafrarium viz. G. pectinatum, G. dispar, G. divaricatum* and *G. tumidum* were also ported from the sandy and vegetated lagoon bottom. The edible marine oyster *Saccostrca cucullata* also reported from these area.

Eulittoral granite boulders: The granite structures of the harbours, jetty and intertdal k form an excellent habitat for many gastropods. At low tide, these blocks get exposed for a g time and reveal the loose boulders underneath and several specifies such as *Thais purpura, carnifera, Conus amadis, C. coranatus, Cyprea moneta, C. caputserpentis* and *Aplysia lineolata* cur. On the surface of boulders *Trochus radiatus* and *Turbo bruneus* are commonly seen.

Reef crust and reef flat: In the Palk Bay, *Trochus radiatus, Turbo bruneus, Astralium micostata and Cronia margariticola* are seen at the top of the boulders. On the sides of the ulders, at a lower level, *Arca* spp., and *Isognomon isognomon* are rarely seen. *Saccostrea ullata* is common. *Pinctada sp* is also reported from reef crest. The fauna was found to be rich

and varied, in the reef habitat probably due to the undisturbed condition of the reef. Gastrop were very common and were represented by *Clypeomorus bifasciata, Eulplica scripta, Ana misera, Cronia margariticola, Morula granulata, Drupa horrida, Cyprea arabica, C.moneta, Troc radiatus, Turbo bruneus, Thais purpura, Pollia undosa and Nerita albicella.* Among the *Amphine* a species of *Ishnochiton* was very common. Among bivalves, only *Saccostrea currulata* reported from this habitat. In Andaman and Nicobar Island *Trochus niloticus* and *Turbo murmora Tridacna* spp are recorded from this habitat in addition to *Cypriaea* spp in good numbers.

Submerged or Sublittoral Habitats

Un-vegetated sand: The un-vegetated sand of the reef area was reported as unsuita for burrowing bivalves; whereas on the surface, *Cronia margariticola, Cerithium spp., Murex tr and Bufonaria echinata* generally occur. The bivalves reported are *Gafrarium tumidum, Ma cuneata, Dosinia cretacea* and *Mesodesma trigona.* The gastropod *Cerithidea cingulata* was repor in large numbers whereas other gastropods like *Nassa thirstis* and *Polinices mamilla* are repor in few numbers. Rare occurrence of *Cardium edulae* and *Pinna bicolor* is also reported.

Submerged dead coral shingle: The most common species found in this habitat *Striarca symmetrica, Arca avellana* and *A. complanata.* The swimming bivalve *Galeomma paucistr* occurs in fair numbers. Other common bivalves reported are *Scintilla hanleyi* and *S. timoren* and *Vulsella vulsella. Isognomon isognomon* and *Pinctada anamoides* are reported in fair numbe Gastropods were by no means a conspicuous element in the fauna, however, *Cronia margaritico Cerithium trailli, Turbo bruneus, Cellana rota* and *Emarginula obovata* are reported.

Sea grass fauna: Among the epi-fauna of this ecosystem, the bivalves are represented *Gafrarium tumidum* and *rarely Circe scripta* and *gastropods by Cypraea histro, C.arabica, Chicore virgineus and Cerithium scabridum and C trailli.* Another common gastropod reported is *Pyre* seen on the leaves and stems and are represented by three species, *Euplica scripta, P. testudina* and *P. flava.* Young ones of *Trochus radiatus* and *T. stellatus* were reported as seen on the leave the adults of which are common inhabitants of eulittoral hard substratum. Another gastrop *Clithon oualaniensis* and opisthobranch *Dolabella rumphii* are recorded. The molluscan fauna of t sea-grass community is dominated by *Pinna bicolor.*

Algae Associated Molluscs

The green algae *Ulva reticulata* forms extensive green beds in the lagoon bottom of t coral reefs and many gastropods are found attached to these algae, such as *Jujubinus interrupt Trochus radiatus and Planispirata fallaciosa Thais tissoti, Cerithium scabridum, Cronia marganitico* Many nudibranchs are reported to be associated with the algae *Caulepra racemosa* including t swimming gastropod *Berthelinia limax.* It is reported that there is specificity in the associati between *Berthelinia* and *Caulerpa* and the same species is not at all collected from any oth algae. Another five species of gastropods viz. *Morula granulata, Cronia margariticola, Anach misera, Trochus radiatus* along with *Ischnochiton* sp. were reported from the leaves of the alga *Padina gymnospora.* The economically important small gastropod *Anachis misera* is common o the stems and leaves of the algae *Turbinaria* sp. Other mollusc species recorded are *Morula granulat Cronia margariticola, Planispira fallaciosa, Phsionella nivosa, Trochus radiatus, Euplica scripta* a *Modiolus* sp. The green algae *Sargassum*, harbour molluscs species; *Anachis misera, Euplic scr*ipta. Juveniles of *Trochus radiatus and Pinctada anamoides* are also reported rarely. *Gracilar edulis* which is available in Gulf of Mannar, Palk Bay and Lakshadweep harbour many gastropod such as *Euplica scripta, Anachis misera, Phasionella nivosa, Cronia margariticola, Pollia undos*

and *Astralium semicostata*. A notable feature of the alga - associated molluscs of the reef ecosystems is the presence of a large number of juveniles of both gastropods and bivalves. These include those of *Trochus, Cellana, Cerithium, Cantharus* and *Pyrene* among the gastropods and of *Pinctada* and *Modiolus* among the bivalves.

Coral Associated Molluscs

The branching coral seem to be favoured by many gastropods like *Pyrene versicolor, Drupa* spp., *Trochus spp.* and *Cerithium* spp., *Spondylus layardi* was also recorded from the branches of the live corals. Both gastropods and bivalves have been reported on the massive corals. *Cronia margariticola, Pyrene* spp. and *Cerithium* spp., were recorded in which the most abundant one is the *C.margarticola. Lambis lambis* is recorded between the massive coral heads. Bivalves attached to the surface and under sides of massive corals were *Arc* spp., *Isognomon, Pinctada* spp. and *Saccostrea*. However, the density of surface living bivalves was more on the dead coral shingle than on the living corals.

Among mytilids, seven species of *Lithophaga viz. L. nigra, L. gracilis, L. teres, L. straminea, L. cumingiana, L. levigata* and *L.* spp., are the coral boring bivalves with *L. nigra* being the commonest. *Botulla cinnamonea, Venerupis macrophyllia, Petricola lithophaga, P. divergens, P. monstrosa, Aloides sulculosa, Gastrochaena gigantea, G. impressa, G. apertissima, Pholadidea cheveyi, Panitella sp. Diplothyra sp., Jouannetia cumingii, J. globulosa, Parapholas quadrizonata and Clavagella* are other recorded coral boring bivalves from Indian waters causing damage to coral eco system.

Benthic Habitat

. Molluscs are abundant in silt- loam habitat with clay and sand in different percentage. Mostly gastropods dominated in this eco system. Important groups were *Xancus pyrum, Babylonia* spp., *Conus* spp., *Murex* spp., *Bursa spinosa, Tibia curta, Hemifusus* sp., *Oliva* spp., *Ficus ficus, Tonna dolium, Rapana bulbosa, Phalium* spp., *Territella attenuata, Xenophora* sp., *Polistyra* sp. and bivalves *viz. Tellina* spp., *Cardium* spp., *Solen* spp., *Dosinia* spp., *Atripinna* sp, and *Venus* spp.

Conservation and Management

The decreasing biodiversity is a threat for mankind as it destabilizes the ecosystem functioning. So, there is an urgent need not only to conserve, but also to improve the biodiversity level in all the ecosystems under threat. Commercial exploitation accounts for the greater reduction of molluscan population in nature and pollution and environmental hazards also cause death of molluscs to a lesser magnitude. Indiscriminate fishing from any ecosystem will lead to depletion of stock of most of the molluscan resources and its magnitude will multiply in folds when it comes to the closed and easily accessible ecosystems like coral reef. Very little is known about the destruction of molluscan fauna by pollution and by exploitation. So, it is necessary to conduct detailed studies to quantify the molluscs species available and the quantity that could be exploited by species without affecting the ecosystem balance. The studies on biodiversity of the molluscs in different ecosystems from India are very less and a detailed study is an urgent need. The various measures used for resource conservation include.

Marine protected areas

Marine protected areas have been established worldwide as recognition of the conservation crisis, over - exploitation of marine resources and the misuse of coastal ecosystems. The MPA's include preserves, marine parks, marine sanctuaries, isolated islands, coastal areas protected by legal decrees such as shores around yales, military facilities etc.

2. Regulation of the mesh size of the fishing nets

The mesh size of the hand dredges and other nets used for shell collection is to be large enough so that the juveniles will not be destroyed. This is to control size at first capture. In case of clam fishery, strict vigilance is needed in exploitation of undersized clams.

3. Regulation of size limits

Existing rules do not permit the divers to collect undersized chanks from the traditional chank beds in Gulf of Mannar and nearby areas. Similarly, there should be regulations on the size of other important groups also especially when it is collected for commercial purposes.

4. Establishment of open or closed seasons

As in the case of other fisheries the closed season of the fishery is an unavoidable one as it saves the breeding stock by which regular recruitments will be made possible and the mass destruction of the young ones will be controlled by allowing the breeders to reproduce for the future.

5. Ban on bottom trawling

This mostly includes the ban of fishing activity in specific areas during certain seasons like regulation of bottom trawling activities in the chank beds during its breeding season to avoid destruction of egg masses.

6. Sea ranching

Sea ranching of juveniles/ larvae is a method normally used in most of the systems for the improvement and replenishment of stock of the particular living resources of the coastal ecosystems. Transplanting is also another method to increase the stock of depleted groups.

7. Total control over species prone to extinction

For an effective management of the resources and their conservation efforts to identify and manage species that are prone to extinction are needed at the regional to global level.

In this connection, it is important to note that the Ministry of Environment, Govt. of India has already banned the collection, possession and trading of these animals or their products (Live or dead) which shall attract a punishment of rigorous imprisonment upto 7 years along with heavy fine under Section 50, 51 of Wildlife (Protection) Act, 1972. A total of 24 molluscs were banned according to this rule, 9 molluscs were banned in Part - IV B and then again 15 more were banned again. All the molluscs banned are coming under the ornamental shell trade. The species under restrictions are found prone to extinction due to less availability and over exploitation.

In addition to the above measures, adaptive management is an active long-term process of management based on scientific, traditional and other knowledge. In adaptive management, the objectives for managing the fishery are jointly identified by the resource users, scientists and managers. Targets are then set for the catch and monitoring, including feedback mechanisms that follows the process. Individual transferable quotas consider the allocation of a share of the total allowable catches either to individual or to communal users of the resource. Quotas can be allocated for defined periods and constitute a quasi-right to property. Territorial "use rights" in fisheries is another method of fisheries management, which has been allocated to communities having long term artisanal fishing traditions and organizational skills. These communities exercise collective responsibilities over a particular designated area and its resources by developing a plan for management. This has served to develop community-based management of each fishery and has encouraged co-management.

References

Annandale, N. & Kemp, S. 1915. Fauna of Chilka Lake, Mollusca, Gastropoda and Lamellibranchiata (with an account on anatomy of the common *Solen* by Ekendranata Ghosh). *Mem. Indian Mus.*, 5: 327-374.

Appukkuttan, K.K. 1972. Coral-boring bivalves of Gulf of Mannar and Palk Bay. *proc. symp. corals and coral reefs*, 379-398.

Appukkuttan, K.K. 1996. Marine Molluscs and their conservation. In *Marine biodiversity biodiversity and conservation* (N.G.Menon and C.S.G.Pillai(eds.), 66-79.

Appukkuttan, K.K. 2008. Molluscan resources and management strategies. *Proc. Natl. Sem. Envtl. Mgt. Sust. Livelihood*, 6-12.

Appukkuttan, K.K., Chellam, A., Ramdoss, K., Victor, A.C.C. & Meiyappan, M.M. 1989. Molluscan Resources. *Bull. Cent. Marine Fish. Res. Inst.*, 43: 77-92.

Appukuttan, K.K. & Shoji, J. 2005. Conservation and management of reef ecosystem associated molluscs for sustainable utilisation. *S D M R I Research Publication*. No.9: 59-68.

Babu Philip, M. & Appukkuttan, K.K. 1995. A cheklist of gastropods landed at Sakthikulangara – Neendakara area. *Mar. Fish. Infor. Serv. T & E. ser.*, 38: 9-10.

Bijukumar, A. & Deepthi, G.R. 2006. Trawling and by-catch. Implication on marine ecosystem. *Current Science*, 90(7): 922-931.

Deepak Apte. 1998. The Book of Indian shells. Bombay Natural History Society, Oxford University Press, Culcutta, Chennai, Delhi, Mumbai, 115.

George, J.P. 2005. (Ed) Mangrove ecosystems- A manual for the assessment of bio diversity. *CMFRI Special publication.* 83: 222.

Gravely, F.H. 1927. Administrative report of Madras Fisheries Department for the year ending 30th March. Report No.1 of 1929. *Madras Fish. Bull.*, 23: 1-86.

Gravely, F.H. 1941. shells and other animal remains found on the Madras Beach (Groups other than snails etc, (Mollusca 62-70). *Bull Madras Govt. Mus. New* ser., 5: 1-112.

Gravely, F.H. 1942. Shells and other animal remains found on the Madras Beach. 1. Groups other than snails etc. (Mollusca : Gastropoda). *Bull. Madras Govt. Mus. (New Ser.) Nat. Hist.*, 5(1): 112.

Hornell, T. 1922. The common molluscs of India. *Madras Fish Bull.*, 14: 95-215.

Hornell, T. 1949. The study of Indian molluscs. *J. Bombay nat. Hist. Soc.*, 48: 303-334, 543-569, 750-774.

Kundu, H.L. 1965. On the marine fauna of the Gulf of Kutch, Part III. Pelecypoda. *J. Bombay nat. Hist. Soc.*, 62 (1-2) : 84-103, 211-236.

Menon, N.G. & Pillai, C.S.G. (Eds). 1996, Marine Biodiversity Conservation and Management. CMFRI, Kochi.

Narasimham, K.A. 2005. Molluscan Fisheries of India. B.R Publication Corporation, Delhi, 34.

Pillai, C.S. & Appukuttan, K.K. Distribution of molluscs in and around the coral reefs of the southeastern coast of India. *J. Bombay nat. Hist. Soc.*, 77: 26-48.

Pinn, F. 1990. *Sea snails of Pondichery.* Nehru Science Centre, Pondichery,India.

Satyamurti, S. T. 1952. The molluscs of Krusadi Island (in Gulf of Mannar) I. Ampheneura and Gastropoda. *Bull.Madras Govt.Mus.*(New Ser.). 1 (2).Part 6: 1-265.

Satyamurti, S.T.1956.The molluscs of Krusadi Island(in Gulf of Mannar). Scaphopoda,Pelecypoda and Cephalopoda. *Bull.Madras Govt.Mus.*(New Ser.), 1(2), Part.7 : 1 - 202 Pl.33.

Subba Rao, N. V. 1991 Mollusca. *Animal Resources of India*, 125-147.