PRELIMINARY CHECKLIST OF MARINE MOLLUSKS FROM BEYT DWARKA, GULF OF KUTCH (ECO-SENSITIVE ZONE), GUJARAT, INDIA

Hiren B. Soni and Kavita Thakur

Institute of Science and Technology for Advanced Studies and Research (ISTAR)

Department of Environmental Sciences (EST)

Vallabh Vidyanagar - 388 120 (Gujarat) India

Corresponding Authors: drhirenbsoni@gmail.com; kavitathakur59@yahoo.com

Abstract

The preliminary investigation of marine mollusks of Beyt Dwarka was carried out to prepare a checklist at the island of Beyt Dwarka, Gulf of Kachchh (Eco-sensitive Zone), Okhamandal Taluka, Jamnagar District, Gujarat, India. The rapid ecological assessment revealed the occurrence of 82 species of mollusks, belonging to 61 genera, 32 families, 9 orders, and 3 classes (including uncommon / rare species). Of the reported species, Class Bivalvia was represented by 5 orders, 8 families, and 20 species, followed by 4 orders of Gastropoda distributed in 23 families and 60 species, and only 1 order (Scaphopoda) with 1 family and 2 species. Of 82 species, 67 species were common throughout the study period (October 2013 to February 2014), whereas 15 species were designated as uncommon or rare therein. The overall ratio of Order, Family and Species of recorded molluscan taxa was found to be 3.00: 3.56: 2.56. From the present survey, it was observed that the study area (Beyt Dwarka) is endowed with rich diversity of marine mollusks prevailed therein. Therefore, it should be declared as "*Sanctum sanctorum*" by employing grassroots efforts involving local inhabitants with the help of forest officials suggesting site-specific conservation and management strategies.

Key Words: Marine mollusks, Beyt Dwarka, Eco-sensitive zone, Gulf of Kachchh, India

Introduction

Seashells form an important part in the biological and geological beach processes, and also are important part of human culture. The organisms that tend to produce the shells provide bulk quantities of food for animals including fishing industry. Seashells act as a major source of organic deposits to the seafloors making up the majority of limestone and chalks. People have collected shells for millennia for a huge variety of uses; European explorers travelling to West Africa were surprised to find the *Cowrie* shells being exchanged as currency instead of the silver or gold. Also, native people all over the Globe have used seashells for basins, tubs, buckets, lamps, and cutting tools. Shells are the external skeletons of mollusks, but not all mollusks make shells. Those mollusks that do make shells, the majority of them live in the seas and oceans of the world (Harasewych and Moretzsohn, 2010).

Mollusks are the second largest animal group, being outnumbered by arthropods, the estimated number of which is approximately 80,000 to 120,000, with more richness (1600 species) at Brazilian coast (Simone, 1999).These are amongst the oldest and the most diverse groups of animals on the earth; having common ancestor of living organisms on the planet (Harasewych and Moretzsohn, 2010). Moreover, the Phylum Mollusca is the second largest group enriched with more than 100000 species, and is extremely old in terms of evolution; the first molluscan seems to have been appeared during Cambrian period (500 million years ago) (Apte,1998). The body of the mollusk usually consists of following major five parts 1) the foot (highly muscular organ used for locomotion), 2) head (located at the anterior end of the foot, bears a pair of eyes and tentacles), 3) visceral mass (amalgamation of digestive, circulatory, excretory and genital organs), 4) mantle (responsible for the formation of shell, and secretion of mantle forms up the shell), and 5) shell made up of Calcium Carbonate. Morphologically and structurally, each species is destined to have its own pattern of shell (Apte, 1998; Harasewych and Moretzsohn, 2010). The external shells are usually made up of Calcium Carbonate that is secreted by many invertebrate phyla. It is secreted by the mantle (also known as the *pallium*), which is a specialized tissue present in every mollusk. One portion of it produces a very thin layer of a protein known as the *Conchiolin*, the other cells are meant to secrete a fluid in between the animal's tissues and the *Conchiolin* layer. Now, Calcium Carbonate crystallizes from this fluid onto the inner surface of the *Conchiolin*, which produces a mineralized shell. Unlike the bones, shells do not bear any cells or DNA

(Harasewych and Moretzsohn, 2010). Conventionally, mollusks are divided into six classes: Monoplacopora, Amphineura, Gastropoda, Scaphopoda, Bivalvia, and Cephalopoda.

Habitat

Mollusks usually occur in three oceanic zones, *i.e.* Benthic, Pelagic, and Littoral, of which the maximum number of species is found in the littoral zone, whereas very few species are found in the Benthic and Pelagic zones. Depending on the nature of the substratum, the various habitats where shells occur can be classified as Rocky Shores, Sandy Beaches, Mud Flats, Mangroves, and Coral Reefs (Apte, 1998).

Indo-Pacific Province

This is one of the largest provinces that comprises of the Indian Ocean as well as the Pacific Ocean, owing to the warm waters that gives refuge to the most colourful mollusks, comprising of Cowries, Cones, Mitres, Drupes, Volutes, Olives, Conches, and Terebrids. The Indian Subcontinent becomes one of the richest and diverse habitats for mollusks as it is surrounded by three oceans. The sandy beaches of *Konkan*, mudflats of Okha, rocky shores of Lakshwadeep islands, and mangroves of Sundarbans and Nicobar islands provide highly varied habitats making the molluscan fauna richest in India (Apte, 1998).

Materials and Methods

Study Area

The island of Beyt Dwarka (22^0 26' 58" N and 69^0 7' 1" E), is situated in southern fringe of Gulf of Kachchh (Eco-sensitive Zone), Okhamandal Taluka, Jamnagar District, Gujarat, India. It is around 3 km away from the mainland towards north adjacent to Okha Port, having 13 km long (NW-SE) strip and 4 km width. The south-eastern part of the island comprises of clayey beaches and high cliffs, and low lying area with fine sandy beaches towards the northwest (Sundaresh and Gaur, 1998). The area experiences average temperature of 22.8 ^{0}C with winter and summer temperature ranges from 7-48 ^{0}C, annual mean rainfall of 458 mm, average annual humidity 60%, which may increase up to 80% summer and decreases up to 50% during November-December, average wind speed is approximately 4.65 m/s with a maximum of 10.61 m/s during June, tides are semi-diurnal with a tidal amplitude of 3-4.5 m,

5-7m MSL. For the present study, three permanent sampling points (East – Rocky, Centre – Sandy, West –Sandy Rocky) were selected **(Figure 1)**.
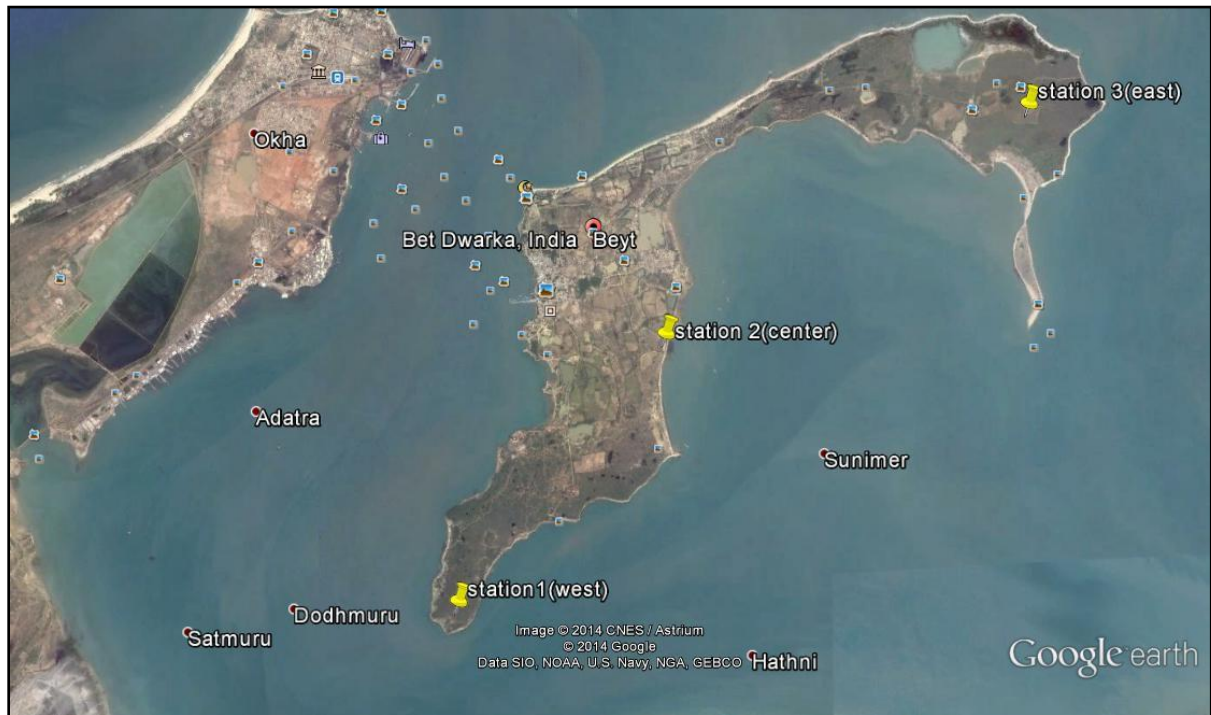

Figure 1: Study Area (Beyt Dwarka, Gulf of Kachchh) (Satellite Image)

Courtesy: Google Earth (Version 7.1.2.2041)

Data Collection and Identification

For the present investigation, the entire study area was treaded by reconnaissance survey, and based on the preliminary observations; the potential sites were selected for the collection of specimens of mollusks. The dead and inactive specimens of mollusks were collected from such diversity-rich sites during October2013 to February 2014. Basic equipments (such as plastic bucket, plastic bags, BB forceps) were used to collect the on-floor specimens, whereas spatula and sharp knives were used to collect Chitons, Limpets or Bivalves, and Barnacles for their lucid dislodging from the rocks. During the study period, the live specimens of mollusks were captured manually by handpicking technique by intensive scrutiny under the stones as well as cracks and crevices in sub-tidal and shallow sub-tidal habitats, from the watery shores as well as by snorkeling and shallow water scuba diving, identified on-site up to species level using standard published literature (Cooke *et al*., 1896; Apte, 1998),and after an appropriate identification, released back to the marine ecosystem in their respective

habitats to preserve the biological richness and the sanctity of the ecosystem. The available species of mollusks were labelled carefully, photographed using mobile camera, and locations were earmarked with the help of a portable GPS device (GARMIN ETREX-10). Later, the unidentified (dead and inactive) specimens were washed with marine water to remove the excess dust and obnoxious elements, collected in zip-locked polyethylene bags, and brought to the laboratory for further identification. After bringing to the experimental laboratory, the specimens were washed with a mixture of tap water, detergent, and disinfectant, air-dried and later were identified using authentic bibliographic sources including species identification field guides (Hyman, 1993; Harasewych and Moretzsohn, 2010; Dholakia, 2013).

Precautions during Sample Collection

During the specimen collection, precautions were taken not to affect its natural habitats as well as colonization pattern. After collecting the specimens from beneath the small rocks and big boulders, they were placed back in their original position and natural habitats so as not to disturb the sheltered organisms to be devoid of scorching sunlight. Besides, the cone shells were picked up by hand due to their poisonous habits and harpoon-shaped *radula*, which may inject venom. Venoms of several molluscan species e.g. *Conus textile*, *C. geographus*, *C. striatus*, etc. have been reported to cause fatal deaths in Australia and Philippines (Apte, 1998).

Results

During the present investigation, in total 82 species of mollusks were recorded from different habitats (East − Rocky, Centre −Sandy, West − Sandy Rocky) of Beyt Dwarka, Gulf of Kachchh, Gujarat, India **(Table 1, Figures 2 & 3)**, which were belonging to 61 genera, 32 families, 9 orders, and 3 classes (including uncommon / rare species). Of the reported species, Class Bivalvia was represented by 5 orders, 8 families, and 20 species, followed by 4 orders of Gastropoda distributed in 23 families and 60 species, and only 1 order (Scaphopoda) with 1 family and 2 species. Of 82 species, 67 species were common throughout the study period (October 2013 to February 2014), whereas 15 species were designated as uncommon or rare therein. The uncommon or rare species are *Retina costata,*

Isanda crenulifera, Astraea semicostata, Calpurnus lacteus, Ornamentaria annulus, Paulonaria fimbriata marmorata, Pustularia globulus, Talparia talpa, Natica tigrina, Natica vitellus, Arabica histrio, Chicorius ramosus, Hexaplex cichoreus, Murex pecten, and *Turris indica.*

Table – 1. Checklist of Marine Mollusks of Beyt Dwarka, Gulf of Kachchh, Gujarat

No.	Class	Order	Family	Species
1		Arcoida	Arcidae	*Arca granosa* Lamarck
2				*A. tortuosa* Linne
3		Carditoida	Carditidae	*Cardita antiquata* Lamarck
4		Mytiloida	Mytilidae	*Brachyodont skarachiensis* Melville
5			Carditidae	*Benguina variegate* Bruguiere
6			Pectinidae	*Chlamys tranquebaricus* Gmelin
7			Cardiidae	*Cardium flavum* Linne
8				*C. setosum* Redfern
9			Pasmmobiidae	*Pasmmobia radiata* Philippi
10	Bivalvia			*Dosinia cretacea* Reeve
11				*D. prostrate* Linne
12		Pterioida		*D. rustica* Linne
13				*Gafrarium divaricata* Chemnitz
14				*Paphia ala-papilionis* Roding
15			Veneridae	*P. malabarica* Chemnitz
16				*Periglypta fischeri* Recluz
17				*Pita rerycina* Linne
18				*Sunetta donacina* Gmelin
19				*Catelysia opima* Gmelin
20				*Venus reticulate* Linne
21			Architectonicidae	*Architectonica laevigata* Lamarck
22	Gastropoda	Archaeogastropoda	Fissurellidae	*Diodara lima* Sowerby
23			Neritidae	*Nerita oryzarum* Recluz

24				*Retina costata* Gmelin*
25			Patillidae	*Cellana radiata* Born
26				*Euchelus tricarinata* Lamarck
27				*Clanculus ceylanicus* Nevil
28			Trochidae	*Isanda crenulifera* A. Adams*
29				*Monodonta australis* Lamarck
30				*Trochus radiates* Gmelin
31				*Turbo brunneus* Roding
32				*T. coronatus* Gmelin
33			Turbinidae	*Astraea stellata* Gmelin
34				*A. semicostata* Kiener*
35		Littorinimorpha	Bursidae	*Bursa tuberculata* Broadrip
36			Cassidae	*B. spinosa* Schumacher
37				*Calpurnus lacteus* Lamarck*
38				*Cypraea tigris* Linne
39				*Erosaria ocellata* Linne
40				*E. turdus* Lamarck
41				*Monetaria moneta* Linne
42			Cypraeidae	*Ornamentaria annulus* Linne*
43				*Paulonaria fimbriata marmorata* Schroeter*
44				*Pustularia globules* Linne*
45				*Ravitrona caputserpentis* Linne
46				*Talostolida teres* Gmelin
47				*Talparia talpa* Linne*
48				*Natica rufa* Born
49			Naticidae	*N. tigrina* Roding*
50				*N. vitellus* Linnaeus*
51			Cypraeidae	*Arabica depressa* Gray
52		Mesogastropoda		*A. histrio* Gmelin*
53			Planaxidae	*Planaxis sulcatus* Born

54		Strombidae	*Tibia curta* Sowerby
55		Buccinidae	*Cantharus undosus* Linne
56			*Nassaria suturalis* A. Adams
57		Conidae	*Conus nussatella* Linne
58			*C. planorbis* Born
59		Dentaliidae	*Dentalium elph* Windworth
60			*D. octagulatum* Donovan
61		Mitridae	*Chrysame ambigua* Swainson
62		Muricidae	*Chicorius ramosus* Linne*
63			*C. virgineus* Sowerby
64			*Drupa contracta* Reeve
65			*D. konkanensis* Blainville
66			*Hexaplex cichoreus* Gmelin*
67	Neogastropoda		*Murex pecten* Lightfoot*
68			*Nassa francolina* Bruguiere
69			*Thais intermedia* Kiener
70			*T. rudalphi* Lamarck
71		Nassariidae	*Nassa ornatus* Kiener
72			*Nassarius nodifera* Powis
73			*N. olivacea* Bruguiere
74		Olividae	*Olivia caerulea* Roding
75			*O. nebulosa* Lamarck
76		Pyrenidae	*Pyrene flava* Bruguiere
77			*P. splendidula* Sowerby
78		Terebridae	*Clavus crassa* Smith
79		Turridae	*Surcula amicta* Smith
80			*Turris indica* Roding*
81	Scaphopoda	Neogastropoda	Xancidae	*Turbinella pyrum* Linne
82				*Hemifusus cochlidium* Linne

* Uncommon / Rare Species

Figure 2. Marine Mollusks of Beyt Dwarka, Gulf of Kachchh (I)

* Numbers indicates Sr. No. of Species (Refer Table 1)
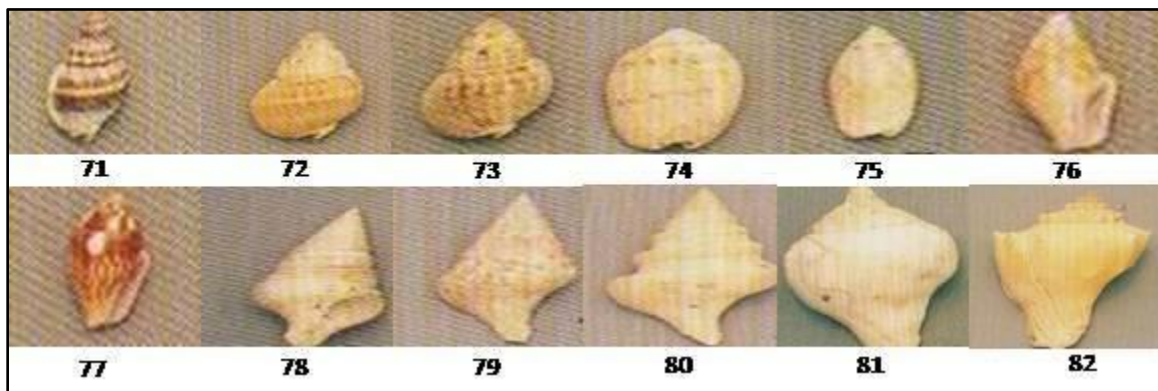

Figure 3. Marine Mollusks of Beyt Dwarka, Gulf of Kachchh (II)

* Numbers indicates Sr. No. of Species (Refer Table 1)

Of the three classes of reported mollusks at Beyt Dwarka, it was evident that species of Class Bivalvia were exhibited by maximum number of Orders (5), accounted for 55.56% of the total taxa occurred therein, followed by Class Gastropoda (4 – 44.44%), and only one species of Class Scaphopoda, accounts for 11.11%. On the contrary, maximum number of

families (23) was represented by species of Class Gastropoda, which accounted for 71.88%, followed by moderate number of species (8) of Class Bivalvia (28.13%), and the least number of species of Class Scaphopoda (3.13%). Moreover, similar pattern of distribution was observed in case of number of species. Maximum number of species (60) was represented by Class Gastropoda, accounted for 73.17%, followed by Class Bivalvia (20 – 39.02%), and the least number of species (2) were represented by Class Scaphopoda, account for only 2.44% of the total taxa present therein **(Figure 4)**.
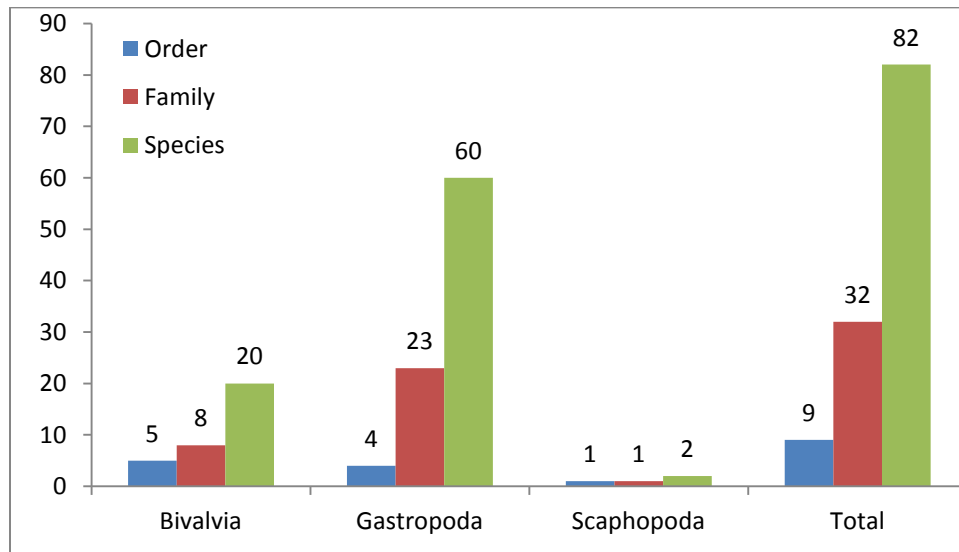

Figure 4. Diversity of Marine Mollusks at Beyt Dwarka, Gulf of Kachchh, Gujarat

Discussion

The findings of the present study reveal the occurrence of 82 taxa of mollusks at Beyt Dwarka, Gulf of Kutch, Gujarat, India. Almost 12.56% of the reported taxa were found to be uncommon or rare therein. The overall ratio of Order, Family and Species of recorded molluscan taxa was found to be 3.00: 3.56: 2.56. The distribution pattern of molluscan fauna observed in the present study is substantiated with the findings of Godwin-Austen (1910), Hiroki (1977) and Peterson (1991). As a result of the physical regime imposed by the tides, a decrease in the species richness generally occurs from sub-tidal bottoms towards the high tide level (McIntyre and Eleftheriou, 1968; Johnson, 1970). Boehs (2000) observed the similar disparity and distribution of different classes of mollusks at Parana, Brazil. Moreover, the spatial distribution of benthic fauna at the intertidal level is reported as being strongly

affected by the variation in physico-chemical conditions (Reise, 1985; Peterson, 1991; Wilson, 1991).

From the field observations, it was evident that specific groups of taxa inhabit the particular marine habitat (Reise, 1985; Subba and Ghosh, 2000). The present findings clearly reflect that most of the molluscan species preferred the sandy rocky terrains for natural colonization (Peterson, 1991; Thapa, 2003), followed by moderate number of mollusks in rocky habitats exhibiting dispersed niche (Rhoads and Young (1970), whereas only few number of mollusks were found to prefer sandy landscapes to be avoided from marine predators as one of the defense strategies (Yadav *et al*. 1980; Peterson, 1991). The high degree of fauna similarity normally observed between the intertidal level and the immediately adjacent infra-littoral zone results, according to Reise (1985), from tidal, nocturnal and/or seasonal migrations to and from the tidal flats and, according to Holland and Polgar (1976), also from passive transport by the carriage (through the action of waves and tides) of animals from the sub-littoral to the intertidal zone.

Among the common species (67) reported, majority of them were commonly found throughout the study period almost in all the surveyed habitats. These common species are usually found as edible species all over the world by indigenous tribes of shorelines including fisherman communities (Apte, 1998). Of the common species, some mollusk species like Snails, Clams, Mail Shells, etc. are found to be commercially exploited and shipped as part of the international trade in shellfish; other species are harvested, sold, and consumed locally. Some species are collected and eaten locally but are rarely bought and sold. A few species of mollusks are not commonly eaten now, but were eaten in historical or prehistoric times (Harasewych and Moretzsohn, 2010).

References

Apte, D., 1998. *The Book of Indian Shells*. Oxford University Press, Mumbai. ISBN: 0195647831.

Boehs, G., 2000. Ecologia populacional, reprodução e contribuição em biomassa de Anomalocardia brasiliana (Gmelin, 1791) (Bivalvia: Veneridae) na Baía de Paranaguá, Paraná, Brasil. PhD Thesis. Curitiba: Universidade Federal do Paraná. 201 pp.

Cooke, A.H., Shipley, A.E. and Reed, F.R., 1896. Molluscs, Brachiopod *In: The Cambridge Natural History*, III Repr. (1968). S.F., Harmer and A.E. Shipley (Eds.), Macmillan & Co. Ltd. England: 459.

Dholakia, A.D., 2013. *Identification of Marine and Freshwater Molluscs Shells*. Daya Publishing House, New Delhi. ISBN: 9788170358605.

Godwin-Austen, H.H., 1910. Land and Freshwater mollusca of India including south Arabia Baluchistan, Kashmir, Nepal, Burma, Pegu Tenasserim, Malay Peninsula, Ceylon and other islands of Indian ocean, *Supplementary to Theobald and Hanley's Conchologia India*, 2, Pl, XI, London.

Harasewych, M.G. and Moretzsohn, F., 2010. *The Book of Shells: A Life-Size Guide to Identifying and Classifying Six Hundred Seashells*. Ivy Press, U.K. ISBN: 12:9780226315775.

Hiroki, K., 1977. On the resistance of isolated bivalve gill pieces to oxygen deficiency and hydrogen sulphide. *Bol. Fisiol. Animal.* Univ. São Paulo. 1: 9-20.

Holland, A.F. and Polgar, T.T., 1976. Seasonal changes in the structure of an intertidal community. *Marine Biology*. 37: 341-348.

Hyman, L.H., 1993. *The invertebrate's volume V.I Mollusca,* 1:792 CBS Publishers and Distributors, India.

Johnson, R.G., 1970. Variations in diversity within benthic marine communities. *American Naturalist*. 104: 285-300.

McIntyre, A.D. and Eleftheriou, A., 1968. The bottom fauna of a flatfish nursery ground. *Journal of Marine Biological Association*. UK. 48: 113-142.

Peterson, C.H., 1991. Intertidal zonation of marine invertebrates in sand and mud. *American Scientist*. 79: 236-249.

Reise, K., 1985. *Tidal Flat Ecology - An Experimental Approach to Species Interactions.* Springer Verlag, Berlin.

Rhoads, D.C. and Young, D.K., 1970. The influence of deposit feeding organisms on sediment stability and community trophic structure. *Journal of Marine Research.* 28: 143-161.

Simone, L.R.L., 1999. *Filo Mollusca*; p. 129-136. In: A.E. Migotto and C.G. Tiago (Eds.). *Invertebrados Marinhos, Vol 3, Biodiversidade do Estado de São Paulo, Brasil: síntese do conhecimentoao final do século XX*. São Paulo: Fapesp.

Subba, B.R. and Ghosh, T.K., 2000. Some freshwater molluscs from eastern and central Nepal. *J. Bombay Nat. Hist. Soc.* 97 (3):452-455.

Sundaresh and Gaur, A.S., 1998. Archaeology of Bet Dwarka. Man and Environment XXIII (2): 77-86.

Thapa, D., 2003. Molluscan diversity of Koshi Tappu Wildlife Reserve and its surrounding area. *Our Nature*.1:73-74.

Yadav, U.K.R., Karki, S.B. and Mishra, P.N., 1980. Population studies of freshwater snails of a lake and three ponds of Kathmandu valley Nepal. *J. Nat. Hist. Mus.* 4(1).