Preliminary Checklist of Marine Mollusks from Beyt Dwarka, Gulf of Kutch (Eco-sensitive Zone), Gujarat, India

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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.
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 Lakshawadheep islands, and mangroves of Sundarbons 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° 26' 58" N and 69° 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 °C with winter and summer temperature ranges from 7-48 °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).

![Study Area](image)

**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 October 2013 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*,

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*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   | Bivalvia   | Arcoida    | Arcidae      | *Arca granosa* Lamarck                        |
| 2   |            |            |              | *A. tortuosa* Linne                           |
| 3   |            | Carditoida | Carditidae   | *Cardita antiquata* Lamarck                   |
| 4   |            | Mytiloida  | Mytilidae    | *Brachyodont skarachiensis* Melville         |
| 5   |            |            | Carditidae   | *Benguina variegata* Bruguiere               |
| 6   |            |            | Pectinidae   | *Chlamys tranquebaricus* Gmelin              |
| 7   |            |            | Cardiidae    | *Cardium flavum* Linne                       |
| 8   |            |            |              | *C. setosum* Redfern                         |
| 9   |            |            | Pasmmbiidae  | *Pasmmbobia radiata* Philippi                |
| 10  |            | Pterioida  | Venerida     | *Dosinia cretacea* Reeve                     |
| 11  |            |            |              | *D. prostrate* Linne                         |
| 12  |            |            |              | *D. rustica* Linne                           |
| 13  |            |            |              | *Gafrarium divaricata* Chemnitz              |
| 14  |            |            |              | *Paphia ala-papilionis* Roding               |
| 15  |            |            |              | *P. malabarica* Chemnitz                     |
| 16  |            |            |              | *Periglypta fischeri* Recluz                 |
| 17  |            |            |              | *Pita rercina* Linne                         |
| 18  |            |            |              | *Sunetta donacina* Gmelin                    |
| 19  |            |            |              | *Catelysia opima* Gmelin                     |
| 20  |            |            |              | *Venus reticulate* Linne                     |
| 21  | Gastropoda | Archaeogastropoda | Architectonicae | *Architectonica laevigata* Lamarck             |
| 22  |            | Fissurellida | Diodara lima | *Diodara lima* Sowerby                       |
| 23  |            | Neritidae  | Nerita oryza | *Nerita oryza* Recluz                        |
| Page | Family     | Species                                      |
|------|------------|----------------------------------------------|
| 24   | Patillidae | Retina costata Gmelin*                        |
| 25   | Patillidae | Cellana radiata Born                          |
| 26   | Trochidae  | Euchelus tricarinata Lamarck                  |
| 27   | Trochidae  | Clanculus ceylanicus Nevil                   |
| 28   | Trochidae  | Isanda crenulifera A. Adams*                  |
| 29   | Trochidae  | Monodonta australis Lamarck                   |
| 30   | Trochidae  | Trochus radiates Gmelin                      |
| 31   | Turbinidae | Turbo brunneus Roding                        |
| 32   | Turbinidae | T. coronatus Gmelin                           |
| 33   | Turbinidae | Astraea stellata Gmelin                       |
| 34   | Turbinidae | A. semicostata Kiener*                        |
| 35   | Bursidae   | Bursa tuberculata Broadrip                   |
| 36   | Cassidae   | B. spinosa Schumacher                        |
| 37   | Cypraeidae | Calpurnus lacteus Lamarck*                    |
| 38   | Cypraeidae | Cypraea tigris Linne                         |
| 39   | Cypraeidae | Erosaria ocellata Linne                      |
| 40   | Cypraeidae | E. turdus Lamarck                             |
| 41   | Cypraeidae | Monetaria moneta Linne                       |
| 42   | Cypraeidae | Ornamentaria annulus Linne*                  |
| 43   | Cypraeidae | Paulonaria fimbriata marmorata Schroeter*    |
| 44   | Cypraeidae | Pustularia globules Linne*                   |
| 45   | Cypraeidae | Ravitrona caputserpentis Linne               |
| 46   | Cypraeidae | Talostolida teres Gmelin                     |
| 47   | Cypraeidae | Talparia talpa Linne*                        |
| 48   | Naticidae  | Natica rufa Born                              |
| 49   | Naticidae  | N. tigrina Roding*                            |
| 50   | Naticidae  | N. vitellus Linnaeus*                         |
| 51   | Naticidae  | Arabica depressa Gray                        |
| 52   | Cypraeidae | A. histrio Gmelin*                            |
| 53   | Planaxidae | Planaxis sulcatus Born                        |
| Page | Family       | Genus          | Species                        |
|------|-------------|----------------|--------------------------------|
| 54   | Strombidae  | Tibia curta    | Sowerby                        |
| 55   | Buccinidae  | Canthus undosus| Linne                          |
| 56   |             | Nassaria suturalis | A. Adams                       |
| 57   | Conidae     | Conus nussatella| Linne                          |
| 58   |             | C. planorbis   | Born                           |
| 59   | Dentaliidae | Dentalium elph | Windworth                      |
| 60   | Mitridae    | Chrysame ambigua | Swainson                      |
| 61   | Neogastropoda | Chicorius ramosus | Linne*                       |
| 62   |             | C. virgineus   | Sowerby                        |
| 63   |             | Drupa contracta| Reeve                         |
| 64   | Muricidae   | D. konkanensis | Blainville                     |
| 65   |             | Hexaplex cichoreus | Gmelin*                      |
| 66   |             | Murex pecten   | Lightfoot*                     |
| 67   |             | Nassa francolina | Bruguiere                     |
| 68   |             | Thais intermedia | Kiener                       |
| 69   |             | T. rudalphi    | Lamarck                        |
| 70   | Nassariidae | Nassa ornatus  | Kiener                         |
| 71   |             | Nassarius nodifera | Powis                       |
| 72   | Olividae    | N. olivacea    | Bruguiere                      |
| 73   |             | Olivia caerulea| Roding                         |
| 74   | Pyrenidae   | O. nebulosa    | Lamarck                        |
| 75   |             | Pyrene flava   | Bruguiere                      |
| 76   | Terebridae  | P. splendidula | Sowerby                        |
| 77   | Turridae    | Clavus crassa  | Smith                          |
| 78   |             | Surcula amicta | Smith                          |
| 79   |             | Turris indica  | Roding*                        |
| 80   | Scaphopoda  | Neogastropoda  | Xancida                        |
| 81   |             | Turbinella pyrum | Linne                       |
| 82   |             | Hemifusus cochlidium | Linne                    |

* Uncommon / Rare Species
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).

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