"BIODIVERSITY OF GASTROPODS IN WESTERN MAHARASHTRA"

Final Report

Of

MINOR RESEARCH PROJET

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By

Dr. Tanaji Shivaji Bhosale

M.Sc., M.Phil., Ph.D.

Principal Investigator,

Associate Professor, Department of Zoology

Y.C Institute of Science, Satara

Yashwantrao Chavan Institute of Science, Satara

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CHAPTER- I

INTRODUCTION:

Meaning of the term Biodiversity:

Biodiversity is a term which is often used in environmental literature. It means "The variety of life in all its forms." The biological diversity or biodiversity includes ecosystem diversity, species diversity and genetic diversity (IUCN, INEP and WWF, 1991)

Meaning and derivation of the name Mollusca:

Mollusca is the phylum which includes a variety of soft bodied, invertebrate, unsegment, hard calcareous shell bearing animals like clams, oysters, snails, squids and octopuses. (Kotpal-Phylum-Mollusca-2001)

The study of soft bodied Molluscan animal is termed as Malacology and study of their shells is termed conchology.

Meaning and definition of the term Gastropod:

The name Gastropods means 'Stomach foot'. It has been derived from the Greek words gaster or gastros (stomach) and pous or podos (foot), referring to the fact that the animal appears to walk on its stomach.

The Gastropods (snail and slugs) are adapted to every mode of life and every kind of habitat exceptaerial.

According to Hyman (1967) the Gastropods are torted or detorted, unsegment, asymmetrical Molluscs, typically provided with a univalve, spirally coiled shell, with a more or less delimited head bearing tentacles and eyes, with a well-developed foot whose ventral surface forms a flat, creeping sole, with a mantle lining the last whorl of the shell, with radula, anteriorly displaced anus and spirally coiled visceral coiled mass, with paired or unpaired heart auricle, osphradium, gill and nephridium and with a single reproductive system.

During unfavorable climatic conditions the Gastropods undergoes natural rest period called aestivation and hibernation. The terrestrial Gastropods are nocturnal animals and their appearance is abundant in rainy season. The Gastropods are moisture loving creatures. These are hermaphrodite animals that is both the male and female reproductive systems are present in same animal.

Number of Identified species:

Mollusca are among the most abundant of all animals. In number of species, the Mollusca is the second phylum to Arthropoda. The exact number of the Molluscan species is not known but there may be 1, 00,000 living and 35,000 fossil species exists. The phylum Mollusca include in all seven classes –Bivalvia, Gastropoda, Cephalopoda, Monoplacophora,

Aplacophora, Polyplacophora and Scapopoda. Out of these, the class Gastropoda is the largest class consisting of near about 80,000 known species with about 1,700 genera found distributed throughout the world (Hyman,1967).

The structure of the shell of the generalized snail:

The typical shell of snail shows parts like- aperture, spire, whorl, suture, umbilicus, protoconch etc. which is shown as below-

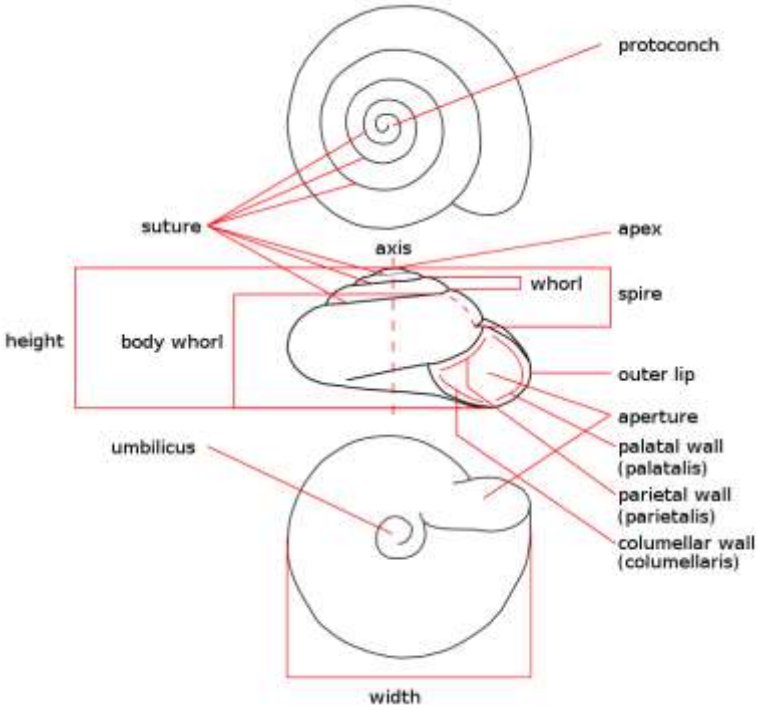

Fig.: The structure of shell of generalized snail.

The normal snail shell is an elongated cone wound into a spiral around a central axis, the columella. The turns of the spiral known as whorls are demarcated by lines called sutures. They may be simple, smooth lines or wavy, irregular or less indented. Usually, the whorls are in close contact, each whorl being partially covered by the succeeding larger whorl. But in some snails, some or all the whorls are disconnected producing the effect of worm tube. The largest whorl, called the body whorl, bounds the large opening, the aperture, through which the foot and anterior part of the snail body can be and retracted. The edge of the aperture is called outer lip and its opposite wall is called inner lip. The smaller whorls, decreasing in size to pointed apex, constitute the spire.

The Molluscan shell is formed of majorly calcium carbonate salt. For proper growth of shell, the freshwater and terrestrial snails tend to restrict the areas where the soil is rich in calcium. Nduku (1976), while studying on *Biomplalariapfeiferi* found that the calcium is the limiting factor for distribution of snails.

Classification of Gastropods:

According to Kotpal (2001) the class Gastropoda has three sub-classes namely-

1) Prosobranchia 2) Opisthbranchia and 3) Pulmonata.

The sub-class prosobranchia or steptoneura has three orders –

1) Archeogastropoda 2) Mesogastropods and 3) Neogastropods

The subclass OPisthobranchia has two orders-

1) Tectibranchia and 2) Nudibranchia.

The sub-class Pulmonata has two orders –

1) Stylommatophora and 2) Basommatophora.

According to Hyman (1967) order Archeogastropoda includes all marine pecies like Patella, Haliotes and Cowries.

The order Mesogastropoda are a very large group consisting of several existing superfamilies. But only superfamily Cyclophoracea includes freshwater and terrestrial snails with around 70 existing genera, widely distributed in warmer areas including India, Australia and Eastern Asia. The shell is usually low, somewhat globos, but of elongated conical shape in some genera.

The family viviparidae are a small group of freshwater snails with the genus viviparous. The family Ampularidae are good-sized snails with broadly conical shell, limited to freshwater in tropica and sub-tropical countries. The genus Ampullarius has over 100 species in south and North America. The famous common Indian species is *Pila globosa*.

The third order Neogastropoda or Stenoglossa of sub-class Prosobranchia is more or less elongated siphonal canal of the shell and the rachiglossate radula. This order includes large number of marine water species and few freshwater forms.

The sub-class Opisthobranchia includes all marine water forms which includes 3000 living and 300 fossil species.

The class Pulmonata, as the name suggests, they are air breathing gastropods in which the mantle cavity is modified into a lung. It includes two orders –

1) Basommatophora and 2) Stylommatophora.

The order Basommatophora includes typical freshwater pulmonates and are grouped under the suborder Hygophila, which includes the superfamily Lymnaecea and c. The superfamily Lymnaecea includes family Lymnacidae and the Ancylacea includes family Ancylidae, planorbidae and physidae.

The Lymniacidae are a large family distributed in freshwaters throughout the world and have conical dextral shells. And expanded body whorl and aperture. The body whorl is expanded and has wide aperture. There are over 10000 species of genu Lymnaea. The other possible

genera are Myxas and Erinna with thin shell with small spire and expanded body whorl and aperture.

The family planorbidae includes freshwater snails with planispiral shells that is with the whorls wound in a flat plane with with a small aperture. This family has received much attention because the members of this family are vectors of schistosome flukes which is very damaging parasite in tropical and subtropical countries.

The members of family physidae are included in genus physa and the and members of family Ancylidae includes freshwater limpates which have patelloid morphology.

Thus, the order Basommatophora includes freshwater snails only. These are characterized by presence of protective calcareous body covering in the form of shell. They possess single pair of tentacles at the base of which there is presence of pigmented spots, hence the order as Basommatophora.

Lastly the order Stylommatophora includes of which the posterior tipped with an eye all terrestrial pulmonates with or without shells, with two pairs of tentacles of which the posterior tipped with an eye and usually with a common gonophore. The further classification of Stylommatophora is based on morphology of the excretory system. According to Baker (1955), there are four sub-orders, namely 1) Orthdrethra 2) Mesurethra 3) Heterurethra and 4) Simurethra. These all suborders includes land snails and slugs like genus – Helix, Limax, Arion etc.

The freshwater snails are found attached to aquatic plants, stones and other hard substratum as well as glides on mud. They respire with lung when they are out of water and respire with gills when present in water.

Survey of Literature:

The book “Indian shells “by Deepak Apte (1998), the phylum Mollusca by Hyman (1967) are useful for identification of Gastropods. In the book “Indian shells” by Deepak Apte (1998) two methods of classification have been given and are – 1) classification based on the structure of radula and 2) classification based on shell structure. In this book the author has explained the biodiversity of marine gastropods only.

Some species of Gastropoda and their habitats and behavior is discussed Bycott (1934). The classification of Gastropoda especially the Stylommatophora species were studied by Bieler (1992). The biodiversity and classification of prosobranch gastropod was studied by Golikov and Tarobogatov (1975). Knight *et al*., (1960) have given important coverageof many gastropod familiesHel viz. cionellidae, Coreospiridae, Mimospirida, Gastropoda, Sinuopeidae, Bellerophontiforms, Bellerophontida , Euomphalida, Metoptematidae, Patellogastropoda. The

list of all recent and fossil families and subfamilies along with synonyms is given by Ponqer and Waren (1988)

The Biodiversity of Pulmonata, Basmmatophora and Stylommatophora are recorded by Paul (2001) in Natural History Museum London.

Barker (1999) studied naturalized terrestrial gastropod fauna of New Zealand and shown to comprise a total 29 species representing 11 Stylommatophoran families. Various aspects of the species of Helix were studied Cadrat (1955).

Analysis of the Problem:

From the above survey of literature, it seems that much attention has been paid on Biodiversity of marine gastropods. But it seems that there is scanty material on fresh water and terrestrial gastropods.

The present work aims to obtain comprehensive knowledge of distribution, collection and identification of gastropod species from some places of western Maharashtra.

Many animals including snails and slugs enter into states of inactivity when conditions are adverse and severe until favorable conditions return.

The gastropods are moisture loving creatures. Generally, they are found in moist places and in water. During drought they withdraw into its shell and can secrete a thin mucin across the peristome.

These snails burrow into the ground and reach a microclimate of lower temperature than the air or may climb high on vegetation to get benefit from wind cooling.

Such terrestrial and freshwater snails and slugs remain dormant for the period of 6 to 8 months. They arouse again after rainfall and it is easy to collect and observe throughout the year until there is the water in the water bodies like ponds, river, lakes, ditches etc.

There are many references of freshwater and terrestrial gastropods in literature but exact classification upto species level is confusing. The key for identification is not available so based on shell morphology, the gastropods can be identified upto genus level.

Among the class gastropods, many species of terrestrial slugs and snails are bothersome pests of various types of crop plants as well as vegetables and the variety of garden plants. The giant African snail *Achatinafulica*, the brown slug*Leviculusalfae*, the black snail *Semperulamaculat*causes severe damage to vegetables and other crop plants.

The gastropods play important role in the nature, i.e., in the production of humus, in the control of fungi and other aquatic weeds like algae and lichens.

The aquatic gastropod species of snails especially freshwater snails like Lymnae, Planorbis, Viviparous commonly found in lakes, ponds and rivers acts as natural cleaning agents

and biological indicators of water pollution. Thus, the aquatic gastropods act as some sort of biological parameters to check the quality of water.

As many of the representative of the gastropods are vectors of various types of trematode larval forms which cause various disease to human beings and their domestic animals like cow, goat, buffaloes, etc.

Thus, it seems that the terrestrial and freshwater gastropod play harmful as well as beneficial role for mankind. Due to all the above-mentioned reasons snails and slugs have got much more importance to man.

Plan of Project work:

The present work is undertaken to study the biodiversity of gastropods in some places of western Maharashtra and to study the behaviors like feeding, breeding, protection and hiding of the Gastrpod species.

As the area decided for the present work is very vast, so out of this only some parts of Kolhapur, Sangli, Satara, and Pune districts are decided for the study of gastropod Biodiversity.

For easy understanding, the next part of the project work is divided into three chapters. The second chapter describes in detail the material used, the actual area covered and the methods of collection employed in the present study. The third chapter deals with the observation on occurrence, behavior of the snails and slugs. The fourth chapter deals with the comparative account of occurrence of these gastropod animals and this chapter also gives general summary and conclusion of this project report and certain ideas for further work on biodiversity of gastropods in western Maharashtra. This chapter is followed by bibliography.

CHAPTER- II

MATERIAL AND METHODS:

For the study of the biodiversity of h Gastropods, the Molluscan snails and slugs were collected from some parts of Western Maharashtra.

The study area covered for the collection of the Gastropod species is shown in Table No. 1.

Table No. 1- Some parts of Western Maharashtra where Gastropods were collected.

Sr. No.	Area covered	Gastropods collected from Terrestrial habitat	Gastropods collected from freshwater habitat
1	Satara District	Satara, Karad, Koregaon and Wai Talukas	Tambave, Kas, Mahadare lakes; Mangalvar tank, Gopalnath tank, Dhom dam, PawarwadiTalav, Krishna, Venna and Koyana rivers.
2	Sangli District	Miraj, Islampur, Digraj, Kadegaon.	Ponds, lakes, Krishna river etc.
3	Kolhapur District	Shirol, Hatkanangle and KarveerTalukas.	Lakes and rivers Krishna and Panchganga
4	Pune District	Pune, Ambegaon, MancharTalukas	Ponds and lakes of Manchar, Narayangaon and Ghodnadi.

The empty shells and live specimens of snails and slugs were collected for the study. Generally the freshwater snails are attached to the substratum like aquatic plants, stones, mud flats etc. The terrestrial snails and slugs are found buried in moist soil, hides under crevices, stones, banana and beetle farms, where the soil is watered consistently and so always it remains moist.

The terrestrial snails and slugs are moisture loving creatures. They move by gliding along on a muscular “foot”. The foot muscles constantly secrets mucus, which later dries to form the salivary “slime trail”. This salivary slime trail indicates the presence of these gastropods. They were found under stones, crevices, debris, in moist places and generally they were found in groups as well as single.

The freshwater Gastropods are found throughout the year and in all seasons. They were collected from various freshwater bodies like rivers, ponds, lakes, ditches, canals etc. Some empty shells of snails were found near the water bodies and on the land of the dried waterbodies during summer.

During unfavorable climatic conditions especially in winter and summer and summer, the terrestrial Gastropods undergoes aestivation where they remains without food, water and oxygen until the advent of rain. When the rain starts the aestivated snails and slugs get awaken from aestivation and in heavy rainfall, large number of snails and slugs comes out in search of food and mate.

Thus the terrestrial snails and slugs were collected during night early in the morning during heavy rain and in cloudy days.

Collection Methods:-

For collection of Gastropods the above mentioned places were visited twice during the study period. The snails and slugs were collected by hand picking. The hand gloves were used during the collection. At a time only one or two live specimens were collected while four to five empty shells of dead animals were collected. The empty shells and live specimens were cleaned in biolong water, dried and packed in polythene bags. The live specimens were photographed, and some of them were preserved in 10% formalin. These shells and specimens were used for identification.

Methods of classification:

According to Apte (1998), there are two methods of classification and are:

1) Classification based on the structure of Radula and 2) The classification based on the shell structure. These methods of classification are described as below:

1)Classification based on the structure of Radula:

Radula is also termed as tongue of Mollusks. It is ribbon-like membrane with transverse rows of denticles on the upper side. Different Mollusks have different feeding habits, namely herbivores, carnivores, scavengers, detritus feeders etc. ; and according to these feeding habits the radula is also modified into various types such as hystricoglossate, rhipidoglossate, docoglossate, pentoglossate, taenioglossate, rachiglossate and toxoglossate. Denticles on the radula of each species have specific formula and comprise the rachidian tooth, lateral denticles and marginal denticles.

2) The classification based on the shell structure:

As mentioned earlier, shell is secreted by the mantle. It has two layers namely outer periostrocum and the inner nacre or mother-of-pearl. The periostrocum is made up of organic material and the remaning shell is made up of calcium carbonate. Most of the gastropod shells are twisted around a central axis and this twisting or coiling is termed as tortion. The twisting or coiling gives diverse shapeto the shells. Most of the gastropods grow in size without changing the primary shape of the shell.

CHAPTER- III

OBSERVATIONS:

The Biodiversity of Gastropods was studied n some parts of Satara, Sangli, Kolhapur and Pune districts of western Maharashtra.

The following gastropod species were collected and identified-

1) *Cyclophorous cyclophorous*:-

These are terrestrial snails and were collected from Satara and Pune districts.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Prosobranchia or Streptoneura.
Order	-	Mesogastropods
Superfamily	-	Cyclophoracea
Family	-	Cyclophoridae
Genus	-	*Cyclophorous*
Species	-	*cyclophorous*

The shell is thin and planispiral, the size of shell ranges between 15-20 mm, and the colour is brownish (Plate No.1 Fig.1). the species were collected from Yevateshwarpathar showed dark orange coloured median line running from anterior end to the end of the body whorl. (Plate No.1 Fig.2 and 3). The opening of the shell is medium sized. At one side the body whorl continues up to last end on otherside it showed 4 to 5 whorls including body whorl.

2) *Helix pomatia*:

These are terrestrial snails collected from Sangli, Satara, Kolhapur and Pune districts.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Pulmonata
Order	-	Stylommatophora.
Family	-	Helicidae
Genus	-	*Helix*
Species	-	*pomatia*

The empty shells were collected throughout the year and live specimens were collected during rainy season. The shell is globose (top like). The body whorl is very large, the shell is thin with low spires. The shell size is 30-40 mm in diameter. The lines of growth are prominent and colour is faint brownish. There are two pairs of tentacles. The tip of first pair of tentacles bears eyes. (Plate No.1 Fig. 4)

3) *Semperula maculata* (Semper):-

These are terrestrial slugs. The shellis completely absent. They were collected from Sangli, Satara, Kolhapur and Pune districts.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Pulmonata
Order	-	Stylommatophora.
Genus	-	*Semperula*
Species	-	*maculate*

It showed single pair of tentacles. The colour is black dorsally and white ventrally. The size of animal is 40-80 mm in length and 10-30 mm in width. The mature slugs showed mid-dorsal white strip. The sexes are united i.e. the animals are hermaphrodite. These are moisture loving creatures, occurs throughout the year in Banana plantation and beetle leaf farm where farmers water the far after every week. It feeds on vegetable plants and organic matter in soil. In favorable climatic conditions it breeds throughout the year. (Plate No.1 Fig. 5)

4) *Leviculus altae*:-

These are also terrestrial slugs, generally occurs in red soil. They were collected from Satara, Sangli, Kolhapur and Pune districts.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Pulmonata
Order	-	Stylommatophora.
Genus	-	*Leviculus*
Species	-	*altae*

It is brown slug. The size ranges between 5 to 8 cm in length and 2-3 cms in width. These are hermaphrodite the colour is reddish brown (Plate No. 1 Fig. 6)

5) *Ampullarius ampullarius* :-

These are large sized freshwater snails, collected from Saras bag Pune.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Prosobranchiata
Order	-	Mesogastropods.
Family	-	Ampullaridae
Genus	-	*Ampullarius*
Species	-	*ampullarius*

The shell size is 40-60 mm in length and 20-30 mm in width. The spires are low .i.e. is only four. The body whorl is very large with large aperture. The shell shows prominent lines of growth. The foot is broad and muscular. The snout is divided into a pair of labial palps. Two pairs of elongated tentacles are present. The second pair bears eyes at its tip. A pair of elongated siphons are present. It can breath in water and in air. (Plate No. 2 Fig.2)

6) *Lymnaea stagnalis*:-

These are freshwater snails collected from various parts of Sangli, Dhom of district Satara Shirol Taluka of district Kolhapur, and some parts of Pune district. Generally they are found in ponds, canals, lakes, etc.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Pulmonata
Order	-	Bassommatophora
Sub-order	-	Hygophilia
Super-family	-	Lymnaceae
Family	-	Lymnaecidae
Genus	-	*Lymnaea*
Species	-	*stagnalis*

The shell is very thin, delicate and easily fragile. The body whorl is large, spires are low i.e. two to three only and conical. Lines of growth are present. Size- 15 to 22 mm. colour- faint brownish in colour.

7) *Planorbis exustus*:-

These are freshwater snails found in lakes, ponds ditches, etc. They were collected from fish breeding centre near Dhom dam, Godoli lake and Mahadare tank of Satara district. Manchar, Ambegaon, Ghodegaon, Narayangaon of Pune district, Rankala lake, Kalamba lake of Kolhapur district.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Pulmonata
Order	-	Bassommatophora
Family	-	Planorbidae
Genus	-	*Indoplanorbis*
Species	-	*exustus*

The shell is delicate and fragile, size- 10-18 mm shell is planispiral. Body whorl is large with medium sized aperture. Colour- dirty greenish or blackish, empty shells are whitish in colour. The lines of growth are prominent.

8) *Viviparus viviparous:*

These are freshwater snails collected from Krishna, Koyana, Yerala river of Sangli, Satara and Kolhapur districts.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Prosobranchia
Order	-	Viviparous or Belamia
Species	-	*bengalensis*

This snail is adapted for running water like rivers, so shell is thick and stout. It is top shell and is conical. Body whorl is large, spires are low, size 20-40 mm in length and 15-20 mm in width, colour whitish or faint brownish.

9) *Viviparus bengalensis*:-

These are collected from Rankala Lake, Rajaram tank, Kalamba Lake of Kolhapur, village top of Kolhapur district. Tambave lake of Satara district.

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Prosobranchia
Order	-	Neogastropoda
Family	-	Viviparidae
Genus	-	*Viviparus or Belmia*
Species	-	*bengalensis*

10) *Achatina fulica*:-

This species is a large land snail that belongs in the subfamily Achatininae of the family Achatinidae. It is also known as the Giant African land snail. It is serious crop pest and has widely distributed

Classification:-

Phylum	-	Mollusca
Class	-	Gastropoda
Sub-class	-	Heterobranchia
Super-order	-	Eupulmonata
Genus	-	*Achatina*
Species	-	*fulica*

CHAPTER IV

RESULT AND DISCUSSIONS

The studies on the Biodiversity of Gastropods in western Maharashtra was undertaken to record the gastropod species in terrestrial and aquatic habitat. The survey of literature showed that there scanty literature available on Biodiversity of gastropods. The number of recorded freshwater gastropods in India are over 100 species till today and taxonomically updated review of the fauna is still lacking (Ramkrishna and Day 2006)

The present project work is carriedin some selected places of Sangli, Satara, Kolhapur and Pune districts where geographical areas are similar and showing repeated species of gastropods. The species of the genus like Helix, Planorbis, Cyclophorous, land slugs and other terrestrial and aquatic snail species are common all over the study area. The gastropods are found abundantly during rainy season. These animals are natural cleaning agents in freshwater bodies and they may survive in adverse climatic conditions by undergoing natural resting period i. e. aestivation. The terrestrial slugs like Semperula maculate, Leviculus altae and terrestrial snails like Achatina fulica and Helix species are found throughout the year in wet soil and moisture content is more.

In the present study total ten species of Gastropoda are recorded on the basis of morphology and shell study. For the detail biodiversity study of animals advanced techniques like DNA bar coding method is to be used which is not fissible in the present study.

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PLATE NO:1 Figure 1 to 6

Cyclophorous cyclophorous

Helix pomatia

Semperula maculata

Leviculus altae

Ampullarius ampullarius

Lymnaea stagnalis

PLATE NO:2 Figure 7 to 10

Planorbis exustus

Viviparous vivaparous

Viviparous bengalensis

Achatina fulica

PLATE NO:3 Sites of Collection 1 to 8