

Molluscan Biodiversity of the North-eastern Region of Bangladesh



Ph.D Thesis

By

Mahiuddin Md. Shahjahan Bhuiyan

Session: 2004-2005

Supervisor

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Institute of Environmental Science
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**Institute of Environmental Science (IES)
University of Rajshahi
Rajshahi, Bangladesh
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Dedicated to

My beloved parents
and uncle Rashid Ahmed
Bhuiyan who has shown the
way of everlasting
thirst for Knowledge

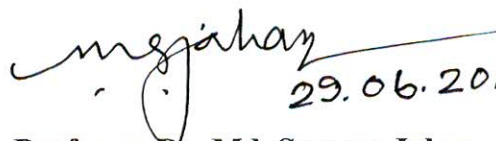
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Certificate

I have the pleasure to certify that the work presented in the dissertation entitled **Molluscan Biodiversity of the North-eastern Region of Bangladesh** is an original research carried out by **Mahiuddin Md. Shahjahan Bhuiyan**, Registration No. 0023 Session 2004-2005 in partial fulfillment of the requirements for the degree of Doctor of Philosophy (Ph. D) in Environmental Science. To the best of my knowledge, this is the researchers own achievement and not a conjoint work. In my opinion **Mahiuddin Md. Shahjahan Bhuiyan** has certainly made distinct contribution to the arena of Environmental Science through his research work. The thesis or thereof the part of it has not been submitted for any degree to any other university.

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Supervisor


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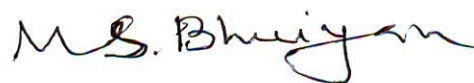
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Declaration

I do hereby declare that the thesis entitled **Molluscan Biodiversity of the North-eastern Region of Bangladesh** submitted to the Institute of Environmental Science (IES), University of Rajshahi for the award of Doctor of Philosophy (Ph.D) in Environmental Science is the result of my own investigation and research work under the supervision of Professor Dr. Md. Sarwar Jahan, Institute of Environmental Science (IES), University of Rajshahi, Bangladesh.

I further declare that this thesis or any part of it has not been submitted to any other university for any degree or diploma or for other similar purposes.



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Ph.D Researcher

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CHAPTER 1

MOLLUSCS OF THE NORTH-EASTERN REGION OF BANGLADESH WITH THEIR SYSTEMATIC ACCOUNTS AND DISTRIBUTION

Chapter 1

Molluscs of the North-eastern Region of Bangladesh with Their Systematic Accounts and Distribution

1.1 Introduction

Mollusca, the second largest phylum in the animal kingdom are characterized by soft, slimy body and glandular body fold of skin or mantle. The mantle secretes a shell which often gives the mollusc's partial or complete shelter for its body. Molluscs are the members of very ancient group whose origin goes back to the earliest fossil bearing rocks of the Paleozoic Era (the Cambrian period, some 500 million years ago). They reached the peak of their development in the Cenozoic Era, but even today molluscs are still, numerically, a very large group. The number of species in the phylum probably about 120,000, but this figure includes extinct species. A common estimate is 80,000 species, the majority of which live in the sea and about 75% of this total are gastropod (Pfleger and Chatfield 1988).

The number of living molluscan species today varies from 80,000 (Boss, 1973) to 135,000 (van Brugen, 1955), of which 31,000 to 100,000 are marine, 1,4000 to 35,000 terrestrial and about 5,000 are freshwater (Abbot, 1989; Seddon, 2000).

Molluscs are markedly diverse with regard to their external morphology and size they range from microscopic clams and snails (smaller than 1 mm) to giant oceanic squid and the massive tridacnid clams of Indopacific reefs (Hochachka, 1983).

Habit and Habitats of Molluscs

Molluscs range from limpets clinging to the rock, to snails, which crawl or dig or swim, to bivalves which anchor or burrow or bore, to cephalopods which torpedo through the water or lurk watchfully on the bottom. They penetrate all habitats: the abyssal of the sea, coral reefs, mudflats, deserts and forest, rivers, lakes and underground. They may become hidden as parasites in the interior of other animals (Morton, 1968).

The molluscs are found in a wide range of habitats, from tropical to the polar seas, at altitudes exceeding 7000 m like Himalayas, in flood plains, ponds, lakes, beels, baors, streams, paddy fields, forest beds, mud flats, mangroves, rivers, and the seas from pelagic to benthic depths.

The land molluscs are adapted to all kinds of weather and dwell on ground habitats ranging from bushes, parks' gardens, vegetations and forests, particularly inhabits that offer sufficient shady and moist places. Their primary habitats are damp shady corners among vegetation, under fallen leaves, litters, and logs and in crevices. Some species crawl on damp walls, trees trunks, petioles and leaves and algal growths. A few prefers salty environments, while some are adopted to leaves and branches of trees or inside the hollow trees bark. Slugs having no protective shell often take shelter inside the petioles or folds of leaves. The young one is usually found attached to under side of the herbs.

Freshwater molluscs are common in ponds, paddy fields, irrigation canals, lakes, hill streams (*chhara*) and rivers. Marine molluscs live in a wide range of habitats, from supra tidal mark of a coast to the extremely deep water. Most of the Bangladeshi marine molluscs live in the Bay of Bengal coast and represent diversified life style, including free -living, sedentary, bottom-dwellers, burrowers, borers and pelagic form. A few are also arboreal on mangrove trees and grasses. The majority of the species, however, inhabit shallower waters (Encyclopaedia of Flora and Fauna of Bangladesh, 2007).

Molluscs as human food and animal food

In Guadeloupe, Mauritius, China, Japan and even in France, certain species of bivalve are used for human consumption (Preston, 1915). The use of fresh water molluscs, protein-rich food very much in practice in a number of countries viz. Mexico (Garia-Cubas, 1989, Valvas-Gonzalez 1989), Taiwan and Formosa (Wu 1989), the Philippine (Talavera and Faustino, 1933, Pagulayan and Cruz, 1989), and Kewajam, 1986). *Pila globosa*, *Bellamya beagalensis*, *Brotia costula*, *Paludomus conica*, *Lamellidens marginalis*, *Solenia soleniformes*, *Trapezoides exolescens* are consumed in West

Bengal, India (Subba Rao, 1989). Land snails are also eaten by people of France. France also consumes 5 million pounds of escargot (a large tree snail *Helix aspersa*) every year (Bourquin *et. al*, 1999). Along the Worlds miles of coastlines, man has always had a readily available food source - high in protein and trace of minerals, because of the many kinds of molluscs to be found there. Mussel and oyster beds, clam-flats and other abundant shell fishes have always provided and easy source of food.

Today fisheries of Europe, Japan and the United States of America produce one billion pounds of oyster meat each year. Taste of molluscan food vary tremendous from one person to the next and from culture to culture; however, when it comes to the question for survival, most molluscs are edible. Some are considered delicacies such as oysters, and escargot, while others such as clams and mussels of freshwater ponds and streams are less likely to be consumed due to taste but none- the-less are very edible. There are many different kinds (species) of scallops (family Pectinidae) being eaten in many parts of the World. Some edible oysters are popular to people.

Conchs, (Family Strombidae) produce a large amount of meat, and are specially treasured in the Caribbean region, where the giant pink (Or Queen) Conch (*Strombus gigas*), is farmed extensively. *Strombus gigas* in the Bahamas is heavily exploited item for food, and along with two species of *Cassis* (Helmet shells), are often cultivated in aquaculture farms.

Squid and Octopus are particularly popular in Japan (where squid are called "Calamari"), but they are catching on in parts of the Western worlds. In New Found land (Canada), they are (squid and octopus) used by the ton as bait for several kinds of fish. Caribbean specially where West Indian top shell (*Cittarium pica* Linne, 1758) is considered a delicacy by some of the locals. Abalone (*Haliotis* sp.) is a well tasty morsel in many parts of the world. Some rare species are sold up to \$ 300 a pound (\$ 760 per kilo). *Busycon carica* is an important ingredient in the Italian dish of "(scungilli marinara)", and is commonly referred to as the Bulot shell (Borquin *et al*. 1999).

In Bangladesh like other countries of the world molluscs are used as food by the Buddhist of Chittagong and Chittagong hill tracts. *Bellamya bengalensis* and *Pila*

globosa are consumed by tribal people belonging to general groups, viz. Bangshi, Bawn, Buna, Chack, Chakma, Coach, Garo, Hajong, Harigon, Khasia, Khyang, Khomi, Lusai, Mahatoo, Marma, Monipuri, Munda, Murang, Pahari, Pankoo, Rajbangshi, Rakhain, Saontal, Tanchanghya, Tipra, Tripura, Urang and Uria (Saha, 1998, Jahan and Rahman, 2000 and Islam 2006).

Molluscs provide food for birds and fishes. As a rule, however, fluviatile species are not in much request for man; though Flesh of *Pila globosa* and *Bellamya bengalensis* are an important food item for African Magur (*Clarius griepinus*) and freshwater prawn (*Macrobrachium rosenbergii*) and estuarine prawn (*Penaeus monodon*) (Jahan and Rahman 2000). The Pangas fishes (*Pangasius pangasius*) has been reported to consume the molluscs in large quantities (Hora, 1952, Ali *et al.*, 1985).

Role of molluscs in ecosystem services

The purification of water is doubtless to certain extent performed by the mollusc in their capacity of scavenger. The freshwater molluscs constitute an important part of ecosystem. Their participation in the way of life of many organisms has made them significant partner of ecological communities (Rao, 1989).

The land molluscs acts as pest, friend of nature, link in food chain, soil fertilizers and calcium supplier. Molluscs particularly, the bivalve, bio accumulators of heavy metals and other pollutant from water. Now a days, they are widely used as bio indicators, to monitor the environmental status of the habitats they occupy. Land snails play a key role to ecosystem as detritivores, feeding on the dead material and contributing to the recycling of the plant nutrients. In natural environments snail density is highest in calcium rich soils in such conditions their biomass can exceed that of all other invertebrate groups combined (Mitra *et al.*, 2005).

Land snails are an important link in the food chain, the cycle between green plants and the animals. Pulmonate land snails alone put the entire molluscs as a group of animals, into third place in bioenergetics term of annual turnover in terrestrial ecosystem, close to annelids (Subba Rao, *et al.*, 1995b) This become possible because of the activities of land

molluscs through which they break down dead plant matters, produce soil, add its fertility and recycle nutrients.

Role of direct decomposition of litter by snail is small (0.35-0.7% of total annual output). But the importance of the role played by snail is in the physical and chemical altering of litters. Large intake, low assimilation and huge amount of mucous coated faecal production promote fungal growth. Early stages of fragmentation facilitates increase in the population of microorganisms, which in turn complete the decomposition process and release the nutrients, thereby increasing the fertility of soil considering the high abundance of the snails in a favorable area (Mitra *et al.* (2005).

Moreover, these snails being nutritionally flexible play the most dominant role in the community. They also add to the fertility of the soil by turning nitrogen into uric acid. Snails living in lime stone rock and feeding on lichens are directly aiding in soil formation in the rocky desert.

Land snails act as calcium supplier; play a very commendable role in supplying calcium in nature. Molluscan shell consists of 93-97% calcium, as calcium carbonate. In India, *Achatina fulica* is common to abundant almost throughout the country. The population density reaching up to 42/m² and about quintals of calcium yearly to the soil. Small land snails also serve as the source of calcium for nesting female birds for production of egg shells (Raut and Ghose, 1984).

Molluscs as a carrier of Zoonotic diseases

Some of the terrestrial snail is known carrier of parasites infecting domestic animals. The species, *Achatina fulica* has been reported as an intermediate host of human lung fluke, *Angiostrongylus cantonensis* in Thailand (Abbott, 1989). *Angiostrongylus* infecting some other snails species in India has also been reported (Limaya *et al.*, 1988). In Africa two genera of snails, *Bulinus* and *Biomphalaria* (Family Planorbidae) are associated with schistosomiasis transmission of the important parasites infecting man. *Biomphalaria* species act as intermediate hosts for *Schistoma mansoni*, which causes intestinal Schistosomiasis, whereas *Bulinus* species transmit *S.haematobium*, responsible for urinary schistosomiasis and also *S.intercalatum*

another intestinal form (Rollinson *et al.*, 1996). About 100 species of fresh water gastropods have been reported to serve as intermediate host of schistosomes, liver fluke, and intestinal and lung flukes (Raut, 1980 and Subba Rao and Mitra 1989). *Lymnaea acuminata* is a registered intermediate host of different fluke parasite of sheep, cattle and man, viz. *Fasciola hepatica*, *F.giantica*, *Shistosoma indica*, *S.nasalis*, *S.spindalis*, *Clinostomum gigantica*, *Echinostoma revolutum*, *E. malayanum* and *Orientobilharzia turkestanicum* in India (Misra and Raut, 1993). Twelve types of cercariae, were recorded in nine species of fresh water molluscs *Bellamya bengalensis*, (Amphistome, Xipidocercous & Distome), *B.dissimilis*, (Distome, Amphistome), *Gyraulus convexiusculus*, (Gymnocephalus, Furcocercous & Xipidocercous), *Indoplanorbis exustus*, (Leptocercous, & Rophalocercous), *Lymnaea luteola* (Monostome, Rophalocercous & Microcercous), *L. acuminata* (Distome, Gasterostome, Microcercous & Furcocercous) *L. stagnalis*, (Monostome, Ophthalmocercous), *Pila globosa* (Gymnocephalus, Leptocercous & Echinostome and *Thiara tuberculata* (Monostome, Amphistome & Leptocercous) from Bangladesh which causes various fatal diseases of man and his pets (Jahan *et al.*, 1996 & 2001; Rahman *et al.*, 1999, 2002, & 2004).

Importance of molluscs as Pest

Malacologist those who studied the land molluscs, unanimously accepted that land snails are causing considerable damage to economic plants through the globe. The economic importance of slugs in horticulture and agriculture crops is recognized worldwide and the extent of damage caused by slug has become increasingly apparent over the last 30 years (Walker *et al.*, 1996). Subba Rao (1975), Raut (1979) and Raut and Ghose (1984) ascertained the pest status of *Macrochlamys indica* on agriculture, horticultures, vegetables and ornamental plants in India.

A secondary group of snails with limited ranges of distribution causes damage to particular crops in restricted areas. Examples are *Bensonina monticola* a pest on beans and ladies finger plants in Himachal Pradesh (Bhadraj and Takur, 1973; Bhalla and Pawar, 1977). *Ariophanta solata* a pest on coffee plants in parts of Karnataka, (Subba Rao, 1975); *Cryptozona semirugata* a pest on medicinal plants in Peninsular India.

The degree of damage caused by this secondary group of pest snails depends upon the particular area. Besides causing extensive damage by devouring the young leaves, twigs, and floral buds of the plants, some large bodied snails. *A. fulica*, *C. semirugata* destroy delicate crop plants by leaving a trail of damage plants cover by snail mucous.

The common garden snail *Helix aspera* and grey field slug *Deroceros reticulatum* are pest throughout temperate regions, including south east Australia. The white snails, *Theba pisana* and *Certhia virgata* are severe pest in Mediterranean countries, South Africa and area of South Australia and Western Australia. *Helix aspera* and *Deroceros reticulatum* are severe pest in suburban gardens and horticulture crops particularly as major cities of Melbourne, and Adelaide (Smith and Kershaw, 1979; Baker, 1986). *T. pisana* on seedling crops and legume based pasture causing severe damage and occasionally total crop destruction in the sandy areas of South Australia (Baker, 1986). *C. virgata* feeds primarily on decaying matter and causes less damage by feeding (Pomeroy, 1969, Butler, 1976). Both *T. pistana* and *C. virgata* causes significant damage to cereal crops because they climb on to the heads and stalks of cereals in late spring /early summer to aestivate. They clog machinery and contaminate grain at harvest.

The brown garden snail, (*Helix aspera*, Muller), was intentionally introduced from France into several areas of California between 1850 and 1860. By 1900, the snail was present through out many parts of California's agricultural district. It has been a problem to citrus growers ever since (Basinger, 1931). The snails feed on the foliage of one-or two- years old trees ,major damage can occur as these trees became completely defoliated. In rare cases, snails have also been found to chew on the bark of the young trees (Sakovich, 1996).

The giant African land snail, *Achatina fulica* is a pest of agro- horticultural and timber yielding plants feeding on nine timber yielding and 63 cultivated plant species of economic importance in Bangladesh. Out of 13 species of land snails and slugs occurring in the country, *Achatina fulica*, *Macrochlamys indica*, *Macrochlamys sequax*, and *Opeas gracile* cause damage to agriculture, horticultures, and ornamental plants in Bangladesh (Jahan, 1992; Jahan and Raut 1994).

Macrochlamys indica and *Macrochlamys opiparus* cause serious damage to mulberry plants. Diurnal *M. opiparus* consumed mulberry leaves and fruits during the day time but *M. indica* consumed the leaves starting from the margin of the lamina during the night (Jahan, *et al.* 2002).

Importance of molluscs in trade

In trade goods, shell currency has been around for over 4000 years and was its heyday, the most widely used currency in the world. Even today there still exist minor countries based on certain shells. Some examples of shells used in trade are Cowry shells (*Cypraea annulus* L. and *C. moneta* L.). Loose in bags or strung into strands were earliest form of currencies used in many countries. The So far we know, the Chinese people to use Cowries as currency. The images of cowries as a type of currencies was so strong that the first oval metal coin minted in Greek colony of Lydia around 670 B.C. was modeled after that shell. By the eighteen century, approximately, 400 millions were being traded per year mostly for the purpose of black slaves. By the mid nineteen century, it could take up to 100000 cowries just to young wives. Inflation, it seems, was the main demise of the cowrie's currency. Hard clam shells and Whelks were the shells used to make the North American Indian wampum. Eastern Indians also used the tusk shell *Dentalium pretiosum* Sowerby, as a trade shell. Wampum continued to be used as money through the first half of the eighteen century when it finally died out due to counterfeiting and mass production.

Beads and other ornaments made of "Spiny oyster" shells (*Spondylus princeps*) and the Panamian pearly oyster *Pinctada mazatlantica* were traded all the over Andean region. Coins from countries display molluscs on one side. Some examples are: Sacred chank (*Turbinella pyrum* Linne) on the chertum coin Bhutan, Imperial voluta (*Cymbiola imperialis*) on the one sentimo Philippine coin, Tritons trumpet (*Charonia tritonis*), on the 5 vatu Vanuato coins, Spider conch (*Lambis*), on the 1 cent Tuvalo coin, Rat cowries (*Cypraea stercoraria*) on the 1 chedi Ghana coin and *Strombus gigas* Linne on the 1 dollar Bahamas silver dollar (Borquin *et al.*, 1999).

Importance of molluscs in Medical Science

In medicinal uses-today the shell, it's living flesh and by products are being studied and used in many areas of medicine. Some examples – the deadly venom of some cone shells (Conidae) are today being used to help victims of strokes and heart disease and produce a revolutionary new drug for chronic pain (Ziconidae- still awaiting FDA approval).It is called mercenine after the clams scientific name. An extract from the hard clam or “Quahog” (*Mercenaria mercenaria*) is strong growth inhibitor of Cancer in mice. Ground and Processed oyster shell used as calcium supplements both for human and animal.

Paolin, a drug made from abalone juice is an effective inhibitor of penicillin resistant strains of bacteria, such as *Staphylococcus aureus*, *S. pyrogenus*, *Salmonella typhus* and paratyphoid A & B bacteria.

Traditional medicine in Vietnam has a wide variety of uses for shells powered oyster. Shell is taken to treat acid indigestion, fatigue and stop to hemorrhage (Borquin *et al.* 1999).

The snails *Bellamya beagalensis*, *Pila globosa*, *Brotia costula*, and *Lamellidens marginalis* are used against eye-swelling, eye-redness, conjunctivitis eye-watering, bed sore, bonding wound, skin injury, headache, cough alignment, dysentery, blood-dysentery, tongue ulcer, anaemia, disorder of menstrual cycle, Spermatorrhoea, jaundice and itching. For eye-swelling, eye-redness, conjunctivitis eye-watering the fluid of *Bellamya beagalensis* and *Pila globosa* is applied drop by drop for a period of 5-7 days.Incase dysentery, and blood-dysentery half burned flesh of *Pila globosa* is prescribed to the persons belong to Kora, Rajwar, Munda, Orao, and Santaol. The tribal people habit of consumption of flesh of *Pila globosa*, *Bellamya bengalensis* regularly to cure the tongue ulcers. Irrespective of cast the anaemia patient are asked to eat flesh of *Bellamya bengalensis* and, *Lamellidens marginalis* regularly for quick recovery. The women suffering for menstrual disturbance are prescribed the flesh of *Lamellidens marginalis*. Daily consumption of any curry prepared with the flesh of *Bellamya bengalensis* and *Pila globosa* give the patient relief from rheumatic pain.

Bellamya bengalensis is prescribed to the patient suffering from spleen enlargement

In jaundice, feeding of the flesh of *Bellamya bengalensis* at the rate of 50 grams per day, for a period four weeks recommended by the expert village people. In case of urinary troubles the patient are prescribed Khuli lime powdered. The powdered is mixed with turmeric acid and honey as per specification to make the dose effective.

A good number of animal's diseases of cattle are being control by using different fresh water mollusc's species. Cattle and Buffaloes suffering from Dukha, Palal and Badalghore are prescribed to flesh of *Lamellidens marginalis*. The flesh (usually 10 grams at a time for adult) is fed with bamboo leaves, in almost cases become able to regain their normal health within a period of three months, (Chattapadhaya, 1992).

A good number of diseases of cattle are being controlled by freshwater mollusc's species. In Bangladesh, *Pila globosa* used in 'Samuk pacha' disease in cattle.

Importance of molluscs in arts and culture

Shell has used for Art and Architecture. Architecture has been profoundly influenced by the symmetry of mollusc. Many great artists were inspired by the beauty, diversity, and design of shells. Few examples of shell artistry, famous artists and architecture Leonardo da Vinci drafted the first spiral staircase plans from studying the simple snail shell with its interior shells. The Sydney Opera house was designed to look like a giant Cock's Comb oyster (*Lopha cristagalli*). Today, man's love affair with shell is still seen in many of his crafts such as: shell caemos :Especially popular in Victorian England. A few Italian artisans still make beautiful caemos out of the Red helmet shell (*Cassia rufa*).

Shells have played a central role in religion from prehistoric time on. Dominating early religious practices, cowry shell (*Cypraea*) had powerful symbolism and this is renewed in the religions of the great civilization that followed. The presence of shell in prehistoric burial places indicates that their symbolic power was believed to continue beyond life. Shells in some cultures even today are used as amulets, good luck charms and symbol for love, fertility and life eternal. In Africa, shell fetishes

were often used in worship. Ceremonial grabs are many times decorated with shells and were used in some religious ceremonies.

In India: Hindus, The God Vishnu holds, his staff crowned with a very rare left handed '*Turbinella*' (Chank) shell. The Hindu, when praying, often clasp a sacred Chank or other venerated object in his hand, believing that it will help his or her petitions be heard. Priest also used it for holding sacred shell. In Asia, Buddhists, the chank or *Turbinella* also plays a significant role in their ritual and ceremonies, and figures in the Buddhists iconography (Bourquin, *et al.*, 1999).

In West Bengal (States of India) in villages 70% of the children may be seen carrying a shell of *Bellamya bengalensis* and *Pila globosa* on loin as per instruction of grandfather and grandmother. It is believed that such shell save the evil effect of ghost. Similarly, the domestic animals are also protected from the evil effect of ghost through the use of *Pila globosa* shell. In certain section of villagers' people it is customary to use of *Lamellidens marginalis* prepare a sacred lamp to worship the God and Goddess with a view to fulfill ones desire. In Setarapuja of Hindus family the shell of *Pila globosa* is used as worship material by the people belong to lower caste. Live individual of *Bellamya bengalensis* are one of the most important worship material of Sital puja.

In 'Chitu amabashya 'the farmer worship the God of paddy field and his medium is the snails *Pila globosa*. There is a belief that before cultivation if the farmers worship the God of the field and his medium by the shell of *Pila globosa*, no harm or evil would occur and other medium at the time of cultivation (Chattapadya, 1992).

Molluscs as Personal adornment

It can be said that every culture has used shells, whole or part, and pearls are personal adornment. Some cultures even wore shells or as part of their costume to signal their distinct tribal identities and display their role and rank within the tribe. In some parts of India's a Hindu women equivalent of a wedding ring is a bracelet made of the section of the Indian (or Sacred) Chank. In Bangladesh Chank bangles are worn by Hindu women. Sea shells are also used in the preparation of ornaments like shell finger ring bracelet ,

nose rings, bracelets, bangles, hair slides, hairpins, etc., house articles such as trays, ashtrays, table lamp, door hanger, stands, screens, toys, wall hanger in, key rings, mother of pearls, buttons, garlands, chains etc. As decoration or intrinsic parts of their function, shell mother of pearls (iridescent interior of many bivalves) were commonly used on ceremonial or religious garbs. As clothing adornments, pearls frequency sewn on as jewellery, fresh and salt-water pearls used in many ways as inserts in ceremonial masks.

Today, molluscan research is taking place in the area of Parasitology, Biochemistry, Archaeology, Palaeobiography, Palaeontology, Taxonomy, Ecology and Zoology. Also, many of the categories of use discussed above have significant economic impact mostly in many small businesses, so total economic activity involved in man's varied uses of molluscs is quite major. Some other industries also making use of mollusc are: Aquaculture (farming of abalone, oyster, scallops, mussels etc) pearl button industries although not as important as it was in the early 1900s, it still remains as an industry in many countries today.

Molluscs are also used for construction industry, lime industry, pearl industry and poultry industry. In construction industries, shells along with gravel are used for building roads in some areas, and lime from shells is a vital component of concrete and plaster.

In lime industry, calcinations of various kinds of molluscs shell can be produce lime. It is used in the tank and well to make the water clean and clear .For chewing betel with nut this lime is needed. It is also applied in the soil in sum areas to neutralize the acidic soil. The freshwater mussels of the Mississippi river system were used extensively to make pearl button for many years. According the one source (Pennak) in the year 1912 there were 196 pearl button factories in 20 states along the river of the great river system. They sold 6 millions dollar worth of buttons that year. These same mussel are today being used as 'seed 'for cultured pearl. Pearl button industry is very important in the early 1900 century; it is still remains as an industry in many countries today (Borquin *et al.* 1999).

Brief account of Study on molluscs in Bangladesh

Bangladesh is producing the famous pink pearl naturally from freshwater mussel *Lamellidens marginalis* and *Parresya* sp. (Begum *et al.*, 1990). In May 2001, new scientific techniques of fresh water pearl culture have been initiated and adopted under the world Bank project of Agricultural Research Management Project, jointed the BFRI culture research program (Dan *et al.* 2001). Marine and freshwater pearls are used in pearl industry.

The malacological study of freshwater and terrestrial molluscs in Bangladesh is very few and there is no sufficient record available here regarding the taxonomy and ecology of molluscs. However, the brief information have been made in this regard in recent past by Zobairi (1956) on pink pearl bearing fresh mussel of the then East Pakistan (Present Bangladesh).

The first scientific study was initiated by Coomans (1940), who recorded some molluscs from St. Martin's Islands. Ali, 1975 reported some taxa from St. Martins Island. Ali and Aziz (1976) have made some taxonomic work on the marine Mollusc of Bangladesh from the St. Martins Islands. Ali and Begum (1976) studied the freshwater Mollusc of Dhaka city with notes on their ecology.

Ali *et al.*, (1985) worked on the abundance and depth distribution of benthic molluscan fauna of a pond. They showed the pond was infested with molluscs and maximum quantity was recorded in the lower depths. Alam and Patra (1986) studied on the freshwater molluscan fauna of Chittagong Division with their ecology. 13 Gastropodan and 2 Pelecypodan species found to be reported from all places of the study area. Ahmed *et al.*, and Ahmed (1978, 1990, and 2003) conducted some detailed surveys along the coast from St. Martins Island to Heron Pont and Dublarchar below the Sundarbans.

Jahan, (1993) worked on some terrestrial and fresh water gastropods of Bangladesh with their ecological notes. A total of 23 gastropods species were recorded by him.

Jahan and Raut (1994) experimented on distribution and food preferences of giant African land snail, *Achatina fulica*.

Jahan *et al.*, (1996) worked on medically important snail *Lymnaea acuminata*. They investigated population density and feeding habit of *Lymnaea acuminata*. Intertidal molluscan diversity of Sundarbans Bangladesh was explicitly described by Jahan *et al.*, (1990, 1998). Jahan *et al.* (1998) studied on population density, breeding biology, food preference of *Lymnaea luteola*. Jahan and Rahman (2000) worked on Biodiversity of the Aquatic habitats of Rajshahi Metropolitan City, Bangladesh with special emphasis on interactions among the soil substratum, plant and snail species. They also expressed biodiversity indices of mollusc's species viz, index of dominance, index of evenness and index of diversity.

Jahan *et al.*, 2001 experimented on ecology of *Gyraulus convexiusculus*. They observed reproduction behaviour, incubation period, hatchability embryonic development, population densities and parasitical importance of *Gyraulus convexiusculus* in natural and under laboratory condition. Ecology of *Macroclamys indica* and *M. opiparus* was reported by Jahan *et al.*, (2002) for the first time in Bangladesh. Jahan, *et al.*, (2003) also worked on Gastropod fauna of Rajshahi university campus. The gastropod fauna of Rajshahi university campus is represented by 16 snail species. Brief descriptions of the recorded species, their morphometric data and ecology were provided. Jahan *et al.*, (2007 a) worked on ecology of *Pila globosa*. They worked on habit, habitat, food preference, breeding biology, population densities of *Pila globosa*.

Jahan *et al.*, (2007 b) also worked on induced breeding of *Pila globosa* for the first time in Bangladesh. They studied on number of egg clutch, copulating pairs, duration of mating, duration of egg laying, and weight of egg clutch of *Pila globosa* by inducing it with pituitary Gland and optic tentacles cut under laboratory condition.

Rahman *et al.*, (1999) worked on ecology of *Thiara tuberculata*. The experiment were conducted on the snail *Thiara tuberculata* in natural habitats and laboratory to study ecology, population densities and breeding habit with the development of their larval trematodes parasites. Rahman (2000) worked on the systematic, abundance, habitats, distribution population, breeding biology, growth rates and parasitological importance of Mollusc in Bangladesh.

Rahman *et al.*, (2003) studied species composition, abundance and distribution of Freshwater molluscs in a pond of Bangladesh Agricultural University Campus, Mymensingh.

Saha (1998) worked on Ecology and Bio-economics of freshwater edible snails of Bangladesh. Food and feeding habits of economically important freshwater snail, *Thiara tuberculata*, and food and feeding habits and reproductive biology of economically important freshwater snail, *Pila globosa* were studied by Saha *et al.*, (2002, 2003 and 2004).

Khanom (2007) studied month wise distribution and abundance of different species mollusc and Crustacians (ind/m²) in Chitra river (Jaleswari-Dhalgram), Jessore. A total of four mollusks species viz. *Pila globosa*, *Bellamya bengalensis*, *Lamellidens marginalis* and *Corbicula assamensis* were reported by her.

The above discussions reflect that molluscs are an important component of the biodiversity, playing vital role for the maintenance of aquatic ecosystem in one hand and on the other hand they are being utilized as supplementary food for shrimp, cat fish and Pangas fish farming. Scientific management for sustainable molluscs populations and their appropriate utilization need detailed account of the malacofauna in respect to the ecological conditions of the habitat concerned. The North-eastern region of Bangladesh, biodiversity rich area offers good habitats for molluscs. Which inspired the researchers to make an attempt to study the biodiversity of molluscs and their distribution in the area concerned and the findings are described in this dissertation.

1.2 Materials and Methods

1.2.1 Description of Study Area

The Northeastern region includes the present districts of Brahmanbaria, Comilla, Habiganj, Moulvibazar, Sylhet and Sunamganj. This region covers a land area of 13,938.65 sq. is situated between 23°. 2 to 25°. 2' N latitude and longitude 91°.7' to 92°.41'E. Reserve forest, hills, haors, and beels are also included in this region.

1.2.1.1 Brahmanbaria District

Brahmanbaria district has an area of 1927.11 sq km, bounded by Kishoreganj and Habiganj district on the north, Comilla district on the south, Habiganj district and Tripura state of India on the east, Kishoreganj, Narsigndi and Narayanganj district on the west. The district is low lying land having hills and hillocks of red soil. Average temperature were recorded $30.48^{\circ} \pm 0.28$ C and minimum $20.90^{\circ} \pm 0.03$ C respectively; Annual average rainfall is 2066.91 ± 208.49 mm. Main rivers are Meghna and Titas, Buri and Haora ; Mehedi and Akasi haors are notable (Table .

1.2.1.2 Comilla District

Comilla district has an area of 3085.17 sq km, bounded by Brahmanbaria and Narayanganj districts on the north, Noakhali and Feni districts on the south, Tripura (state of India) on the east, Munshiganj and Chandpaur districts on the west. Annual average temperature maximum $30.48^{\circ} \pm 0.28$ C and minimum $20.90^{\circ} \pm 0.03$ C respectively; Annual average rainfall 2141.5 ± 542.5 mm. The only hill in the district, the Lalmai hill situated five miles away to the west of Comilla Town. Gomoti and Dakatia are the main rivers that flow through the district.

1.2.1.3 Habiganj District

Habiganj district having an area of 263.58 sq km is bounded by Sunamganj district on the north, Tripura state of India on the south, Maulvibazar and Sylhet districts on the

east, Brahmanbaria and Kishoreganj districts on the west. Monthly maximum and minimum average temperature recorded as $30.6^{\circ} \pm 0.70$ C and $19.62^{\circ} \pm 0.31$ C respectively. Annual average rainfall 2341.5 ± 163.15 mm. Notable Rivers are Khowai, Sutang, Korangi, Kalni, Kushiya, Gopala, Ratna and Barak (Appendix Table 20).

1.2.1.4 Maulvibazar districts

Maulvibazar district having an area of 2799.39 sq km is bounded by Sylhet district on the north, Tripura state of India on the south, Assam and Tripura states of India on the east, and Habiganj district on the west. Main rivers are Manu, Dhali, Juri, etc. The noted depressions are Hakaluki, Hail and Kawadighi haors. Monthly maximum and minimum average temperature was recorded $30.6^{\circ} \pm 0.70$ C $19.62^{\circ} \pm 0.31$ C respectively; annual average rain fall $2124.48 \text{ mm} \pm 5.25$. The total forest area is 413.65 sq. km; noted forest ranges are Patharia, Sanergaz or Longla, Rajkandi and Vanugach (Lawachara Reserved forest).

1.2.1.5 Sylhet district

Sylhet district has an area of 3490.40 sq km, bounded by the Khasia-Jainta hills of India on the north, Maulvibazar district on the south, Kachar and Karimganj district of India on the east, Sunamganj and Habiganj district on west. Monthly maximum and minimum average temperature was recorded $30.75^{\circ} \pm 0.28$ C and $21.12^{\circ} \pm 0.38$ C respectively, Annual average rain fall 3901.00 ± 572.1 mm. Main River are Surma and Kushiya, Reserve forest 236.42 sq. km. Parts of Khasia and Jainta hills are included in the district. Notable tilas, hills are Jaintapur, Sary tila, Khan tila and Dhaka Dakshin tila series (Appendix Table 20).

1.2.1.6 Sunamganj District

District has an area of 3669.50 sq km, is bounded by the Khasia-Jainta hills (India) on the north, Habiganj and Kishoreganj districts on the south, Sylhet district on the east, Netrokona and Greater Mymensing districts on the west. Annual average temperature

was recorded $30.75^{\circ} \pm 0.28$ C and minimum $21.12^{\circ} \pm 0.38$ C respectively; annual average rainfall 3901.00 ± 572.1 mm.

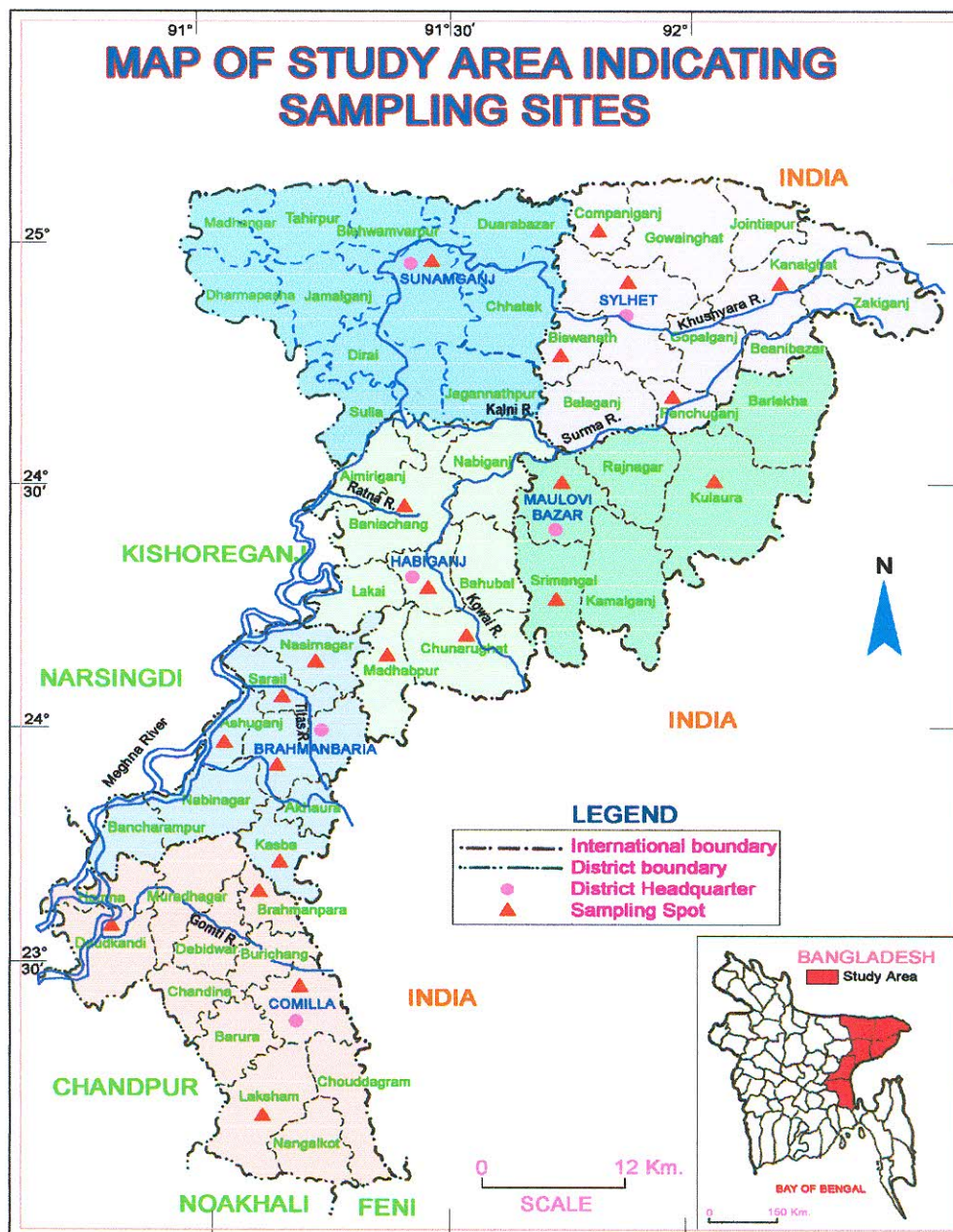
1.2.2 Climate

Bangladesh is a tropical country. There are six seasons in the climate of Bangladesh. All seasons are visible in the study area. The winter commence in December. In winter, rainfall is very scanty or nil and temperature is low. This season includes two consecutive months: December and January. April-May is considered as the summer. Hot air, little water vapour in air, rain together with gusty wind from the north-west direction is the main characteristic of this season. June-July considered as monsoon. Heavy rainfall occurs during the season. Annual average precipitation recorded from five districts were as in Brahmanbaria, 2066.74 ± 208.49 mm in Comilla, 2141 ± 543 in Habiganj 2371.45 ± 163.15 mm in Maulvibazar 2124 ± 5.52 in Sylhet and Sunamganj district 3901 ± 572.10 during the period from July 2005 to June 2007.

1.2.3 Soil

Physiographically the area contained flood plain, deltaic plains, Haors, Hills and Hill locks. Acidic soils are found in Comilla and Brahmonbaria districts. Sylhet, Sunamganj, Maulvibazar and Habiganj district may well have the widest variations in geomorphology and soils of the whole of Bangladesh. Steep hills exceeding 1,000 feet in height with shallow, stony and rocky soils, and perennially wet basins with peat soils occur within a few miles from each other, e.g., to the south of Juri. Most of the land, however, consists of different kinds of river flood plain and out wash plains bordering the hill ranges.

Map 1.1
Study area and the sampling localities are shown in Map-1



TERRESTRIAL HABITATS

Figure 1.1
Site A : BARD annex forest, Comilla



Figure 1.2
Site B : BARD annex forest, Comilla



Figure 1.3
Site A : Lawachara National Park, Lawachara



Figure 1.4
Site B: Terrestrial habitat, Lawacha



Figure 1.5
Site A: Terrestrial habitat, Malnichara



Figure 1.6
Site B: Terrestrial habitat, Malnichara



Figure 1.7
Site A: Pond, Brahmonbaria



Figure 1.8
Site B: Pond, Brahmonbaria



Figure 1.9
Site A, Pond, Comilla



Figure 1.10
Site C, Pond, Comilla



Figure 1.11
Site A, Pond, Habiganj



Figure 1.12
Site B, Pond, Habiganj



Figure 1.13
Site A, Pond, Maulvibazar



Figure 1.14
Site B, Pond, Maulvibazar



Figure 1.15
Site A, Pond, Sylhet



Figure 1.16
Site B, Pond, Sylhet



Figure 1.17
Site A, Titas River, Brahmonbaria



Figure 1.18
Site B, Titas River, Brahmonbaria



Figure 1.19
Site A, Gomti River, Comilla



Figure 1.20
Site B, Gomti River, Comilla



Figure 1.21
Site A, Ratna River, Habiganj



Figure 1.22
Site B, Ratna River, Habiganj



Figure 1.23
Site A, Kushyara River, Fenchuganj, Sylhet



Figure 1.24
Site B, Kushyara River, Fenchuganj, Sylhet



Figure 1.25
Site A, Surma River, Sylhet



Figure 1.26
Site B, Surma River, Sylhet

Sylhet, Sunamganj, Maulvibazar and Habiganj districts may be subdivided into four main landscapes: the hills, the out wash plains, the Surma-Kushiara flood plain and the Sylhet basin.

The northern tips of Tripura hill ranges from the main parts of Sylhet hills which extends into Bangladesh in the south-eastern and eastern part of Maulvibazar and in the south-eastern part of Habiganj districts. Small areas of high alluvial terrace occur along and in the hills of Balisera Valley and both sides of Dolai valley, and scattered patches in other hill ranges. The out wash plains occur in a band up to 4 miles wide along the foot of the most hill ranges, cover most of the valleys between the south Sylhet hills. The Surma-Khushiyara flood plain covers about two-thirds of the two eastern districts and extends a few miles into Sunamganj and Habiganj. Most of these two districts are occupied by the Sylhet basin.

The soils of Sylhet, Sunamganj, Maulvibazar and Habiganj districts have different characteristics depending on age, drainage, and parent material. Almost all soils are acidic, but top soils become near neutral when flooded for more than two weeks.

In the Surma-Kushyara flood plain, there are a few small areas with recent soils for example, in the northern part of Hakaluki haor. The soils are grey, generally stratified, silty and loamy. Annually in the rainy season, fresh sediment is added.

In the Sylhet basin most soils are grey, or locally dark-grey, clays with blocky structure, about 2 feet thick, overlying an older soil which may range from clayey to sandy at short distance.

The soils of the outwash plains are intermittently flooded for a few hours to a few days after heavy rains. Along the northern border and around the hill range, northeast of Sylhet town these soils are generally sandy or loamy. Elsewhere, the soils of the outwash plains are silty or loamy to clayey.

The high terrace occurring in small areas along some of the hill ranges in the south are covered by generally yellowish brown, deep, permeable, well-drained clay soils with good structure. The hills soils are gradually steep or very steep, well-drained, yellowish brown or brown, with a moderate blocky structure. The soils on the hill range near Sylhet town are rather sandy, but elsewhere hill soils are loamy to silty or clayey.

1.2.4 Methodology for faunal study

Extensive surveys were conducted in the twenty two Upazillas of the 6 (six) districts (Brahmanbaria, Comilla, Habiganj, Maulvibazar, Sylhet and Sunamganj) of Northeastern region of Bangladesh during the period of last two years (July 2005-June 2007).

(a) Terrestrial habitat: Considering the limitations of time, resources and logistic supports, three localities were selected in the study area for determination of population density and seasonal variation of terrestrial molluscs. From each of the localities three spots of 10 m² quadrat area each were taken in respect of Summer, Monsoon and Winter season. A total of 54 quadrates were taken in two years. The selected localities were ‘BARD’ annex forest of Comilla District, Lawachara National park of Maulvibazar District and Malnichara Tea garden annex forest of Sylhet District. Each spots was chosen to represent a typical part of the surrounding vegetations avoiding edges or transitions.

(b) Aquatic habitat: Considering the limitations of time, resources, and logistic supports, two aquatic habitats (viz. One River and One pond) from each of the 5 (five) study districts were selected for determination of population density and seasonal variation of aquatic molluscs. From each of the spots three sites were selected. Again, from each site three quadrates of 1 m² area of each were taken according to the depth of water (viz. 0-50 cm, 50-100 cm and 100-200 cm) in respect of Summer, Monsoon and Winter season. A total of 540 quadrates were explored in two years (2005-2007).

1.2.4.1 Exploration and collection of molluscs

Observations on the occurrence, distribution and population density of molluscs species in the Northeastern side were performed between July 2005 - June 2007. Terrestrial and Aquatic molluscs were surveyed thrice in a year (viz., summer, monsoon, and winter).

(A) Terrestrial molluscs: From all quadrates snails, slugs, empty shell and shell fragments were collected by hand. Land snails were usually narcotised by asphyxiation. So, live specimens were put into an airtight glass bottle or a jar completely filled with water. The specimens thus narcotised, species washed to remove mucous and then treated with ascending grade of ethylalcohol. Finally they were preserved in 70% ethyl alcohol. In addition, to litter was collected sieved (10×10 mm mesh); the coarsest fraction searched by eye in the field and discarded. The remainder was bagged and taken to laboratory where it was air-dried, sieved 0.5mm mesh and sorted down.

(B) Aquatic molluscs: Population density estimated by counting the number of individuals present in a square meter area of the study area. Samples were collected by Ekman dredge and a wooden frame structure. All Samples were sieved through a 2mm sized mesh. The molluscs were counted by species wise. The samples were then preserved in plastic container containing 70% alcohol.

Through regular watch the habit and habitats of Molluscs species had been noted. To determine the factors regulating the densities of snail population, soils were sampled regularly from selected spots. Meteorological data were collected (temperature, humidity and rainfall) from Meteorological Offices of Comilla, Srimangal and Sylhet Districts.

Measurement of Morphological parameters of Mollusc species: Morphological parameters (length, height, breadth, and thickness) of 10 samples (random) collected each mollusc species were determined by a divider, scale and Side callipers.

1.3 Observations and Results

Observations was made to record the terrestrial and aquatic flora and Molluscs fauna of the study area during the tenure of the investigation.

In the study area 192 terrestrial and 76 aquatic plants species were recorded during the survey mentioned in the table 1.1 below:

Table 1.1
Terrestrial Plants of North-eastern Region of Bangladesh

Sl.no.	Scientific Name	Family	Local Name
1	<i>Acacia nilotica</i>	Legimonosae	Babla
2	<i>Acacia manginum</i>	Legimonosae	Mangium
3	<i>Acacia moniliformis</i>	Legimonosae	Akasmoni
4	<i>Acacia catechu</i>	Legimonosae	Khair
5	<i>Acacia concinna</i>	Legimonosae	Bonrita
6	<i>Acacia pennata</i>	Legimonosae	Aila
7	<i>Acanthus ilicifolius</i>	Acanthaceae	Hargoja
8	<i>Actinodaphne angustifolia</i>	Lauraceae	Modanmosta
9	<i>Adatoda vasica</i>	Acanthaceae	Basak
10	<i>Aegle marmelos</i>	Rutaceae	Bell
11	<i>Ageratum conyzoides</i>	Compositae	Ochandi
12	<i>Albizia moluccana</i>	Legimonosae	Koroi
13	<i>Albizia lebbek</i>	Leguminosae	Kalo-Koroi
14	<i>Albizia lucida</i>	Leguminosae	Shil-Koroi
15	<i>Albizia chinensis</i>	Leguminosae	Chekua-Koroi
16	<i>Albizia richordiana</i>	Leguminosae	Shiris
17	<i>Allophyllus cobbe</i>		
18	<i>Alpinia malaccensis</i>	Zingiberaceae	Deotara
19	<i>Alstonia scholaris</i>	Apocyanaceae	Chhatim
20	<i>Amoora wallichii</i>	Meliaceae	Amur
21	<i>Ammorphophallus companulatus</i>	Araceae	Oal
22	<i>Amorphophallus bulfer</i>	Araceae	Jongle- Oal
23	<i>Anthocephalus cadamba</i>	Rubiaeceae	Kadamb
24	<i>Anthocephalus chinensis</i>	Euphorbiaceae	Pat kharolla
25	<i>Anona murica</i>	Anonaceae	Ata
26	<i>Anona squamosa</i>	Anonaceae	Sharifa
27	<i>Aporosa dioica</i>	Euphorbiaceae	Kakra
28	<i>Aphanamixis polystachya</i>	Meliaceae	Pitraj
29	<i>Aquilaria agallocha</i>	Thymelaceae	Agor
30	<i>Ardisia solanacea</i>	Myrsinaceae	Bon jam
31	<i>Artocarpus chaplasha</i>	Moraceae	Chapalish
32	<i>Artocarpus lacucha (lakoocha)</i>	Moraceae	Dewa
33	<i>Areca catechu</i>	Arecaceae	Suapari
34	<i>Atrocarpus heterophyllis</i>	Moraceae	Katal
35	<i>Axonopus compressus</i>	Poaceae	-
36	<i>Averrhoa bilimbi</i>	Averrhoaceae	Bilimbi
37	<i>Averrhoa carambola</i>	Averrhoaceae	Kamranga
38	<i>Azadirachta indica</i>	Meliaceae	Neem
39	<i>Baccaurea ramiflora</i>	Euphorbiaceae	Latka
40	<i>Barringtonia acutangulata</i>	Lacynthidaceae	hijol

Sl.no.	Scientific Name	Family	Local Name
41	<i>Bambausa tulda</i> ,	Poaceae	Mirtinga(Bamboo)
42	<i>Bambausa jaintinana</i>	Poaceae	Konkoi ban
43	<i>Bambausa balcooa</i>	Poaceae	Bamboo
44	<i>Bambausa tulda</i>	Poaceae	Mahal
45	<i>Bambausa tulda</i>	Poaceae	Jaiban
46	<i>Belamcanda chinensis</i>	Iridaceae	Desba
47	<i>Blumea lacerta</i>	Asteraceae	Kokursunga
48	<i>Borassus flabelifer</i>	Areaceae	Tal
49	<i>Bomber malabaricum</i>	Bombaceae	Citrika
50	<i>Bursera serrata</i>	Burseraceae	Simul
51	<i>Calamus tenuis</i>	Areaceae	Bet
52	<i>Callicarpa arborea</i>	Verbenaceae	Bormola
53	<i>Cassia fistula</i>	Leguminosae	Badorlati
54	<i>Cassia sophora</i>	Leguminosae	Small kalkasunda
55	<i>Cassia siamea</i>	Leguminosae	Kalkasunda
56	<i>Cassia tora</i>	Leguminosae	Chakunda
57	<i>Canna indica</i>	Fagaceae	Khiribadam
58	<i>Castanopsis tribuloides</i>	Fagaceae	Batna
59	<i>Caesalpinia pulcherrima</i>	Leguminosae	Rhadachura
60	<i>Callistemon linearis</i>	Myrtaceae	Bottle brush
61	<i>Carissa carandus</i>	Apocyanaceae	Karamcha
62	<i>Casuarina littorera</i>	Casuarinaceae	Jhau
63	<i>Camellia sisensis</i>	Theaceae	Tea
64	<i>Cestrum nocturnum</i>	Solanaceae	Hasnahena
65	<i>Citrus aurantifolia</i>	Rutaceae	Kagogi lebu
66	<i>Citrus grandis</i>	Rutaceae	Batabilebu
67	<i>Citrus sinensis</i>	Rutaceae	Kamal lebu
68	<i>Cinnamomum cecidodaphne</i>	Lauraceae	Gonoro
69	<i>Cinnamomum tamala</i>	Lauraceae	Tejpata
70	<i>Coccinia cordifolia</i>	Cucurbitaceae	Telachuca
71	<i>Colocasia esculenta</i>	Araceae	Kachu
72	<i>Codiaeum variegatum</i>	Euphorbiaceae	Patabahar
73	<i>Cordia dichotoma</i>	Boraginaceae	Kalahuja
74	<i>Cuscuta reflexa</i>	Cuscutaceae	Sornalata
75	<i>Commelina benghalensis</i>	Commelinaceae	Kansira
76	<i>Connarus paniculatus</i>	Connaraceae	Katagula
77	<i>Cocos nucifera</i>	Araceae	Narical
78	<i>Curcuma aromatica</i>	Zinziberaceae	Bon halud
79	<i>Curcuma longa</i>	Zinziberaceae	Halud
80	<i>Calotropis procera</i>	Asclepiadaceae	Akanda
81	<i>Cestrum nocturnum</i>	Solanaceae	Hasnahena
82	<i>Cedrus deodara</i>	Pinaceae	Debdaro
83	<i>Dalbergia rimosa</i>	Fabaceae	Kawaguran
84	<i>Dalbergia sissoo</i>	Fabaceae	Sissoo gatch
85	<i>Dendrocalamus giganteus</i>	Poaceae	Budumbans
86	<i>Dendrocalamus hamiltoni</i>	Poaceae	Pencha bans
87	<i>Delonix regia</i>	Leguminosae	Krishnachura
88	<i>Dillenia pentagyna</i>	Dilleniaceae	Bon chalta
89	<i>Dillenia indica</i>	Dilleniaceae	Chalta
90	<i>Diospyros philippensis</i>	Ebenaceae	Bilatigab
90	<i>Diospyros peregrina</i>	Ebenaceae	Deshi gab
92	<i>Dipterocarpus turbinatus</i>	Dipterocarpaceae	Kaligorjon
93	<i>Dysoxylum excelsum</i>	Meliaceae	Pitraj
94	<i>Duranta piumieri</i>	Verbenaceae	Bilati mehed
95	<i>Eucalyptus camaldulensis</i>	Myrtaceae	Eucalyptus

Sl.no.	Scientific Name	Family	Local Name
96	<i>Eugenia fruticosa</i>	Myrtaceae	Bonjam
97	<i>Eugenia jambolana</i>	Myrtaceae	Black jam
98	<i>Elaeocarpus floribundus</i>	Elaeocarpaceae	Jalpai
99	<i>Embelica officienalis</i>	Ephorbiaceae	Amlaki
100	<i>Feronia limonia</i>	Rutaceae	Katbell
101	<i>Ficus benghalensis</i>	Moraceae	Bot
102	<i>Ficus erecta</i>	Moraceae	-
103	<i>Ficus curpites</i>	Moraceae	Swet bot
104	<i>Ficus benamina</i>	Moraceae	Pakur
105	<i>Ficus racemosa</i>	Moraceae	Jogdumur
106	<i>Ficus hispida</i>	Moraceae	Dumur
107	<i>Ficus virens</i>	Moraceae	Pakur
108	<i>Ficus auriculata</i>	Moraceae	Boro dumur
109	<i>Ficus religiosa</i>	Moraceae	Ashwathwa
110	<i>Ficus rumphii</i>	Moraceae	Gai- Ashwathwa
111	<i>Ficus semicordata</i>	Moraceae	Jogdumur
112	<i>Garcinia cowa</i>	Clusiaceae	Kao
113	<i>Gardenia jesminoides</i>	Rubiaceae	Gondoraj
114	<i>Gmelina arborea</i>	Verbenaceae	Gamar
115	<i>Grewia asiatica</i>	Tiliaceae	Falsa
116	<i>Hedyotis scandens</i>	Rubiaceae	Gugi
117	<i>Holigarna longifolia</i>	Anacardiaceae	Jhawa
118	<i>Hevea brasilliensis</i>	Euphorbiaceae	Rubber
119	<i>Imperata cylindrica</i>	Poaceae	Kash
120	<i>Lagerstroemia speciosa</i>	Lythraceae	Jarul
121	<i>Lantana camara</i>	Verbenaceae	Lantana
122	<i>Lannea coromandelica</i>	Anacardiaceae	Deshi badi
123	<i>Lawsonia inermis</i>	Lythraceae	Mandi
124	<i>Leea crispa</i>	Leeaceae	Banchalita
125	<i>Litsea glutinosa</i>	Lauraceae	Kukur-chita
126	<i>Litchi chinensis</i>	Sapidaeae	Litchi
127	<i>Leucaena leococophala</i>	Legimosae	Epil Epil
128	<i>Mangifera indica</i>	Anacardiaceae	Aam
129	<i>Mangifera sylvatica</i>	Anacardiaceae	Jonli-Aam
130	<i>Madhuca indica</i>	Sapotaceae	Mahua
131	<i>Melastoma malabathricum</i>	Melastomataceae	Bon tejpata
132	<i>Melilotus indica</i>	Leguminaceae	Bonmethi
133	<i>Melocanna baccifera</i>	Poaceae	Muli
134	<i>Mikania cordata</i>	Compositae	Assamlata
135	<i>Mikania scandens</i>	Compositae	NK
136	<i>Mimosa pudica</i>	Leguminosae	Lajjabati
137	<i>Michelia champaca</i>	Magnoliaceae	Champa
138	<i>Mimosops elengi</i>	Saptoaceae	Bokul
139	<i>Murraya paniculata</i>	Rutaceae	Kamini
140	<i>Naravelia zeylanica</i>	Ranunculaceae	Chagalbati
141	<i>Phyllanthus embelica</i>	Euphorbiaceae	Amlaki
142	<i>Plumeria acutifolia</i>	Apocyanaceae	Champa
143	<i>Polyalthia longifolia</i>	Annonaceae	Debdaru
144	<i>Psilotrichum ferrugineum</i>	Amaranthaceae	Rakto-sirinchi
145	<i>Mucuna imbricata</i>	Leguminosae	Alkusi
146	<i>Musa sapientum</i>	Musaceae	Green Banana
147	<i>Musa parasdisica</i>	Musaceae	Ripen Banana
148	<i>Mussaenda roxburghii</i>		
149	<i>Pterospermum acerifolium</i>	Sterculiaceae	Kanakchapa
150	<i>Phoenix sylvestris</i>	Areaceae	Khejur

Sl.no.	Scientific Name	Family	Local Name
151	<i>Psidium guajava</i>	Myrtaceae	Pagara
152	<i>Punica granatum</i>	Punicaceae	Dalim
153	<i>Quercus velutina</i>	Fagaceae	Oak
154	<i>Randia dumetorum</i>	Rubiaceae	Mankata
155	<i>Rauwolfia serpentina</i>	Apocyanaceae	Sarpaganda
156	<i>Rosa centifolia</i>	Rosaceae	Golap
157	<i>Sacrolobus globosus</i>	Asclapiadaceae	Baolilata
158	<i>Sapium baccatum</i>	Euphorbiaceae	Bolos
159	<i>Schima wallichii</i>	Theaceae	Makrishal
160	<i>Semecarpus anacardium</i>	Anacardiaceae	Bela
161	<i>Setaria italica</i>	Poaceae	Kaon
162	<i>Shorea robusta</i>	Dipterocarpaceae	Shal
163	<i>Smilax macrophylla</i>	Smilacaceae	Kumarilata
164	<i>Smilax roxburghiana</i>	Smilacaceae	-
165	<i>Spatholobus parviflorus</i>	Fabaceae	Goalialata
166	<i>Sterculia foetida</i>	Moraceae	Badam
167	<i>Streblus asper</i>	Moraceae	Sheora
168	<i>Swietenia mahogoni</i>	Meliaceae	Mehogoni
169	<i>Swintonia floribunda</i>	Anacardiaceae	Ceevit
170	<i>Syzygium cumini</i>	Myrtaceae	Kalojam
171	<i>Syzygium fruticosum</i>	Myrtaceae	Putijam
172	<i>Syzygium grande</i>	Myrtaceae	Daki jam
173	<i>Syzygium jambos</i>	Myrtaceae	Golapjam
174	<i>Syzygium cymosum</i>	Myrtaceae	Jonkijam
175	<i>Syzygium ramosissimum</i>	Myrtaceae	Khor jam
176	<i>Syzygium macrocarpum</i>	Myrtaceae	Chalta jam
177	<i>Syzygium samarangense</i>	Myrtaceae	Jamrul
178	<i>Tapiria hirsuta</i>	Anacardiaceae	-
179	<i>Tamarindus indicus</i>	Leguminosae	Tetul
180	<i>Tectona grandis</i>	Verbenaceae	Segun
181	<i>Terminalia arjuna</i>	Combretaceae	Arjun
182	<i>Terminalia belirica</i>	Combretaceae	Bohera
183	<i>Terminalia catappa</i>	Combretaceae	Kat Badam
184	<i>Terminalia catappa</i>	Combretaceae	Haritaki
185	<i>Thespesia lampas</i>	Mavaceae	Bonkarpus
186	<i>Toonia ciliate</i>	Meliaceae	-
187	<i>Trewia nudiflora</i>	Euphorbiaceae	Pitali
188	<i>Thuja orientus</i>	Cupressaceae	Thuja
189	<i>Vallis solanacea</i>	Apocyanaceae	Hadpurmali
190	<i>Xylia dolabriformis</i>	Mimosae	Loha kat
191	<i>Zizyphus rugosa</i>	Rhamnaceae	JonliKul
192	<i>Zizyphus mauritiana</i>	Rhamnaceae	Kul

Table 1.2
Aquatic plants of North-eastern region of Bangladesh

Sl.no	Scientific Name	Family	Local Name	Submerged	Floating		Marginal and emergent weeds
					Free floating	Floating but root	
1	<i>Myriophyllum tuberculatum</i>	Haloragaceae	Myrio	+			
2	<i>Ceratophyllum demersum</i>	Ceratophyllaceae	Jhaji	+			
3	<i>Hydrilla vericillata</i>	Hydrocharitaceae	Jhaji	+			
4	<i>Vallisneria spiralis</i>	Hydrocharitaceae	Pataseola	+			
5	<i>Ottelia alismoides</i>	Hydrocharitaceae	Panikorola				
6	<i>Blyxa auberti</i>	Hydrocharitaceae	Blyxa				
7	<i>Nechamandra alternifolia</i>	Hydrocharitaceae	Jhaji		+		
8	<i>Utricularia stellaris</i>	Utriculaceae	Rhasna jugi		+		
9	<i>Utricularia bifida</i>	Utriculaceae	Rhasna jugi		+		
10	<i>Azolla pinnata</i>		Azola		+		
11	<i>Eichorinia crassipes</i>	Pontederiaceae	Kchuri panapana		+		
12	<i>Pistia stratiotes</i>	Araceae	Topa pana		+		
13	<i>Lemna perpusilla</i>	Lemnaceae	Kudipana		+		
14	<i>L. minor</i>	Lemnaceae			+		
15	<i>Wolffia arrhiza</i>	Lemnaceae	Suji pana		+		
16	<i>Wolffia punctata</i>	Lemnaceae	Chara		+		
17	<i>Chara sp.</i>		Muskgrass		+		
18	<i>Cyperus nutans</i>	Cyperaceae	NK				+
19	<i>Cyperus rotundus</i>	Cyperaceae	Mutha				+
20	<i>Cyperus odoratus</i>	Cyperaceae	NK				+
21	<i>Cyperus articulatus</i>	Cyperaceae	NK				+
22	<i>Cyperus compactus</i>	Cyperaceae	NK				+
23	<i>Cyperus compressus</i>	Cyperaceae	Chancha				+
24	<i>Cyperus difformis</i>	Cyperaceae	Behua				+
25	<i>Cyperus digitatus</i>	Cyperaceae	NK				+
26	<i>Cyperus exaltatus</i>	Cyperaceae	NK				+

Sl.no	Scientific Name	Family	Local Name	Submerged	Floating		Marginal and emergent weeds
					Free floating	Floating but root	
27	<i>Cyperus odoratus</i>	Cyperaceae	NK				+
28	<i>Kyllinga odorata</i>	Cyperaceae	Nirbishi				+
29	<i>Cyperus platistylis</i>	Cyperaceae	NK				+
30	<i>Cyperus kylingia</i>	Cyperaceae	Mutha				+
31	<i>Schoenoplectus juncooides</i>	Cyperaceae	NK				+
32	<i>Trapa hispinosa</i>	Trapaceae	Panifal		+		
33	<i>Trapa natans</i>	Trapaceae			+		
34	<i>Nymphaea nouchali</i>	Nymphaeaceae	Shapla			+	
35	<i>Nymphaea stella</i>	Nymphaeaceae	Nil shapla			+	
36	<i>Nymphaea lotus</i>	Nymphaeaceae				+	
37	<i>Nymphaea rubra</i>	Nymphaeaceae				+	
38	<i>Euryale ferox</i>	Nymphaeaceae	Makna			+	
39	<i>Nymphoides cristatum</i>	Gentaceae	Chand mula			+	
40	<i>Ludwigia adscendens</i>	Alismataceae	Keshordam			+	
41	<i>Ludwigia hyssopifolia</i>	Alismataceae	Keshordam				
42	<i>Sagittaria guyanensis</i>	Alismataceae	Kawa			+	
43	<i>Sagittaria sagittifolia</i>	Alismataceae	Kawa				
44	<i>Aponogeton appendiculatus</i>	Aponogetonaceae	Ghetu			+	
45	<i>Potamogeton mucronatus</i>	Potamogetonaceae	Potamogeton			+	
46	<i>Potamogeton nodosus</i>	Potamogetonaceae	Potamogeton			+	
47	<i>Najas graminea</i>	Najadaceae	NK				
48	<i>Marsilea quadrifolia</i>	NK	Susni shak				+
49	<i>Alternanthera philoxeroides</i>	Amaranthaceae	Helencha				+
50	<i>A. sessilis</i>	Amaranthaceae	Sachi sakh				+
51	<i>Impomoea aquatica</i>	Convolvaceae	Kalmi lata				+
52	<i>Sporobolus indicus</i>	Poaceae	Smut grass				+

Sl.no	Scientific Name	Family	Local Name	Submerged	Floating		Marginal and emergent weeds
					Free floating	Floating but root	
53	<i>S. tramulus</i>	Poaceae	NK				
54	<i>Panicum paludosum</i>	Poaceae	Dalagrass				+
55	<i>Panicum cambogiense</i>	Poaceae	NK				
56	<i>Oryza minuta</i>	Poaceae					+
57	<i>Oryza rufipogon</i>	Poaceae	Jhara dan				+
58	<i>Saccharum spontaneum</i>	Poaceae	Kash				
59	<i>Limnophila cana</i>	Scrophulariaceae	Limnophila				+
60	<i>Limnophila sessiliflora</i>	Scrophulariaceae	Limnophila				+
61	<i>Monochoria hastate</i>	Pontederiaceae	Boronukha				+
62	<i>Polygonum barbatum</i>	Polygonaceae	Bekundabaj				+
63	<i>P. lanatum</i>	Polygonaceae	Panim arich				+
64	<i>Spirodela polyrhiza</i>	Lemnaceae	Kudipana				+
65	<i>Scirpus articulatus</i>	Cyperaceae	Checur				+
66	<i>Leersia hexandra</i>	Graminae	Flating grass				+
67	<i>Hygroryza aristata</i>	Graminae	Fepri				
68	<i>Drepanocladus sp.</i>	Amblystegiaceae					+
69	<i>Brasenia schreberi</i>	Cabombaceae					
70	<i>Calla pulustris</i>						
71	<i>Peltandra virginica</i>	Areaceae	Arum				
72	<i>Rotala wallichii</i>	Lythraceae	Rotala				+
73	<i>Rotala rosea</i>	Lythraceae	Rotala				+
75	<i>Rotala rotundifolia</i>	Lythraceae	Rotala				+
76	<i>Enhydra fluctuous</i>	Compositae	Helencha				+

Aquatic Plants of the North-eastern region of Bangladesh

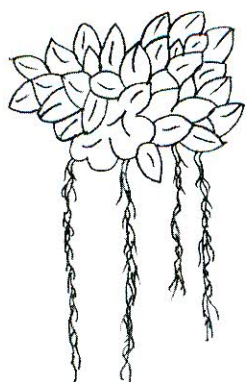


Figure 27: Azolla pinnata

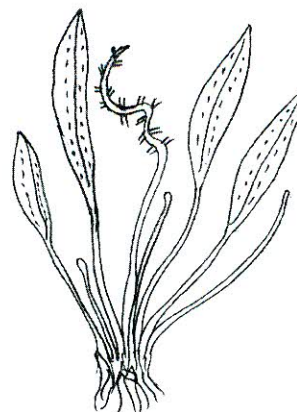


Figure 28: Aponogeton appendiculatus

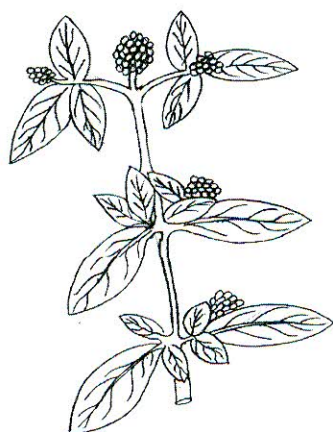


Figure 29: Alternanthera sesilis



Figure 30: Alternanthera philoxeroides

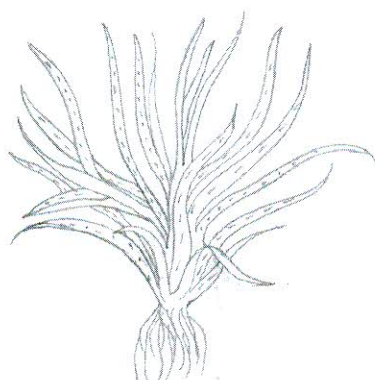


Figure 31: Blyxa auberti

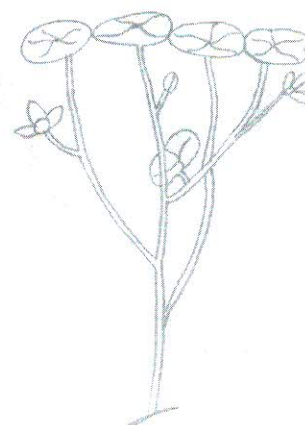


Figure 32: Brasiaenia schreberi

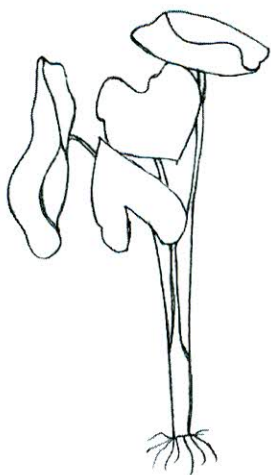


Figure 33: Colocasia antiquorum



Figure 34: Chara sp.

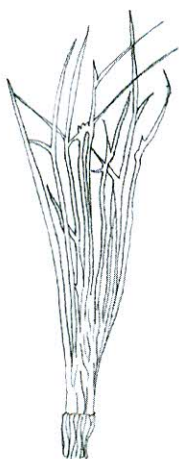


Figure 35: Cyperus kylingio



Figure 36: Cyperus playtistylis



Figure 37: Cyperus tegetiformis



Figure 38: Ceratophyllum demersum

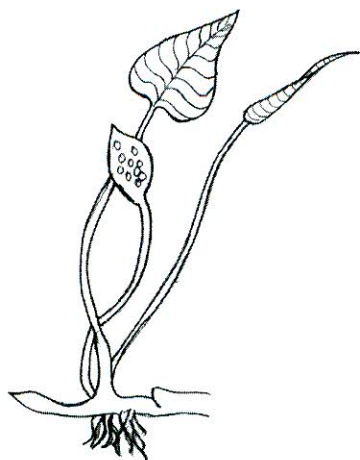


Figure 39: Calla palustris



Figure 40: Drepanocladus sp.

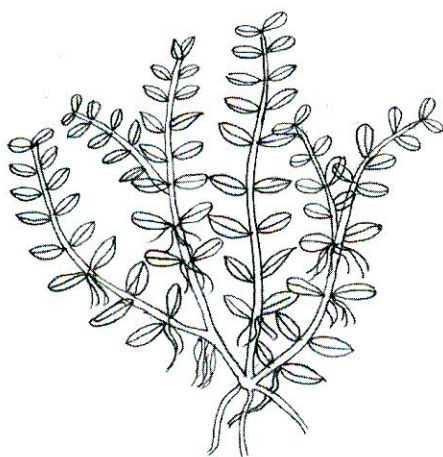


Figure 41: Elatine triandra



Figure 42: Eleusina indica

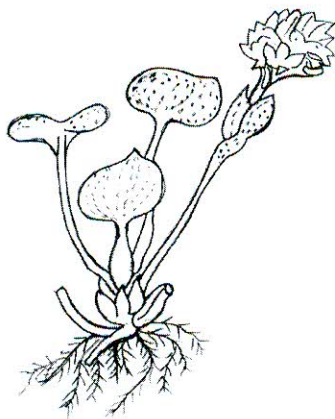


Figure 43: Eichhornia crassipes

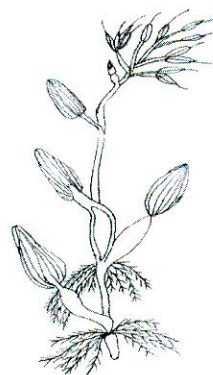


Figure 44: Hygroryza aristata

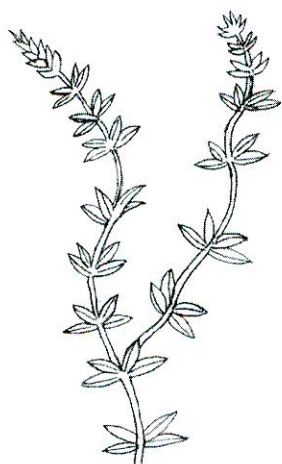


Figure 45: Hydrilla verticillata

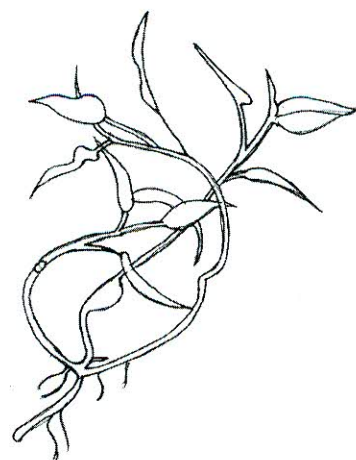


Figure 46: Ipomoea reptans

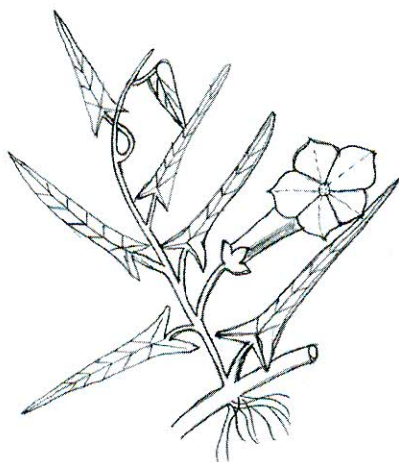


Figure 47: Ipomoea aquatica

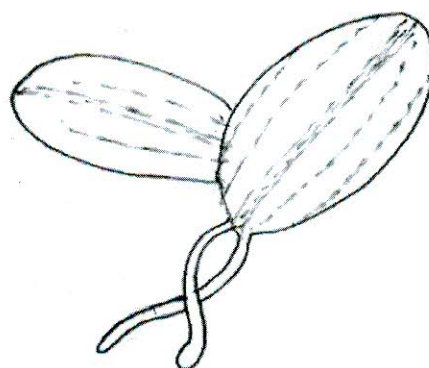


Figure 48: Lemna perpusilla

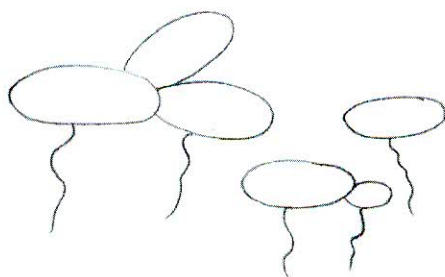


Figure 49: Lemna minor

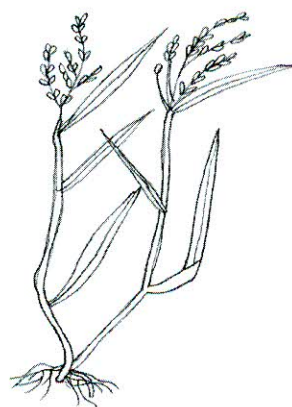


Figure 50: Leersia hexandra

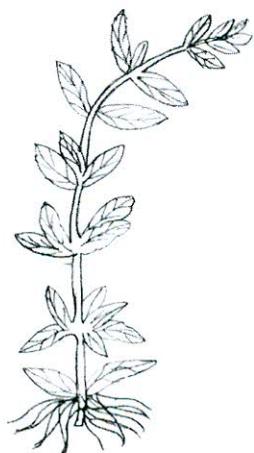


Figure 51: Limnophila cana

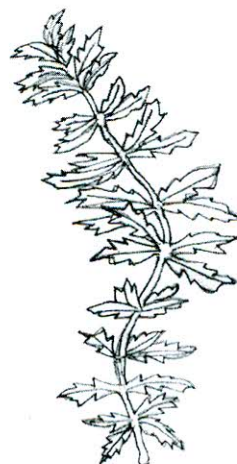


Figure 52: Limnophila sessiliflora



Figure 53: Ludwigia adscendens



Figure 54: Leptochloa chinensis

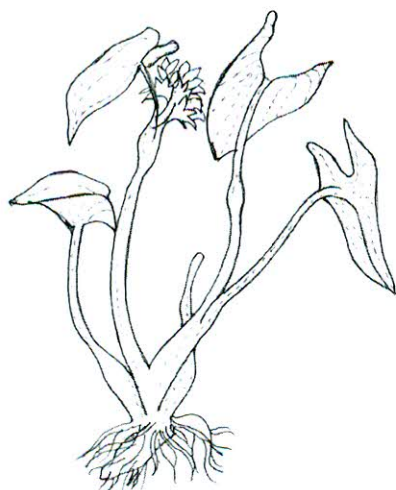


Figure 55: Monochoria hastata



Figure 56: Myriophyllum tuberculatum

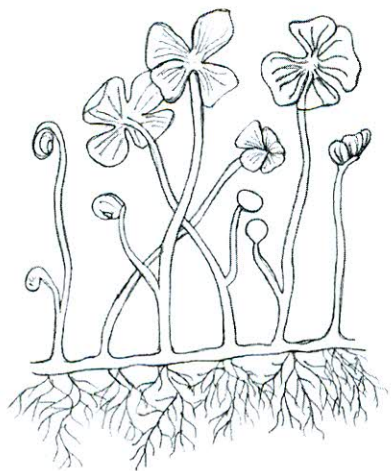


Figure 57: Marsilea sp.

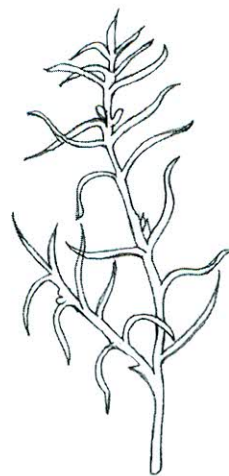


Figure 58: Nechamandra alternifolio

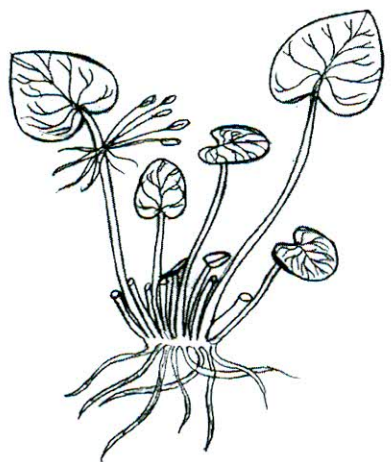


Figure 59: Nymphoides cristatum



Figure 60: Najas graminea

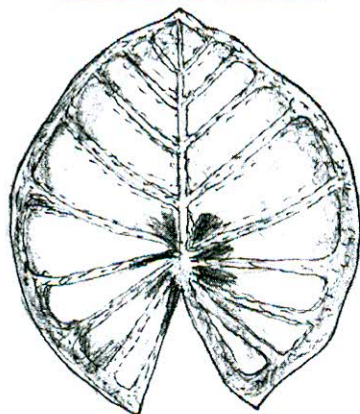


Figure 61: Nymphaea lotus

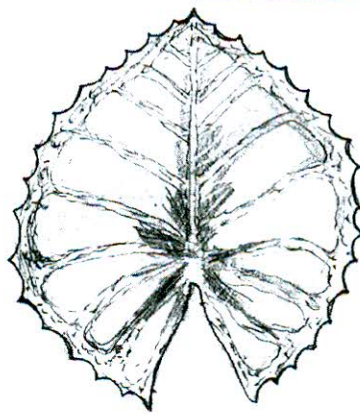


Figure 62: Nymphaea nouchali

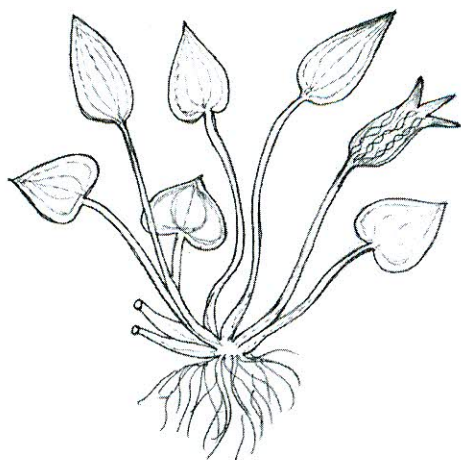


Figure 63: Ottelia alismoides



Figure 64: Oryza sp.

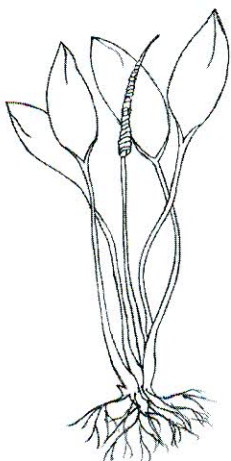


Figure 65: Orontium aquaticum

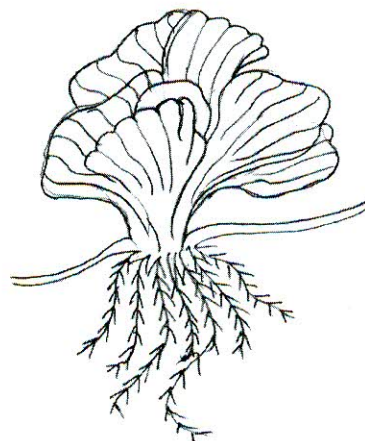


Figure 66: Pistia stratiotes.

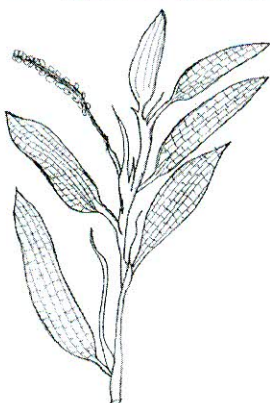


Figure 67: Potamogeton mucronatus

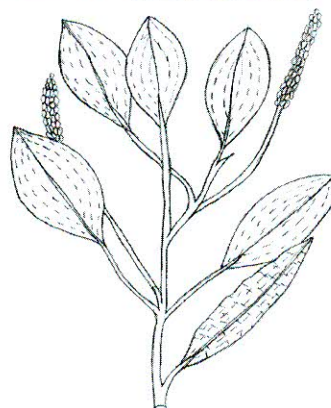


Figure 68: Ptamogeton nodosus



Figure 69: Polygonum barbatum



Figure 70: Polygonum lanatum

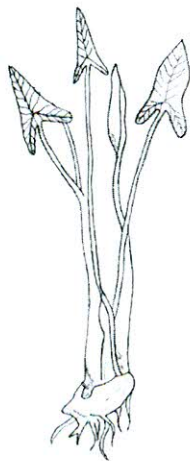


Figure 71: Peltandra virginica

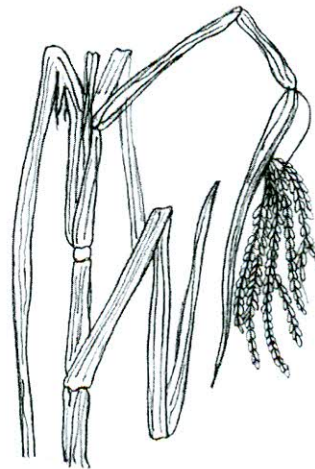


Figure 72: Panicum paludosum



Figure 73: Sporobolus indicus



Figure 74: Schoenoplectus articulatus

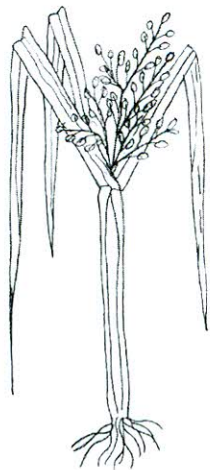


Figure 75: Schoenoplectus grossus

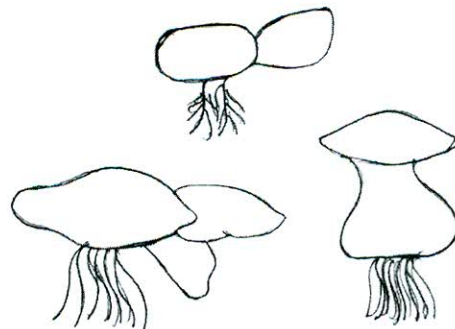


Figure 76: Spirodela polyrhiza



Figure 77: Sagittaria gnayanensis

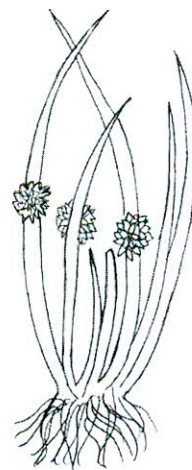


Figure 78: Scripus articulatus



Figure 79: Trapa natans

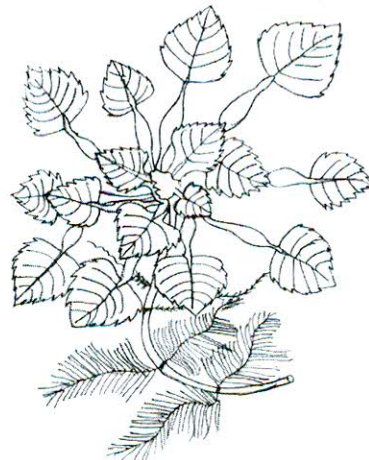


Figure 80: Trapa bispinosa

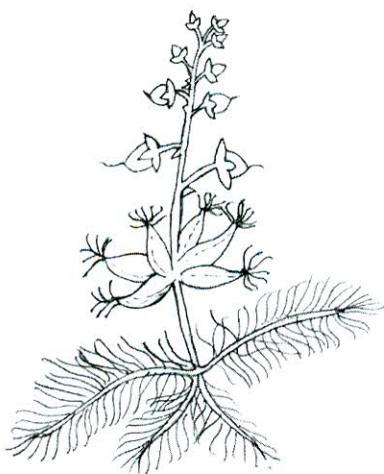


Figure 81: Utricularia stellaris

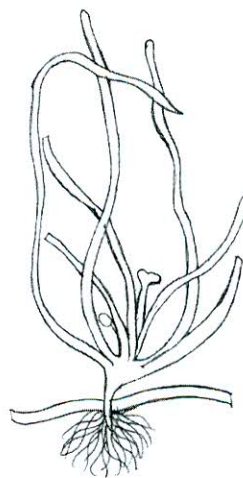


Figure 82: Vallisneria spiralis

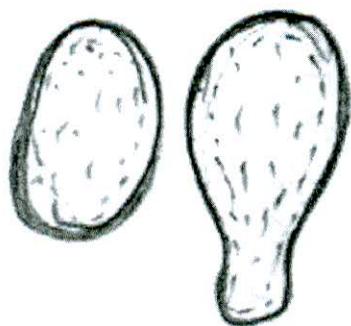


Figure 83: Wolffia arrhiza



Figure 84: Wolffia punctata

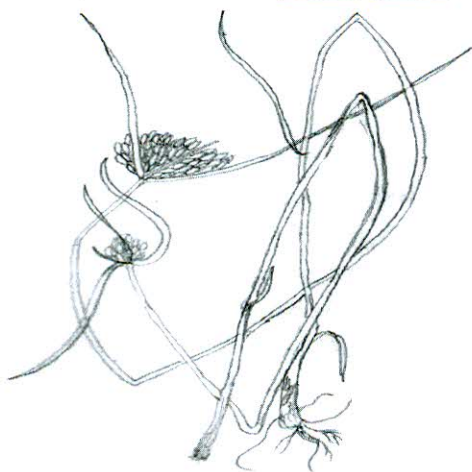


Figure 85: Cyperus nutans

Molluscs fauna: The occurrence of 72 (26 terrestrial, 24 freshwater Gastropod and 22 aquatic Bivalve) Gastropods and Bivalve species belonging to 26 families and 4 orders were recorded from different localities of the North-eastern Region of Bangladesh during the present studies. The systematic accounts of the molluscs, rerecorded from different habitats in the North-eastern region of Bangladesh with their distribution is presented in the Table 1.3.

Table: 1.3. Systematic accounts and District wise distribution of Molluscs species in North-eastern Region of Bangladesh

Systematic accounts of Molluscs species inhabiting the Study area	District	Brahmonbaria	Comilla	Habiganj	Maulvibazar	Sylhet	Sunamganj	Total	Number of District occupied by the species						Recorded in the fauna of British India (FBI)	Reported from Bangladesh in literature other than (FBI)
									1	2	3	4	5	6		
A) Terrestrial molluscs Gastropods																
Order 1: Stylommatophora																
Family 1: Achatinidae																
Genus 1: <i>Achatina</i>																
Species 1: <i>A. fulica fulica</i>	+	+	+	+	+	+	+	6						-		+
Family 2: Cerastuidae																
Genus 2: <i>Rachis</i>																
Species 2: <i>R. bengalensis</i>											+				+	-
Family 3: Ariophantidae																
Genus 3: <i>Macrochlamys</i>																
Species 3: <i>M. indica</i>	+	+	+	+	+	+	+	6						+		-
Species 4: <i>M. opiparus</i>																
Species 5: <i>M. lubrica</i>									1	1					-	+
									1	1					-	-

Genus 4: <i>Girasia</i> Species 6: <i>G. crocea</i>		+	+	+	+	+	+	+	4	1		-	-
Species 7: <i>G. hookeri</i>		+						+	2			-	-
Genus 5: <i>Austenia</i> Species 8: <i>A. gigas</i>							+	+	1	1		-	-
Genus 6: <i>Euaustenia</i> Species 9: <i>E. cassida</i>								+	1	1		-	-
Genus 7: <i>Sitala</i> Species 10: <i>S. attegaia</i>		+							1	1		-	-
Family 4: Subulinidae Genus 8: <i>Glessula</i> Species 11: <i>G. gemma</i>		+	+	+	+	+	+	+	4			+	+
Species 12: <i>G. notigena</i>		+	+	+	+	+	+	+	4			-	-
Genus 9: <i>Lamellaxis</i> Species 13: <i>L. (A.) gracile</i>	+	+	+	+	+	+	+	+	6			-	+
Family 5: Helicarionidae Genus 10: <i>Seasera</i> Species 14: <i>S. diplodon</i>								+	1	1		+	-
Genus 11: <i>Sivella</i> Species 15: <i>S. castra</i>							+	+	1	1		+	-

Family 6: Camaenidae Genus 12: <i>Chloritis</i> Species 16: <i>C. delibrata</i>	+			+				2									+		-
Family 7: Succineidae Genus 13: <i>Indosuccinea</i> Species 17: <i>I. plicata</i>	+				+			2									-		-
Genus 14: <i>Succinea</i> Species 18: <i>S. daucina</i>	+							1					1				-		-
Family 8: Plectopylidae Genus 15: <i>Plectopylis</i> Species 19: <i>P. (E.) plectostoma</i>								1					1				+		-
Family 9: Streptaxidae Genus 16: <i>Streptaxis</i> Species 20: <i>S. pffiere</i>																			-
Family 10: Philomycidae Genus 17: <i>Meghimatium</i> Species 21: <i>Meghimatium</i> sp.																	-		-
Family 11: Veronicellidae Genus 18: <i>Filicaulis</i> Species 22: <i>F. alte</i>	+			+													-		-

Species 30: <i>B. dissimilis</i>	+	+	+	+	+	+	+	+	+	6								-	+
Family 14: Ampularidae																			
Genus 23: <i>Pila</i>																			
Species 31: <i>P. globosa</i>	+	+	+	+	+	+	+	+	+	6								-	+
Species 32: <i>P. virens</i>				+						2								-	
Family 15: Bithinidae																			
Genus 24: <i>Bithynia</i>																			
Species 33: <i>B. (D.) cerameopoma</i>							+			1								+	-
Species 34: <i>B. (D.) pulchella</i>							+			1								+	+
Genus 25: <i>Gabbia</i>																			
Species 35: <i>G. oracula</i> var. <i>producta</i>	+	+					+			2								-	+
Family 16: Stenothyridae																			
Genus 26: <i>Stenothyra</i>							+											+	-
Species 36: <i>S. deltae</i>										1						*			
Family 17: Physidae																			
Genus 27: <i>Physa</i>																			
Species 37: <i>P. acuta</i>							+		+	2								-	-
Family 18: Thiaridae																			
Genus 28: <i>Thiara</i>							+	+	+	6								-	+
Species 38: <i>T. scabra</i>	+						+												

Genus 29: <i>Melanoides</i> Species: <i>M. tuberculata</i>	+	+	+	+	+	+	+	+	6								-	+
Genus 30: <i>Tarebia</i> Species 40: <i>T. granifera</i>	+	+	+	+	+	+	+	+	6								-	-
Species 41: <i>T. lineata</i>	+	+	+	+	+	+	+	+	6								+	+
Family 19: Pleuroceridae Genus 31: <i>Brotia</i> Species 42: <i>B. costula</i>	+	+	+	+	+	+	+	+	6								+	+
Genus 32: <i>Paludomus</i> Species 43: <i>P. conica</i>									3								+	+
Order 3: Basommatophora Family 20: Lymnaeidae Genus 33: Lymnaea Species 44: <i>L. (P.) acuminata</i>	+	+							2								+	+
Species 45: <i>L. (P.) acuminata</i> f. <i>gracilior</i>		+						+	2								+	-
Species 46: <i>L. (P.) luteola</i> f. <i>typica</i>		+							1								-	+
Species 47: <i>L. (P.) luteola</i> f. <i>ovalis</i>		+							1								-	-

Species 67: <i>P.(R.) lima</i>		+	+															-	-
Species 68: <i>P.(R.) shurtleffiana</i>		+	+															-	-
Species 69: <i>P.(R.) caerulea</i>	+	+	+	+														+	-
Family 24: Corbiculidae																			
Genus 40: <i>Corbula</i>																			
Species 70: <i>C.striatella</i>	+		+	+				+										-	+
Species 71: <i>C.sylhetica</i>		+																+	+
Family 25: Psammobiidae																			
Genus 41: <i>Novculina</i>			+															+	+
Species 72 : <i>N.gangetica</i>																			
Subtotal 22	7	17	11	7	18	6													
Grand total	72	24	44	33	42	46	20	207											

Table 1.4. Systematic accounts of recorded Molluscs fauna from Bangladesh by different authors with present findings from the North-eastern Region of Bangladesh

Authors name Systematic accounts	Ali & Begum (1976)	Ali <i>et al.</i> (1978)	Ali <i>et al.</i> (1985)	Alam & Patra (1986)	Begum <i>et al.</i> (1989)	Jahan (1993)	Jahan <i>et al.</i> (2003)	Rahman (2003)	Khanom (2007)	Siddique <i>et al.</i> (2007)	BD	FBI	PS
A)Terrestrial molluscs Gastropod													
Order1:Stylommatophora													
Family 1:Achatinidae													
Genus 1: <i>Achatina</i>							+			+		+	+
Species1: <i>A.fulica fulica</i>													
Family:2 Cerastuidae							+			+		+	+
Genus 2 <i>Rachis</i>													
Species 2: <i>R. bengalensis</i>							+						
Species 2: <i>R.bengalensis</i>													
Family 3: Ariophantidae													
Genus 3: <i>Macrochlamys</i>							+			+		+	+
Species 3: <i>M.indica</i>													
Species 4: <i>M.opiparus</i>										+		+	+
Species 5: <i>M.lubrica</i>												+	+
Species 6: <i>M.hardwickii</i>											+	+	
Species 7 : <i>M.sequax</i>										+		+	
Genus 4: <i>Ariophanta</i>							+						
Species 8: <i>A.interrupta</i>										+	+	+	

[illegible]

Table 1.3
Morphometrical parameters of mollusc species

Name of molluscs Species	Shell/Body length(mm) M±SD	Shell /body width(mm) M±SD	Aperture length/diameter(mm) M±SD	Apertur width(mm) M±SD
GASTROPODS				
1. <i>A. fulica fulica</i>	83.83±5	44.16±2.25	42±4.35	22.16±0.89
2. <i>R. bengalensis</i>	14.87±3.59	7.32±1.51	5.75±1.44	3.87±0.47
3. <i>Filicaulis alte</i>	27±2.44	7.33±0.78		
4. <i>Meghamatium striatum</i>	37.6±3.59	6.65±0.60		
5. <i>Austenia gigas</i>	22.25±1.06	28±1.41	18.75±0.35	18.25±0.35
6. <i>Girasia crocea</i>	48.75±4.94	7.68±0.47		
7. <i>Girasia hookeri</i>	61±6.55	10.16±0.76		
8. <i>Macrochlamys indica</i>	13.83±0.28	20.66±0.76	9.33±0.28	7±0.5
9. <i>Macrochlamys opiparus</i>	8.4±2.11	11.83±2.64	5.8±1.43	3±0.91
10. <i>Macrochlamys lubrica</i>	10.25±0.35	18.5±0.70	7.5±0.70	7.25±0.35
11. <i>Euaustenia cassida</i>	5.5±1.41	8.75±2.47	4.75±1.06	5.12± 1.59
12. <i>Sitala attegaia</i>	7±5.81	7.33±6.08	2.66±0.28	1.66±0.28
13. <i>Cyclophorus theobaldinus</i>	23.92±5.81	30.64±6.08	14.61±1.63	
14. <i>Cyclophorus pearsoni</i>	23±1.21	27.10±0.52	12.10±0.17	
15. <i>Pterocyclus parvus</i>	7.12±0.75	14.12±3.82	4.35 ± 0.28	
16. <i>Chamalycaeus (Dicharax) crenatus</i>	5.12±0.17	5.18±0.90	1.81±0.08	
17. <i>Glessula gemma</i>	6.7±0.57	3.70±0.27	2.16±0.22	1.66± 0.13
18. <i>Glessula notigena</i>	23±1.73	7.21±1.21	5.42±1.01	2.85±0.69
19. <i>Lamellaxis (Allopeas) gracile</i>	12.08±4.57	3.62±0.11	2.20±0.55	
20. <i>Seasara diplodon</i>	5.6±0.27	8.72±0.88	3.06±0.51	1.12±0.25
21. <i>Sivella castra</i>	5±0.70	11±2.75	3.75±0.64	1.87±0.25
22. <i>Chlorotis delibrata</i>	11.33±0.23	20.83±2.30	8.5±1.5	
23. <i>Indosuccinea plicata</i>	14.33±0.57	8.66±0.44	10.83±0.41	6.08±0.15
24. <i>Succinea daucina</i>	5.45±1.57	4.3±1.57	3.83±0.57	1±0.47
25. <i>Plectopylis (Endothyra) plectostoma</i>	5.33±0.17	8.33±0.11	2.91±0.12	
26. <i>Streptaxis pfeiffere</i>	6.75±0.35	5.25±0.35	1.37±0.17	
27. <i>Physa acuta</i>	12.62±0.32	8.25±0.12	8.06±0.13	3.31±0.20
28. <i>Lymnaea (Pseudosuccinea) acuminata f. typica</i>	21.5±2.12	10.25±1.06	13.0±1.41	5.75 ± 0.35
29. <i>Lymnaea (Pseudosuccinea) acuminata f. gracilior</i>	26.37±7.12	11.62±1.25	19.12±2.25	7.25±0.64
30. <i>Lymnaea (Pseudosuccinea) luteola f. typica</i>	13.75±0.35	7.75±1.06	9.12±0.17	7.37±0.17
31. <i>Lymnaea (Pseudosuccinea) luteola f. ovalis</i>	13.66±1.25	8.66±0.76	8.41±1.28	4.66±0.28
32. <i>Radix persica</i>	28.5±0.70	16.25±2.4	20.25±1.06	11.5±0.91
33. <i>Bellamya bengalensis f. typica</i>	32.5±3.53	22.5±0.75	12.55±1.62	8.5±2.12
34. <i>Bellamya bengalensis f. doliaris</i>	17.5±0.51	14±1	7.5±0.52	4.5±0.5
35. <i>Bellamya dissimilis</i>	18.62±1.17	15.5±2.67	8.87±1.03	6.75±1.25
36. <i>Bellamya crassa</i>	18.6±0.74	14.2±0.56	9.2±0.33	7.8±0.20
37. <i>Brotia costula</i>	46.6±10.41	18.00±2.76	16.8±2.75	10.7±1.48

Name of molluscs Species	Shell/Body length(mm) M±SD	Shell /body width(mm) M±SD	Aperture length/diameter(mm) M±SD	Apertur width(mm) M±SD
GASTROPODS				
38. <i>Pila globosa</i>	48.6±4.34	42±4.49	33.8±2.38	19.1±1.96
39. <i>Pila virens</i>	32.0±2	21±4	24.25±1.62	13.75±1.12
40. <i>Indoplanorbis exustus</i>	15.80±3.2	5.7±1.5	6.37±1.5	4.2±0.5
41. <i>Gyraulus convexiusculus</i>	5.2±0.12	1.68±0.12	2±0.05	1.3±0.05
42. <i>Mellanoides tuberculata</i>	24.37±2.10	8±0.68	6.37±0.69	3.75±0.12
43. <i>Tarebia scabra</i>	6.5±0.28	3.25±0.75	8.5±2.51	5.5±1.04
44. <i>Tarebia granifera</i>	22.3±2.91	8.95±1.13	8.6±1.37	6.75±0.54
45. <i>Tarebia lineate</i>	16.5±1.16	6.4±0.59	4.7±0.54	2.6±0.21
46. <i>Stenothyra deltae</i>	4.5±0.20	3.25±0.23	1.33±0.11	0.96±0.01
47. <i>Bithynia (Diagoniostoma) cerameopoma</i>	6±0.31a	4.85±0.24	2±0.26	2.1±0.81
48. <i>Bithynia (Diagoniostoma) pulchella</i>	7.12±0.53	4.75±0.35	3.47±1.59	2.3±0.17
49. <i>Gabbia orcula</i> var. <i>producta</i>	5.12±0.28	3.83±0.28	2.37±0.16	1.79±0.19
50. <i>Paludomus conica</i>	20.5±1.41	13.5±1.35	11.62±1.88	6.5±0.70

Morphometrical parameters of BIVALVES

Name of molluscs Species	Shell length M±SD	Shell width M±SD	Shell thickness M±SD
51. <i>Scapula deltae</i>	13.2±2.38	7.08±0.67	5.06±1.21
52. <i>Lamellidens marginalis</i>	75.4±15.45	40.2±7.51	26.3±6.82
53. <i>Lamellidens jenkinsianus</i>	81.4 ±9.01	42.4±2.9	27.33±2.19
54. <i>Lamellidens jenkinsianus</i> sub.sp.daccaensis	94.66±4.72	56.33±4.61	32.66±9.25
55. <i>Lamellidens phenchooganjensis</i>	87.33±15.85	43.66±8.04	28.08±6.91
56. <i>Lamellidens indawgyiensis</i>	106±11.8	53.05±12.02	38.5±5.65
57. <i>Lamellidens generosus</i>	79.02±20.74	43.66±12.34	27.8±9.35
58. <i>Lamellidens corrianus</i>	90.1±19.42	43.6±9.76	30.6±10.35
59. <i>Parreysia (Radiatula) andersonia</i>	34.5±0.70	16.5±0.70	12.75±0.35
60. <i>Parreysia (Radiatula) bonneaudi</i>	40.12±6.25	20.87±1.81	15.0±2.34
61. <i>Parreysia (Radiatula) lima</i>	33.25±2.75	18.25±2.5	12.06±0.42
62. <i>Parreysia (Radiatula) shurtleffiana</i>	41.37±3.77	21.87±2.28	15.37±0.85
63. <i>Parreysia (Radiatula) caerulea</i>	42.75±2.38	20.33±1.6	15±0.5
64. <i>Parreysia (Parreysia) favidens</i>	46.5±3.96	30.2±2.86	20.1±1.94
65. <i>Parreysia (Parreysia) favidens</i> var.assamensis	48.33±0.77	30.41±3.95	19.58±2.43
66. <i>Parreysia (Parreysia) favidens</i> var.marcens	52.3±8.02	34.4±5.69	22±2.22
67. <i>Parreysia (Parreysia) favidens</i> var.viridula	47.5±0.7	30.5±0.7	23.5±0.7
68. <i>Parreysia (Parreysia) corrugata</i>	25.5±8.26	17.16±6.25	11.83±4.25
69. <i>Parreysia (Parreysia) gowhattensis</i>	41.12±10.28	29.75±8.29	19.37±2.56
70. <i>Novaculina gangeica</i>	35.75±1.06	8±0.70	8.2±1.06
71. <i>Corbicula striatella</i>	16.37±3.44	11.37±4.15	8.5±1.77
72. <i>Corbicula sylhetica</i>	9.33±0.75	7.83±0.43	5.75±0.61

1.3.1 Identification key of Molluscs species found in the North-eastern Region of Bangladesh

Land molluscs were identified mainly on the basis of shell character. For taxonomic identification be found in Mitra *et al.*, (2005), unidentified species are taken to Zoological survey of India for confirmation of species.

For taxonomic identification of freshwater molluscs keys can be found in Subba Rao (1984) and Mitra *et al.*, (2005) and Ramakrishna *et al.*, (2007) unidentified species are taken to be Zoological survey of India for confirmation of species

Identification key of molluscs found in North-eastern region of Bangladesh given below.

Land molluscs

Key to families

1. Shell with an operculum closing the aperture (2)
 Shell without an operculum 8)
2. Shell depressed or candidly depressed, broader than high (3)
 Shell ovate, elongately ovate higher than broad (5)
3. Shell smaller, usually not exceeding 10mm in diameter, smooth, polished, without distinct sculpture, perforation closed by a callus Helicinidae
 Shell larger, usually exceeding 10 mm in diameter, sculptured, openly perforate (except Otopoma in Pomatiasidae) (4)
4. Peristome double, usually expanded and reflected, foot without any groove Cyclophoridae
5. Columella reflected over umbilicus, umbilical opening rather narrow Camaenidae
 Columella not reflected over umbilicus, umbilical opening wide (6)
6. Shell aperture with columellar callus or entering lamella, also a series of teeth/lamella inside the last whorl Plectopylidae
7. Shell thin, peristome not thick; dart sac usually lacking Helicarionidae
 Shell thick, peristome often tick inside; dart sac large Ariophantidae
8. Shell sinistral, with internae plicae (visible from outside) Clausilidae
 Shell dextral, without internal plicae Streptaxidae

9. Shell very large and swollen, seldom below 50 mm in length Achatinidae
 Shell small and narrow, seldom exceeding 30 mm in length (10)
10. Spire equal or shorter than the last whorl in length (11)
 Spire larger than the last whorl in length (12)
11. Shell thin, imperforate last whorl constituting 75% to 90% of the total length, columella not reflected Succineidae Shell fairly thick, perforate, last whorl equal or slightly larger than spire, columella reflected Cerastuidae.
12. Shell usually imperforate or very narrowly perforate usually without coloured spots and streaks, outer lip simple Subulinidae
13. Animal without external shell Veronicellidae.
14. Snails with out shell or with only shell remnants Phylomycidae.

Family Cyclophoridae

Key to genera

1. Shell much larger, seldom below 20 to 23 mm in diameter *Cyclophorus*
2. Shell with a wing like projection on the peristome above *Pterocyclus*
3. Shell more depressed, distinctly broader than high with a wider umbilicus *Chamalycaeus*.

Genus: *Cyclophorus*

Key to species

Shell ordinary thick, solid turgid sculptured with tread like spiral line, a few of which are distinctly raised, decussated by oblique striae *C. theobaldinus*

Shell granularly sculptured below *C. pearsoni*

Genus: *Pterocyclus*

Key to species

Shell sub diaphanous white, encircled with a dark brown line along the circumference of whorles *P. parvus*

Genus : *Chamalycaeus*

Key to species

Shell bigger (above 25 mm in diameter) ribbed at base *Chamalycaeus (Dicharax) crenatus*.

Family : Ariophantidae**Key to genera**

1. Shell internal *Girasia*
2. Shell shallow, ear shaped, number of whorls more than 2 *Austenia*
3. Whorls widely Coiled, 5-6 in number *Macrochlamys*
4. Shell subtrochiform to trochiform, nearly as high as broad *Sitala*
5. Shell large, ovately depressed, very thin and fragile *Euastenia*

Key to species

1. Shell very thin, flat rudimentary *G. crocea*
 Shell slightly thin, calcareous *G. hookeri*

Genus: *Austenia***Key to species**

- Shell large, rather thick shallow, yellowish, number of
 whorls 2 *A. gigas*

Genus - *Macrochlamys***Key to species**

- a. Shell moderately large, perforate, depressed, basal margin of the shell
 reflected *M. indica*
- b. Shell medium thin, perforate, subglobesly depressed *M. opipara*
- c. Shell larger rather thin, depressed, perforate, smooth above 20 mm
 diameter *M. lubrica*

Genus : *Sitala***Key to species**

- Shell rather small, conoid subtrochiform deccussately sculptured by
 oblique striac whorls $7-7\frac{1}{2}$ *S. attegaia*

Family : Cerastidae**Key to Genera**

- Shell with coloured bands, upper margin of peristome straight *Rachis*
 Shell without infra peripheral band or whitish oblique streaks *Edouardia*

Family: Subulinidae

Key to Genera

Shell smooth, faintly striate, Columella abruptly truncate
at base *Glessula*.

Key to species

1. Shell elongated, conical upwarls gradually tapering into slender,
number of whorls 9-10 *G notigena*
2. Shell smooth, glossy without sculpture *G gemma*
3. Shell smaller, less than 15 mm in length, obliquely striate columella
not thickened *Lamellaxis*
4. Whorls swollen and rounded, suture shallow *L. (A.) gracile*

Family : Achatinidae

Key to Species

Shell large, ovately conoid, strongly inflated. whorls 8, suture
deep *A. fulica fulica*

Family Streptaxidae

Key to Genera

Shell with a number of apertural process *Streptaxis*

Family : Plectoplylididae.

Key to Genera

Shell smaller below 20 mm in diameter, with hairy growth, margin of
aperture joined by a callus Genus *Plectopylis*

Shell with decussating sculpture below *P. plectostoma*

Family : Succinidae

Key to genera

Shell thinner, spire very poorly developed, columellar fold with a
distinct ridge *Indosuccinea*

Shell comparatively thicker, spire better developed, calumellar fold with a distinct ridge penis with a penial sheath..... *Succinea*

Shell thin, peristome not thick; dart sca usually lacking (Family Helicarionidae)

Shell larger above 10 mm in diameter, convex at base *Sivella*

Shell smaller, less than 10 mm in diameter, flat on base..... *Sesara*

Shell with thickened and reflected peristome, columella reflected over umbilicus, umbilical opening rather narrow (Family Camaenidae)

Shell striate or decessate, not granulated, lip of the aperture not expanded..... *Chloritis*.

Fresh water Gastropoda

Key to Family:

1. Shell discoide or when extended sinistrally coiled (2)
 - Shell dextrally coiled..... *Lymmaeidae*
2. Shell sinisterly coiled; columellar axis twisted; animals with triangular tentacles *Physidae*
3. Shell discodial or plan spiral; small with small aperture *Planorbidae*
4. Shell pyramidal; whorls regularly in creasing; operculum horny; animals with gills only, labial palps absent..... *Viviparidae*
 - Shell globose body whorl inflated and larger than spire, operculum calcareous; animals with gills and labial pulps *Ampularidae*
5. Shell elongate, turreted, calumellar callus indistinct; operculum oblong with a terminal nucleus *Thiaridae*
 - Shell either roundly ovate or elongate, turreted; columellar callus distinct operculum round with usually central or subcentral nucleus .. *Pleuroceridae*
6. Operculum calcareous and concentric, as large as aperture; verge bifurcate *Bithynidae*
 - Operculum corneous smaller than aperture verge not bifurcate (7)
7. Shell elongate and turreted; operculum without ridges on internal surface (8)

- Shell compressed in its dorso ventral axis; operculum with two prominent ridges on internal surface Stenothyridae

Family : Viviparidae

Key to Gnera:

1. Shell smooth, without traces of distinct ridges or sculpture (2)
 - Shell ornamented with number of well developed spiral ridges, which may be continuous or broken up into nodular or squamous tubercles (3)
2. Adult shell large, without any colored bands edge of mantle greatly thickened with a conspicuous sphincter muscle along it, superior margin of gill lamella usually thrown into folds, embryonic shell with three ridges bearing curved chate *Cipangopaludina*
 - Adult shell medium sized, with or with out colored bands and when no bands the shell feebly ridge or keeled, edge of mantle not so thickened and without a conspicuous sphincter, superior margin of gill lamella never thrown in to folds, embryonic shell with three primary ridges bearing chate and number of secondary ridges *Bellamyia*

Key to species

1. Sheel with dark spiral bands, suture not greatly impressed *B. bengalensis*
 - Colour uniform without any bands in the adult shell, suture generally impressed (2)
2. Shell globose, spire small and blunt *B. crassa*
 - Shell ovate or conical, spire elongated (3)
3. 3. Shell with deeply impressed sutures, body whore generally with one slightly elevated peripheral ridge or broad and obscure pale spiral band *B. dissimilis*

Family : Ampularidae

Key to Genera:

- Shell large or very large globose, aperture large, expanded, and surface of shell smooth, body whore inflated, umbilicus open, lateral teeth with five cusps, third or central one the largest and innermost reduced, the lung less spacious, its opening small *Pila*
- 4. Shell globose, and spacious, upper surface of whorls obliquely flattened, suture not deep, spire depressed *P. globosa*

- Shell ovoid or semiglobose, suture deeply impressed, spire elevated (2)
- 5. Suture canaliculate with a distinct carination of whorls on the out side, spire prominent and conical *P. virens*

Family Bithinidae

Key to Genera:

1. Shell not thick, smooth or with fine spiral ridge, columellar fold ridge like; central tooth with a series of latero-basal denticulations on either side (2)
2. operculum with paucispiral figure situated in the middle of the lower part transparent; columellar fold ridge like a definite, not prominent groove running from the umbilicus is absent *Gabbia*
- Operculum concentric, thick with central or subcentral nuclus; columellar fold ridge like and prominent, a well definite grove running down wards from umbilicus *Bithynia*

Key to species

1. Outer lip thick, produced and angulate or subangulate at its inner extremity (2)
- Outer lip thin not produced and angulate or sub angulate at its inner extremity (4)
2. Lip at the base of columella produced, spire shorter than body whorl (3)
- Lip at the base of columella not produced spire equal or more than body whorl *B. (D.) puchella* (Benson)
3. Shell elongated, suture impressed *B. (D.) cermeopoma*
- Shell oval suture not impressed *B. (D.) textum*

Genus: *Gabbia*

Key to Species:

1. Shell ovately fusiform not much thick, body whorl not much swollen, columellar callus not well developed (2)
- Shell globose thick, body whorl swollen, columellar callus well developed *G. stenothyroides*
2. Shell with rounded whorls suture deep columellar margin descending at an angle *G. orcula*

Family: Thiaridae

Key to genera

1. Height of body whorl more often exceeding the height of the spire, shell sculptured with conspicuous nodules, granules, axial ridges or spines(2)
 - Height of body whorl less than that of spire; shell sculptured with axial and spiral ridges but never with spines(3)
2. Shell spinous or sharply nodulose; whorl angular between suture and periphery; spiral whorls descending in steep, pagoda like *Thiara*
 - Shell granulose or tessellated with nodules; whorls rounded between suture and the periphery; spiral whorls gradually increasing *Tarebia*
3. Shell slender and elongated, whorls more than 12, sculptured with spiral striae only *Stenomelania*
 - Shell neither slender nor much elongated, whorls upto 12. sculptured with spiral striae crossed by axial striae *Melanoides*

Genus : *Melanoides*

Key to Species:

- Sculptured uniformly strong throughout the shell, outer lip curved at upper angle *M. peddamunigalensis*
- Sculptured stronger on outer upper whorls, outer lip not curved at upper angle *M. tuberculata*

Genus : *Tarebia*

Key to Species:

- Shell thicker with blunt apex and distinct rows of nodules *T. granifera*
- Shell thinner with a pointed apex and dark spirae lines *T. lineata*

Family : Pleuroceridae

Key to Genera

- Shell elongate turreted, spire longer than body whorl *Brotia*
- Shell globose, spire shorter than body whorl *Paludomus*

Sub Genus : *Paludomus* s. str.

Key to Species:

- Shell smaller more globose body whorl shouldered above the periphery *P. blanfordiana*
- Shell bigger, more conical, body whorl evenly rounded above the periphery *P. conica*

Family : *Lymnaeidae*

Key to Genera

1. Shell elongated turreted, number of whorls *Stagnicola*
 - Shell ovate, number of whorls 5 (2)
2. Outer lip extending far beyond the body whorl posteriorly, flattened at anterior end suture canaliculate; laterals in the radula bicuspid *Radix*
 - Outer lip not much extending posteriorly, rounded at anterior end, sutures simple, laterals in the radula tricuspid *Lymnaea*

Subgenus : *Pseudosuccinea*

Key to species :

1. Spire proportionately long, gradually tapering, outer lip nearly straight and less expanded, sutures transverse *L. luteola*
 - Spire proportionally short, abruptly pointed outer lip convex and much expanded, suture oblique (2)
2. Outer lip pointed below at base *L. biacuminata*
3. Outer lip broad and rounded at base *L. acuminata*

Genus : *Radix*

Key to species

1. Spire scalariform or canalised at the base; body whorl inflated (2)
 - Spire not scalariform or canalised at the base ; body whorl not much inflated *R. persica*

Family : *Planorbidae***Key to Genera:**

1. Shell large (above) 5 mm in diameter, whorls rounded at the periphery *Indoplanorbis*
- Shell large (upto 5 mm in diameter), whorls angular or carinate at the periphery *Gyraulus*

Genus: *Gyraulus***Key to Species:**

- Last whorl not much wider and not descending in front of aperture *G. convexiusculus*

Family : *Stenothyridae***Key to genera**

1. Mouth very small, not at all prominent, separated from the outer edge of shell above by a well defined triangular area *Stenothyra*
- Mouth larger and slightly prominent, less regular in outline, separated from the outer edge of shell above by a small and ill defined area *Gangetia*

Genus : *Stenothyra***Key to species:**

1. Shell minute, 2 mm long, with a very short spire and bluntly rounded apex *S. nana*
- Shell relatively large, with a prominent conical spire and an acuminate apex (2)
2. 2. Shell globose conical, body whorl large and swollen, with a well developed boss *S. deltae*

Key to Class Bivalvia

1. Shell internally nacreous (2)
- Shell internally non-nacreous (3)
2. Beak sculpture radial and well developed; all four gills marsupials *Amblemidae*

-Beak sculpture concentric-radial and rudimentary; only two outer gills
marsupials.....*Unionidae*

3. Shell thick, and strong, with strong and blunt ribbing, above 10mm
in length..... *Corbiculidae*

- Shell thin, and fragile, with fine ribbings, below 10mm in length(4)

Family: Unionidae

Key to the species

1. Posterior wing developed *L. generosus* (Gould)

- Posterior wing feebly developed or absent (2)

2. Posterior end elongate, shell narrow(3)

- Posterior end not elongate, gradually sloped, shell broad.....(4)

3. Shell elongately ovate, less thick umbones flat, anterior side angled,
posterior margin obtusely rounded.....*L. phencooganjensis* Preston

- Shell transversely elongated, thick broader umbones, more distinct and
convex, anterior end short and rounded, posterior side
sloping *L. jenkinsianus* (Benson)

4. Shell broad, dorsal margin obliquely truncate posterior end *L. consobrinus*. (Lea)

- Shell narrower, dorsal margin gradually sloping posteriorl.....(5)

5. Umbo prominent, colour brown with a lighter band along the
margin..... *L. marginalis* (Lamarck)

- Umbo less prominent, colour uniformly dark*L. corrianus*

Family: Amblemidae

Genus : *Parreysia*

Key to Subgenera

Shell oval to elliptical, centre of ventral margin swollen, thick, strong beak
sculpture*Parreysia* s.str

Shell elongate, with almost straight ventral margin, comparatively thin,
sculpture not so strong.....*Radiatula* Simpson

Subgenus *Parreysia* s.str.

Key to Species

Central teeth very strong, 3 or more in number *P. favidens* (Benson)

Central teeth very strong, less than 3 in numbers..... *P. corrugata* (Mueller)

Family: Subgenus *Radiatula*

Key to the Species

1. Umbo anterior (less than 1/4th of the total length) (2)

-Umbo anterior (more than 1/4th of the total length) (4)

2. Ventral margin straight or slightly convex..... *P. (R.) caerulea* (Lea)

-Ventral margin depressed..... (3)

3. Corrugated sculpture almost through out the body *P.(R.) cylindrica*

- Corrugated sculpture on the umbonal region *P.(R.) shurtleffiana* (Lea)

4. Posterior end wide (5)

- Posterior end narrow (6)

5. Sculpture on the umbonal region..... *P.(R.) bonneaudi* (Eydoux)

- Sculpture well developed on the dorsal region *P.(R.) lima* (Simpson)

6. Umbo indistinct, not at all raised..... *P. (R.) andersoniana* (Nevill)

- Umbo indistinct, raised *P. (R.) occata* (Lea)

Morphological structure and taxonomic features of some terrestrial molluscs

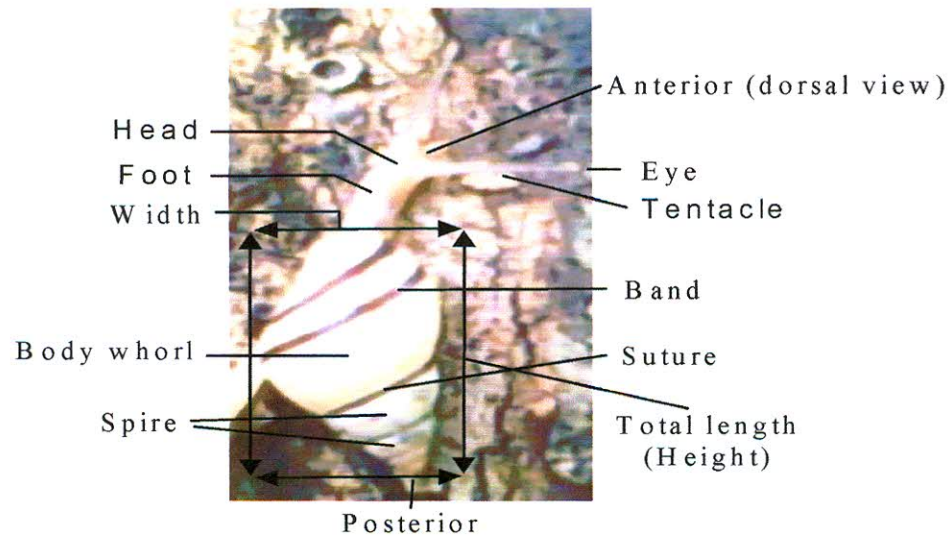


Figure 86: Morphological structure and taxonomic features in Landsnail *R. bengalensis*.

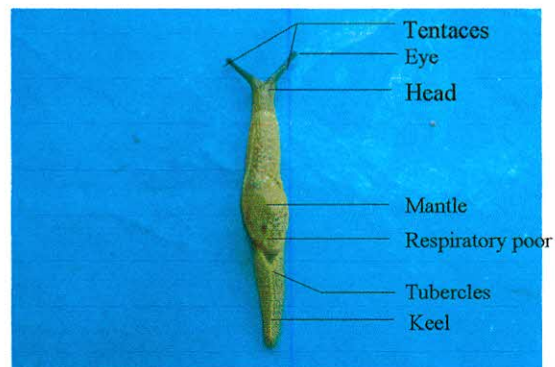


Figure 87: Morphological structure and taxonomic features of Slugs (*G.crocea*).

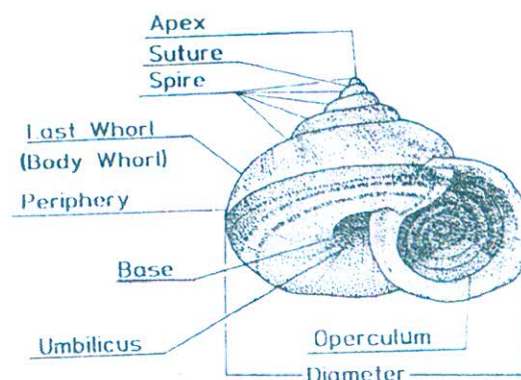


Figure 88: Different Parts of Land snail *Cylophorus* sp

Morphological structure and taxonomic features of some aquatic molluscs

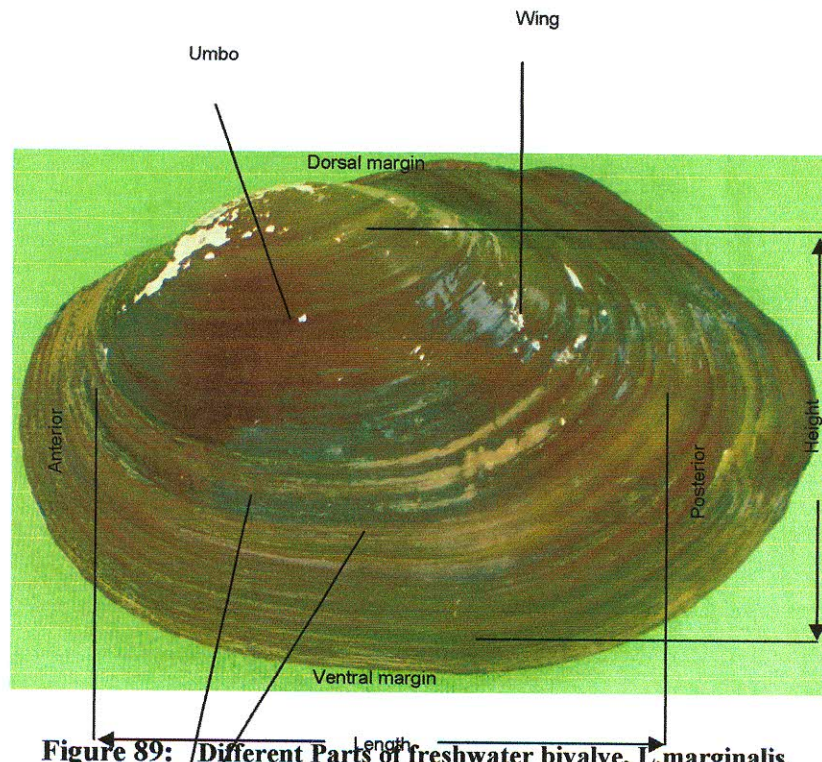


Figure 89: Different Parts of freshwater bivalve, *L. marginalis*.

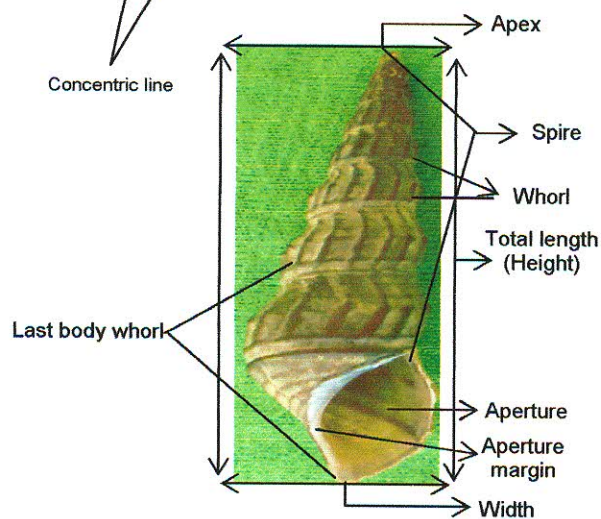


Figure 90: Morphological Structure and taxonomic features of *Brotia costula*

1.3.2 Diagnostic Characters of Mollusc Species

Land Mollusc

Family Cyclophoridae

Genus: *Cyclophorus* Monfort, 1810.

1810. *Cyclophorus* Monfort, *Conchyl. Syst.*, 2:290.

Species name: *Cyclophorus theobaldinus* Benson

Synonyms:

1857. *Cyclophorus theobaldinus*, Benson, *A.M.N.H.*, Ser 2.xix P, 206.

1875. *Cyclophorus specious*, var, Hanley & Theobald, *Conch*, India, pl. 104, fig. 7.

1897. *Cyclophorus (Salpingophorus) theobaldianus* Kobelt & Mollendorff, , *Nachr Deuts, Malak Ges*, xxix, p, I 10.

1921. *Cyclophorus theobaldionus* G. K. Gude, *The fauna of British India, Mollusca*, Land operculates, P, 86.

Local name: Sanka Shamuk, Gugly.

Description: Shell ordinary, thick, solid, turbate to depressed, umbilicate, sculptured with thread like spiral line, a few of which are distinctly raised decussated by a oblique channel with furrows; lower portion smooth, painted by whitish with chestnut colour, after this pale colour, white narrow band in the middle, just below chestnut ash colour, apex pointed, suture distinct, whorl 5, convex aperture oblique, sub circular border, inside white, peristome thickened, clay yellow colour, parietal thick expanded columellar margin curve, small operculum, straw colour, thick, border round and umbone small.

Size: Average length of shell, width, and aperture diameter 23.92 ± 5.81 , 30.64 ± 6.08 and diameter 14.61 ± 1.63 mm. respectively



Figure 91: Abaptural view of Cyclophorus theobaldinus (X2)



Figure 92: Aptural Ventral view of Cyclophorus theobaldinus (X2)

Habits: They are scavenger, living on dead or live plant matters, fungal rich detritus and damp soil. During the dry season, the snails undergo aestivation. Majority of them aestivate on ground in bushy places, base of big tree, crevices of tree, under stones and decaying leaves

Habitat: Ground, among low vegetation, evergreen forest, leaf litters, under stones or logs and crevices of trees. During the study period the snails were seen to Betel nut, Jack fruit, Mahogany, Acacia and Teak trees.

Population density: *Cyclophorus theobaldionus* highest ($11.66/10 \text{ m}^2$) during Monsoon in Malnichra tea garden forest, Sylhet and minimum ($0.16/10 \text{ m}^2$) summer 2005-07 in the same forest (Appendix table. 3.iii).

Distribution: Sylhet and Moulvibazar Districts.

Elsewhere: India, Assam, Himalaya, Myanmar.

Economic importance: It is a minor pest of crops. Feeds on soft twigs or leaves of plants.

Ecological role: The snails play an important role in the terrestrial ecosystem as a scavenger; and also contributes to recycling the plants nutrients.

Species: *Cyclophorus pearsoni* Benson.

Synonyms

1851. *Cyclostoma pearsoni*, Benson,, *Ann. Mag. nat. Hist: Soc.* 2(8): 185. 1851.
Cyclophorus pearsoni: Pfeiffer, *Zeits, Malak*, viii P. 138.

1897. *Cyclophorus (Glossostylus) pearsoni*, Kobelt & Mollendorff, *Nachr Deuts Malak, Ges xxiv*, P. 107.

1921, *Cyclophorus (Glossostylus) pearsoni*: Gude, *Fauna of British, India, Mollusca*, 3: 65.

Local name: Shanka Shamuk, Gugly

Description: Shell depressedly turbinate, fairly thick, narrowly umbilicate, spire conoid, apex acuminate, whorls 5, convex, crowded with numerous fine spiral marking, decussated by vertical striate, spiral sculpture obsolete on apical whorls; brown zig zag markings above, whitish band around periphery, dark narrow band just below also a number of fine spiral markings on the base, aperture sub oblique circular, peristome orange coloured, continuous, reflected, a little angulate above. Head and tentacles dark colour, feet comparatively lighter, Tentacles, single pair, brownish with dark rings. Hermaphrodites.

Size: Average length of shell, width, and aperture diameter 23.0 ± 1.21 , 27.1 ± 0.52 and 12.1 ± 0.17 mm respectively.



Figure 93: Apertural view of *C. pearsoni* (X2)



Figure 94: Abapertural view of *C. pearsoni* (X2)

Habit: They are scavenger, living on dead or live plant matters, fungal rich detritus and damp soil. During the dry season, the snails undergo aestivation. Majority of them aestivate on ground in bushy places, base of big tree, crevices of tree, under stones and decaying leaves

Habitat: Ground, among low vegetation, evergreen forest, leaf litters, under stones or logs and crevices of trees. During the study period the snails was seen to, Jack fruit, Mahogany, *Acacia* and Teak trees.

Population density: *Cyclophorus pearsoni* highest ($10.66/10 \text{ m}^2$) during Monsoon in Malnichra tea garden forest, Sylhet and minimum ($0.16/10 \text{ m}^2$) summer in the same forest (Appendix table 3.IV).

Distribution: Bandarban, Rangamati, Chittagong Hilltracts Sylhet and Moulovibazar Districts.

Elsewhere: India, Assam, Himalaya, Myanmar. Also found in Africa and Australia.

Economic importance: It is a minor pest of crops. Feeds on dead leaves or twigs of plants.

Ecological role: The snails play an important role in the terrestrial ecosystem as a scavenger; and also contributes to recycling the plants nutrients.

Genus: *Pterocyclus* Benson, 1832

1832. *Pterocyclus* Benson, *J. Asiat. Soc. Bengal*, 1: 11.

Shell discoid, depressed, without a sutural tube; spire nearly flat; whorl, narrowly wound, without inflation and constriction visible on both on both side, whitish with chocolate marking a band below the periphery; widely umbilicate; aperture circular peristome double, with inner and an outer wing like protrusion. Operculum horny, multispiral, convex, nucleus central (Thakur *et al.*, 1992; Subba Rao *et al.*, 1995).

Species: *Pterocyclus parvus* Pearson, 1833

Synonyms:

1833. *Spiraculum parvum* Pearson, *J. Asiat. soc. Beng.* 2:592, pl.20, fig.7.

1921. *Pterocyclus parvum*, Gude, *Fauna of British India, Mollusca*, 3; 108.

1985. *Pterocyclus parvus*: Day, Barua Mitra, *Rec, Zool, Surv. India*, 82(1-4): 265.

Description: Shell sub diaphanous, white encircled with a dark brown line along the circumference of whorl, striated above with brown zigzag striate; and incomplete breathing tube situated near the aperture; aperture circular, peristome thickened and reflected; umbilicus widely open, operculum fairly thick, flat externally, internally concave, multi spiral, whorls with rough edges, nucleus central; Tentacles 2, brownish with darker rings; head dark brownish, foot light brown.

Size: Average length of shell, width, aperture diameter 7.12 ± 0.75 , 14.12 ± 3.825 and 4.35 ± 0.28 . 10 mm respectively.



Figure 95: Dorsal view of Pterocyclus parvus



Figure 96: Ventral view of Pterocyclus parvus

Habits: They are scavenger, living on dead or live plant matters, fungal rich detritus and damp soil. During the dry season, the snails undergo aestivation. Majority of them aestivate on ground in busy places, base of big tree, crevices of tree, under stones and decaying leaves.

Habitat: Ground, among low vegetation, evergreen forest, leaf litters, under stones or logs and crevice of trees. During the study period the snails was seen attached to Loha, Raktan, and Mango trees.

Population density: *Pterocyclus parvus* highest ($8.83/10 \text{ m}^2$) during Monsoon in Lawachra forest, Maulvibazar (Table 16) and minimum ($0.33/10 \text{ m}^2$) summer in Malnichara tea garden forest (Appendix table 2.III).

Economic importance: It is a minor pest of crops. Feeds on soft twigs and floral buds of plants.

Ecological role: The snails plays an important role in the terrestrial ecosystem as a scavenger; and also contributes to the recycling the plants nutrients.

Genus: *Chamalycaeus* Kobelt & Mollendorff, 1897

1897. *Chamalycaeus*, Kobelt & Mollendorff. *Nachr Deuts Malak. Ges.*, 29: 151.

Subgenus: *Dicharax* Kobelt & Mollendorf 1900

1900. *Dicharax* Kobelt & Mollendorff, Nachr, *Deuts. Malak. Ges.*, 32:186.

Species: *Chamalycaeus (Dicharax) crenatus* Godwin-Austen

Synonyms:

1871 *Alycaeus crenatus* Godwin-Austen, *J. Asiat. Soc. Beng.* 40(2):90 pl. 3, fig. 5, 5a, 5b.

1897. *Alycaeus (Charax) crenatus* Kobelt & Mollendorff, *Nachr. Deuts. Malak. Ges.*, xxix, P. 152.

1902. *Alycaeus (Dicharax) crenatus*. Kobelt, , *Das Tierreich, Lief.* 16, P. 3 66.

1921. *Alycaeus (Dicharax) crenatus*. Gude, *Fauna British India, Mollusca*, 3:241.

Description: Shell depressedly turbate, moderately umbilicate, whitish, very finely and indistinctly costulately throughout sculptured distinction the swell of the last whorls; whorls 4, rounded, last whorls swollen and constricted at the base of sutural tube which is moderately long and thick constricted portion with sub vertical ridge just behind the peristome; aperture circular deeply waved on the outer margin; peristome closely double expanded and reflected.

Size: Average length of shell, width and aperture diameter 5.12 ± 0.17 , 5.18 ± 0.90 and 1.81 ± 0.08 . mm respectively.



Figure 97: Dorsal view of *Chamalycaeus (Dicharax) crenatus*

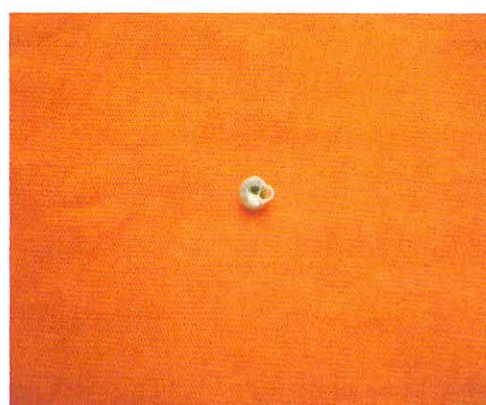


Figure 98: Ventral view of *Chamalycaeus (Dicharax) crenatus*

Distribution: Maulvibazar District.

Elsewhere: India. Assam, Meghalaya, Nagaland.

Habit: They are scavenger, feeds on algae, moss and, fungal rich detritus from the bark of trees.

Habitat: Found in Evergreen hill area of Maulvibazar District. They are attached to stem and branches of trees.

Population density: During the study period the snails found in sporadically.

Economic importance: Feeds on soft twigs or leaves of plants.

Ecological role: The snail plays an important role in the terrestrial ecosystem as a scavenger.

Order: Stylommatophora

Family: Veronicellidae

Genus: *Flicaulis* Simorth 1913

1913. *Filicaulis* Simorth, Reise in Ostafrika v. a. Voeltzhaw Stuttgart. p.202.

Subgenus: *Eleutherocaulis* Simorth, 1913

1913. *Eleutherocaulis* Simorth, Reise in Ostafrika v.a. Voeltzkaw Stuttgart. p. 202.

Species name: *Filicaulis (Eleutherocaulis) alte* Ferrussac

Synonyms:

1821. *Vaginulus alte* Ferrussac, Tabl. Syst. Limaces, p. 14.

1914. *Vaginulus alte* Gude, Fauna of British India, Mollusca, 2: p. 3 52.

1991. *Laevicaulis alte*: Subba rao and Mitra, Rec. Indian Mus., Occ. Paper, 126:36.

Local name: Chatt, Atali.

Description: Animal without shell, elongate, linear in extended condition, completely covered by mantle, dark brownish, usually with a yellowish band down the middle. A deep furrow around the margin separates the mantle from the foot. Head retractile, with two pairs of tentacles, which are contractile, sole of foot tripartite, middle portion numerous marking (Mitra *et al.*, 2005).

Size: Average body length and width about 27.0 ± 2.44 and 7.33 ± 0.78 .



Figure 99: Dorsal view of Filicaulis (E.) alte **Figure 100:** Ventral view of Filicaulis (E.) alte

Habits: Found in moist place. They are nocturnal and herbivorous, Feeds on plant leaves, and decaying vegetable material. The slug's active at night and crawl with help of muscular foot in search of food. It is monoceious or hermaphrodite.

Habitat: They inhabit kitchen garden, bushes etc. During the dry period, it aestivates under soil, bricks, logs decaying twigs and leaves.

Population density: *F. alte* highest ($2.16/10\text{m}^2$) during Monsoon in BARD annex forest, Comilla and minimum ($0.16/10\text{m}^2$) during winter in Malnichara tea garden forest, Sylhet district (Appendix table 1.IV & 3.III)

Distribution: Abundant in Comilla Habiganj, Maulvibazar, Rajshahi, Sythet Khulna, Jessore, Chittagong and Chittagong hill tracts.

Elsewhere: India, Myanmar, Srilanka, Malay pensula, Indonesia and China; also in East Africa and Australia.

Economic importance: It is a vegetable pest. The slugs feed on plants in cultivated lands. It is also the intermediate host of rat lung worms (Encyclopedia of Flora and Fauna of Bangladesh, (2007 Vol : 17).

Ecological role: The slug plays an important role in the terrestrial ecosystems as herbivores.

Family Ariophahtidae

Shell small to large, dextral or sinistral. Thin to fairly thick, narrowly perforate, rarely imperforate, usually depressely globose, and broader than high, sometimes conid, a few genera have internal or partly internal shell, usually without strong sculpture; aperture lunate, peristome thin.

Genus: *Girasia* Gray, 1855

Species name: *Girasia crocea* Godwin-Austen

Synonyms:

1872. *Helicarion (Hoplids)* Godwin-Austen, P.Z.S.p.517.

1908. *Girasia crocea* Blanford & Godwin-Austen, *Fauna of British India, Mollusca*, Testacellidae and Zontidae p. 201.

Local name: Kukurjak (Sylhet)

Description: Shell thin flat, rudimentary, horny translucent, with a broad band of dark green from apex to the edge of the membranous peristome; pointed apex; peristome continuous, convex.

Colour: Animal a fine saffron-yellow colour and pale yellow outside of foot.

Size: Average body length, and width about 42.00 ± 4.94 and 7.05 ± 0.37 mm.



Figure 101: *Girasia crocea* (Live)



Figure 102: Dorsal view of *Girasia crocea*

Habit: Hermaphrodite and herbivorous. Feeds on soft twigs or leaves of plants.

Habitat: Found in terrestrial habitat, kitchen garden, bushes and leaves of large trees. During the observation they are found in Jackfruit, Teak, Mehogoni, Krisnachura, Bakul, Tamarind, Akasi, Papaya, Mangium and Banana tree.

Population density: *Girasia crocea* highest ($6/10 \text{ m}^2$) during Monsoon in BARD annex forest, Comilla and minimum ($0.16/10 \text{ m}^2$) summer in the same forest (Appendix table 1.IV).

Distribution: Abundant in Comilla Habiganj, Maulivibazar, Sylhet, Chittagong and Chittagong hill tracts.

Elsewhere: India, Myanmar, Srilanka and some other Asian counties. **Economic importance:** It is a vegetable pest.

Ecological role: The slug plays an important role in the terrestrial and arboreal ecosystems as herbivores.

Species name: *Girasia hookeri* Gray

Synonyms:

1855: *Girasia hookeri* Gray, *Cat. Pulm. Brjt. Mus.* p. 61.

1872. *Helication (Hoplifis) theobaldi*, Godwin-Austen, *P.ZS.* p. 517.

1875. *Helicayion shillongense*, Godwin-Austen, *J.A.S.B.* p. 4.

1875. *Helication brunneum*, Godwin-Austen, *J.A.S.B.* p. 5.

1891. *Girasia extranea* Cockerell, *A, M.N.H.* (6) P. 104.

1908: *Girasia hookeri* Blanford & Godwin-Austen, *Fauna of British India, Mollusca*, Testa cellidae and Zontidae p. 200.

Local name: Local name: Kukurjak (Sylhet)

Description: Shell oblong membranous and soft, with a thin olivaceous, epidermis curled up so as to form an incipient spire at one end, drawn out into a broad ribbon like stripe at the other.

Animal varying from pale yellowish dull grey or pale brown to ochraceous or dark umber-brown sometimes spotted on mantle. The mantle-lobes completely cover the shell, at times leaving a small area exposed; they also cover a considerable portion of the animal in front of the shell.

Size: Average body length and width 61.00 ± 6.55 and 10.16 ± 0.76 mm respectively



Figure 103: Whole view of Girasia hookeri



Figure 104: Shell of Girasia hookeri

Habits: Hermaphrodite and herbivorous. Feeds on soft twigs or leaves of plants.

Habitat: Found in terrestrial habitat, kitchen garden, bushes and leaves of large trees. During the observation they are found creeping on grass and, crevices of Bricks.

Population density: Found in sporadically. So population density cannot determine.

Distribution: Abundant in Comilla, Maulvibazar, Sylhet Chittagong and Chittagong hilltracts.

Elsewhere: India

Economic importance: It is a vegetable pest.

Ecological role: The slugs play an important role in the terrestrial and arboreal ecosystems as herbivores.

Species name: *Austenia gigas* Benson

Synonyms:

1836. *Vitrina gigas* Benson, *J. Asiat. Soc, Beng*, 5:3 5 0.

1908. *Austenia gigas* Blanford and Godwin- Austin, *Fauna of British India, Mollusca*, Testcellide and Zonitidae : 192.

Local name: Chatt

Description: Shell large, (Largest among Indian Species), rather thick shallow, depressedly ovate, yellowish, faintly striate, number of whorls 2, very rapidly increasing, spire projecting beyond the peristome considerably, apex small, flat, last whorls depressedly elongate; aperture very large, oval, peristome thin, columella slightly thickened.

Distinct for its bigger size, more number of whorls and also the spire projecting beyond the peristome.

Size: Length of shell, width, aperture length and width $22.5-+1.06, 28 \pm 1.41, 18.75 \pm 0.35$ and 18.25 ± 0.35 mm respectively.



Figure 105: Ad apertural view of *Austenia gigas*



Figure 106: Apertural view of *Austenia gigas*

Habit: Hermaphrodite and herbivorous. Feeds on soft twigs or leaves of vegetable, small plants and leaves of banana trees.

Habitat: Found in slope of evergreen forest. They are also found in banana leaves and bushes throughout the year. This snails are active in the night hours to till morning. During the dry season, the snails undergo aestivation. Their activity completely depends on the soil and air moisture.

Population density: *A.gigas* highest (1.16/10 m²) during Winter Lawachara forest, Maulvibazar district and minimum (0.33/10 m²) Summer in the same forest (Appendix table 3.III).

Distribution: Mauvibazar, Chittagong and Chittagong hilltracts.

Elsewhere: India: Meghalaya, Myanmar.

Economic importance: It is a vegetable pest.

Ecological role: The slugs play an important role in the terrestrial and arboreal ecosystems as herbivores.

Subfamily: Macrochlamydinae

Genus: *Macrochlamys* Benson, 1832

Synonym:

1832. *Macrochlamys* Benson, *J. Asiat. Soc. Beng.*, 1: 13&76.

1908. *Macrochlamys indica* Blanford & Godwin-Austen, *Fauna of British India, Mollusca* Testacellidae Zonitidae: 77.

Species name: *Macrochlamys indica* Godwin-Austen

Synonym:

1883. *Macrochlamys indica* Godwin-Austen *Moll. Ind.*1: 76,97.

1908. *Macrochlamys indica* Blanford & Godwin-Austen, *Fauna of British India, Mollusca* Testacellidae Zonitidae: 95.

Local name: Chakti shamuk

Description: Shell perforate, depressed, pale brown, surface smooth and polish, translucent, whorls five and half spire low and conoid suture slightly impressed, the body

whorls slightly convex above, not descending rounded at the periphery. Aperture slightly oblique broadly lunate, columellar margin curved, oblique and slightly reflected, above, peristome thin. (Raut & Ghos, 1984)

Size: Average length of shell, width, aperture length and width 13.83 ± 0.28 , 20.66 ± 0.76 , 9.33 ± 0.28 , 7 ± 0.5 ,



Figure 107: Dorsal view of Macrochlamys indica



Figure 108: Ventral view of Macrochlamys indica

Habits: Hermaphrodite. Feeds on mulberry plants, gourds, beans, cabbage, cauliflower, Amaranth, cosmos, marigold and some wild and ornamental plants. Often feeds on the dead individuals of its own species. Nocturnal and remains hidden in the soil and litters near the base of the plants with the approach of dusk. It starts eating from the margin of the leaf lamina at night (Jahan *et al.*, 2002) In laboratory the recorded mean mating duration of *Mindica* was 34.48 ± 1.45 , (range 32-36) minutes. The snails dig hole in the moist soil with the help of the anterior end of their snout and foot. The holes are about 1.5-2.3 cm. deep and 0.3 cm. in diameter. The eggs are translucent and round, with a tough elastic leathery eggshell impregnated with certain amount of calcareous material. The diameter of egg is on the average 3.0 to 3.5 mm. In the laboratory they survived for 196 days on mulberry plants.

Habitats: Found in terrestrial habitat, kitchen garden, mulberry plantations, and bushes. Sometimes found in damp concrete wall.

Population density: *M. indica* highest ($5/10 \text{ m}^2$) during Monsoon in BARD annex forest, Comilla and minimum ($0.5/10 \text{ m}^2$) summer in the same forest (Appendix table 1.IV).

Distribution: Brahmanbaria, Comilla, Habiganj, Maulvibazar, Sylhet, Moist parts of Rajshahi Khulna, Jessore, Chittagong districts and Chittagong hill tract

Elsewhere: India: Common through out, except drier parts of north-west region, Srilanka, Myanmar and some other Asian countries.

Economic importance: *Macrochlamys indica* has already established itself as a pest of mulberry plants in silk growing regions of Bangladesh. It is frequently observed to graze upon the leaves of seedling and sapling of the rabi or winter crops.

Ecological role: *M indica* is a menace to vegetables and mulberry plants grown parts of Bangladesh.

Status: Abundant.

Species name: *Macrochlamys opiparus* Godwin-Austen 1883.

Synonym:

1883. *Macrochlamys opipara* Godwin-Austen,

1908. *Macrochlamys opipara* Blanford & Godwin-Austen, *Fauna of British India, Mollusca Testacellidae & Zonitidae*.

Local name: Chakti shamuk

Description: Shell perforate, impressed, brownish, surface smooth and polish, translucent, whorls five, spire high and conoid, suture deeply impressed, the body whorls slightly convex above, rounded to the periphery. Aperture oblique broadly, lunate, columellar margin curved, oblique and slightly reflected, above, peristome thin, apex pointed (Jahan *et al.* 2003).

Size: Average length of shell, width, aperture length and width 8.40 ± 2.11 , 11.83 ± 2.64 , 5.8 ± 1.43 and 3.0 ± 0.91 mm respectively.



Figure 109: *Apertural view of Macrochlamys opiparus*



Figure 110: *Abapertural view of Macrochlamys opiparus*

Habits: Hermaphrodite It is diurnal in habit and consumes on leaves and fruits of mulberry plants. During the day time the snails keep attached to the under surface of the leaves or the stem and branches at night. Juvenile snails feed only on the chlorophyll materials of the leaves leaving net like skeleton of veins and veinules (Jahan *et al*, 2003).

Habitats: Found in terrestrial habitat, kitchen garden, mulberry plantations, and bushes.

Population density: Found in sporadically in the studied region.

Distribution: Maulvibazar, Sylhet, Moist parts of Rajshahi, Khulna, Jessore, Chittagong districts and Chittagong hilltract.

Elsewhere: India: Common throughout, except drier parts of north-west region, Srilanka, Myanmar and some other Asian countries

Economic importance: *Macrochlamys opiparus* is a serious vegetable pest and has already established itself as a pest of mulberry plants in silk growing regions of Bangladesh. It is frequently observed to graze upon the leaves of seedling and sapling of the rabi or winter crops.

Ecological role: *M. opiparus* plays a role as a vegetable pest in the food chain.

Status: Abundant.

Species name: *Macrochlamys lubrica* Benson. Synonyms: 1852. *Helix lubfica* Benson, Ann. Mag, nat, Hist. (2) 10:349.

1908 *Mocrochlamys lubrica*, Branford & Godwin-Austen, *Fauna of British India, Mollusca*, Testa cellidae and Zontidae 89.

Description: Shell large, rater thin, depressed, perforate, smooth, and polished. yellowish to brownish with, finely microscopically striate; spire low, almost flat; whorls 5, flatly convex above, the last much broad, rounded at the periphery, and blow, aperture spherical, broadly lunate peristome thin, arcuate above, calomella reflected above, basal margin slightly thickened inside. Distinct for its shining shell with flattened spire and broad last whorl.

Size: Length of shell, width, aperture length and width 10.25 ± 0.35 , 18.5 ± 0.7 and 7.5 ± 0.70 and 7.25 ± 0.35 mm respectively.



Figure 111: Apertural view of *Macrochlamys lubrica*



Figure 112: Abapertural view of *Macrochlamys lubrica*

Distribution: Sylhet District.

Elsewhere: India, West Bengal, Skkim, Maghalaya (Gareohills)

Habit: *M lubrica* is nocturnal in habit. In the daytime hidden in the soil and litters near the base of tree. They feed on tender leaves of plants like as gourd, beans, and marigold, lettuce, cabbage and wild plants.

Habitat: Found in terrestrial habitat, kitchen garden, and bushes.

Population density: This species found in sporadically during the study period.

Economic importance: *Macrochlamys lubrica* is a serious vegetable pest and has already established itself as a pest of mulberry plants in silk growing regions of

Bangladesh. It is frequently observed to graze upon the leaves of seedling and sapling of the rabi or winter crops.

Ecological role: *M. lubrica* plays a role as a vegetable pest in the food chain. Genus: *Austenia* Nevill, 1878. *Austenia* Nevill, *Hand list. Moll. Indian Mus.*, 1: 16.

Genus: *Sitala* H.Adams, 1865

1865. *Sitala* H. Adam, *Proc.zool.Soc.Lond.*, p.408.

Species name: *Sitala attegia* Benson

Synonyms:

1959. *Helix attegia* Benson *Ann. Mag. Nat. Hist.*, (3): 184.

1908. *Sitala attegia* Blanford & Godwin-Austin, *Fauna of British India, Mollusca, Testa cellidae & Zonitidae*: 227.

Description: Shell rather small conoid, subtrochiform, very narrowly perforate, thin pale, yellowish translucent; decussately sculptured by oblique striate and raised spiral lines, both above and below, some of the spiral lines more prominent; spire conoidly raised, apex pointed; whorls $7-7\frac{1}{2}$ convex, gradually increasing, the last keeled at the periphery, rounded beneath; aperture oblique, subquadrately lunate, peristome thin, slightly arcuate above, columellar margin vertical, broadly reflected above.

Size: Average height of shell 7 ± 5.81 , diameter 7.33 ± 6.08 , and aperture 2.66 ± 0.28 mm respectively.



Figure 113: Dorsal view of *Sitala attegia* (Live)



Figure 114: Apertural view of *Sitala attegia*



Figure 115: Abapertural view of *Sitala attegia*

Distribution: Comilla, Maulvibazar districts Elsewhere: India Andaman Inlands, Myanmar.

Habit: They feed decaying leaves and bark of the tree. These snail are nocturnal. They are found active June to August. The remaining month of the year are spent in aestivation. Occasionally, during the aestivation, they become active for a short period following heavy shower.

Habitat: Found in terrestrial habitat, bushes twigs and stem of large trees. During the observation they are found Jackfruits (*Artocarpus heterophyllus*), Teak tree (*Tectona grands*). Wood apple tree, (*Aegle marmelous*), Bohera tree. They are also found in banana leaves.

Population density: During the study period, *S.attegia* was found in sporadically.

Economic importance: It is feeds on soft twigs and leaves of plants.

Ecological role: The snail plays an important role in the terrestrial and arboreal ecosystems as herbivores.

Shell medium sized, depressed to turbate; usually openly umbilicate, sculptured; more or less, circular, often variously, modified. Operculum calcareous or horny, many whorl, sometimes externally convex.

Genus: *Euaustenia* Cockerell, 1891

Species: *Euaustenia cassida* Hutton, 1838

Synonyms:

1838. *Euaustenia cassida* Hutton, *J. Asiat Soc, Beng.*, 7:214.

1908. *Euaustenia cassida*: Blanford & Godwin-Austen, *Fauna of British India, Mollusca, Testacellidae & Zonitidae*: 150.

Description: Shell large, ovately depressed, very thin and fragile, imperforate, yellowish brown; decussately sculptured by raised oblique striae and very fine, close spiral lines both above and below; spire slightly convex, very slightly raised; whorls 4-4¹/₂, convex, rapidly increasing in size, the last very broad and large, well rounded above and below; aperture strongly oblique, ovately lunate, peristome thin, upper margin remarkably arcuate, columellar margin curved, sinuate and reflected above forming a false perforation like opening.

Distribution: Maulvibazar and Sylhet, District.

Elsewhere: India: Western Himalaya, Himachal Pradesh, Kashmir, Punjab, Uttaranchal

Size: Average length of shell, width, shell aperture and width 5.5 ± 1.41 , 8.75 ± 2.47 , 4.75 ± 1.06 mm respectively.

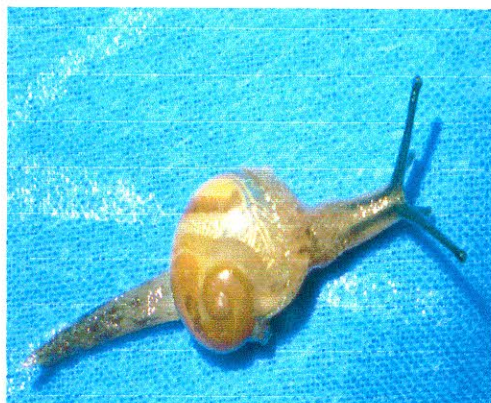


Figure 116: Whole view of *Euaustenia cassida*



Figure 117: Apertural view of *Euaustenia cassida*

Habit: They feed decaying leaves, and bark of the tree. These snails are nocturnal. They are found active June to August. The remaining month of the year are spent in aestivation. During the monsoon found in daytime.

Habitat: Found in tree like as Jackfruit, Mehogoni, Rakton Tree (*Lophopetolum fimbrianum*). The snail can run fast.

Population density: *E.cassida* was highest ($5.33/10\text{ m}^2$) during Monsoon in Malnichara tea garden forest, Sylhet and minimum ($0.33/10\text{ m}^2$) summer in the same forest (Appendix table 3.III).

Economic importance: It is a vegetable pest.

Ecological role: The slugs play an important role in the terrestrial and arboreal ecosystems as herbivores.

Genus: ***Rachis*** Albers, 1850

1850. *Rachis* Albers, *Die Heliceen* p. 164.

Family: Cerastuidae

Shell small to medium, ovate-oblong, narrowly perforate or deeply umbilicate, with fine sculpture or coarse striate, whorls convex, last whorls equal or less than the spire, aperture ovate peristome simple or reflected, columella margin a little reflect over the umbilical opening.

Species: *Rachis bengalensis* Lamarck.

Synonyms

1822. *Bulimus bengalensis* Lamarck, *Hist. Nat. Anim. Sans. Vert.*, 6(2): 124.

1856. *Bulimus (Mesembrinus) bengalensis* Pfeiffer, *Malak. Blati.ii* p. 158.

1860. *Bulimus (Rhachis) bengalensis* von Martens, *Die Heliceen*, ed. 2, p. 23 1.

1878. *Buliminus (Rhachis) bengalensis* Nevill, *Hand List i*, p. 130.

1881. *Bulimina (Rachis) bengalensis* Pfeiffer & Clessin, *Nomencl. Hefic viv.* p. 285.

1894. *Buliminus (Rhachis) bengalensis*, Jousseume, *Mem. Soc.Zool. France*, vii, p. 296.

1903. *Rhachis bengalensis*, Kobelt & Mollendorff, *Nachr. Deuts. Malak. Ges*, P. 37.

1921. *Rhachisellus bengalensis*: Gude, *Fauna of British India, Mollusca* 2: 274.

1991. *Rhachis bengalensis*, Raut and Biswas, 1991.

Local name: Dorakata Gesho shamuk.

Description: Shell perforate ovate-acute, thin diaphanous, pale white or yellowish white, usually encircled by two rarely three chocolate bands, one bordering the suture. Spire conoid, apex acute, black, whorls 6 slightly flattened, last whorls swollen; aperture oval, wide peristome thin a little reflected, columella margin dilated.

Size: Average shell length, width aperture length, and width 14.87 ± 3.59 , 7.32 ± 1.5 , 5.75 ± 1.44 and 3.87 ± 0.47 mm. respectively.



Figure 118: *Dorsal view of Rhachis bengalensis*



Figure 119: *Apertural view of Rhachis bengalensis*



Figure 120: *Dorsal view of Rhachis bengalensis*

Habit: *R. bengalensis* are phytophagous, feed exclusively on barks of *Mangifera indica*, *Aegle marmelos*, *Zizyphus mauritiana*, *Erythrina indica*, *Citrus aruantifiblia*, and *Lannaesa coromendefica* trees (Raut and Biwas, 1991). The snails were performing all types of activities on the trees. Under no circumstances, they were seen to come to the ground. The activities of these snails was mostly confined to night hours but sometimes were active in day hour, the following heavy showers in rainy cloudy days. In nature they are active in July -October during the monsoon. They remain months were spent in aestivation. Occasionally, during aestivation, they

became active for a short period following heavy shower. In monsoon, in sunny days the snails were seen to spent the day time in quiescent state at the under surface of leaf, stem and branches of tress. The sigh is entirely protected from direct sunlight, at the onset of darkness, the snails were seen to come out of the resting place form nocturnal activities. The snails were seen to aestivate at the ventral side of the leaf, on the lateral walls of tee trunk and also inside the holes and crevices of the tree. It secrets a thin transparent epiphragm, which glues the shell to tree (Raut and Biswas, 1991, Jahan *et al.*, 2003). During the present investigation the snails were found in *Aegle marmelos*, *Dulanchapa* and *Mahua* trees.

Habitat: The snails attached to stems, branches or leaves of trees like wood apple, lemon, mango and mahua tress.

Population density: *R.bengalensis* only (0.66/10 m²) during Monsoon in BARD annex forest, Comilla (Appendix table 1.IV).

Economic importance: The colorful shell used for decoration.

Ecological role: The snail plays an important role in the terrestrial ecosystem as herbivores.

Distribution: Comilla, Habiganj, Maulvibazar, Sylhet, Rajshahi, Noakhali, Jessore, Chittagong.

Elsewhere: India: Common through except North West India.

Family: *Subulinidae*

Shell small to moderate in size, elongate, turreted to cylindrical uniformity coloured imperforate, apex globosely obtuse, whorls smooth or with indistinct sculpture on apical whorls and in sutural region on lower whorls; aperture simple, ovate, outer lip curved in some, columella straight or curved, truncate or rounded.

Foot with undivided sole and without caudal gland.

Genus: *Glessula* von Martens, 1860

1860. *Glessula* von Martens, *Die Heliceen*, and ed.2: 254.

Species name: *Glessula gemma* Reeve.

Synonym

1850. *Achatina gemma* (Benson) Reeve, *Conch, Icon.*, 5 *Achatina* pl. 22 fig. 123.

1855. *Oleacina (Electra) gemma*, Adams, *Gen. Rec. Moll.* ii, P. 105.

1856. *Achatina (Electra) gemma* Pfeiffer, *Malak. Blatt.* ii, P. 168.

1860. *Cionella (Glessula) gemma* Vor Martens., *Die Heliceen.* ed. 2, P. 254.

1878. *Stenogyra (Glessula) gemma* Nevill, *Hand list*, p. 170.

1881. *Glessula gemma* Pfeiffer & Clessin, *Nomencl. Helic.* Viv. p. 33 1.

1914. *Glessula gemma*: Gude, *Fauna of British India Mollusca*, 2: 428.

Description: Shell small oblong conical, imperforate polished and shining, light -chocolate coloured, very finely striate, whorls 6, apex obtuse, and aperture sub oval columella slightly arched and truncate below.

Size: Average length of shell, width, and aperture length and aperture width 6.7 ± 0.57 , 3.7 ± 0.27 , 2.16 ± 0.022 and 1.66 ± 0.13 mm respectively.

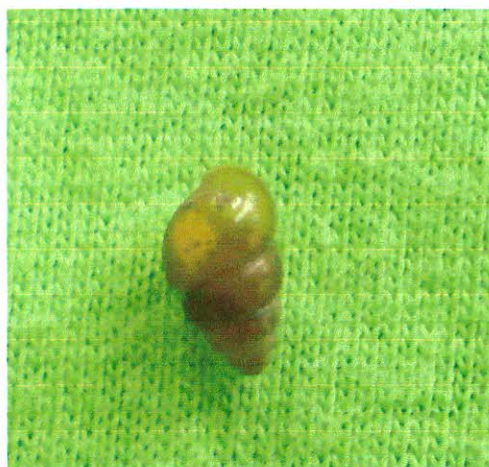


Figure 121: Apertural view of *Glessula gemma* (X2)

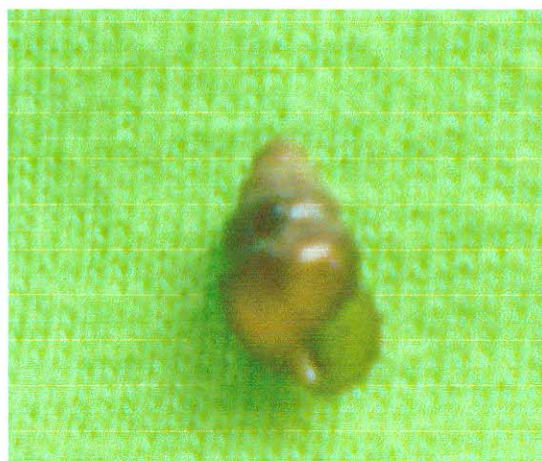


Figure 122: Apertural view of *Glessula gemma* (X2)

Distribution: Comilla, Habiganj, Maulvibazar & Sylhet districts.

Elsewhere: India, Meghalaya, Bihar, Orissa, West Bengal and Myanmar.

Habits: *G. gemma* found active during monsoon, or in summer following repeated pre monsoon showers. They feed on decaying leaves and damp soil. They also feed tender leaves of plants. The snails are nocturnal in habit.

Habitat: The snails inhabit leaf litters, damp soil and crevices of bark. In monsoon the snails become active within few hours following rains. The snails thrived well up to October. In the advent or winter (November) they entered into there aestivating

homes and became active by next year following heavy showers. They were active up to September (Raut *et al.*, 1985).

In aestivating time they aestivate in to bark of tree, crevices, under, decaying leaves and soil in the base of big tree.

Population density: *G.gemma* highest (4.66/10 m²) during Monsoon in BARD annex forest, Comilla diastrict and minimum (0.33/10 m²) Summer in the same forest (Appendix table . . .).

Economic importance: Feeds on soft twigs, bark or leaves of plants.

Ecological role: The snail plays an important role in the terrestrial ecosystem as a scavenger.

Species : *Glessula notigena* Benson Synonyms ?

1853. *Achatina notigena*, Benson, A.M.N.H. ser. 2, xii, p. 94.

1856. *Achatina (Subulina) neruina* Pfeiffer, *Malak, Blaff*, ii, p. 169.

1878. *Stenogyra (Glessula) veruina* Neveill, , *Hand list* 1, p. 17 1.

1881. *Stengogyra (Subulina) veruina* Pfeiffer 8 Clessin, *Nomenel-Helic. viv*, p. 3 31.

1921. *Glessula notigena*: Gude, *Fauna of British India Mollusca* 2: 412.

Discription: Shell elongated, conical upwards gradually tapering into slender, obliquely striate bright reddish yellow or gold colour; spire turreted; apex obtuse suture impressed, irregular notch whorls 9-10 convex, aperture sub vertical and small semi oval, columella arched, sub vertical, base sub obliquely truncated; one third of the last whorls is no attingenate (to touch the rest whorls), peristome straight, slender, edges thick, thin at the joined.

Size: Average length of shell, width, aperture length and aperture width 23 ± 2.58 , 7.21 ± 1.21 , 5.42 ± 1.01 and 2.85 ± 0.69 mm respectively.



Figure 123: *Abapertural view of Glessula notigena*

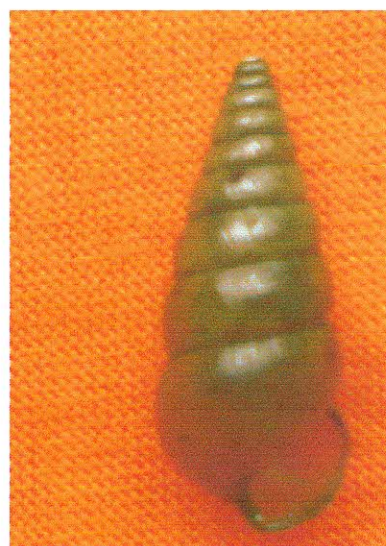


Figure 124: *Apertural view of Glessula notigena*

Habits: *G. notigena* was found active during monsoon, or in summer following repeated pre monsoon showers. They feed on decaying leaves and damp soil. They also feed tender leaves of plants. The snails are nocturnal in habit.

Habitat: The snails inhabit leaf litters, damp soil and crevices of bark. In monsoon the snails become active within few hours following rains. In the advent or winter (November) they entered into there aestivating homes and became active by next year following heavy showers. During the present investigation the snails found in damp soil of big trees like as Koroi, Mango, Jackfruit, Krishnachura, Cassia, trees.

Population density: *G.gemma* highest ($6.66/10\text{ m}^2$) during Monsoon in Malnicha teagardn annex forest, Sylhet district and minimum ($1.00/10\text{ m}^2$) Summer in the same forest (Appendix table 3.III).

Distribution: Sylhet, Habiganj, Maulvibazer districts.

Elsewhere: India: Mahableshwar Hills, Sikkim, Darjeeling.

Genus: *Lamellaxis*: Strebel and Pfeffer, 1822

1822. *Lamellaxis* Strebel and Pfeffer, *Mex. land Conch.*, p.77.

Shell small less than 15mm in length, oblique striate, without spiral sculpture last whorls less than half, of the total length, columella simple, rounded at the base, straight (Mitra *et al.*, 2005).

Subgenus: *Allopeas* H.B.Baker, 1935

1935. *Allopeas* H.B.Baker, *Nautilus Philad.*, 48(3):84.

Species name: *Lamellaxis (Allopeas) gracile* Hutton, 1834

Synonym:

1834.No. 5, *Bulimus* ? Hutton, *J.Asiat.Soc.Beng.*, 3, p. 84.

1856. *Bulimus (Opeas) gracilis* Pfeiffer, , *Malak. Blatt*, ii, p. 156. 1860.*Stenogyra (Opeas) gracilis*, von Martens, *Die Heliceen*, ed. 2, p. 265.

1861.*Spiraxis gracilis* Blanford, *J.A.S.B.* XXX, P. 362.

1867.*Stenogyra gracilis* von Martens, press, *Exp. Ost-Asien, Zool. Iheil*, ii, p. 375

1878.*Opeas gracile* Theobalds *J.Asiat. Soc.Beng.*, xviip. 146.

1894. *Opeas gracile* Mollendorff *P. Z S*, p. 151.

1905. *Opeas indicus* Dautzenberg & Fischer, *Journ. Conchyl.*, I iii, p. 102.

1914. *Glessula gracile* Gude, *Fauna of British India Mollusca*, 2: 355.

Description: Shell small, narrow-elongate, thin, imperforate, transparent, spire gradually tapering to a blunt apex, very finely striate; whorls 8-10, convex; aperture semi ovate, columella lip straight and almost parallel to the outer lip; slightly reflected, widely rounded at the base.

Size: Average length of shell, width, aperture length and aperture width 12.08 ± 4.57 , 3.62 ± 0.91 , 2.20 ± 0.55 mm respectively.



Figure 125: Abapertural view of *Lamellaxis (Allopeas) gracile*



Figure 126: Apertural view of *Lamellaxis (Allopeas) gracile*

Habits: *Lamellaxis (Allopeas) gracile* is a common garden snail. It feeds fallen decomposed leaves of garden plant and rarely attacked lives one normally consumes fallen decomposed litters leaves of potted garden plants. The snail lays egg at night and rarely in daytime. Eggs are usually laid under leaves, stones and bricks like wise. They are hermaphrodite.

Habitat: Found in terrestrial habitat, kitchen garden, potted plantations bushes etc, *Lamellaxis (Allopeas) gracile* prefers moist soil for aestivation majority of them aestivate on ground and shady or covered plant were found active between mid May and November. The snail prefers ornamental plants grown in earthen pot (Jahan *et al.*, 2003).

Population density: *L. (A.) gracile* highest (7.5/10 m²) during Monsoon in BARD annex forest, Comilla (Appendix table 1.IV) and Malnichara tea garden forest and minimum (0.66/10 m²) winter in BARD annex forest, Comilla (Appendix table 3.III & Appendix table 1.IV).

Distribution: Comilla, Habiganj, Maulvibazar & Sylhet districts.

Elsewhere: India: Meghalaya, Bihar, Orissa, West Bengal and Myanmar.

Order- Stylommatophora

Family- Achatinidae

Genus: *Achatina*, Lamarck, 1799.

Synonym

1799 *Achatina*, Lamarck, *Mem. Soc. His, Nat. Paris*, 7:75.

1991. *Achatina*, Subba Rao and Mitra, *Rec. zool. Surv. India*, occ. paper, 126: 39.

Shell moderately large to very large ovately conical, imperforate, whorls convex, aperture ovate, outer lip thin, unexpanded, columella concave or straight, usulally truncate below.

Subgenus : *Lissachatina* Benquaert, 1951

1951. *Lissachatina* Benqua rt. *Bull. Mus. Comp. Zoll., Harv.*, 105 : 136.

Species name: *Achatina fulica fulica* (Bowdich, 1822)

Synonyms:

1821. *Helixfulica* Ferussac. *Tabl. Syst. Limacons*, p. 49.No.347 (nom. nud).

1822. *Achatina fulica*, Lamarck, Bowdich *Elements of Conchology*, 1. pl. 13. fig. 3.
 1838. *Achatina fulica*, Deshayes, *Anim. sans vert.* ed.2, viii, p.297.
 1881. *Achatina (Achatinus) fulica*, Pfeiffer & Clessin, *Nomencl. Helic. Viv.* p.266.
 1914. *Achatina fulica* Gude, *Fauna of British India, Mollusca* 2:340.
 1950. *Achatina (Lissachatina) fulica*: Benquart. *Bull. Mus. Comp. Zool., Harv.*, 105(1): 216 pl.8.

Description: Shell large to very large ovate conoid, imperforate, thick pale yellowish with brown streak flames, vertical arrange; rather coarsely sculptured with vertical striae decussated by fine spirals (absent in the last whorls); whorls 8, convex and large equaling half of total length; aperture elliptic ovate, white or bluish violet inside columella broad, slightly curved and abruptly truncate below, peristome thin and sharp margin joined by a thick callus.

Size: Average length of shell, width, aperture length and width 83.83 ± 5.00 , 44.16 ± 2.25 , 42.00 ± 4.35 and 22.16 ± 1.89 mm respectively.



Figure 127: Apertural view of *Achatina fulica fulica*



Figure 128: Abapertural view of *Achatina fulica fulica*

Habits: *Achatina fulica fulica* is a serious agro-horticulture pest. The giant African land snail *A. fulica fulica* are found in night hours during monsoon month some times they are seen in active state for considerable length of time in day hours in rainy and cloudy days depending upon the weather condition of the area concerned. They spent day hours either in hiding under litters, bricks, wooden logs, or resting on the walls and tree trunks. They move out from these sites with the approach of night hours for their activities.

and tree trunks. They move out from these sites with the approach of night hours for their activities.

Habitats: Generally the snail occurs in agriculture and horticulture areas coastlands, natural and planted forest, riparian zones, shrub lands, urban areas and wetlands. *A. fulica* found in bushes, crevices, crotches of tree, inside the leaf bases of young coconut tree, under bricks, wooden logs and decaying twigs and leaves.

Population density: *A. fulica fulica* highest (5.33/10m²) during Monsoon in Malnichra tea garden forest, Sylhet and minimum (0.33/10 m²) summer in the same forest (Appendix table .III).

Economic importance: The snails *Achatina fulica fulica* are seen to feed on about 70 species of wild and economic plants usually cultivated in Bangladesh. They are used to attack the leaves of food plants but the bark, twigs, buds, flowers and fruits are never spared (Jahan and Raut 1994). They also create hazards in social fonts. Like in the district of eastern region of our country these snails' treaties problems on the road. In night hours they crashed out by the vehicles and in the day hours bared footed peoples faces danger of injury from broken shells.

Ecological role: *Achatina fulica fulica* are registered agro-horticulture pest in all most all countries where they have been introduced (Mead, 1961, 1979, Godan, 1983; Raut and Ghose, 1984).

Distribution: India except Northwestern parts, Bhutan, Malagasy, Mauritius, Nepal, Seychelles, Singapore, Zanzibar.

Bangladesh: Almost all districts.

Family: Streptaxidae

Shell depressedly helcoid, without strong sculptured, perforate, last one or two whorls usually moving away from the axis of upper whorls.

Genus: *Streptaxis*

Haplotychius is a new genus

1867. *Streptaxis pfeiffere* Zelebor, Zoo Bot Ges. Wien., 17:806.

1908. Blanford & Godwin-Austen, *Fauna of British India, Mollusca*, Testa cellidae and Zontidae, p.6.

Description: Shell slightly bigger, depressedly ovate, narrowly perforate, whitish, finely arcuately sculptured above, smooth below;

Whorl so well rounded, penultimate whorls rounded and scarcely projecting beyond the last when viewed from below; last whorls much broad and rounded, not compressed, aperture nearly vertical, roundish, margins thickened and reflected outer margin not arcuate, a single parietal lamella.

Size: Length of shell, width, aperture length and width 6.75 ± 0.35 , 5.25 ± 0.35 and 1.37 ± 0.17 mm, respectively



Figure 129: *Abapertual view of Streptaxis pfeiffere (X2)*



Figure 130: *Apertual view of Streptaxis pfeiffere (X2)*

Distribution: **Habit:** They feed on decaying leaves.

Habitat: Mostly occur among leaf litters, under stones, logs of wood or under the exposed roots of trees.

Population density: This Species found sporadically found during the study period.

Economic importance: The snails contribute to recycle to plants materials.

Ecological role: Plays a role in the terrestrial ecosystem as a scavenger; also contributes to recycle to plants materials.

Family: Plectopylididae

Ecological role: Plays a role in the terrestrial ecosystem as a scavenger; also contributes to recycle to plants materials.

Family: Plectopylididae

Shell moderately large, with a low or flat spire, widely umbilicate coarsely sculptured whorls 5 to 5.5, the last often deflected in front; aperture oblique lunate, mostly with callus and or an entering lamella; lip reflected or recurved; interior of the last whorls obstructed by a series of plates and denticles.

Genus: *Plectopylis* Benson, 1860

1860. Benson, *Ann, Mag.nat.Hist.*, (3):244

Subgenus: *Endothyrella* Zilch, 1960.

1960. *Endothyrella* Zilch, *Arch, Molluskenk.*, 89:1939)

Species name: *Plectopylis plectostonta* Benson

Synonym:

1836. *Helix plectostonta* Benson, *J. Asiat.Soc.Beng.*, 5351.

1914. *Plectopylis (Endothyra) plectostoma*: Gude, *Fauna of British India, Mollusca*, and 2:81.

Description: Shell small, narrowly umbilicate, depressed with a conoid spire, apex obtuse very coarsely sculptured, with oblique striate and spiral plicaton giving the shell a plaited appearance above, smoother below; whorls 5, last whorls compressed and descending; aperture oblique broadly lunate peristome thickened and reflected raised ridge on parietal callus indistinct -parietal armature includes above vertical plates with two folds one on each end two small denticles above and free horizontal fold below the vertical plates. Palatal armature consists of six horizontal folds.

Size: Length of shell, width, aperture length and width 5.33 ± 0.28 , 8.33 ± 0.38 , and 2.91 ± 0.28 mm are respectively.



Figure 131: *Abapertual view of Plectopylis plectostoma(X2)*



Figure 132: *Apertual view of Plectopylis plectostoma(X2)*

Distribution: Maulvibazar and Sylhet Districts.

Elsewhere: India: Arunachal pradesh, Assam, Meghalaya, Mizoram, Nagaland, Skkim, West Bengal (Darjeeling).

Habit: They feed on rotten leaves. Also feed on algae, moss and lichens from the bark of trees. *Plectopylis (Endothyra) plectostoma* is nocturnal in habit. It is active in monsoon. After monsoon the snails go to aestivation under the base of big tree, fallen leaves etc.

Habitat: Remain attached to stems, branches or leaves of trees like mango, mullberry plants, Raktan (*Lophopetalum fimbrianum*), Jackfruit (*Artocarpus heterophyllus*) trees. During the study period the snails were seen to attach to 30to 40 feet hieght of the trees.

Population density: *Plectophyllis plectostoma* highest ($19.16/10m^2$) during Monsoon in Lawachara forest, Maulvibazar District (Appendix table 2.III) and minimum ($1.16/10m^2$) during winter in Malnichara tea garden forest, Sylhet district (Appendix table 3.III)

Economic importance: The snails contribute to recycle to plants materials.

Ecological role: Plays a role in the terrestrial ecosystem as a scavenger; also contributes to recycle to plants materials.

Status: uncommon

Family: Succinidae

Shell oval or cap neither like, imperforate, thin, and horny, neither smooth nor, with distinct sculpture (the Genus *Hyalimax* an internal shell), translucent, spire conoid, short, whorls few, very rapidly increasing in size; aperture large and wide, columella simple, sometimes thin columella fold. Animal with a large foot, tentacles short, upper pair conoid with swollen base, lower pair absent or poorly developed conoid, short, whorls few, very rapidly increasing in size; aperture large and wide, columella simple, sometimes thin columella fold. Animal with a large foot, tentacles short, upper pair conoid with swollen base, lower pair absent or poorly developed

Genus: *Indosuccinea* Rao, 1924.

1924. *Indosuccinea* Rao, Rec. Indian Mus., 26:3 73

Species: *Indosuccinea plicata* Blanford

Synonym:

1865. *Succinea plicata* Blanford *J.A.S.B.* xxxiv, p.80.

1881. *Succinea* (*Tapada*) *plicata*, Pfeiffer & Clessin, Nomenclature Helic. Viv. p.412.

1914. *Succinea plicata* Gude, *Fauna of British India, Mollusca*, 2:448.

Local name: Gesho Shamuk

Description: Shell depressdly subovate, very thin, irregularly, obliquely and more or less, coarsely plaited, pale amber in colour, horny. Spire short; apex minutely papilar. Whorls 2.5 the last about 4/5 of entire length. Aperture oblique, curved backward at the base, nearly oval, openly angulate above; peristome simple, columellar margin regularly bow-shaped; right margin rather straighter.

Size: Length of shell width, aperture length and width 14.33 ± 1.88 , 8.33 ± 1.03 , 10.45 ± 1.03 and 5.95 ± 0.37 mm respectively.



Figure 133: Whole view of *Indosuccinea plicata* (X2)



Figure 134: Apertural view of *Indosuccinea plicata* (X2)

Habit: Mainly arboreal sometimes amphibious and terrestrial. Herbivore, feeding on the leaves of plant like mango, Jackfruit, trees. Hermaphrodite.

Habitat: Mainly found in leaves of plant like mango, Jackfruit, and other trees. Occasionally found in Betel nut tree.

Population density: *I. plicata* highest ($17.16/10 \text{ m}^2$) during Monsoon in Malnichra tea garden forest, Sylhet and minimum ($0.83/10 \text{ m}^2$) during winter in the same forest (Appendix table 3.III).

Distribution: Comilla, Sythet districts.

Economic importance: A pest on the leaves of mango and other plants.

Ecological role: Plays an important role in the arboreal ecosystems a herbivore.

Genus: *Succinea* Draparnaud, 1801

1801. *Succinea* Draparnaud, *Table. Moll. Terr. Fluv. France*, p. 55

Species name: *Succinea daucina* Pfeiffer

Synonyms:

1801. *Succinea daucina* Pfeiffer, *Proc. zool. Soc. London*, 1854:298.

1914. *Succinea daucina* Gude *Fauna of British India, Mollusca*, 2:453.

Local name: Gesho shamuk

Description: Shell small, thin, ovately conical, imperforate, flexuously striate, pale whitish with a reddish tinge, spire conical with sharp apex, whorls 3, rounded, rapidly

increasing in size, last whorl large, angulately oval, peristome simple, columella with a very thin callus, rounded at the base.

Size: Average shell length, width, aperture length, and width 5.45+1.57, 4.3±1.57, 4.5+0.34, 3.83+0.57 and 2.9+0.41 mm respectively.



Figure 135: *Abapertual view of Succinea daucina (X2)*

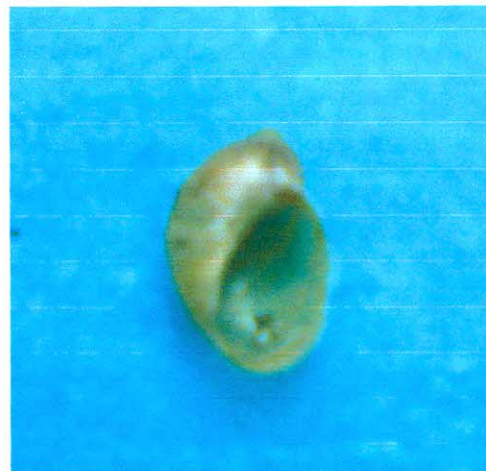


Figure 136: *Apertual view of Succinea daucina (X2)*



Figure 137: *S. daucina (Live)*

Habits: Mainly arboreal, sometimes amphibious and terrestrial. They feed on plants leaves, algae. Hermaphrodite.

Habitat: Mainly occurs on plants leaves like mango and other trees and damp wall.

Distribution: Comilla, Habiganj, Maulvibazar and Sylhet district.

Population density: This species was found sporadically during the study time.

Elsewhere: India: West Bengal, Myanmar.

Economic importance: A pest on leaves like mango and other trees. They also feed algae and moss of damp wall.

Ecological role: Plays an important role in the terrestrial ecosystem as an herbivore and scavengers.

Family: Helicarionidae

Shell small, depressed, or conically raised, ovate and ear shaped in some, smooth or sculptured, usually perforate and angulate at the periphery; aperture widely lunate, peristome not continuous, thin; sole of foot divided or undivided, caudal gland usually present.

Family: Halicarionidae

Genus: *Sesara* Albers, 1880

1860 *Sesara* Albers, *Heliceen*, ed. 2, p. 911.

Species name: *Sesara diplodon*

Synonym:

1859. *Helix diplodon* Benson, *Ann. Mag. nat. Hist.*, (3) 3 :187.

1908. *Sesara diplodon* : Blanford & Godwin-Austen, *Fauna of British India. Mollusca*. (Testacellidae & Zonitidae) p. 247.

Description

Shell small, trochiform, flattened at base, minutely perforate, pale whitish, very finely decussately sculptured both above and below, spire conoidly raised (varying in height) apex blunt, suture marginate; whorls 7, convex, the last sharply keeled at the periphery, flattened below, slightly impressed around the perforation, longitudinally compressed behind the peristome producing a small hollow ridge ; aperture oblique, trapezoid, peristome thin, sharply angulate at the keel and arcuate at the basal ridge, columella minutely thickened and reflected above. Two teeth in the aperture on small conical inside the columellar edge, another larger, curvedly entering inside the basal margin.

Size: Average length of shell width aperture length and width 5.6 ± 0.27 , 8.72 ± 0.88 , 3.06 ± 0.51 and 1.12 ± 0.25 mm. respectively.



Figure 138: *Abapertual view of Seasara diplodon(X2)*



Figure 139: *Apertual view of Seasara diplodon(X2)*

Habits : They are scavenger, living on dead or live plant matters.

Habitat: Ground, among low vegetation, evergreen forest, leaf litters, under stones or logs and crevice of trees. During the study period the snails was seen attached to Loha, Raktan, and Mango trees.

Population density: *S. diplodon* highest ($9.00/10 \text{ m}^2$) during Monsoon in Lawchacra forest, Sylhet and minimum ($0.33/10 \text{ m}^2$) summer in the same forest (Appendix table 2.III).

Economic importance: It is a minor pest of crops. Feeds on soft twigs and floral buds of plants.

Ecological role: The snail plays an important role in the terrestrial ecosystem as a scavenger; and also contributes to the recycling the plants nutrients.

Distribution: Maulvibazar Distract

Elsewhere: India, Myanmar.

Economic importance: A pest on leaves like mango and other trees. They also feed algae and moss of damp wall.

Ecological role: Plays an important role in the terrestrial ecosystem as an

Genus: *Sivella*

1863. *Sivella* Blanford, *Ann. Mag. nat. Hist.*, (3) 11: 86.

Species name: *Sivella castra*.

1852. *Helix castra* Benson, *Ann. Mag. nat. Hist.*, (2) 10: 349.

1914. *Trochomorpha (Sivella) castra* : Gude, *Fauna of British India, Mollusca*, 2 : 3.

Shell moderately large, thin, depressedly conoid, openly umbilicate, pale whitish to light brown, conspicuously obliquely striate above, deccussately sculptured below ; spire raised, apex obtuse; suture marginate ; whorls 5-6, the last sharply keeled at periphery, slightly convex below ; aperture oblique, subquadrate, peristome thin; columellar margin oblique, simple.

Synonym:

Description:

Size: Average length of shell width aperture length and width 5 ± 0.70 , 11 ± 0.40 , 3.75 ± 0.64 and 1.87 ± 0.25 . respectively.



Figure 140: Abapertural view of *S. castra*

Figure 141: *S. castra* (Live)

Figure 142: Apertural view of *S. castra*

Habits: They are scavenger, living on dead or live plant matters.

Habitat: Ground, among low vegetation, evergreen forest, leaf litters, under stones or logs and crevice of trees. During the study period the snails was seen attached to Loha, Raktan, and Mango trees.

Population density: *S.castra* highest ($12.66/10\text{ m}^2$) during Monsoon in Lawachra forest, Maulvibazar and minimum ($0.16/10\text{ m}^2$) Summer in the same forest (Appendix table 2.III).

Economic importance: It is a minor pest of crops. Feeds on soft twigs and floral buds of plants.

Ecological role: The snail plays an important role in the terrestrial ecosystem as a scavenger; and also contributes to the recycling the plants nutrients.

Distribution: Maulvibazar District

Elsewhere: India: (Assam, Arunnachal Pradesh, Meghalaya, Mizoram, Sikkim, West Bengal), Malaysia, Myanmar, Thailand.

Family-Camaenidae

Shell of varying shape and size, small to fairly large, many with coloured bands or patches depressed-globosed or trochoid to elongate ovate, usually umbilicate, dextral or sinistral, body whorls rounded or carinated; aperture lunate or ovate usually oblique columellar margin often reflected over umbilicus ; peristome usually thickened and reflected.

Animal with long tail over which there is a dorsal groove, sole of foot very faintly divided foot margin absent.

Genus: *Chloritis* Beck, 1837

Synonym:

1837. *Chloritis* BeckM6111Index, p.29

Species name: *Chloritis delibrata* Benson Synonym:

1836. *Helix* 'delibrata' Benson,.

1914. *Chloritis delibrata*: Gude, Fauna of British IndiaMollusca 2:172.

Description: Shell depressed widely umbilicate, rather thin, semi transparent, brownish to pale yellowish white, often with a single brown band on the last whorl, closely oblique striate above finely decussate below; with close set stiff hairs and bristles arranged in several rows (seen in the fresh condition); spire much depressed, apex flat; whorls 3 -4, convex, increaseing rapidly, the last much broad, sub angulate around the umbilicus, dilated and distinctly descending in front, aperture oblique, sub circular, margins joined by a thin callus, peristome thin, reflected, columellar margin oblique reflected.

Size: Average length of shell, width, aperture length and width 11.33 ± 0.57 , 20.83 ± 2.3 , 8.5 ± 1.5 mm respectively.



Figure 143: *Abapertural view* *Chloritis delibrata*



Figure 144: *Apertural view of* *Chloritis delibrata*

Habits: Feeds on bark of trees, decaying leaves.

Habitat: Found in terrestrial habitats, evergreen forest, bushes like Teak (*Tectona grandis*), Gamari (*Gmelina arborea*), Mehogoni (*Swietenia mahagoni*), Jackfruit (*Artocarpus heterophyllus*), Wood apple (*Aegle marmelos*) trees.

Population density: *C. delibrata* highest ($5.5/10 \text{ m}^2$) during Monsoon in BARD anex forest, Comilla and minimum ($0.49/10 \text{ m}^2$) during winter Lawachara Reserved forest Moulovibzar District (Appendix table 1.IV & 2.III).

Distribution: Comilla, Habiganj, Maulvibazar Districts.

Elsewhere: India: Whole of N.E. region Assam, Arunachal pradesh, Meghalaya, Mizoram, Tripura, West Bengal (northern part)

Economic importance: It devours young leaves and bark of trees. It is a minor pest of plants.

Family: Phylomycidae

Genus: *Meghimatium* van Hasselt, 1823.

Description: Body coloration creamy-white, dorsal with 3 diagonal streaks projecting to rear from both lateral margins between which are scattered reticulated streaks. Sole white.

Distribution: Maulvibazar district

Elsewre: China, Japan, the East Indies, central and eastern North America and thought Central America into northern South America.

Size: Body length and width 37.6 ± 3.59 and 6.65 ± 0.60 mm respectively.



Figure 145: Dorsal view of *Meghimatium* sp.(live)



Figure 146: Ventral view of *Meghimatium* sp.

Habit: They feed on algae, moss and lichens from the bark of trees. It is active in monsoon. After monsoon the snails go to aestivation under the base of big tree, fallen leaves etc.

Habitat: Remain attached to stems, branches or leaves of trees like mango, Raktan (*Lophopetalum fimbrianum*), Jackfruit (*Artocarpus heterophyllus*) trees ,bottle brush

tree and Acatia tree. During the study period the snail was seen to attach to 30to 40 feet height of the trees.

Population density: This Species found sporadically found during the study period.

Economic importance: The snail feeds on bark of trees.

Ecological role: Plays a role in the terrestrial ecosystem as a scavenger; also contributes to recycle to plants materials.

Class: Gastropoda

Order Mesogastropoda

Family: Viviparidae

Genus: *Bellamya* Jousseanume, 1886

1886 *Bellamya* Jousseanum, *Bull,Soc. Zool. France*,ii:478.

Species: *Bellamya bengalensis* Lamarck, 1822

1822. *Paludina bengalensis* Lamarck, *Hist. nat. Anim.sans Vertt.*, 6;2:174.

1921.*Vivipara bengalensis* Annandale, *Rec.Indian Mus.*,22:267.

***Bellamya bengalensis* f. *typica*:** Lamarck.

1822. *Paludina bengalensis* Lamarck, *Hist. nat. Anim.sans Vertt.*, 6;2:174.

1921.*Vivipara bengalensis* Annandale, *Rec.Indian Mus.*,22:267.

1989. *Bellamya bengalensis* f. *typica* Subba Rao, *Hand book of Fresh water Molluscs of India*, P. 45, fig.55.

2005. *Bellamya bengalensis* f. *typica* Mitra,Dey and Ramakrishna, *Fauna of Andhra Pradesh ,State fauna Series*,5 (part-5),p.188.*Zool.Surv.India*.

Description: Shell thin, spire and body whorl of almost equal height, whorl gradually increasing, less rounded and with rather straight sides, sutures shallow; aperture sub circular with a narrow black margin. Bands are variable and irregular, alternating broad and narrow band. Whorls 6.

Size: Average shell length, width, aperture length and aperture width 32.5 ± 3.53 22.5 ± 0.75 , 12.55 ± 1.62 and 8.5 ± 2.12 mm respectively.



Figure 147: *Abapertual view of B.bengalensis f.typica.*



Figure 148: *Apertual view of B.bengalensis f.typica.*

Habits: *Bellamya bengalensis* f. *typica* feed on algae, macrophytes detritous and animal remain. The species prefers soft or clay bottom and avoid sandy bottom. This snails breeds twice in a year. *Bellamya bengalensis* f. *typica* like all member of the genus dioecious. Sexual dimorphism is aparent in right tentacles. The right tentacles of males are thickened, recurved and acts as penis or intromittent organ but the same is female is straight.

Habitat: They were found abundantly in permanent and temporary water body viz. river, ponds canals and paddy field etc. The species prefers soft or clay bottom and avoid sandy bottom.

Population density: The population density was recorded highest ($35.71/m^2$) during summer and minimum ($0.05/m^2$) during monsoon in Surma, Sylhet district (Appendix table 4.VII). In Pond *Bellamya bengalensis* f. *typica* was recorded highest ($20.93/m^2$) during Summer Pond in B.Barua and minium ($0.88/m^2$) during monsoon in the same Poind district B. Barua (Appendix table 12.VII).

Distribution: India, Myanmar

Bangladesh distribution: Almost all district.

Economic importance: It is used as food for poultry, fish etc. *Bellamya bengalensis* f. *typica* is an important food item for African Magur, *Clarias griepinus* (Cat fish), and freshwater prawn *Macrobrachium rosenbergii* (Jahan and Rahman 2000). The tribal people also eat its flesh. *Bellamya bengalensis* f. *typica* common intermediate host of various types of digenetic trematodes.

***Bellamya bengalensis* race *doliaris* Gould 1843**

Synonym:

1843. *Paludina doliaris* Gould, *Proc. Boston Soc. Nat. Hist.*, 1:144.

1989. *Bellamya bengalensis* form *doliaris* Subba Rao, *Hand book of Fresh water Molluscs of India*, P. 46.

2005. *Bellamya bengalensis* race *doliaris* Mitra, Dey and Ramakrishna, *Fauna of Andhra Pradesh, State fauna Series*, 5 (part-5), p.189. *Zool. Surv. India*.

Description: Shell smaller and more conical, last whorl distinctly biangulate.

Size: Average shell length, width, aperture length and aperture width 17.5 ± 0.51 , 14.5 ± 1.00 , 7.58 ± 0.52 , and 4.5 ± 0.5 mm respectively.



Figure 149: *Abapertual view of B. bengalensis f. typica.*



Figure 150: *Abapertual view of B. bengalensis f. typica.*

Habits: *Bellamya bengalensis* race *doliaris* feed on algae, macrophytes detritous and animal remain. The species prefers soft or clay bottom and avoid sandy bottom.

Habitat: They were found abundantly in permanent and temporary water body viz. river, ponds canals and paddy fields etc. The species prefers soft or clay bottom and avoid sandy bottom.

Population density: Found in sporadically.

Distribution: India, Myanmar.

Economic importance: It is used as food for poultry, fish etc. *Bellamya bengalensis* race *doliaris* is an important food item for African Magur, *Clarias griepinus* (Cat fish), and freshwater prawn *Macrobrachium rosenbergii* (Jahan and Rahman 2000). The tribal people also eat its flesh.

Species: *Bellamya crassa* Benson

1836. *Paludina crassa* (Hutton Ms.) *J.Asiat.Soc.Beng.*, 5:745.

Description: Shell olive brown, globose, without color bands, spire small and blunt, shell surface sculptured with fine wavy spiral lines; aperture sub oval, columella arched anterior margin almost straight, outer lip arched, umbilicus rimately perforate.

Size: Shell parameters: Average shell length, width, and aperture length and aperture width 18.6 ± 0.74 , 14.2 ± 0.56 , 9.2 ± 0.33 and 7.8 ± 0.2 mm. respectively



Figure 151: Abapertual view of *B. crassa* ab.



Figure 152: Apertual view of *B. crassa*.

Habit: It buries itself in mud or sand in shallow water. Unfavourable conditions like drough etc. by buryng themselves in the mud.

Habitat: *Bellamya crassa* usually occur in the shallow zone of the river throughout the year.

Population density: The population density was recorded highest (90.77/m²) during winter in Gomoti River, Comilla district (Appendix table 8.VII) and minimum (0.11/m²) during summer in Ratna river, Habiganj district (Appendix table 6.VII)

Distribution: India, Myanmar, Malaysia; Pakistan; Srilanka.

Bangladesh distribution : Comilla, Chittagong, Feni, Habiganj, and Sylhet.

Economic importance: It is used as food for duck, fish and poultry feed.

Species: *Bellamya dissimilis* (Mueller, 1774).

Synonyms:

1774. *Nerita dissimilis* Mueller, 1774. *Hist.Verm.Test.*,pt. 2:184.

1862. *Paludina variata* Fraenfeld, *Verhandl. Zool.bot.Ges.Wien*.p.1163.

1989. *Bellamya dissimilis* Subba Rao, *Hand Book of Fresh water molluscs of India*.p.48 .figs.64-67.

Description: Shell small, high, and narrow, spire swollen and sutures deeply impressed, body whorl with one slightly elevated ridge and longitudinal pale spiral bands. Rim of aperture often black, operculum thicker and muscular scar better developed. Edge of mantle smooth in the adult. Whorls 5.

Size: Average shell length, width, aperture length and aperture width 18.62 ± 1.17 , 15.5 ± 2.67 , 8.87 ± 1.03 and 6.75 ± 1.25 mm respectively.



Figure 153: Abapertural view of *B. dissimilis*



Figure 154: Apertural view of *B. dissimilis*. ad.

Habit: Feeds on semi-decayed debris, algae and zooplankton. *B. dissimilis* is also dioecious and the right tentacles act as a penis. They breed twice in a year; maximum ova diameter recorded as 0.015 mm (Jahan *et al.*, 2003).

Habitat: *Bellamya dissimilis* usually occur in the littoral zone of the ponds throughout the year, but in the rainy season they were also found in temporary water bodies, irrigated paddy fields and canals.

Population density: Found in sporadically.

Distribution: India, Myanmar, Malaysia; Pakistan; Srilanka.

Bangladesh: Almost all district.

Economic importance: It is used as food for people of Jharkhand, Bihar, Meghalaya, and Orissa. It is also used as food for domestic duck, and exotic fishes.

Family: Ampullaridae

Generic name: *Pila*, (Botlen) Roeding, 1798.

1798. *Pila* (Botlen) Roeding, Museum *Bolteniaum*, pt.2, p.145.

Species: *Pila globosa* Swainson 1822

Synonyms:

1822. *Ampullaria globosa* Swainson, *Zool. Illustrations*, Vol.2, pl.cxix.

1989. *Pila globosa* Subba Rao, *Handbook of Fresh water Molluscs of India*, P.58, fig.80-82.

English name: Apple snail

Local name: Bara shamuk, Gul shamuk

Description: Shell globose with an inflated body whorl and depressed spire, suture shallow, coloured bands inside the aperture. It shows remarkable variation in shape and elevation of the spire and body whorl.

Size: Average shell length, width, aperture length and aperture width 48.6 ± 12.77 , 42 ± 10.6 , 49 , 33.8 ± 5.32 and 19.1 ± 4.39 mm respectively.



Figure 155: Abapertural view of *P. globosa*



Figure 156: Apertural view of *P. globosa*

Habits: *Pila globosa*, completely amphibious snails, shows an advanced trend towards a terrestrial habit as to its breeding activities. The female *Pila globosa* selects a place a few inches above water level where it makes a hole to deposit the eggs. The egg masses vary in size and weight and in the number of contained eggs (75.52-356.47) (Jahan *et al.*, 2003).

Habitat: It was found in ponds, canals, paddy field stream and rivers. *Pila globosa* was found in ponds large number during monsoon and remained active up to December. However, as the pond dried up the animal burrowed into the moist soil.

Population density: Found in sporadically during the study period.

Economic importance: It is used for food for duck, fish and Pungas. Jahan *et al.*, (2003) noted that *Pila globosa* carry larval trematodes.

Distribution: India: Assam, Bihar, Himachal Pradesh, Jharkhand, Maharashtra, Meghalaya, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, West Bengal.

Bangladesh: Almost all districts.

Species name: *Pila virens*, Lamark. 1822.

Synonym:

1822. *Ampularia virens*, Lamarck, *Hist. nat. anim.sans Vert.*, 6(2): 72

1856. *Ampullaria marua* Reeve, *Conch. Icon.*, 10, *Ampullaria* sp.no.57, pl.xiii. Figure 57.

1925. *Pila virens* Prasad, *Mem. Indian Mus.*, 8:75. pl.xiv, fig.13.

Description: The species is very variable in its colour and shape of the spire shell ovoid or semiglobose, suture deeply impressed, and spire elevated. The eyes are situated on small stalks anterior margin almost straight, outer lip arched, umbilicus remotely perforate.

Size: Average shell length, width, aperture length and aperture width 32.00 ± 0.70 , 31 ± 4 , 24.25 ± 0.35 and 15.25 ± 0.35 (Table-1E).

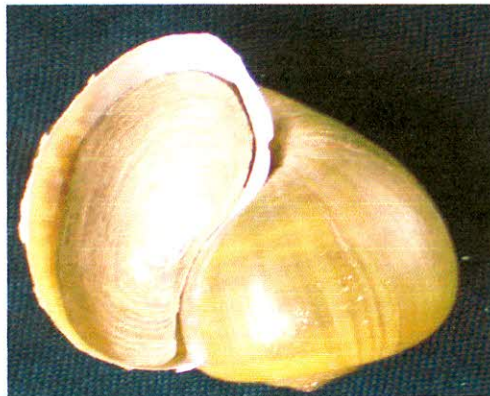


Figure 157: Apertural view of *P. virens*



Figure 158: Abapertural view of *P. virens* ab.

Habits: *P. virens* is herbivorous, amphibious and oviparous.

Habitat: The species found in the mud or sandy in shallow water of the rivers, they burrow themselves in the mud or shallow water of the rivers. In drought conditions, they conceal themselves in the mud.

Population density: Found in sporadically during the study period.

Distribution: India (Uttar Pradesh,) River Gomti, Jaunpur; WestBengal; Ranaghat, Siliguri, Orissa; Assam, Pakistan, Srilanka, Myanmar, Malaysia to the Philippines and the Ethiopian Region.

Bangladesh distribution: Dhaka, Feni, Habiganj and Sylhet district.

Economic importance: It is used for food for poultry and fish. The snails used as food by the tribal people of Bangladesh and Indian some states. *P. virens* is a common intermediate host of various types of digenetic trematodes.

Species: *Bithynia (Diagoniostoma) cerameopoma*

Genus: *Bithynia* elongately conical and acuminate. Spire conical, perforate and constricted, with a well developed groove extending obliquely downwards from umbilicus to columellar fold. Whorls convex; operculum heavily calcareous, concentric with a small spiral nucleus. Lateral teeth greatly in large, marginal teeth minute and sharp.

Family: Bithynidae

Species: *Bithynia (Diagoniostoma) cerameopoma* Benson, 1830

Genus: *Bithynia* Leach, 1818

1818. Bithynia Leach In: *Abel's Narrative of Journey into interior of China* p. 362.

Shell up to 15 mm high, elongately conical and acuminate. Spire conical, perforate and constricted, with a well developed groove extending obliquely downwards from umbilicus to columellar fold. Whorls convex; operculum heavily calcareous, concentric with a small spiral nucleus. Lateral teeth greatly in large, marginal teeth minute and sharp.

Subgenus: *Diagoniostoma* Annandale, 1920

1920. *Diagoniostoma* Annandale, Indian J. Med. Res., 7:104.

Shell up to 15 mm high, pyramidal or elongately ovate. Whorls convex; body whorl large and inflated; sculptured finely striated and narrowly perforate. Aperture rounded, peristome continuous, somewhat expanded at the base, columellar callus broad, thick, prominent with laminated appearance. Operculum spirally coiled with central nucleus. Central tooth of radula with small cusp in basal corners.

Species: *Bithynia (Diagoniostoma) cerameopoma* Benson ,1830.

Synonyms:

1830. *Paludina cerameopoma* Benson *Gleanings in Science*, Calcutta, 2:125.

1989. *Diagoniostoma cerameopoma* Subba Rao, *Hand Book of Freshwater Molluscs of India*, p. 79, fig. 121.

2005. *Diagoniostoma cerameopoma*: Mitra, Dey and Ramakrishna, *Fauna of Andhra Pradesh, State Fauna Series*, 5 (Part-5), p.192.

Description: Shell oblong- ovate, whorls 5, regularly and rather rapidly increasing, sculpture with very fine, weak spiral striae and weak growth lines, suture well impressed, umbilicus moderately narrow and deep, peristome continuous and slightly reflected, aperture oval and oblique. Operculum calcareous, concave, nucleus sub central.

Size: Average shell length, shell width, aperture length and aperture width are 6.0 ± 0.79 , 4.85 ± 0.60 , 2.7 ± 0.64 and 2.1 ± 0.45 mm respectively.



Figure 159: Abapertual view of *B. (D.) cerameopoma*.

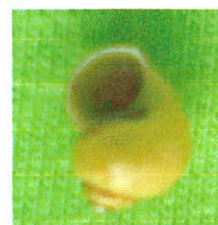


Figure 160: Apertural view of *B. (D.) cerameopoma*.

Habit: Feeds on debris, semi-decayed debris.

Habitat: Found in stagnant freshwater like ponds, lakes, pools ditches or small sluggish streams.

Population density: Found in sporadically during the study period

Distribution: India: Andhra Pradesh, Assam, Bihar, Delhi, Jharkhand, Madhya Pradesh, Meghalaya, Punjab, Rajasthan, West Bengal, Pakistan,

Bangladesh distribution: Brahman baria, Comilla, Habiganj,

Economic importance: It helps in controlling the aquatic environment pollution through recycling of detritus.

Species: *Bithynia (Diagoniostoma) pulchella* Benson, 1836.

Synonyms:

1836. *Paludina pulchella* Benson, *J. Asiat. Soc. Beng*, 5:746.

1876. *Paludina pulchella* Hanley and Theobald, *Conch. India*, pl.38, figs.5, 6.

1989. *Diagoniostoma pulchella* Subba Rao, *Hand Book of Freshwater Molluscs of India*, p. 80, fig. 113,114,119,120.

2005. *Diagoniostoma pulchella* Mitra, Dey and Ramakrishna, *Fauna of Andhra Pradesh, State Fauna Series*, 5 (Part-5), p.193. *Zool. Surv. of India*.

Description: Shell elongate, spire longer than the body whorls, sutures depressed umbilicus almost closed and oval.

Size: Average shell length, shell width, aperture length and aperture width are 7.12 ± 0.53 , 4.75 ± 0.35 , 3.87 ± 1.59 and 2.3 ± 0.17 mm respectively.



Figure 161: Abapertual view of *B. pulchella* ab



Figure 162: Apertual view of *B. pulchella*.

Distribution: India, Myanmar, Malay Archipelago and Pakistan

Habit: Feeds on debris, semi-decayed debris.

Habitat: Found in stagnant freshwater like ponds, lakes, pools ditches or small sluggish streams. The species was also found in shallow parts of rivers and occasionally found in well depth 2-3m of river.

Population density: Found in sporadically during the study period

Bangladesh distribution: B. Baria Comilla, Habiganj, Sylhet District.

Economic importance: It helps in controlling the aquatic environment pollution through recycling of detritus.

Genus: *Gabbia* Tryon 1865

1865. *Gabbia* Tryon, *Amer. J. Conch.*, 1:216.

Shell globose with whorls; body whorls large, suture wide, imperforate or subumblicate, columellar fold ridge like but not so prominent; operculum thick, calcareous but usually hyaline or sub hyaline, distinctly spiral and with slightly concentric nucleus, ornamented round the margin with concentric line.

Foot short, rounded or pointed posteriorly and angulatae anteriorly, snout long and narrow. Radula similar with Genus *Amnicola*, central tooth with distinct quadrate projection on the disc. Verge (penis) large, flattened and almost in the middle.

Species: *Gabbia orcula* var. *producta* Nevill, 1884.

Synonym:

1884. *Bithynia orcula* var. *producta* Neveill, *Hand List Moll. Indian Mus*, 2:37.

1963. *Alocinma orcula* var. *producta* Ray and Mukerjee *Rec, Zool. Surv, India*, 61:420, Pl. 19, figs 1, 1a.

1989. *Gabbia orcula* var *producta*: Subba Rao, *Handbook of Freshwater Molluscs of India*, P. 77, fig. 142.

Description: Shell much narrower and more elongate than *Gabbia orcula*.

Size: Average shell length, shell width, aperture length and aperture width are 5.12 ± 0.73 , 3.85 ± 0.69 , 2.33 ± 0.41 and 1.73 ± 0.48 m.m. respectively (Table 1).



Figure 163: Abapertural view of *G. orcula* var. producta



Figure 164: Apertural view of *G. orcula* var. producta ab.

Habit: Feeds on debris, semi-decayed debris.

Habitat: Occurs in pond, Canal and River. It's generally found along the shores on the sandy and muddy bottom (bed) of the rivers.

Population density: Found in sporadically during the study period

Distribution: India: Andra pradesh, Assam, Bihar, Jharkand, Mahrashthra, Orissa, Rajas than, Uttar Pradesh and West Bengal states,

Bangladesh distribution: Brahmonbaria, Comilla, Dhaka, Habiganj, Mymensingh, and Sylhet District.

Economic importance: It helps in controlling the aquatic environment pollution through recycling of detritus.

Genus: *Paludomus* Swainson, 1840.

1840. *Paludomus* Swainson, *Treatise on Malacology*, p. 340.

Shell strong, oblong-globose, aperture larger than the spire, inner lip or columella very thick.

Family: Thiaridae

Species: *Thiara scabra*.

Synonyms:

1774. *Buccinum scabrum* Mueller, *Hist. Verm. Terr. Fluv.*, 2:136.

1850. *Melania acanthica* Lea, *Proc. zool. Soc. London.*, p.194.

1973. *Thiara (Thiara) scabra*: Pace, *Malac Review Suppl.* 1:52, pl. 12, figs.1, 2 pl. 13, fig. 3.

1989. *Thiara (Thiara) scabra* Subba Rao, *Handbook of Fresh water Molluscs of India*, p. 96, figs. 185,186,189.

Description: Whorls regularly increasing in size, suture distinct, whorls often shouldered above and rounded below the row of spines, shell sculptured with characteristics vertical ribs bearing prominent spines directed obliquely outward, surface with rough spiral striations, on the body whorls near the umbilical region striations form strong ridges.

Size: Average shell length, width, aperture length and aperture width 20.37 ± 5.57 , 8.75 ± 2.06 , 8.5 ± 2.51 and 5.25 ± 1.04 mm respectively.



Figure 165: Abapertural view of *T. scabra*



Figure 166: apertural view of *T. scabra*

Habits: Feeds on algae, small particles of organic matter, mainly diatoms and detritous.

Habitats: This snail prefers slow or fast moving streams, rivers but may also occur in pond.

Population density: The population density was recorded highest (2.44/m²) during Summer in Khushyara River, Sylhet (Appendix table 5.VII) and minimum (0.6./m²) during in Surma river ,same district (Appendix table 4.VII). In pond *T. scabra* was recorded highest summer (9.33/m²) pond in Sylhet district (Appendix table 9.VII) and minimum monsoon (0.77/m²) Pond in Habiganj district (Appendix table 11.VII)

Distribution: Distribution: India: Throughout, except Kashmir. Elsewhere: Coasts of Indo Pacific, from Zanzibar to New Hebrides, north to the Philippines, various Pacific islands.

Bangladesh Distribution: Allmost all district.

Species: *Melanoides tuberculata* Mueller, 1774

Synonyms:

1774. *Nerita tuberculata* Mueller, *Hist. Verm. Terr. Fluv.*, 2:191.

1836. *Melania pyramis*, Benson *J. Asiat. Soc. Beng.* 5:354.

1969. *Melanoides (Melanoides) peddamunigalensis* Ray & Ray Chowdhuri, *Proc. zool. Soc. Calcutta* 22:48, figs, 12-17.

1976. *Melanoides (Melanoides) tuberculata* Starmuehlner, *Natur Hist. mus. Wine.*, 80:591

Description: Shell with a high spire and moderately large body whorl, whorls evenly rounded, dark red-brown dots and flames, either irregularly distributed longitudinally arranged on the shell surface, sculptured with vertical ribs and spire striae, distinct and raised on the upper whorls, but flater on the lower ones.

Size: Average shell length, width, aperture length and aperture width 24.5 ± 5.04 , 8.00 ± 1.58 , 6.37 ± 1.6 and 3.75 ± 0.28 mm respectively.

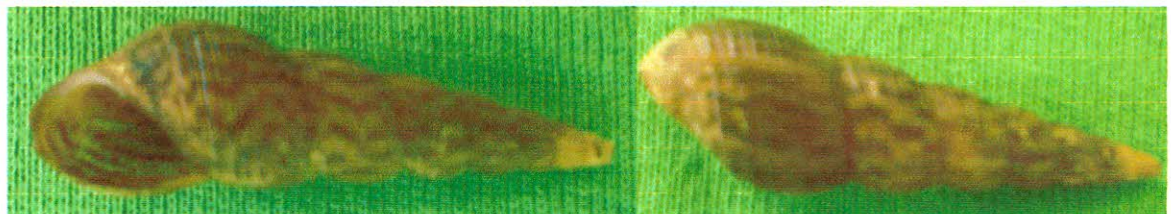


Figure 167: Apertual view of *M. tuberculata*

Figure 168: Abapertual view of *M. tuberculata*

Habit: *Melanoides tuberculata* is a scavenger snail. It lives on semi-decayed organic matter and debris with sand grains.

Habitat: The snails normally occur in all types of fresh water bodies such as ponds, canals, river and streams. *M. tuberculata* inhabits the littoral zone extending up to two meter depth with muddy sands and detritus at the bottom of permanent water bodies. Incase of the temporary water bodies the snails burrowing the semi dry substratum during the dry season to over come the unfavorable condition but during the monsoon the snails migrates to temporary stagnant water bodies with dense vegetation. The snail was found to breed through out the year with peak reproductive rate after monsoon.

Population density: The population density was recorded highest (7.21/m²) during Summer in Surma River, Sylhet (Appendix table 4.VII) and minium (0.11/m²) during monsoon in Titas river ,B.Barua district (Appendix table 7.VII). In Pond was this snails **recorded** highest ((57.60/m²) during Winter Pond in Sylhet district (Appendix table 9.VII) and minium (0.77/m²) during monsoon in the Pond Comilla (Appendix table 13.VII).

Distribution: Through out India, except Kashmir North and South Africa,Southern China,Malaysia; Malay Archipelago,North Australia,Various Pacific Islands and north yo the Ryukyu Islands of Japan,New Hebridies.Pakistan;

Bangladesh: All most all district.

Economic importance:It is one of the established intermediate hosts of different helminths, which causes various fatal diseases of man and his pets. Rahman and Jahan (2001) recorded that out of 35.39% infected snails recorded 23.2%, 28.5% and 48.3% were infected with Monostome, Amphistome and Leptocercous cerariae respectively.

Species: *Tarebia granifera* Lamarck 1822

Synonyms:

1822 .*Thiara granifera* Lamarck, *Hist. nat .Anim. ,sans Vert.*, 6(2): 167.

1973.*Thiara (Tarebia) granifera* Pace, *Mal. Review Supplement* 1:62, pl.12.fig. 3, pl.13, fig. 4.

1976.*Tarebia granifera* Starmuehlner, *Ann Naturhist. Mus Wien*, 80:569, figs.72-75, 1.16, figs.175-179.

Description: Shell elongately conical, sculptured with distinct spiral rows of nodules, spire with flat whorls, height of body whorl more than half the total height of the shell.

Size: Average shell length, width, aperture length and aperture width 22.3 ± 7.28 , 8.6 ± 3.55 , 4.1 ± 1.14 mm respectively.



Figure 169: apertural View T. granifera

Figure 170: Abapertural View T. granifera

Distribution: India: West Bengal, Madhya Pradesh, Bihar; Madagascar, Malaysia, Philippines, Formosa and Pacific Islands. Introduced into United States of America (Abbott, 1952).

Bangladesh distribution: All most all districts.

Habit: It lives on semi-decayed organic matter and debris with sand gains.

Habitat: Found in Sandy bottom of the river, Ponds, canals.

Population density: The population density was recorded highest ($38.49/m^2$) during summer in Surma River, Sylhet (Appendix table 4.VII) and minimum ($0.05/m^2$) during monsoon in Ratna river, Habiganj district (Appendix table 6.VII).

Economic importance: *Tarebia granifera* used as poultry feed.

Species: *Thiara lineata*. Gray, 1828

Synonyms:

1828. *Helix lineata* Gray in Wood, s index Test. Suppl. p.24, fig.68.

1915. *Tiara (Tarebia) lineata*: Preston, *Fauna of British India*, Mollusca (Freshwater

Gastropoda and Pelecypoda), p.34.

English name: Melanid snail.

Local name: Lomba shamuk.

Description: Shell medium, elongate, solid, with blunt apex, broader with blunt apex, broader with raised spiral lines. Spire short and exerted; whorls prominent rounded, sculptured with close superficial spiral ridge and minute longitudinal striae; suture overlapping. Body whorls rounded, with spiral lines. Aperture somewhat round, lips thin without teeth; outer lip thin with a Sharpe edge; inner lip calloused.

Size: Average shell length, width, aperture length and aperture width 16.5 ± 2.91 , 6.4 ± 1.48 , 4.7 ± 1.35 and 2.6 ± 0.57 mm respectively.



Figure 171: Abapertural View *T. lineata*



Figure 172: apertural View *T. lineata*

Habit: Feeds on algae, small particles of organic matter, mainly diatoms and detritous.

Habitat: Found in rivers, streams and Ponds.

Population density: Found in sporadically during the study period

Distribution: India: West Bengal, Bihar, Madhya Pradesh, Uttar Pradesh, Maharashtra, Assam; Bhutan; Burma; Sri Lanka.

Bangladesh distribution: Almost all districts.

Economic importance: *Tarebia lineata* used as poultry feed.

Economic importance: *Tarebia scabra* used as poultry feed.

Family: Pleuroceridae

Genus: Brotia H.Adams 1866

1866. *Brotia*, H.Adams, *Proc.zool.soc.Lond.*,p.150.

1874. *Acrostoma* Brot, Martini and Chemnitz, s *Syst. Conch. Cab.*,1(24):17.

Shell large 5 to 8 cm. shell, high conoid or turreted with many whorls, spire longer than the body whorls, apex of the shell asymmetrical, coated with dark brown, almost black epidermis, axial ribs heavy and clear, columellar angle of the lip of aperture produced slightly forward or round. Operculum round, multispiral, central or nearly central nucleus.

Species: *Brotia costula* Rafinesque, 1833

Synonym:

1833. *Melania costula* Rafinesque, *Atlantica J.*,5:166.

1989. *Brotia (Antimelania) costula*: Subba Rao, *Hand book of Fresh water Molluscs of India*, P. 108, fig.55192-194, 197,198.

2005. *Brotia costula* Mitra, Dey and Ramakrishna, *Fauna of Andhra Pradesh, State fauna Series*,5 (part-5),p.201. *Zool.Surv.India*.

English name: Brotia snail

Local name: Boro morano shamuk

Description: Shell elongate, whorls 12-14 regularly increasing, sculpture with spiral ridges or nodules, prominent axial ribs, often with spines.

Size: Average shell length, width, aperture length and aperture width were 46.6 ± 10.41 , 18.00 ± 2.76 , 16.8 ± 2.75 and 10.7 ± 1.48 mm respectively.



Figure 173: apertural View *B. costula*

Figure 174: Abapertural View *B. costula*

Habit: This snail attaches to submerged vegetations or bottom in the permanent and running water bodies.

Habitat: It lives in muddy water and muddy bottom of river and stagnant water bodies.

Population density: The population density was recorded highest (59.94/m²) during summer 2005-07 in Surma River, Sylhet (Appendix table 4.VII) and minimum (2.71/m²) during monsoon in Titas river, B. Baria district (Appendix table 7.VII). In Pond *Bellamya bengalensis* f. *typica* was recorded highest ((4.05/m²) during Summer Pond in Maulvibazar district (Appendix table 10.VII) and minimum (0.88/m²) during monsoon in Pond B. Baria district (Appendix table 12.VII).

Distribution: India, Myanmar, Malay Archipelago, Indonesia.

Bangladesh distribution: All most all district.

Economic importance: The snails used as food by the tribal people of Bangladesh and Indian states Arunachal Pradesh, Manipur, Meghalaya, West Bengal. Flesh of *B. costula* also be used as a fish bait and poultry feed. It is a host of the helminthes parasites *Cercaria indica* (Sewell, 1922).

Species: *Paludomus conica*, Gray, 1834.

Synonyms:

1834. *Paludomus conica* Gray, *Griffith Cuvier, Moll.*, pl. 14, fig. 5.

852. *Paludomus rudis*, Reeve, *P.Z.S.* p.126; *H & T., C.I.* pl.124, fig.4.

1915. *Paludomus conica* Preston, H.B. *The Fauna of British India including Ceylon & Burma*, Mollusca. p.39.

Description: Shell globose conical, whorls 5, smooth for the most part excepting for one broad or three to four spiral ridges in the natural region, colour yellowish brown to dark-brown, often ornamented with dark spiral bands as in *P. blonfardina*.

Size: Average shell length, shell width, aperture length and aperture width are 20.5 ± 1.41 , 13.5 ± 1.35 , 11.62 ± 1.88 and 6.5 ± 0.70 mm respectively (Table 1E).



Figure 175: apertural View *P. conica*



Figure 176: Abapertural View *P. conica*

Distribution: India: Meghalaya-Teria Ghat, South-Jairta Hills, Garo hills, Kopili River, West Khasia Hills, Sibsagar (Assam), Bhutan.

Bangladesh distribution: Chittagong, Habiganj, Maulvibazar, Sylhet, Sherpur, Netrakona.

Habits: Feed on decaying plant matters and sand grains. Sexes separate.

Habitats: *Paludomus* is chiefly found in rocky mountain-streams, hill streams or running small canals (Called Chara).

Population density: Found in sporadically during the study period

Economic importance: It used as food of peoples of Indian States (Arunachal Pradesh, Manipur, Meghalaya and Mizoram).

Family: *Lymnaeidae*

Shell small to large, dextral, ovately oblong, thin and light, spire pointed and variable in height. Body whorls inflated and proportionately large, columellar axis typically twisted; aperture rather large, lip thin and simple. Tentacles flat and triangular; pseudobranch lacking. Stomach divided into three parts, the anterior oval crop, the middle stomach and posterior tapering pylorus. Genital opening two,

copulatory organ with a slender penis sheath and simple penis. Eggs are deposited in clusters in gelatinous capsule.

Genus: *Lymnaea* Lamarck, 1799

1799. *Lymnaea* Lamarck, *Prodr. Nouv. Clas. Coq.*:75.

Shell thin ovate or elongate rimate or imperforate; spire exerted; body whorl large: aperture oval, peristome thin and simple; columella spirally twisted; mantle not extending over the shell.

Subgenus: *Pseudosuccinea* Baker, 1908

1908. *Pseudosuccinea* Baker, *Science Newyork*, 27: 943.

Shell succineiform. Prostrate unfolded.

Species: *Lymnaea (Pseudosuccinea) acuminata f.typica* Lamarck, 1822

Synonym:

1822. *Lymnaea (Pseudosuccinea) acuminata* Lamarck, *Hist. nat. Anim Sans. Vert.*, 6(2):160.

1925. *Lymnaea acuminata*: Annandale and Rao, *Rec. Indian Mus.*, 27:177.

form *typica* Lamarck, 1822

1822. *Lymnaea (Pseudosuccinea) acuminata* Lamarck *Hist nat Anim Sans. Vert.*, 6(2):160.

1925. *Lymnaea acuminata*: Annandale and Rao, *Rec. Indian Mus* 27:177.

1989. *Lymnaea acuminata* form *typica*: Subba Rao, *Hand book of Fresh water molluscs of India*. p.127, figs.258, 259.

2005. *Lymnaea (Pseudosuccinea) acuminata f.typica* Mitra, Dey and Ramakrishna, *Fauna of Andhra Pradesh, State fauna Series*, 5 (part-5), p.203. *Zool. Surv. India*.

English name: Pond snail.

Local name: Patla shamuk.

Description: Shell thin, ovate, spire short, acuminate, body whorls much inflated, a little angular above.

Size: Average shell length, width, aperture length and aperture width 21.5 ± 1.67 , 10.25 ± 0.83 , 13 ± 0.40 and 5.75 ± 0.10 mm. respectively.

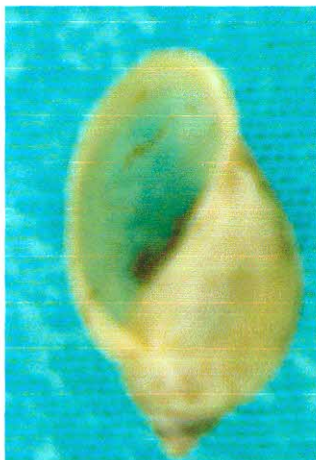


Figure 177: *apertural View* *L. acuminata f. typica*



Figure 178: *Abapertural View* *L. acuminata f. typica*

Habit: This species usually occurs in permanent water bodies with abundant vegetations. It feeds on aquatic vegetations viz. *Pistia stratiodes*, *Azolla pinnata*, *Hydrilla verticillata*, *Vallisneria spiralis*, *Chara* sp. seedling of *Oryza* sp. as well as zooplankton viz. *Daphnia* sp. *Cyclops* sp. and early instars mosquito larva (Jahan *et al.* 2003.)

Habitat: These snails found in ditches, paddy field and pond etc. It attaches to floating plants, grass etc. and mostly remain close to the water edges. *Lymnaea acuminata* form *typica* was dominant in the habitats containing water form household drainage (Jahan *et al.*, 2003.)

Population density: This species found sporadically during the study period.

Distribution: India, Myanmar, Pakistan and Worldwide.

Bangladesh distribution: All most all districts.

Economic importance: The snail *Lymnaea (Pseudosuccinea) acuminata f. typica* is much medical and agricultural importance. It is an intermediate host of different fluke's viz. *Fasciola gigantica*, *F. hepatica*, *Schistoma indica*, *S. nasalis*, *S. spindalis* and *Clinostomum giganticum* and *Echinostoma* sp. (Mitra *et al.*, 2005).

Species: *Lymnaea (Pseudosuccinea) acuminata f. gracilior* Martens, 188

Synonym:

1881. *Lymnaea acuminata f. gracilior* Martens, Conch Mittheil, 1:77.

1989. *Lymnaea (Pseudosuccinea) acuminata f. gracilior* Subba Rao, *Hand book of Fresh water molluscs of India*.p.127, figs.262,263.

2005. *Lymnaea (Pseudosuccinea) acuminata f. gracilior* Mitra, Dey and Ramakrishna *Fauna of Andhra Pradesh, State fauna Series, 5 (part-5)*, p.203. Zool. Surv. India.

English name: Pond snail.

Local name: Patla shamuk.

Description: Shell linear with a long narrow spire, colour of shell varies between grayish to light pink.

Size: Average shell length, width, aperture length and aperture width 26.7 ± 7.12 , 10.25 ± 0.06 , 13.00 ± 1.41 and 5.75 ± 0.35 mm respectively.



Figure 179: *apertural View L. acuminata f. gracilior*



Figure 180: *Abapertural View L. acuminata f. gracilior*

Habit: This species usually occurs in permanent water bodies with abundant vegetations. It feeds on aquatic vegetations.

Habitat: These snails found in ditches, paddy field and pond etc. It attaches to floating plants, grass etc. and mostly remain close to the water edges.

Population density: This species found sporadically during the study period.

Distribution: India, Myanmar

Bangladesh distribution: Brahmanbaria, Maulvibazar and Rajshahi Districts.

Economic importance: The snail *Lymnaea (Pseudosuccinea) acuminata* f. *gracilior* is much medical and agricultural importance. It is an intermediate host of different fluke's viz. *Fasciola gigantica*, *F. hepatica*, *Schistoma indica*, *S. nasalis*, *S. spindalis* and *Clinostomum giganticum* and *Echinostoma* sp. (Mitra et al, 2005).

Species: *Lymnaea (Pseudosuccinea) luteola* f. *typica*

1822. *Lymnaea luteola* Lamarck, *Hist nat Anim Sans. Vert.*, 6(2):160.

1925. *Lymnaea luteola*: Annandale and Rao, *Rec. Indian Mus* 27;183.

1989. *Lymnaea (Pseudosuccinea) luteola* f. *typica* Subba Rao, *Hand book of Fresh water molluscs of India*. p.129. figs. 275, 276.

English name: Lymneid snail

Local name: Patla shamuk

Description: Shell thin, glossy, body whorls less inflated and laterally compressed a little; spire comparatively longer and gradually tapering; aperture angulately narrows above. Whorls 4-5.

Size: Average shell length, width, aperture length and aperture width 13.75 ± 0.88 , 7.75 ± 0.95 , 9.12 ± 0.87 and 3.62 ± 0.87 m.m. respectively (Table-1).



Figure 181: Apertural View *L. luteola* f. *typica*



Figure 182: apertural View *L. luteola* f. *typica*

Habits: The snail usually occurs in all sorts of temporary and permanent water bodies with abundant vegetation. Remain attached or floats upside down to the surface film of water.

Habitats: The species is not very particular about its habitat. It is often found in pond, ditches, stagnant and temporary water bodies. When habitat dry up in summer, it tides over the unfavourable conditions by burrowing it self in the mud. The snails is a hermaphrodite and oviparous.

Population density: This species found sporadically during the study period.

Distribution: India, Myanmar, Nepal and Pakistan.

Bangladesh distribution: Allmost all districts.

Economic importance: *Lymnaea (Pseudosuccinea) luteola f. typica*, one of the most important freshwater molluscs from the viewpoint of medical sciences and as a source of animal protein. The snails may be serves as a source of animal protein for human and poultry farm. Prawn production may inhance by supplying this snails (Zaman 1995). It is one of the important snails serving as intermediate host of some cattle, pig and dog etc. It is too cosidered as pest of paddy and azolla.

Species: *Lymnaea (Pseudosuccinea) luteola f. ovalis* Grey, 1822.

Synonyms:

1822. *Lymnaea ovalis* Gray, in Sowerbys: *Gen. Rec. Foss. Shells*: Pl. 178.

1989. *Lymanaea (Pseudusuccinea) luteola f. ovalis*: Subba Rao, *Handbook of Freshwater Molluscs of India*, P. 129, figs. 266, 267, 283, 284.

2005. *Lymnaea (Peseudusucciea) luteola form, ovalis*: Mitra, Dey and Ramakrishna, *Fauna of Andra Pradesh, State Fauna Series*, 5 (Part-5), P. 206. *Zool. Surv. India*.

English name: Lymneid snail

Local name: Patla shamuk

Description: Shell larger than preceeding species, last whorls much inflated without any compression spire short and abruptly acuminate.

Size: Average shell length, width, aperture length and aperture width 13.66 ± 1.25 , 8.66 ± 0.76 , 8.41 ± 1.28 and 4.66 ± 0.28 m m respectively. (Table-1).



Figure 183: *apertural View* L. luteola f. ovalis



Figure 184: *Abapertural View* L. luteola f. ovalis

Habits: The snail usually occurs in all sorts of temporary and permanent water bodies with abundant vegetation. Remain attached or floats upside down to the surface film of water.

Habitats: The species is not very particular about its habitat. It is often found in pond, ditches, stagnant and temporary water bodies. When habitat dry up in summer, it tides over the unfavourable conditions by burrowing it self in the mud. The snails is a hermaphrodite and oviparous.

Population density: This species found sporadically during the study period.

Distribution: India, Myanmar, Nepal and Pakistan.

Bangladesh distribution: Allmost all districts.

Economic importance: *Lymnaea (Pseudosuccinea) luteola f. ovalis* , one of the most important freshwater molluscs from the viewpoint of medical sciences and as a source of animal protein. The snails may be serves as a source of animal protein for human and poultry farm. Prawn production may inhance by supplying this snails (Zaman 1995). It is

one of the important snails serving as intermediate host of some cattle, pig and dog etc. It is too cosidered as pest of paddy and azolla.

Genus: *Radix* Monfort 1810

1810.*Radix*, Monfort, *Conch.Syst.*,2.266.

Shell medium, variable in size; spire acuminate, never very long, often very short; body whorl inflated and usually expanded;outer lip more or less broadly flatttened; radula with tricuspid lateral;male intrromittent organ with the proximal slender and at least nearly as long as distal part;prostrate subcylindrical or pyliform

Species: *Radix persica* Issel, 1865.

Synonyms:

1865. *Lymnaea auricularea* var *persica* Issel, *Moll. Miss Ital Persca* (Torimo): 47.

1925. *Lymnaea persica*: Annandale and Rao, *Rec, Indian Mus*, 27; 151.

1989. *Lymnaea persica*: Subba Rao, *Handbook of Fresh water Molluscs of India*, P. 133 fig. 304,305.

2005. *Radix persica*: Mitra, Dey and Ramakrishna, 2005. *Fauna of Andra pradesh, State Fauna Series*, 5 (Part 5), P. 207 *Zool. Surv. India*.

Description: Shell not much large, body whorl inflated, spire short, pointed and slightly oblique, sutures deep, canaliculated, a thin calumella callous present. Outer lip well expanded, extends beyond the body whorl posteriorly; columella distinctly reflected and twisted.

Size: Average shell length, width, aperture length and aperture width 28.5 ± 0.70 , 16.25 ± 2.47 , 20.25 ± 1.06 and 11.5 ± 0.70 m.m. respectively (Table-1)



Figure 185: apertural View R. persica



Figure 186: Abapertural View R. persica

Habits: Found in permanent water bodies. Abundant in paddy fields. It feeds on seedling of rice, aquatic vegetation and zooplanktons. It is hermaphroditic.

Habitat: The snails occur in stagnant water body and irrigated paddy fields. It attaches to base of paddy and other aquatic plants.

Population density: This species found sporadically during the study period.

Distribution: India Andhra Pradesh, Himachal Pradesh; Kumanon lakes. Kangra valley, Renuka; Jammu & Kashmir, Mizoram, Punjab, Uttar Pradesh; Europe as far south as Spain and Italy; East Asia, Afghanistan.

Bangladesh distribution: Sylhet District

Economic importance: The snails may be serves as a source of animal protein for human and poultry farm. It is one of the important snails serving as intermediate host of some cattle, pig and dog etc. It is too cosidered as pest of paddy and azolla.

Family: Planorbidae

Genus: *Indoplanorbis* Annandale and Prasad, 1921

1921. *Indoplanorbis* Annandale and Prasad, *Rec. Indian Mus.*, 22(4) 1: 578.

Shell large and thick, sutures deeply impressed, aperture ear-shaped.

Animal sinistral, foot relatively broad and short, leaf- shaped broadly rounded

anteriorly and pointed posteriorly, branchial process lobed.

Genital aperture slit-like and relatively large, penis long a simple cylindrical tube, no penial stylet

Species: *Indoplanorbis exustus* Deshayes, 1834

1834. *Planorbis exustus* Deshayes, *Belang. Voy. Ind. Orient. Zool. Moll.*, Paris: 417, pl 1 figs, 11-13.

1969. *Indoplanorbis exustus* Ray and Mukherjee, *Rec.zool.Surv.India*, 61(3-4): 422, pl. 19, fig.5.

1989. *Indoplanorbis exustus* Subba Rao, *Hand book of Fresh water Molluscs of India*, P.142, fig.326-327.

Description: Shell thick and large, striated, discoidal with a sunken spire, whorls well rounded and aperture ear shaped.

Size: Average shell length, width, aperture diameter width 15.80 ± 3.20 , 5.7 ± 1.5 , 6.37 ± 1.5 and 4.2 ± 0.5 mm respectively



Figure 187: apertural View *I. exustus*



Figure 188: apertural View *I. exustus*

Habit: These snails found in stagnant water containing many kinds of aquatic vegetations. It prefers aquatic vegetations. It is hermaphroditic.

Habitat: Species found in ponds, ditches, canals and rice fields. Sometimes found attached with some hard substrate or aquatic vegetation.

Population density: In Pond was *I. exustus* recorded highest (3.55/m²) during Winter Pond in Sylhet district and minimum (2.10/m²) during monsoon in the same Pond (Appendix table 9.VII).

Distribution: India, China, Iran and Indonesia.

Bangladesh distribution: Almost all district.

Economic importance: It is one of the most important snails from the medical and veterinary points of view as the trematode parasites of horse, goat, sheep, camel, dog, buffalo and other livestock develop to the cercarial stage in this snail, which serves as the intermediate host.

Genus: *Gyraulus* Charpentier, 1837.

Gyraulus (agassiz MS) Charpentier., 1837, *Neue Denkschr. Allg. Schweiz. Gesell.* 1, no.2: 21.

Species: *Gyraulus convexiusculus* (Hutton, 1849)

Synonyms:

1849. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc. Beng.*, 18(2) : 657.

1864. *Planorbis saigonensis* Crosse et Fischer, *J. Conchyl.* 11: 362, pl. xiii, fig.7.

1867. *Planorbis compressus* von Martens, in Weber *Zool. Ergebn. Niederl. Ost. Ind.*, 4:13, pl.1, figs. 17-22, pl. xii, figs.7,10.

1885. *Planorbis demissus* Westerland, *Ur. Vega Expeditiones Vetenskapliga Jakattagelser*.

1956. *Gyraulus convexiusculus* Benthem Jutting, *Treubia*, 23(2): 463.

1969. *Gyraulus convexiusculus* Ray and Mukherjee, *Rec. zool. Surv. India*, 61(3-4): 424, pl. 19, fig. 4.

1989. *Gyraulus convexiusculus* Subba Rao, *Handbook of Fresh water Molluscs of India*: 154, figs. 362-364.

English name: Horn Snail.

Local name: Chapta shamuk.

Description: Shell small, always less than 1 cm in diameter, thin, greatly depressed, pale translucent or transparent, three to five rapidly increasing whorls, without strong

transverse ribs, with or without short, hair-like projection of the periostracum, with or without peripheral keel, body whorls without an aperture slightly deflected, oblique, simple.

Size: Average shell length, width, aperture diameter width 5.2 ± 0.12 , 1.68 ± 0.12 , $2 \pm$ and 1.3 ± 0.05 mm respectively (Table 1).



Figure 189: *apertural View G. convexiuscula*

Figure 190: *Whole G. convexiuscula*

Habit: *G. convexiusculus* feeds on detritous, algae, semi-decayed debris and zooplankton, etc.

Habitat: These snails found abundantly in ponds, ditches, canals and paddy fields. They usually keep themselves attached to leaves and roots of aquatic vegetations. With the onset of dry season the snail migrated to the ponds from the temporary water bodies. During rainy season when ponds over flooded the snails migrated towards the canal ditches and other temporary water bodies with one centimeter to one meter water depth and sufficient aquatic vegetation (Jahan *et al* 2003).

Distribution: India, Iran to Philippines and Japan.

Bangladesh distribution: Allmost all district

Economic importance: It is one of the most important snails from the medical and veterinary points of view. *G. Convexiusculus* is one of the eastablished host of larval forms of *Gastrothylase crumerife,r Paraphistomum explanatum*, *Fasiola elongatus* and other cercariae viz. *Cercariae chugathi*, *C.gyraulusi*, *C. rithorensis* and *C. furgolensis* (Subba Rao, 1989). Two types of cercariae viz. gymnocephalus and xiphidiocercous found in *G. convexiusculus* (Jahan *et al.* 2001).

Family- Stenothyridae

Shell minute, rarely more than 5 mm, high, ovate or sub cylindrical, compressed in its dorso ventral axis, whorls moderately convex, body whorls more or less descending to the small, sub circular aperture, surface smooth but often ornamented with minutely punctuated spirals lines, rarely with fine spines, narrowly umlicated to imperforated. Operculum calcareous to horny, externally paucispiral, internally with two prominent transverse ridges.

Genus: *Stenothyra* Benson, 1856

Shell small but relatively thick, ovate or sub cylindrical whorls ay least 4 (4-6), with sculptured minutely punctated spirals lines, occasionally with small spines, aperture ovate or sub circular, peristome continuous, uniform or hardly thickened. Operculum horny, brittle internally with two transverse ridges or smooth, polished or convex.

Species: *Stenothyra deltae* Benson, 1836

Synonyms:

1836. *Nematura deltae* Beson, *J.Asiat.Soc.Beng.*, 5:782.

1921: *Stenothyra deltae* Annandale and Prasad, *Rec. Indian Mus.*, 22:131.text.fig.2.

Description: Shell whorls flattened ventrally, sculptured with spiral punctured lines, aperture very small, sub circular with merely the trace of a notch above, periostracum thick and often with spirals rows of spines.

Size: Average shell length, width, aperture length and aperture width were 4.5 ± 0.35 , 3.95 ± 0.24 , 1.41 ± 0.34 and 0.96 ± 0.05 mm respectively.



Figure 191: Apertural View A: *Stenothyra deltae*

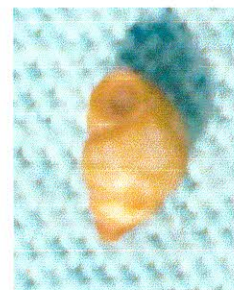


Figure 192: apertural View B: *Stenothyra deltae*

Habits: This species occur far above the area with tidal influence in pure freshwater as well brackish water. They were observed crawling on the small muddy patches in

Riverbank and in the mangrove area the high tide marks of mangrove areas, which inundated during the spring tides.

Habitats: Found in freshwater and brakish water

Population density: Found in sporadically during the study period

Distribution: India,(Wes Bengal) Australia, China, formosa, Japan, Malay Archipelago, Myanmar,Philippines.Bangladesh Distribution

Family: Physidae

Shell medium, sinistral with Sharpe pointed spire and smooth surface. Tentacles long and slender. Pseudobranch absent and respiration performed by long finger like projection of mantle. Copulatory organ with a simple penis; preputium have a large externally visible. Radular teeth arranged in transverse and oblique rows. Eggs are deposited irregularly in rounded masses.

Genus: *Physa* Draparnaud, 1801

1801. *Physa* Draparnaud, *Tab.Moll.France*, 31:52.

Sinistral shell with pointed spire and externally visible gland within preputium.

Species: *Physa acuta* Draparnaud, 1805

1805.*Physa acuta* Draparnaud, *Histoire naturelle des mollusques terrestres et fluviatiles de la France*, Paris : 55.

1980. *Physa acuta*: Brown, *freshwater snails of Africa and their Medical importance*, p. 212, fig. 115a.

1997. *Physa acuta* Surya Rao, *Fauna of Delhi, State Fauna Series*, 6,p. 121. *Zool. Surv. India*.

English name:

Local name: Ditches snail

Habit: The species prefers less polluted water. They feed on organic debris and moderate amount of aquatic vegetation.

Habitat: The species prefers polluted water, found irrigation channel, ditches, dams and streams in or near town. Generally, it is found in abundance in shallow water areas with algal mats or where there is moderate amount of organic debris or where the water is more greenish.

Population density: This species found sporadically during the study period.

Description: Shell moderate, sinistral, ovate, transparent but thick and sharply pointed apex; spire sharp and pointed; suture oblique; body whorl large and around, sculpture smooth; aperture ovate.

The colour of the shell is variable, pale green or brown and tinged with black, gray, green or red. The colour of the apex is also variable, red or black or similar to the shell colour.

Size: Average shell length, shell width, aperture length and aperture width are 12.62 ± 0.32 , 8.25 ± 0.12 , 8.06 ± 0.13 and 3.31 ± 0.20 m.m. respectively (Table 1).



Figure 193: apertural View *P. acuta*



Figure 194: Abapertural View *P. acuta*

Distribution: India, North America introducing in Europe, Africa and South East Asia: Pakistan.

Bangladesh distribution: Comilla, Dhaka, Maulvibazar and Rajshahi District.

Economic importance: Plays an important role as detritivore.

Order: Basommatophora

Shell bears one pair of non-invaginable tentacles with eyes located near the tentacles base. Some with secondary gills. Most have thin, fragile shells with conical

spire and large aperture. Primarily freshwater inhabitants, a few are marine and brakishwater forms.

Class Bivalvia

Order Arcoida

Family Arcidae Lamarck, 1809

Sub family Anadarinae Reinhart, 1935

Genus: *Scapula* Benson, 1834.

1834. *Scapula* Benson, *Proc.zool.Soc.London*, p19.

Shell small, equivalve, inequilateral, subtrapezoidal, elongate, smooth, lacking ornamentation over most of the shell surface excepting at the angle, posterior umbonal carina high and narrow, ligament external, hinge linear with numerous subequal teeth, separated into two by the middle edentate portion of cardinal lamina, at the laminar posterior teeth sometimes ramose, turning obsoletely and obliquely into the interior of the shell, muscular distinctive, the lower one on the posterior side squarish.

Species: *Scapula deltae* Blanford, 1867

1867. *Scapula deltae* Blanford, *J. Asiat. Soc. Beng.*, 36(2); 71.pl.iii.figs. 7-10.

1912. *Scapula deltae* Preston, *Fauna of British India, Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 130.

1989. *Scapula deltae* Subba Rao, *Handbook of Fresh water Molluscs of India* p. 160, figs. 374-376.

Local name: Tin cona jhinuk.

Description: Shell very tumid, elongately rhomboidal, covered with a thick dark epidermis, which rather rough and radiately ribbed behind the keel. Beneath the epidermis the shell is white and decussately very minutely sculptured, one flat broad rib, scarcely raised, The valves are bluish within, rounded in front, obliquely truncated

at the posterior margin; the ventral margin is convex anterior, sub concave posteriorly, being straight for the greater part of its course in young shells but becoming slightly concave, at the spot where the bysuss passes out, in old specimens. The keel is very high and sharp, separating the valve into two sub divisions, the anterior of which is the tumid, the posterior concave. The area is polished striated rather, obliquely; the ligament is diamond shape and covering only the anterior portion, about $\frac{1}{3}$ to $\frac{1}{2}$ the length of the area. The hinge teeth is oblique but less so then in either *S.celox* or *S.pinna*, and posterior teeth are much farther from the extremity of the shell than in either of those species.

Size: Average valve length, height and thickness about 13.2 ± 2.38 , 7.08 ± 0.67 and 5.96 ± 1.20 mm respectively.



Figure 195: Inner View of *S. deltae*



Figure 196: Whole View of *S. deltae*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.).

Habitat: Found in aquatic habitat Viz. Rivers and streams. Found in inter tidal region, often in muddy sand localities. Species are usually attached with a byssus to the substratum. They are also attached with a byssus to the Mussels.

Population density: This species was recorded highest ($4.27/m^2$) winter in Ratna River, Habiganj district (Appendix table 6.VII) and minimum ($0.11/m^2$) during monsoon in Gomoti River (Appendix table 8.VII)

Bangladesh distribution: Comilla, Habiganj

Elsewhere: India and Myanmar

Economic importance: Mussel flesh is uses as shrimp and poultry feed.

Order: Unionoida

Shell inequilateral, equivalve to sub equivalve, flatly compressed to globular. Hinge

dentition, when present, consists of one or two subumbonal teeth. Foot lacking byssus structure in adult. Mantle lobe fused to form siphons.

Family: Unionidae

Shell equivalve, covered with a thick periostracum, umbones generally corrugately sculptured and remnants of larval shell, umbonal cavity deep, ligament elongated and projecting, hinge with strong teeth, two cardinals and posterior lateral lamellar teeth in left valve and a single cardinal and lateral in right valve, gills, water tubes, marsupium occupying outer pair only or all the four gills.

Genus: *Lamellidens* Simpson, 1900.

1900. *Lamellidens* Simpson, *Proc. U.S. natn. Mus.*, 22:854.

Shell moderately thick, elongate elliptical; anterior end narrow and curving regularly; posterior end broad with a post dorsal wing, a low, often biangularate posterior ridge and also two sharp radiating lirae; umbo curved radiating ridge of zig-zag shaped and concentric reaching about halfway from beak and fading out gradually; periostracum smooth; brownish or dark, shiny and ray less; hinge with two elongated cardinals and two laterals in the left valve and right valve with two parallel lamellar cardinals and one laterals.

Exhalent aperture with a row of minute tubercles at its extreme lateral margin, inhalant aperture with a single row of stout and short tubercles.

Species: *Lamellidens marginalis* Lamarck, 1819

1819. *Lamellidens marginalis* Lamarck, *Hist. Nat. Anim. Sans. Vert.*, 4:79.

1900. *Lamellidens marginalis*: Simpson, *Proc. U.S. natn. Mus.*, 22:854.

1989. *Lamellidens marginalis* Subba Rao, *Hand book of Fresh water Molluscs of India* p. 168, figs. 404-405.

English name: Freshwater mussel

Local name: Jhinuk, Chinai, Jhinai and Kafna

Description: Shell oblong-ovate, thin, very smooth, perisostracum blackish-brown and shining light brown border along the ventral margin, posterior side broad, roundly angular, produced, wing very narrow, dorsal margin a little curved, anterior side short and narrow, ventral margin slightly contracted in the middle, hinge with two cardinals in the right valve, lower better developed, a single lateral and trace of a second one, left valve with one feebly developed cardinal, two curved lateral teeth.

Size: Average valve length, height and thickness about 75.4 ± 15.88 , 40.2 ± 7.51 and 26.3 ± 6.82 mm respectively



Figure 197: Outer View of *L. marginalis*



Figure 198: Inner View of *L. marginalis*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.).

Habitat: Found in aquatic habitat Viz. Ponds, Lakes, Rivers and streams. It lives nearly buried in muddy or sandy bottom, with only the posterior tips of the shell valves exposed. May also occur wedged in between rocks and stones, with valve slightly spread and two siphon exposed.

Population density: The estimated Population density of the mussel highest ($17.33/m^2$) winter in Titas river of Brahman baria (Appendix table 7.VII) and minimum ($0.05/m^2$) Monsoon in Gomoti river, Comilla (Appendix table 8.VII). In the Pond highest winter ($2.88/m^2$) Habiganj (Appendix table 11.VII and minimum monsoon ($0.33/m^2$) Pond in Brahman baria (Appendix table 12.VII).

Bangladesh distribution: Almost all districts

Elsewhere: India, Myanmar and Srilanka

Economic importance: Mussel's flesh used as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The freshwater mussel *L. marginalis* produces freshwater pearl. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc. These mussels are filter feeders and acts as natural water cleaner and indicators of water quality conditions. Peoples of Bihar, Jharkhand, Orissa, West Bengal, Meghalaya (Indian states) consumes its meat (Ramakrishna *et al*, 2007).

Species: *Lamellidens jenkinsianus* (Benson, 1862).

Synonyms:

1862. *Unio jenkinsianus* Benson, 1862. *Ann. Mag. Nat. Hist.*, (3) 10: 185.

1920. *Lamellidens jenkinsianus* Prasad, *Rec. Indian Mus.*, 19: 172. Pl. ix, fig. 3, 4.

1989. *Lamellidens jenkinsianus*: Subba Rao, *Hand Book of Freshwater Molluscs of India*, P. 166. fig. 390, 341.

Description: Shell transversely elongated, thick, tumid, anterior end short, and rounded, posterior sore sloping, right valve with two cardinals, lower long, thick and heavily built and very ragged, upper one usually thin, a single blade like lateral, left valve with a small pad like tooth from the inner margin of the umbo, two lamellar teeth.

Size: Average length of shell, width and thickness are 81.40 ± 9.01 , 42.40 ± 2.90 and 27.33 ± 2.19 mm respectively.



Figure 199: Outer View of *L. jenkinsianus*



Figure 200: Inner View of *L. jenkinsianus*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus brought in current of water caused by ciliary movement.

Habitat: Found in aquatic habitat viz. ponds, lakes, rivers and streams. They are more abundantly nearly the bank and bottom of the river.

Population density: This species found in different river of the studied area sporadically. Their population density was not determined.

Bangladesh distribution: Dhaka, Brahmonbaria, and Sylhet.

Elsewhere: India: Assam. Upper Brahmaputra (Tezpur): Bihar: Bhagalpur, Myanmar and Srilanka.

Economic importance: Mussel flesh used as shrimp and poultry feed. *Lamellidens jenkinsianus* long been used for valuable pink pearl and mother pearl production. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Species: *Lamellidens jenkinsianus* sub sp. *daccaensis* (Preston, 1912).

Synonyms:

1912. *Parreysia daccaensis* Preston, *Rec. Indian Mus.*, 7: 300.

1920. *Lamellidens jenkinsianus* sub. sp. *daccaensis*: Prasad, *Rec. Indian Mus.*, 19: 173, Pl. ix, figs. 5-8.

1989. *Lamellidens jenkinsianus* sub sp. *daccaensis*: Subba Rao, *Handbook of Freshwater Molluscs of India* P. 167. figs. 394-397.

English name: Fresh water mussel

Local name: Jhinuk, Chinai, Jhinai and Kafna

Description: Shell shorter, broader elongately ovate, more convex; umbo more distinct; sculpture much more coarsely concentrically striate and is also considerably malleated; dorsal margin more arched than the typical form; darker in colour; being of a blackish brown; left valve with small pad like tooth from the inner margin of umbo and two lateral; right valve with two cardinals, lower one thick and heavy and ragged, upper one thin, lateral tooth single blade like.

Size: Average valve length, height and thickness about 94.66 ± 4.72 , 56.33 ± 4.61 and 32.66 ± 9.25 mm respectively.



Figure 201: *Outer View of L. jenkinsianus var. daccaensis*



Figure 202: *Inner View of L. jenkinsianus var. daccaensis*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus brought in current of water caused by ciliary movement.

Habitat: Found in aquatic habitat viz. ponds, lakes, rivers and streams. They are more abundantly nearly the bank and bottom of the river.

Population density: This species found in different river of the studied area sporadically. Their population density was not determined. This species only found Pond in Habiganj.

Bangladesh distribution: Comilla, Habiganj Dhaka, Nababgang (Jessore district) and Sylhet.

Elsewhere: India: Assam, Bihar: Bhagalpur.

Economic importance: Mussel flesh used as shrimp and poultry feed. *Lamellidens jenkinsianus* sub sp. *daccaensis* long been used for valuable pink pearl and mother pearl production. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Distribution: India: Assam, Bihari Bhagapur.

Elsewhere: Comilla, Habiganj, Dhaka, (Mirpur), Nababganj (Jessore Dist) and Sylhet.

Species: *Lamellidens phancooganjensis* (Preston)

Synonyms:

1912. *Lamellidens phenchooganjensis* Preston, *Rec, Indian Mus*, 7:306.

English name: Freshwater mussel

Local name: Jhinuk, Chinai Jhinai and Kafna

Description: Shell very elongate ovate. Pictorially obtusely rostrate dark blackish-brown, with umbones flat, much enrolled, anterior side angled above, gently rounded below posterior margin obtusely rounded antero-dorsal margin gently sloping, Postero- dorsal margin more rapidly sloping in slight curve. Anterior scars ovate moderately impressed; Posterior scars roughly triangular, not well impressed; interior of shell shading from plate brown to bluish, nacreous, and marked especially towards the anterior ventral region, with very shallow radiate furrows.

Size: Average length of shell, width and thickness are 87.33 ± 15.85 , 43.66 ± 8.04 and 28.80 ± 6.91 mm respectively.

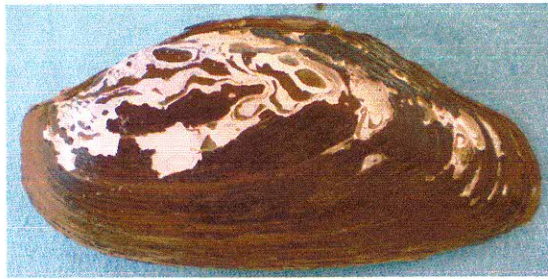


Figure 203: *Outer View of L. phancooganjensis*



Figure 204: *Inner View of L. phancooganjensis*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus brought in current of water caused by cilliary movement.

Habitat: Found in aquatic habitat viz. Rivers, haors beel and streams. They are more abundantly nearly the bank and bottom of the river.

Population density: The estimated Population density of the mussel highest

(2.68/m²) winter in Khushyara river Sylhet (Appendix table 5.VII) and minimum (0.22/m²) summer in Khushyara River and Monsoon in Ratna River Habiganj (Appendix table 5.VII & 6.VII).

Bangladesh Distribution: Brahmanbaria, Habiganj, Maulvibazar and Sylhet Districts.

Elsewhere: India

Economic importance: Mussels flesh used as shrimp and poultry feed. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc. They are also filter feeder and act as natural water cleaner and indicators of water quality conditions.

Species: *Lamellidens indawgyiensis* Prasad.

1930. *Lamellidens indawgyiensis*, Prasad, *Rec. Indian Mus.*, 32: 253, Pl. viii, figs 9, 10.

English name: Fresh water mussel

Local name: Jhinuk, Chinai, Jhinai and Kafna

Description: Shell large (more than 100 mm) elongate-ovate, rather thick, moderately inflated surface with low, concentric ridges, umbones anterior not prominent, dorsal margin almost straight, ventral margin some what arched, anterior end short and broad, posterior rostrate, with well-marked post-dorsal wing.

Size: Average valve length, height and thickness about 106.00±19.80, 53.05±12.02 and 38.5±5.65 mm. respectively.



Figure 205: *Outer View of L. indawgyensis*



Figure 206: *Inner View of L. indawgyensis*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus.

Habitat: Found in aquatic habitat viz. lakes, rivers and streams.

They are more abundantly nearly the bank and bottom of the Beel and river.

Population density: These individuals were found occasionally; their population density was not determined.

Bangladesh distribution: Habiganj, Maulvibazar and Sylhet districts.

Elsewhere: Myanmar.

Economic importance: Mussel flesh used as shrimp and poultry feed. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Species: *Lamellidens corrianus* Lea, 1834

Synonyms:

1834. *Unio corrianus* Lea, *Trans. Amer. Philos. Soc.*, 6(2): 65, pl. 9 fig. 25.

1900. *Lamellidens corrianus*: Simpson, *Proc. U.S. natn. Mus.*, 22: 857.

1921. *Lamellidens corrianus*: Prasad, *Rec. Indian Mus.*, 22: 609, fig. 29c.

1989. *Lamellidens corrianus*: Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 165. fig. 386. 387.

2005. *Lamellidens corrianus* Mitra, Dey and Ramakrishna, *Fauna of Andhara Pradesh, State Fauna Series*, 5 (Part-5), p.212, *Zool Surv. India*.

English name: Fresh water mussel

Local name: Jhinuk, Chinai, Jhinai and Kafna

Description: Shell elenogate, elliptical umbones slightly inflated; periostracum smooth and dark brown; dorsal margin almost straight and long; cardinals two in each value.

Size: Average valve length, height and thickness about 90.1 ± 19.42 , 43.6 ± 9.76 and 30.6 ± 10.35 mm. respectively.



Figure 207: *Outer View of L. Corrianus*

Figure 208: *Inner View of L. Corrianus*

Habit: Filter feeder, feeds on microscopic plants (diatoms), zooplankton and organic detritus brought in current of water caused by ciliary movement.

Habitat: Found in aquatic habitat viz. ponds, lakes, rivers and streams. They are more abundantly nearly the bank and bottom of the river.

Population density: The estimated Population density of the mussel highest ($5.21/m^2$) winter in Khushyara river Sylhet (Appendix table 5.VII) and minimum ($0.22/m^2$) Monsoon in Surma river (Appendix table 4.VII). In Pond the highest Population was recorded winter ($1.77/m^2$) in Pond Habiganj and minimum ($0.60/m^2$) Monsoon in same Pond (Appendix table 11.VII).

Bangladesh distribution: Common through out Bangladesh.

Elsewhere: India and Myanmar.

Economic importance: Mussel flesh used as shrimp and poultry feed. *Lamellidens corrianus* long been used for valuable pink pearl and mother pearl production. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Species: *Lamellidens generosus* (Gould, 1847)

Synonyms:

1847. *Unio generosus* Gould. *Proc. Boston Soc. nat. Hist.*, 2:220.

1922. *Lamellidens generosus*: Prasad, *Rec. Indian Mus.* 24: 107, Pl 2, Fig 12-17.
1989. *Lamellidens generosus*: Subba Rao, *Hand Book of Fresh Water Molluscs of India*, P. 165, Figs. 388, 389.
2004. *Lamellidens generosus* Surya Rao, Mookerjee, Mitra, Manna and Barua, *Fauna of Manipur, State Fauna Series*, 10.p.86. *Zool Surv. India*.

English name: Fresh water mussel

Local name: Jhinuk, Chinai, Jhinai and Kafna

Description: Shell solid, oblong-ovate, anterior rounded posteriorly oblique subrostrate, dorsal margin straight, ventral margin arcuate, posterior wing narrow in adults.

Size: Average valve length, height and thickness about 79.2 ± 20.74 , 43.66 ± 12.34 and 27.8 ± 9.35 mm respectively.



Figure 209: *Outer View of L. generosus*

Figure 210: *Inner View of L. generosus inner*

Habit: Filter feeder, feeds on microscopic plants (diatoms), Protozoa, water fleas, etc.

Habitat: Found in aquatic habitat viz. ponds, lakes, rivers and streams. They are more abundantly nearly the bank and bottom of the river.

Population density: These individuals were found occasionally; their population density was not determined.

Bangladesh distribution: Brahmanbaria and Habiganj, Maulvibazar and Sylhet District.

Elsewhere: India, Myanmar.

Economic importance: Mussel flesh used as shrimp and poultry feed. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc. *Lamellidens generosus* are edible food to people of Manipur (States of India) (Ramakrisna *et al.*, 2007.)

Genus: *Parreysia* Conrad, 1853

1853. *Parreysia*, Conrad, *Proc.Acad.Nat.Sci.philad.*,6:267.

Species: *Parreysia (Radiatula) andersoniana* (Nevill, 1877)

Synonyms:

1877. *Unio andersonianus* Nevill, *J. Asiat. Soc. Beng.*, 46: 40.

1915. *Nodularia (Nodularia) andersoniana*: Preston, *Fauna British India Mollusca*, (Freshwater Gastropoda and Pelecyropoda), p. 143.

1989. *Parreysia (Radiatula) andersoniana* Subba Rao, *Hand book of Freshwater of Molluscs of India*, p.187, figs. 508.509.

English name: Fresh water mussel

Local name: Soro jinuk

Description: Shell small, thin, umbo indistinct, not at all raised; sculpture strong on umbonal region, pallial line prominent.

Size: Average valve length, height and thickness about 34.5 ± 0.70 , 16.5 ± 0.70 and 12.75 ± 0.35 mm respectively.



Figure 211: Outer View of *P. (R.) andersoniana* **Figure 212: Inner View of *P. (R.) andersoniana***

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus brought in through current of water.

Habitat: Found in aquatic habitat viz. lakes, rivers and streams.

Population density: The species have been found sporadically. So the population density was not estimated.

Bangladesh distribution: Comilla and Sylhet districts.

Elsewhere: India: Assam, West Bengal and Myanmar.

Economic importance: Mussel flesh used as shrimp and poultry feed. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Species: *Parreysia (Radiatula) bonneaudi* Eydoux 1838

1838. *Unio bonneaudi* Eydoux, *Mag., de. Zool. cl.*, 5:101, pl.119, figs.1, 1a.

1900 *Nodularia (N.) bonneaudi*: Simpson, *Proc, U.S. natn. Mus.*, 22: 813.

1921. *Indonaia bonneaudi*: Prasad, *Rec. Indian Museum.*, 22: 103.

1852. *Margaron (Unio) bonneaudi*, Lea, syn. 1852, p. 32; 1870, p. 50.

1989. *Parreysia (Radiatula) bonneaudi*: Subba Rao, *Handbook of Freshwater Molluses of India*, P. 187, figs. 510, 511.

2005. *Parreysia (Radiatula) bonneaudi* Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, state fauna series*, 5 (part-5), P. 216, *Zool.Surv. India*.

English name: Freshwater mussel

Local name: Choto Jhinuk, Chinai

Description: Shell variable in shape and color, thick, elongate, tumid with fine sculpture on umbonal region and with vertical marking on the rest of the surface, umbo central; dorsal margin convex, anterior end short, rounded, posterior end long and sloping.

Size: Average valve length, height and thickness about 40.12 ± 6.25 , 20.87 ± 1.81 and 15.00 ± 2.34 mm respectively.



Figure 213: *Outer View of P. (R.) bonneaudi*



Figure 214: *Inner View of P. (R.) bonneaudi*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus brought in through current of water.

Habitat: Found in sandy bed of the lakes, rivers and streams.

Population density: The species have been collected sporadically. So the population density was not estimated.

Bangladesh distribution: Comilla and Sylhet districts.

Elsewhere: India: Andra Pradesh: Khammam, Srikakulam; Assam, Manipur, Myanmar.

Economic importance: Mussel flesh used as shrimp and poultry feed. The shell is also used for lime production and poultry feed ingredients.

Species : *Parreysia (Radiatula) lima* (Simpson, 1900)

1900. *Nodularia (Radiatula) lima* Simpson, Proc. U. S. natn. Mus., 22:820.

1908. *Unio Siliguriensis*: Preston, Rec. Indian Mus., 2: 47, Figure 7.

1915. *Nodularia (Radiatula) lima*: Preston, *Fauna of British India Mollusca* (Freshwater Gastropoda & Pelecypoda) p. 147.

1921. *Indonaia lima* Prasad, Rec. Indian Muse. 22: 604.

1989. *Parreysia (Radiatula) lima* Subba Rao, *Handbook of Freshwater Mollusa of India*, P. 190, Figs. 528-531.

Description: Shell Small with broad pesterior end, umbo much anterir, scarcely raised; sculpture conspicuous, more prominent on umbonae region, zig-zag and transverse lines preminent on pasteriar side, finer on anterior. Highly variable species, greenishin colour.

Size: Average valve length, height and thickness about 33.75 ± 2.75 , 18.25 ± 2.5 and 12.06 ± 0.42 mm. respectively.



Figure 215: *Outer View of P. (R.) lima*



Figure 216: *Inner View of P. (R.) lima*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in the shallow water zone of the rivers.

Population density: The species was found sporadically during the study period.

Economic importance: Mussel flesh is used as shrimp and poultry feed. The shell is also used for lime production and poultry feed ingredients.

Ecological role: These mussels play an important role in maintaining the aquatic ecosystem by breaking down the organic matter and thereby recycling both nutrients and energy.

Distribution: Comilla, Habiganj and Sylhet

Elsewhere: India; Assam, Sikkim & West Bengal

Species: *Parreysia (Radiatula) shurtleffiana* Lea 1856

Synonyms:

1856. *Unio shurtleffiana* Lea. *Proc. Acad. Nat. Sci. Philad.*, 8: 94.

1915. *Nodularia (Nodularia) shurtleffiana*: Preston, *Fauna of British India, Mollusca* (Freshwater Gastropoda and Pelecypoda), P. 138.

1989. *Parreysia (Radiatula) shurtleffiana* Subba Rao, *Handbook of Freshwater Molluscs of India*, P. 192, figs. 512, 513.

English name: Freshwater mussel

Local name: Patla jhinuk

Description: Shell small, smooth, umbo prominent; sculpture on umbonal region and also on anterior slope.

Size: Average valve length, height and thickness about 41.37 ± 3.77 , 21.87 ± 2.28 and 17.37 ± 0.85 mm respectively.



Figure 217: Outer View of *P. (R.) shurtleffiana*



Figure 218: Inner View of *P. (R.) shurtleffiana*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in the shallow water zone of the rivers.

Population density: The estimated Population density of the mussel highest (0.33/m²) summer in Surma River Sylhet and minimum (0.05/m²) Monsoon in Surma and Khushyara river (Appendix table 4..VII & 5.VII)

Bangladesh distribution: Commila, Habiganj and Sylhet districts.

Elsewhere: India: Maharashtra: Ahmednagar.

Species : *Parreysia (Radiatula) caerulea* (Lea, 1831)

Synonyms:

1831.*Unio caerulea* Lea, *Trans Amer. Phil. Soc.*, 4: 95: Pl. 13, fig. 25.

1915.*Nodularia (Nodularia) caerulea*: Preston, *Fauna of British India Mollusca*, (Freshwater Gastropoda and Pelecypoda), P. 136.

1989.*Parreysia (Radiatula) caerulea*: Subba Rao, *Handbook of Freshwater Molluscs of India*, P. 188, figs. 516, 517.

2005.*Parreysia (Radiatula) caerulea*: Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna series*, 5 (part-5), p. 216, *Zool. Surv. India*.

English name: Freshwater mussel

Local name: Patla jhinuk

Description: Shell elongate, variable in shape, sculpture restricted to the upper half of the valves in the adult whereas in the young one the whole shell surface sculptured, posterior umbonal carina very distinct.

Size: Average valve length, height and thickness about 42.75 ± 0.97 , 20.33 ± 0.65 and 15.00 ± 0.20 mm. respectively.



Figure 219: *Outer View of A: Parreysia (Radiatula) caerulea*



Figure 220: *Inner View of B: Parreysia (Radiatula) caerulea*

Bangladesh distribution: Comilla, Habiganj, Maulovibazer and Sylhet Districts.

Elsewhere: India: Andra Pradesh, Assam, Jharkand, Meghlaya, Mizorum, Orissa, Punjab, Rajasthan, Uttar Pradesh, West Bengal; Myanmar; Nepal; Pakistan: Sind.

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals (Protozoa, water fleas, etc.) and organic detritus brought in through current of water.

Habitat: Found in aquatic habitat viz. lakes, rivers and streams.

Population density: The species have been collected sporadically. So the population density was not estimated.

Economic importance: Mussel flesh used as shrimp and poultry feed. The shell is also used for lime production and poultry feed ingredients.

Ecological role: These mussel are plays important role in maintaining the aquatic ecosystem by breaking down the organic matter and thereby recycling both nutrients and energy.

***Parreysia (Parreysia) favidens* Benson, 1862.**

1862. *Unio favidens* Benson *Ann. Mag. Nat.Hist.*, 3(10): 188.

1870. *Margaron favidens* Lea, *Syn.*, p.38.

1890. *Unio favidens*, Paetel, Conch.Sam.iii,p.152.

1863. *Unio tirostris*, Musgrave, Hanley, *Phot. Conch* pl.2 fig.9.

1863. *Unio tripartitus* Lea, Proc. Acad. Nat.Sci. Philadelphia, vii.p.190.

1870. *Margaron (Unio) tripartitus* Lea, Syn., p.35.

1862. *Unio smaragdites* Benson, A.M.N.H. x.p. 190.

1900. *Parreysia favidens*: Simpson, Proc. U. S. natn. Mus., 22:842.

1912. *Parreysia favidens*: Preston, Rec. Indian Mus, and 7:244.

1989. *Parreysia favidens* Handbook of Freshwater Molluscs of India, P. 180, figs. 466, 467, 484, 485.

English name: Freshwater mussel

Local name: Gol jhinuk, Sobuj jhinuk

Description: Shell thick and heavy, inflated, with strong zig-zag ribs on beak, unequilateral and angulate both on anterior on posterior margins, cardinal teeth strong and broad.

Size: Average valve length, height and thickness about 46.5 ± 3.96 , 30.2 ± 2.86 and 20.1 ± 1.94 mm respectively.



Figure 221: Outer View of *P. (P.) favidens*



Figure 222: Outer View of *P. (P.) favidens*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Lakes, ponds, Rivers and streams. It lives nearly buried in mud or sand bottom, with only the posterior tips of the shell valves exposed.

Population density: The estimated Population density of the mussel was highest (22.21/m²) winter in Ratna river Habiganj (Appendix table 6.VII) and minimum (0.22/m²) Monsoon in Surma river (Appendix table 4.VII).

Bangladesh distribution: Comilla, Habiganj, Sylhet, Mymensingh and Chittagong districts.

Elsewhere: India, Pakistan, Myanmar and Srilanka.

Economic importance: Mussel's flesh is used as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc. Peoples of Bihar, Jharkhand, Orissa, West Bengal, Manipur and Mizoram (Indian states) consumes its meat (Ramakrishna *et al*, 2007)

Ecological role: These mussels are filter feeders and acts as natural water cleaner and indicators of water quality conditions.

***Parreysia (Parreysia) favidens* var. *assamensis* Preston**

synonym:

1912. *Parreysia favidens* var. *assamensis* Preston, *Rec. Indian Mus.*, 7: 299.

1989. *Parreysia (Parreysia) favidens* subsp. *assamensis*: Subba Rao, *Handbook Freshwater Molluscs of India* P. 181, figs. 468, 469.

2000. *Parreysia (Parreysia) favidens* subsp. *assamensis* ,Takur *et al.* *Fauna of Tripura, State Fauna Series*, 7,p.337, Zool.Surv. India.

English name: Freshwater mussel

Local name: Gol jhinuk, Sobuj jhinuk

Description: Shell more convex than typical form, dorsal margin rather less posterior angled, anterior side is more rounded and posterior slightly more truncate.

Size: Average valve length, height and thickness about 48.33 ± 0.77 , 30.41 ± 3.95 and 19.58 ± 2.43 mm. respectively.

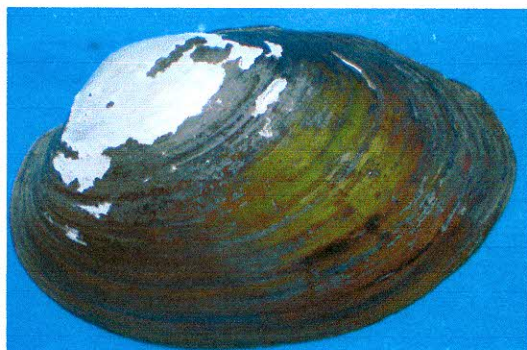


Figure 223: *Outer View of P. favidens var. assamensis*



Figure 224: *Inner View of P. favidens var. assamensis*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Lakes, ponds, Rivers and streams. It lives nearly buried in mud or sand bottom, with only the posterior tips of the shell valves exposed.

Population density: The species have been collected sporadically. So the population density was not estimated.

Bangladesh distribution: Brahmonbaria, Comilla, and Sylhet Districts.

Elsewhere: Assam: Digong; Bihar: Arrah; Mizoram and Tripura (Indian states).

Economic importance: Mussel's flesh used as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Ecological role: These mussels are filter feeders and acts as natural water cleaner and indicators of water quality conditions.

Species: *Parreysia (Parreysia) favidens* var. *marcens* Benson.

Synonym:

1862. *Unio favidens* var. *marcens* Benson, *Ann. Mag. nat. Hist.*, (3) 10: 188.

2005. *Parreysia (Parreysia) favidens* var. *marcens* Ramakrishna et al. *Fauna of Andhra Pradesh, State Fauna Series*, 5(Pat-5), p.215, Zool.Surv. India.

English name: Freshwater mussel

Local name: Gol jhinuk

Description: Shell larger, more elongate dark brown, umbonal region weakly sculptured, posterior margin broadly rounded.

Size: Average valve length, height and thickness about 52.30 ± 8.02 , 33.44 ± 5.69 and 22.00 ± 2.22 mm respectively.



Figure 225: Outer View of *P. (P.) favidens* var. *marcens*



Figure 226: Inner View of *P. (P.) favidens* var. *marcens*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Lakes, Rivers and streams. It lives nearly buried in mud or sand bottom, with only the posterior tips of the shell valves exposed.

Population density: The species have been collected sporadically. So the population density was not estimated.

Bangladesh distribution: Comilla, Sylhet.

Elsewhere: Andra Pradesh: Khammam, Srikakulum, Assam, Maharashtra, West Bengal: Bardhaman, Kolkata.

Economic importance: Mussel's flesh used as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Ecological role: These mussels are filter feeders and acts as natural water cleaner and indicators of water quality conditions.

Species: *Parreysia (Perreysia) favidens* var. *viridula* Benson.

1862. *Parreysia favidens* var. *viridula* Benson, *Ann. Mag. nat. Hist.*, (3) 10: 189.

1989. *Parreysia favidens* var. *viridula* Subba Rao *Handbook Freshwater Molluscs of India* P. 182, figs. 474, 475.

English name: Freshwater mussel

Local name: Gol Jhinuk

Description: Shell compressed; cardinal teeth broad; nacre bluish white; umbonal rugae strong and extended.

Size: Valve length, height and thickness about 47.5 ± 0.7 , 30.5 ± 0.7 and 23.50 ± 0.7 mm respectively.



Figure 227: Outer View of *P. viridula*



Figure 228: Inner View of *P. viridula*

Habit: They are too filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Lakes, Rivers and streams. It lives nearly buried in mud or sand bottom, with only the posterior tips of the shell valves exposed.

Population density: The species have been collected sporadically. So the population density was not estimated.

Bangladesh distribution: Sylhet (Fenchugonj).

Elsewhere: India.

Economic importance: Mussel's flesh is used as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Ecological role: These mussels are filter feeders and act as natural water cleaner and indicators of water quality conditions.

Species: *Parreysia (Parreysia) corrugata* Mueller

Synonyms:

1774. *Mya corrugata* Mueller, *Verm. Terr. et. Fluv*, Pt. 2: 214, no. 398.

1900. *Parreysia corrugata*: Simpson, *Proc. U.S. natn. Mus.*, 22: 841.

1912. *Parreysia corrugata*: Preston, *Rec. Indian Museum* 7: 297.

1989. *Parreysia (Parreysia) corrugata* Subba Rao *Handbook Freshwater Molluscs of India* P. 179, figs. 448, 449.

English name: Freshwater mussel

Local name: Sabuj gol jhinuk

Description: Shell elliptic to oval, smooth, scarcely inequilateral; umbones prominent; lunule well marked; sculptured with somewhat radiating, oblique, linear ridges, ventral margin convex, cardinal teeth strong net lamellar; green in colour.

Size: Average valve length, height and thickness about 25.5 ± 8.26 , 17.16 ± 6.25 and 11.83 ± 4.25 mm respectively.



Figure 229: *Outer View of P. corrugata*



Figure 230: *Inner View of P. corrugata*

Population density:

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Lakes, Rivers and streams. It lives nearly buried in mud or sand bottom, with only the posterior tips of the shell valves exposed.

Population density: The estimated Population density of the mussel highest ($4.77/\text{m}^2$) winter in Khushyara river Sylhet (Appendix table 5.VII) and minimum ($0.05/\text{m}^2$) Monsoon in Surma river (Appendix table 4.VII).

Bangladesh distribution: Comilla, Sylhet dist.

Elsewhere: India; Srilanka; Myanmar.

Economic importance: Mussel's flesh is uses as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Ecological role: These mussels are filter feeders and acts as natural water cleaner and indicators of water quality conditions. It plays critical role of recycling the nutrients by breaking down.

Species: *Parraysia (Parreysia) gowhattensis* (Theobald, 1873)

1873. *Unio gowhattensis* Theobald; J. Asiat Soc. Beng. 42(2): 208, pl.17, fig 4.

1900. *Parreysia gowhattensis*: Simpson *Proc. U.S. natn. Mus.*, 22: 845.

1912. *Parreysia gowhattensis* Preston, *Rec. Indian Mus.*, 7: 301.

1989. *Parreysia (Parreysia) gowhattensis*: Subba Rao *Handbook Freshwater Molluscs of India* P. 183, figs. 498, 499.

English name: Freshwater mussel

Local name: Gol jhinuk

Description: Shell thick, in equilateral, quadrately ovate, periostracum brownish-yellow, concentrically striated and rugose, umbone prominent but eroded; anterior side curved and short, posterior side long and truncate; posterior dorsal margin straight between umbones and suddenly sloping on the posterior margin; ventral margin curve-and indented on the posterior side.

Size: Average valve length, height and thickness about 41.12 ± 10.28 , 29.75 ± 8.29 and 19.37 ± 2.56 mm respectively.



Figure 231: Outer View of *P. gowhattensis*

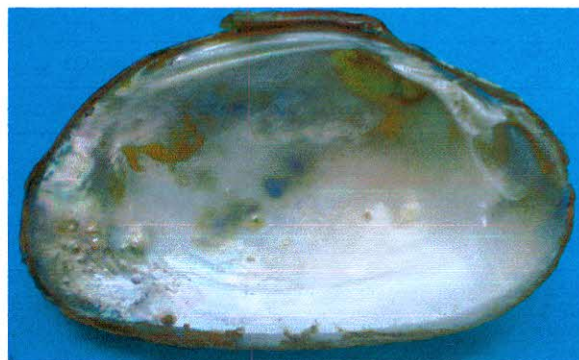


Figure 232: Inner View of *P. gowhattensis*

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Lakes, Rivers and streams.

Population density: The estimated Population density of the mussel highest ($5.21/m^2$) winter in Khushyara river Sylhet (Appendix table 5.VII) and minimum ($2.49/m^2$) summer in the same river (Appendix table 5.VII).

Bangladesh distribution: Sylhet dist.

Elsewhere: Assam (India).

Economic importance: Mussel's flesh used as shrimp and poultry feed, crushed shell used as poultry feed ingredients. The shell is also used for ornamental inlay work, lime production, making buttons, knife handles, etc.

Ecological role: These mussels are filter feeders and acts as natural water cleaner and indicators of water quality conditions. It plays critical role of recycling the nutrients by breaking down.

Family Solecurtidae d'Orbigny, 1846

Shell quadrately elongated with wide gapes at both ends. Hinge plate narrow and weak; the pallial sinus either deep or shallow.

Subfamily: Novaculininae E.N.Ghos 1920.

Shell inequivalve, long and cylindrical resembling that of Solenidae, beaks placed anteriorly; hinge with two or three cardinal teeth.

Foot short and stout with a disc-like anterior end projecting forwards and downwards.

Genus: *Novaculina* Benson, 1830.

Shell subinequivalve, transversely elongated, with uniform width throughout, umbones prominent and hinge line almost straight, hinge with three cardinals in left valve and two in right valve.

Species name: *Novaculina gangetica* Benson, 1830.

Synonyms:

1830. *Novaculina gangetica* Benson, 1830, *Gleaning in Science*, Calcutta, 2: 63.

1854. *Novaculina novaculina*, Gray, A.M.N.H. xiv, p. 24.

1874. *Solecurtus novaculina*, Reeve, *Con. Icon.* pl. 7. figs. 31 a & b. 1888. *Tagelus gangeticus*, Clessin, in *Conch. Cab.* pp.81-82, pl.23, fig.6.

1915. *Novaculina gangetica* Preston, *Fauna of British India, Mollusca* (Freshwater Gastropoda and Pelecypoda) p.229.

1989. *Novaculina gangetica* Subba Rao *Handbook Freshwater Molluscs of India* P. 223, figs. 637,638.

English name: Freshwater mussel

Local name: Lomba jhinuk

Description: Shell oblong, with truncated extremities, periostracum olivaceous. Animal flattened in dorsoventral direction, foot stumpy with a disc- like flattened surface.

Branchial siphons longer and stouter than the anal surface of siphons finely ribbed but not segmented apertures constricted and without tentacular fringe.

Size: Average valve length, height and thickness about 30.75 ± 1.06 , 8.00 ± 0.70 and 8.2 ± 1.06 mm respectively.

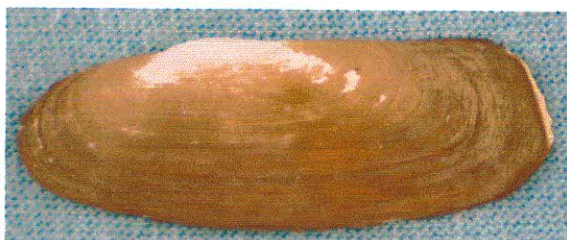


Figure 233: *Outer View of N. gangetica*



Figure 234: *Inner View of N. gangetica*

Population density: The species was found sporadically during the study period.

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitat: The specimens found in aquatic habitat viz. Rivers and streams.

Population density: The species have been collected sporadically. So the population density was not estimated.

Bangladesh Distribution: Comilla

Elsewhere: India

Economic importance: Mussel's flesh used as shrimp and poultry feed, crushed shell used as poultry feed ingredients.

Family: Corbiculadae

Genus: *Corbicula*, Megerle von Muchifield, 1811

Corbicula, Megerle von Muchifield, 1811, *Mag. Gesell. Naturf.* Berlin, 5:56.

Shell subtrigonal, thick, with strong, concentric ribs, umbones prominent and central, ligament prominent and external, hinge with three cardinal teeth in each valve, lateral

teeth elongated, compressed, lamelliiform, finely serrated, right valve with two laterals on each side, left with one on each side, pallial line mostly without sinus.

Mantle margin with papillae siphons very short and close, orifices without papillae.

Species: *Corbicula striatella*, Deshayes, 1854.

Synonyms:

1854. *Corbicula striatella*, Deshayes, *Proc.zool.Soc.London.*, 22.344.

1861. *Corbicula subradiata*, Prime, *Acad Nat.Sci.Philad.*, p.128.

1915. *Corbicula striatella* Preston, *Fauna of British India, Mollusca* (Freshwater Gastropoda and Pelecypoda) p.214.

1989. *Corbicula striatella* Subba Rao *Handbook Freshwater Molluscs of India* P. 204, figs. 575,576.

English name: Freshwater mussel

Local name: Choto gol jhinuk

Description: Shell thick, large (22.7to 42.3 mm) tumid, triangular ovate to ovate umbones prominent, periostracum shining lemon yellow in young, darker and brown in full grown specimens, striae regular, concentric and raised into ridges, pallial line with a trace of sinus, muscle scars fairly deeply developed.

Size: Average valve length, height and thickness about 16.37 ± 3.94 , 11.37 ± 4.15 and 8.5 ± 1.77 mm respectively.



Figure 235: *Outer View of C. striatella*



Figure 236: *Inner View of C. striatella*

Bangladesh Distribution: Brahmon baria, Chittagong, Comilla, Habiganj, Maulvibazar, Sylhet, Dhaka, Mymensingh and Rangamati,

Elsewhere: India, Pakistan, Peshawer, Sindh and Burma.

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus brought in through current of water.

Habitats: These molluscs are found in sandy and muddy bottom of the river of the concerned area.

Population density: The estimated Population density of the mussel highest (19.33/m²) winter in Surma River. Sylhet (Appendix table 4.VII) and minimum (0.11/m²) Monsoon in Titas River (Appendix table 7.VII)

Economic importance: *Corbicula striatella* flesh used as shrimp and poultry feed, crushed shell used as poultry feed ingredients.

Ecological role: These mussels are too filter feeders and acts as natural water cleaner and indicators of water quality conditions. It plays critical role of recycling the nutrients by breaking down.

Species name: *Corbicula sylhetica*, Prasad, 1908.

Synonyms:

1908. *Corbicula sylhetica*, Preston, Rec. Indian Mus., 2:47.

1908. *Corbicula sylhetica*, Preston *Fauna of British India*, Mollusca (Freshwater Gastropoda and Pelecypoda) p.218.

1928. *Corbicula sylhetica* Prasad, *Mem. Indian Mus.*, 9:28.

1989. *Corbicula sylhetica*, Subba Rao *Handbook Freshwater Molluscs of India* P. 205, figs. 573,574,579,580.

Description: Shell nearly equilateral tumid, sub-trigonal, pale olive green, dorsal margin sloping, ventral margin rounded, umbones slightly prominent, striae fine and irregular, interior of the shell purplish-white.

Size: Average valve length, height and thickness about $9.33 \pm 0.0.75$, 7.83 ± 0.93 and 5.75 ± 0.61 mm. respectively.



Figure 237: Inner View of A: Corbicula sylhetica

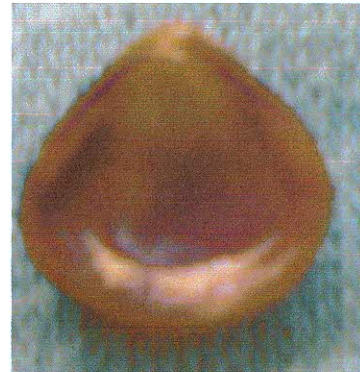


Figure 238: Inner View of B: Corbicula sylhetica

Habit: Filter feeder, feeds on microscopic plants (diatoms), animals and organic detritus.

Habitat: These species found in sandy and muddy bottom of the rivers of the studied area.

Population density: The estimated Population density of the mussel highest ($6.88/m^2$) winter in Surma River Sylhet and minimum ($0.49/m^2$) Monsoon in same river (Appendix table 4.VII).

Bangladesh Distribution: Comilla, Habiganj and Sylhet Districts.

Elsewhere: India

Economic importance: *Corbicula sylhetica* 's flesh is uses as shrimp and poultry feed, crushed shell used as poultry feed ingredients.

Ecological role: These mussels are too filter feeders and acts as natural water cleaner and indicators of water quality conditions. It plays critical role of recycling the nutrients by breaking down.

1.4 Discussion

Molluscs play a vital role in the terrestrial and aquatic environment. They are used for human food and animal feed. As vectors, they are instrumental in the transmission of many diseases in livestock and human. The land molluscs acts as pest, friend of nature, link in food chain, soil fertilizer and calcium supplier. Molluscs are also used in trade, Medical science, arts, culture, and personal adornment.

Some interested British naturalist considered the study of the variously important animals in the subcontinent in 19th century their research work mostly patronized them and published Asiatic Society of Bengal, Bombay Natural History Society and Indian Museum, Kolkata in British India.

So far knowledge goes Benson (1830) published the first scientific description of animal *Melania*. Later worker who conducted study of taxonomy and life history of Indian Land and fresh water molluscs are Annandale and Rao (1923a, b), Benson (1830, 1832, 1836, 1836a, b, 1843, 1850, 1852, 1853, 1854, 1855, 1856 a,b, 1857, 1858, 1859a ,b, c, d, 1860 a ,b, 1862 a, b, 1863 a, b, c, 1864), Beddome (1875, 1891, 1906), Blanford 1862, 1863, 1865, 1866, 1867, 1869, 1870, 1880, 1899), Blanford and Blanford (1860, 1861), Godwin-Austen (1876, 1879, 1882-1920, 1893, 1895, 1897, 1898, 1899, 1910, 1917, 1914-1918, 1919 a, b, c, 1920), Gude (1906, 1921), Henley and Theobald (1876), Hora, (1926b, 1928, 1929 a, 1933, 1933a, 1952, 1953, 1955) Theobald (1876, 1877, 1878) Nevill 1878, 1881, Pilsbry (1909-1910), Prasad (1918a, 1918b, 1919a, 1919b, 1920a, 1920b, 1921a, 1921b, 1921c, 1921d, 1919-1921, 1922a, 1922b, 1923, 1925, 1927, 1928, 1928a, 1928b, 1928c, 1930, 1931, 1932, 1933, 1934, 1936, 1937), Preston (1908, 1909, 1912, 1914, 1915, 1915a, 1915b, 1916) and Tryon (1869).

The total world mollusc is estimated at between 30,000 to 40,000 in the minimum (Solem, 1984, Abbot, 1989), though a more conservative estimation puts the number of valid described species at round 10,000. The fauna of Indian land molluscs consists

of a little less than 1,500 species under around 140 genera and 34 families. India, with her vast land area (approx. 75 million hectares) and widely varied topographic and climatic conditions accommodate 5% of the total world fauna (Mitra *et al.*, 2005). Subba Rao (1989) mentioned that Indian aquatic molluscs harbored 283 species belonging to 57 genera under 21 families.

Though Bangladesh possess long coastline on the southern edge of the country, vast territorial and deep sea areas in the Bay of Bengal having diversified molluscan habitats like sandy, muddy, clayey, rocky, mangroves and nutrient rich coral island, SaintMartin along with various freshwater habitats (Rivers, Haor, Baors, Lakes, Streams and Ponds) evergreen and deciduous forest and hills) till very little was known about the molluscan fauna of the country.

Recently, sporadic surveys and investigations were carried out by Ali (1975), Ali and Aziz (1976), Ali and Begum (1976 and 1978), Ali *et al.*, (1985), Ahmed (1978,1990 and 2003), Alam and Patra (1986), Begum *et al.*, (1989), Islam (2009) , Jahan (1992 and 1993), Jahan and Raut (1994), Jahan and Rahman (1996,2000), Jahan *et al.*, (1990, 1996, 1998, 1999, 2001a,2001b,2001c, 2002, 2003, 2007 a and 2007 b, Khanom (2007), Mannan and Khan(1990), Rahman (2000), Rahman and Jahan (1999a,1999 b and 2002), Rahman *et al.*, (1999 and 2000), Saha (1998) and Saha *et al.*, (2002, 2003 and 2004) to study the distribution, abundance, ecology and developmental biology of molluscs in Bangladesh.

Ali (1975) recorded 32 Molluscs species belonging to 24 genera and 20 families from the St.Martins Islands of Bangladesh. The recorded families were Trochidae, Ceritidae, Strombidae, Amphiperatidae, Pyrenidae, Chitonidae, Turbinidae, Neritidae, Olividae, Volutidae, Solenidae, Cypraeidae, Thaisidae, Buccinidae, Conidae, Terebridae, Siphonariidae, Onchidiidae, Mytilidae and Ostreidae. Ahmed (1990) recorded 301 Molluscs species under 151 genera and 79 families of 16 orders from the Coastal belt of Bangladesh. Jahan *et al.*, (1990, 1998) recorded 42 molluscs' species from the Intertidal zones of Sundarbans. In another study of the intertidal

zones of Cox's bazar and its adjacent areas Jahan *et al.* (1999) reported 35 species of molluscs belonging to 27 genera under 18 families of 3 orders.

Ali and Begum (1976) reported 19 molluscs species belonging to 12 genera and 9 families under the 4 orders from the Pond of Dhaka City of Bangladesh. The recorded species were *Vivipara bengalensis*, *Vivipara dissimilis*, *V. lecythis* (Family Viviparidae), *Pila globosa* (Ampularidae), *Bithynia orcula*, *B. pulchella* (Bithynidae), *Melanoides tuberculata*, *M. scabra*, *M. lineata* and *Sulcospira variabilis* (Melanidae), *Planorbis exustus* (Planorbidae), *Lymnaea acuminata*, *L. luteola* (Lymnaeidae), *Lamellidens marginalis*, *Parreysia daccaensis* (Unionidae), *Corbicula striatella* (Corbiculide) and *Solenia* sp. (Soleniformes). Later on, Ali (1978) worked on the bottom fauna of three fish pond from Dhaka city. They reported 10 species belonging to 8 genera and 7 families under the 3 orders from the Pond of Dhaka City, Bangladesh. The recorded species were *V. bengalensis*, *Cipangopaludina lecythis* (Family Viviparidae), *Alocinma* sp, (Bithynidae), *M. tuberculata*, *M. scabra*, (Melanidae), *P. exustus* (Planorbidae), *Lymnaea* sp (Lymnaeidae), *L. corrianus* (Unionidae) and *Psidium clarkeanum* (Psididae). Investigations were performed by Ali *et al.*, (1985) and Rahman (2003) on abundance and depth wise distribution of benthic molluscan fauna from a pond in Bangladesh Agricultural University Campus in Mymensingh. They reported a total of 7 species belonging to 6 genera, 5 families under 2 orders. The species were *V. bengalensis*, (Viviparidae), *M. tuberculata* (Melanidae), *Alocinma orcula* (Bithynidae), *L. marginalis*, *L. corrianus*, *Ligumia* sp. (Unionidae) and *Psidium clarkeanum* (Psididae).

In 1993, Jahan reported 23 (13 terrestrial and 10 fresh water) gastropod species belonging to 19 genera, 14 families and 4 orders from different localities of Bangladesh. Later on Jahan *et al.*, (2003) reported sixteen molluscs species from Rajshahi university campus, Bangladesh of which 14 species were also reported previously by Jahan in 1993. Thus Jahan (1993) and his associate workers (2003) recorded the presence of 14 species of land molluscs from the territory of

Bangladesh for the first time after a long time of publication of the Fauna of British India. The species were viz. *Cyclophorus auranticus* var. *pernobilis*, *C. aurora*, *Pterocyclus parvus*, (Cyclophoridae), *Achatina fulica* (Achatinidae), *Macrochlamys sequax*, *M. opiparus*, *M. indica*, *Girasia burtii* (Ariophantidae), *Glessula gemma* (Glessulidae), *Opeas gracile* (Subulinidae), *Rachis bengalensis* (Enidae), *Incillaria monticula* (Philomycidae), *Indosuccinea semiserica* (Succinidae), *Semperula birmanica* (Veronicellidae) (Table.1 A).

Siddiqui *et al.*, (2007) included a total of 479 (20 land, 22 fresh water and 437 marine and brackish water) molluscs species belonged to 210 genera, 105 families, and 23 orders under 4 classes recorded by different workers from Bangladesh.

In course of the present investigation a total of 72 species of Terrestrial (26) and freshwater (46) molluscs belonging to 41 genera, 25 families under 4 orders were collected from the study area (1.1C). Of the total 72 species 46, 44, 42, 33, 24 and 20 were recorded from Sylhet, Comilla, Maulvibazar, Habiganj, Brahmanbaria and Sunamganj districts respectively.

In context of terrestrial habitat, maximum 21 in Maulvibazar and minimum 3 species were recorded from each of Brahmanbaria and Sunamganj district. Whereas in aquatic habitats maximum 37 and minimum 17 numbers of species were recorded from Comilla and Sylhet districts respectively (Table 1.1 C). Out of these 72 land and fresh water molluscs species, 37 species (*R. bengalensis*, *M. indica*, *G. crocea*, *G. gemma*, *Seasara diplodon*, *Sivella castra*, *Chloritis delibrata*, *Plectopylis* (E.) *plectostoma*, *C. pearsoni*, *B. bengalensis*, *B. Crassa*, *B. dissimilis*, *P. globosa*, *B. (Diagonostoma) cerameopoma*, *B. (D.) pulchella*, *T. scabra*, *T. lineata*, *P. conica*, *L. acuminata* f. *typica*, *L. acuminata* f. *gracilior*, *L. luteola* f. *typica*, *L. luteola* f. *ovalis*, *I. exustus*, *G. convexiusculus*, *L. marginalis*, *L. corrianus*, *L. jenkinsianus*, *L. phancooganjensis*, *P. (P.) favidens*, *P. (P.) favidens* var. *assamensis*, *P. (P.) corrugata*, *P. (Radiatula) caerulea*, *P. (R.) bonneaudi*, *C. sylhetica* and *N. gangetica*) were reported previously

from the same area (Blanford and Godwin-Austen 1908, Gude 1914, 1921 Preston 1915, Subba Rao 1989, Jahan 1993 and Siddiqui *et al.*, 2007).

The molluscs *M. lubrica*, *G. hookeri*, *Euaustenia cassida*, *Sitala attega* (Ariophandae) *G. notigena* (Subulinidae), *S. diplodon*, *S. castra* (Helicarionidae), *C. delibrata* (Camaenidae), *I. plicata*, *Succinea daucina* (Succinidae), *P. (E.) plectosoma* (Plectopilidae) *Streptaxis pfeifferi* (Streptaxidae) *Meghimatium* sp. (Philomycidae), *F. alte* (Veronicellidae), *C. theobaldinus*, *Chamalycaeus crenatus*, (Cyclophoridae), *B. bengalensis* race *doliaris* (Viviparidae), *Physa acuta* (Physidae) *Lymnaea* (P.) *luteola* f. *ovalis*, *Lymnaea* (P.) *luteola* f. *gracilior*, *Radix persica* (Lymnaeidae), *Stenothyra deltae* (Stenothyridae), *Scapula deltae* (Arcidae), *L. phancooganjensis*, *L. indawgyiensis*, *L. generosus*, *Parreysia* (P.) *favidens* var. *assamensis*, *P. (P.) favidens* var. *marcens*, *P. (P.) favidens* var. *viridula*, *P. (P.) favidens* var. *gowhattensis*, *P. (Radiatula) andersoniana*, *P. (R.) lima*, *P. (R.) bonneaudi* and *P. (R.) shurtleffiana* (Unionidae) were recorded during the present study for the first time from Bangladesh. All the 72 species recorded during the present study belonged to 25 families of which 11 (eleven) families viz. Achatinidae, Cerastuidae, Camaenidae, Plectopylidae, Streptaxidae, Philomycidae, Veronicellidae, Stenothyridae, Physidae, Arcidae, and Psammobidae were represented by single species.

In terrestrial habitat, *A. fulica*, *M. indica* and *L. (A.) gracile* were ubiquitous species. The snails *C. pearsoni*, *C. theobaldinus* were collected from evergreen hill forest and tea garden of Maulvibazar and Sylhet districts. The slug *Meghimatium* sp. was confined to Maulvibazar district. The land snails *I. plicata* was found in Comilla and Sylhet districts. *S. attega* and *S. daucina* were found in Comilla district only. *A. gigas*, *M. opiparus*, *M. lubrica*, *E. cassida*, *C. crenatus*, *S. diplodon*, *S. castra*, *P. (E.) plectostoma* and *S. pfeifferi* were found in Maulovibazar district only.

In the aquatic habitat *B. bengalensis* f. *typica*, *B. dissinilis*, *I. exustus*, *G. convexiusculus*, *B. costula*, *L. marginalis*, *C. stritella*, *M. tuberculata*, *T. scabra*, *T. granifera* *T. lineata*, *L. phenchooganjensis* and *L. corrianus* were ubiquitous species

in the context of localities. Whereas *L. (P) luteola* f. *typical*, *L. (P.) luteola* f. *ovalis*, *B. (D.) cerameopoma*, *B. (D.) pulchella* and *N. gangetica*, *S. deltae* were found in Comilla district only. *Radix persica*, *L. jenkinsianus* were found in Sylhet district only. *P. acuta* collected in Maulovibazar District only. Each of *P. (R.) lima*, *P. (R.) shurtleffiana*, *P. favidens*, *C. sylhetica* were obtained from two districts, Comilla and Sylhet. *P. (P) gowhattensis* obtained from Sylhet district. *B. bengalensis* race *doliaris* was found in Brahmanbaria district only. *P. virens* recorded in Habiganj and Sylhet district but not found in Brahmanbaria, Comilla, Maulvibazar and Sunamganj districts.

The slug, *Meghimatium* sp., was not reported in Fauna of British India and even not in any other work from the Bangladesh territory. *Meghimatium* sp. is belonging to Family Philomycidae under the order Pulmonata, class Gastropoda and is an agro-horticulture pest. It feeds on bark of trees (*Dalbergia sisso*, Bottle brush tree) and tender leaves of wild trees. Slugs in this family are found in China, Japan, the East Indies, Central and eastern North America and through Central America into northern South America (www.wapedia.mobi/en/Philomycidae) but recorded from the study area for the first time during the present investigation.

The presence of *B.costula* confirmed the finding of Jahan (1993), though it was not reported in the Fauna of British India, *P. acuta* and *R. persica* were found for the first time in Bangladesh during the present investigation. *P. acuta* prefers polluted water, found commonly in irrigations channel, dam and streams in or near town and may be well adapted to under go anhydrobiosis which also supports the findings of Brown, (1940). Generally, it is found in abundance in shallow water areas with algal mats or where there is a moderate amount of organic debris or where the water is more greenish. In India, this species were recorded in Pune, Maharashtra by Subba Rao (1994). The snails in this family are found in North America, introducing in Europe, Africa and South East Asia: Pakistan (Begum and Nazneen, 1992).

The mussel *L. genorossus*, *L. indawgyensis* and *P. (R.) andersoniana* were reported from Myadong, Myanmar in The Fauna of British India. At present, it was found in North-eastern region of Bangladesh. *P. (L.) lima*, *P. (P.) favidens* var. *marcen* and *P. (P.) favidens* var. *gowhattensis*, were found in Assam but during the present investigation it was also found in the present study area. The Fauna of British India recorded *P. (P.) favidens* var. *virudula* (Damuda, Manbhoom) and *P. (R.) shurtleffiana* (Siria River, Ahmednagar) from India. Whereas *P. (P.) favidens* var. *virudula* was found in Khusyara River Fenchoojanj, Sylhet. On the other hand, *P. (R.) shurtleffiana* was found in Gomoti, Ratna and Surma River from Comilla, Habiganj and Sylhet districts respectively.

The Fauna of British India reported a total of 54 terrestrial and freshwater molluscs species from present Bangladesh territory (Blanford and Godwin-Austen, 1908; Gude, 1914, 1921; Preston, 1915) (Table 1.4).

Though the presence of *M. hardwickii*, *Clausilia loxostoma*, *Alycaeus sylheticus*, *Amphidromus sinensis*, *Tiara (Melanoides) terebra* and *T. (Mellanelia) zonata* were reported in Fauna of British India from the study area but did not encountered during the present study. More over, *C. auranticus* and *C. aurora* and *I. monticola* were reported by Jahan (1993) but could not found during the present study.

Most of the land snails are nocturnal. The shell of several terrestrial and aquatic molluscs are extremely so alike that the eye fails to differentiate them externally. This might be one of the causes of such missing. More over to find out the snails in their natural habitats throughout the country require very extensive survey. Besides, these natural habitats are degrading day by day due to deforestation and development activities on land. Pollution from industries, agriculture and erosion has seriously threatened Gastropod and Mussel populations. As well as river siltation, impoundment and agriculture activities in haors, baors also destructing the natural habitats for the malacofauna. Thus it might be so happened that species previously reported are not found presently and they may be extinct.

It is inevitable that the molluscan biodiversity of any habitat play various roles for the maintenance of sustainable ecosystem, food chain and soil fertility. Accordingly, the molluscan biodiversity of Bangladesh deserves proper management. Management of biodiversity is the basis for its states in a given region, can disclose the position of biodiversity indicating the on going trend of sustainability of local flora and fauna. It also helps us to gain and understand sufficient knowledge of interdependences of species within ecosystem, economic, aesthetic, health and culture impacts of the decrease or extinction one species to others. Biodiversity is the inter related multiplicity of life forms. Maintenance of biodiversity is necessary for sustainable development,

As the elsewhere global biodiversity is decreasing in Bangladesh, mainly because of natural resource degradation taking place as a consequence of clearing forests and drying of wetlands, pools, and streams to meeting increasing agricultural and consumers needs .The degradation of soil and water quality, destructive human activities and other reasons also playing vital roles in reducing biodiversity. Consequently, many species have disappeared, many others are endangered. The success of biodiversity maintenance efforts will depend on how well the over all landscapes and water are managed.

Finally, it must be emphasized that extensive survey should be made throughout the country to explore and register the total malacofauna of Bangladesh with their interrelationships to existing ecosystem components and underlying causes of their population reduction. So that the appropriate measures can be taken to keep sustainable molluscan biodiversity for the benefit of the country.

CHAPTER 2

ABUNDANCE AND DIVERSITY OF MOLLUSC SPECIES IN THE NORTH-EASTERN REGION OF BANGLADESH

Chapter 2

Abundance and diversity of Mollusc species in the North-eastern Region of Bangladesh

2.1 Introduction

Ecology is the study of organism in relation to the surroundings in which they live. These surroundings are called environment of the organism. This is made up of many different components, including other living organisms and their effects, and purely physical feature such as climate and soil type.

According to Liken (1992), “ecology is the scientific study of the processes influencing the distribution and abundance of organisms, the inter action among organisms, the interaction between organisms and the transformation and flux of energy and matter. Communities interacting with biotic and abiotic components (energy and matter) makes ecosystems”. Ecosystem means a dynamic complex of plant, animals and microorganism communities and their non-living environment interacting as a functional unit (CBD, article 2, 1992).

Biodiversity are the most vital and characterizing component of ecosystems. Biodiversity entails all forms of biological entities inhabiting the earth including prokaryotes and eukaryotes, wild plants and animals, microorganisms, domesticated animals and cultivated plants and even genetic material like, seeds and germplasm (Kothari, 1992). More over, The Convention of Biological Diversity define : “Biological Diversity” means the variability among living organism from all sources including interalia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species between species and of ecosystems (CBD, Articles-2).

The Biodiversity exist at three levels. These are (i) Species diversity, which embrace the variety of living organism on the earth, (ii) Genetic diversity, which is concerned with variation in genes within particular species, and (iii) Ecosystem diversity, which is related to the variety of habitats.

A large number of indices have been developed that attempt to describe different factors of biodiversity (Magurran, 1988).

In classical terms biodiversity is described as a function of two components, (a) the total number of species, which can be expressed as species richness or species abundance, and (b) the distribution of individuals among those species i.e. Species evenness or species equitability (Margalef, 1958). Species diversity is a statistical abstraction with two components reflecting the number of species richness and distribution of individuals of all species at a particular site (Shastri *et al.*). For the quantitative measure of diversity and comparison of species diversities between different ecosystems in various climatic conditions, it is useful and convenient to calculate an index for diversity and dominance. This index is usually calculated on the basis of ratios of the part to the whole (Dash, 1998).

Several recent reviews have addressed the issue of biodiversity as it relates to ecosystem functioning (Peet, 1984; Potter and Meyer, 1990; Ehrlich and Wilson, 1991; Walker, 1992; Lawton and Brown, 1993; Pimm, 1993; Swift and Anderson, 1993; Vitousek and Hooper, 1993; Anderson, 1994; Elliot and Lynch 1994; Bianchi and Bianchi, 1995; Pankhurst, 1997).

As the biodiversity is of the immense importance for furnishing the food, fuel, fiber, medicine, construction materials and etc. to sustain the human civilization it had to be over explored. Such over exploration (Over harvesting) and some other destructing environmental factors lead to deplete the biodiversity. Some of these major causes for biodiversity depletion are as follows:

- (i) **High population growth:** Population growth is a most serious problem. Expanding human population has increased the exploitation of resources and altered the land use pattern. Over population has the greatest impact on biological resource.
- (ii) **Natural hazards:** Natural hazards (Cyclone, Tidal surge, Tsunami, and flood) are common phenomena in the world. In many cases tidal surge reaching height of

more than 20 feet causes serious havoc to human, livestock, vegetation, houses and economic structures of the country.

(iii) Habitat degradation: Human are changing natural habitats in various ways.

They are cutting hills indiscriminately, filling Pond, Dighi, and other water bodies. More over, they are also changing the land use patterns. As a result, a huge number of animals and plants are going to be depleted.

(iv) Deforestation: Forest are disappearing at a rapid and alarming rate. The main

causes of deforestation are over exploitation due to population pressure, encroachment, shifting cultivation etc. To the great extent, destruction of forest cover expose soil to accelerate erosion, reduce soil fertility and moisture retention capacity, resulting in drainage problem and increasing damage from flash floods. Above all, it causes depletion of forest resources and biodiversity and ultimately degrades the environment.

(v) Pollution: River and streams receive untreated waste from industry, domestic waste

and industrial chemicals- particularly effluent containing high toxic agrochemicals, which pollute the aquatic environment, kill a huge number of fish and disrupt the aquatic ecosystem. The solar radiation due to depletion of ozone layer in the atmosphere will also adversely affect our agriculture productivity, health, growth of plants and animals. The aquatic life is also likely to be affected by radiation.

The extinction rate is rapidly increasing can be seen simply from statistics on the destruction of tropical forest, the locus of at least half of the planet's biodiversity. The rate of tropical deforestation in 1989 was almost double that in 1979, with roughly 1.8% of the remaining forest disappearing per year (Ehrlich, 1991)

A Harvard Biologist Edward Wilson estimated that 140 plants and animals species are being extinct every day in the world (in Kapoor 1994.) The loss of earth's biodiversity is one of the most pressing environmental and developmental issues. The developing countries loss potential for sustainable development with the loss of each species (Agarwal 1996).

Mollusc are very large and diversified groups of invertebrate animals with varied forms, structure, habits, and habitats. Mollusc are used as human food and animal feed, role of ecosystem service and personal adornment. They are also used in trade, medical science and arts and culture. So, the study of distribution, density, diversity and so on of molluscan species is of great importance to us. Studies on different aspects of various mollusc species populations are extensive in the world of which a few are as follows: -

Amin *et al.*, (1995) worked on distribution of benthic young shell of *Corbicula japonica* Prime in lake in Hinuma, Japan. They estimated the average density (260 individuals /m²) of *C. japonica*. The density of *Corbicula japonica* was minimum in July-August then gradually increased to maximum in November-December. The density of *C. japonica* was positively related with temperature, DO and OP but negatively with salinity, fine particles and organic contents.

Cameron *et al.*, (2002) studied on Land Snail diversity in a square kilometer of Cretans Macuis. They recorded a total of 27 mollusc species from the study area with modest richness, high density and local homogeneity were observed very high.

Dadon and Silvina (1998) experimented on distribution and abundance of Gymnosomata (Gastropoda: Opisthobranchia) in the Southwest Atlantic. They estimated the densities of *Spongiobranchaea australis* (730/1000m³) and *Clione antarctica* (230/1000 m³). Horsak *et al.*, (2003) worked on Composition and species richness of molluscan communities in relation to vegetation and water chemistry in the Western Carpathian Spring Fens, and stated that a total of 57 mollusc species were found from the study area; 51 were terrestrial and 6 were aquatic. A linear correlation between mollusc species richness and water calcium concentration were found in poor fens. In rich fens a linear correlation was not found, and species richness was dependant on biotic and abiotic factors (Fe concentration and the water regime).

Harper and Gray (2001) experimented on variation in abundance and distribution of the Chiton, *Acanthopleura japonica* and associated mollusc on seasonal, tropical and rocky shore in Hongkong. Temporal and spatial distribution of Chiton, *A. japonica* and associated mollusc were recorded on semi exposed tropical rocky shore in Hongkong. Many mobile gastropods e.g. *Monodonta labio*, *Cellana toreuma*, *Nerita albicilla* and *Thais clevegera* were found lower on the shore in summer but extended there range during winter. *A. japonica* was distributed throughout the eulittoral and shows such strong seasonal pattern.

Jurkiewicz-Karnkowska (2009) worked on diversity of aquatic malacofauna of floodplain of a large lowland river (Lower Bug), Eastern Poland. They showed that species composition was related to permanence, size, and depth, and hydrological connectivity, successional stages of water bodies, bottom sediments and macrophyte abundance. A total of 54 mollusc species have been reported.

Khan and Chowdhuri (1984) studied on population and production ecology of *Bellamya bengalensis* in artificial lake of Calcutta, India. Kelaher and Cole (2004) worked on variation in abundance and size structure of population of the small Chiton *Acanthochitona retrojecta*. *A. retrojecta* were more abundant in mid than in low shore areas. Densities of this species were high, often exceeding 3500/m². Temporal sampling showed there was a little variation in the total abundance.

Mishra and Raut (1993) studied on dynamic of population- dynamics in medically importance snail species *Lymnaea luteola*. They observed the nature of influencing factors (temperature, P^H, chloride, alkalinity and hardness) on life cycle parameters (attainment of sexual maturity, reproductive period, postreproductive, individuals survived up to the age of attainment of sexual maturity, number of capsules/individual, number of egg laid/individual, hatching and longevity) of *Lymnaea luteola*.

Panigrahi and Raut (1992) worked on influence of temperature and food on the growth of the pestiferous slug *Laevicaulis alte*.

They noted that different temperature with different plant foods influence the growth of the slugs, which ultimately reduced the density of natural slug population.

Qkland and Kuiper 1982 worked on distribution of small mussel in Norway with notes on their ecology. They showed, Calcium and P^H can play role in distribution of small mussell (Sphaeriidae).

Raut (1979) worked on distribution and population of two pestiferous land snails *Achatina fulica* and *Macrochlamys indica* in West Bengal. He disclosed that distribution and population status of *A.* and *M. indica* in different districts of West Bengal, India is directly related with the climatic conditions of the areas.

Raut (1981) explored that the population densities of the snail species *V. bengalensis*, *L. acuminata*, *G. convexiusculus*, and *A. variabilis* are positively related with temperature and rainfall. Raut and Mitra (1985) determined the population densities, reproductive and prereproductive individuals of the land snail *Glessula gemma*. Rao and Sukumar (1982) experimented on distribution, zonation and habits of a tropical mud snail *Cerithedea cingulata* Gmelin at Nizampatam in Krishna river estuarine region on the coast of South India. They showed, snails prefer mid tide level and they were most abundant in shallow water.

Starmuhiner (1982) experimented on occurrence, distribution and geographical range of the freshwater gastropods of the Andaman Island. They observed that ecological factors of the habitat (velocity of surface current, temperature of the water, bottom material (mud, sand, gravel, boulder and rocks), and water chemistry (electrolytic conductivity, total hardness, P^H , Ca, Mg, K, N, Cl and SiO_2) played effective roles on distribution of Freshwater gastropods.

Skeldon *et al.*, (2007) studied on terrestrial gastropods responded to an ecosystem level calcium manipulation in a northern hard forest. Snail abundance was significantly correlated with litter Ca concentration ($P < 0.001$).

Schilthuizen *et al.*, (2001) worked on Land snail diversity in a square kilometer of tropical rainforest in Sabah, Malaysia Borneo and recorded 61 species under 14 families.

There is a great paucity of information about mollusc population in Bangladesh. In Bangladesh Alam and Patra (1986) studied on the freshwater molluscan fauna of Chittagong Division with their ecology and found 13 Gastropodan and 2 Pelecypodan species from all places of the study area.

Ahmed (1990) studied on density and abundance of molluscan fauna of Bay of Bengal. He recorded 301 marine species, under 151 genera, 79 families of 16 orders under 4 classes of mollusc of Bay of Bengal.

Alam *et al.*, (1999) studied on the diversity of the macro zoo benthos of five zones (viz. 1, 2, 3, 4, & 5) of intertidal area of Haliashahar coast, Chittagong, Bangladesh. Jahan *et al.*, (1990) studied intertidal mollusc of Sundarbans, Bangladesh-with special emphasis on their habitats and population densities. A total of 26 mollusc species were recorded by them. Jahan *et al.*, (1998) experimented on Molluscan Biodiversity of Sundarbans. They recorded a total of 21 mollusc species as well as systematic and ecological notes.

Jahan *et al.*, (2000) worked on Biodiversity of the Aquatic habitats of Rajshahi Metropolitan City with special emphasis on interactions among the soil substratum, plant and snail species. They also estimated biodiversity indices of mollusc species viz, index of dominance, index of evenness and index of diversity. Khan *et al.*, (1996) studied community structure and ecology of macrobenthic invertebrate fauna

of Lake Kaptai, Bangladesh. He disclosed the population density, diversity, species composition and physico-chemical parameters of the lake.

The North-eastern region includes reserve forest, hills, haors, and beels. Yet no work is available on molluscan biodiversity of the North-eastern region of Bangladesh. This lead to study density and diversity of mollusc species in the selected North-eastern region of Bangladesh.

2.1.1 Aims and Objectives

Determination of distribution and abundance of mollusc species, and the influence of the environmental factors on them in the North-eastern region of Bangladesh is the general aim of the study.

Objectives: The main objective of the study were as follows: -

1. To study the population densities and seasonal variations of mollusc species in respect of climatic factors (Temperature, humidity and rainfall).
2. To study the influences of soil components on mollusc species population densities
3. To study the influences of water (Pond and River) qualities on mollusc species population densities
4. To calculate biodiversity indices, Shannon - Wiener index (H'), evenness index (e), Species richness (d) and Simpson index of dominance (c) for the determination of molluscan community structure.

2.2 Materials and Methods

Determination of population densities and seasonal variations of mollusc species in respect of climatic factors, soil parameters and water qualities of the North-eastern region of Bangladesh in course of two years (2005-2007) intensive surveys the following materials and method were considered:

(a) Terrestrial habitat: Considering the limitations of time, resources and logistic supports, three localities were selected in the study area for determination of population density and seasonal variation of terrestrial mollusc. From each of the localities three spots of 10 m² quadrature area each were taken in respect of Summer, Monsoon and Winter season. A total of 54 quadrats were taken in two years. The selected localities were 'BARD' annex forest of Comilla District, Lawachara National park of Maulvibazar District and Malnichara Tea garden annex forest of Sylhet District. Each locality was chosen to represent a typical part of the surrounding vegetations avoiding edges or transitions.

(b) Aquatic habitat: Considering the limitations of time, resources, and logistic supports, two aquatic habitats (viz. One River and One pond) from each of the 5 (five) study districts were selected for determination of population density and seasonal variation of aquatic mollusc. From each of the habitats three sites were selected. Again, from each site three quadrates of 1 m² area of each were taken according to the depth of water (viz. 0-50 cm, 50-100 cm and 100-200 cm) in respect of Summer, Monsoon and Winter season. A total of 540 quadrates were explored in two years (2005-2007)

2.2.1 Determination of Minimal area

It is essential to determine the appropriate size of the quadrature to be used in much faunal survey. The quadrature, which is used to sample the animal community, must be such dimension that all the species, which occurred, in that communities are fully represented. To determine the minimal area of sample or quadrature (increase

gradually in size) were placed and the number of species found in them were collected and recorded sperately.

Then the number of species found in the plots or quadrate of difeferent size were plotted on vertical axis (Y) against the gradually increasing plots or quadrate of size on the horizontal axis (X. The desirable minimal area of minial quadrate size was determine by locating a point on the curve where the line took horizotal course and by joining it to line of axis quadrate size (Figure 2) The joining point indicates the minimal size of the quadrate (Michael, 1987; Shukla and Chandal, 2000). During the study, the determined minimal area was 1m×1m and this size was used throughout the period of investigation.

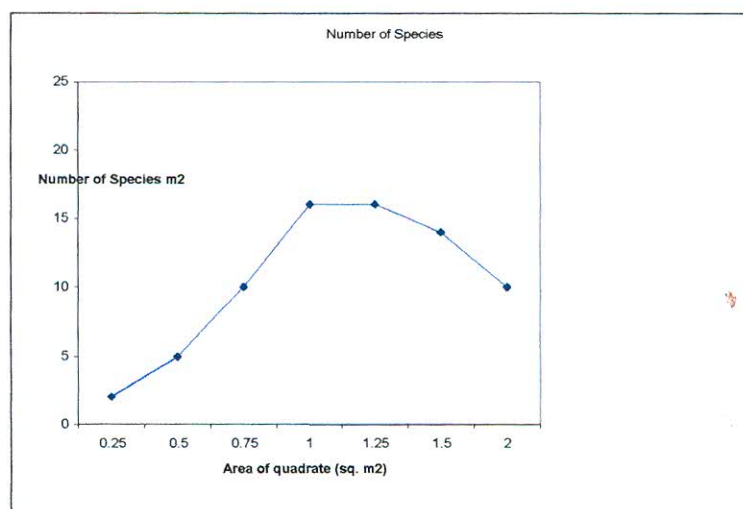


Figure 2.1
Species area curve

Population densities were determined according to following formula (Michael 1990; Sukla and Chandal, 2000): -

$$\text{Density} = \frac{\text{total number of individuals of the species}}{\text{total number of quadrats used in sampling}}$$

(b) i. To determine the factors regulating the densities of snail's population soil was sampled regularly during the survey from each selected spots.

(b) ii: Soil sample collection: Soil samples were collected from the study area to study soil parameters. Thirteen spots were selected for this purpose. From each spots, soil samples were collected from three sites randomly to plough layer i.e. 0-15 cm depth. The soils were then mixed together to make a composite sample. By quartering bulking were reduced and about 400 gm of composite sample was retained and was taken to the laboratory. The soil samples were air dried, crushed, mixed well and passed through 2 mm sieved for chemical analysis. Soil analysis was carried out at the Soil Resource Development Institute laboratory, Shampur, Rajshahi. Some important parameters of the soil sample such as; pH, amounts of organic matters (OM), Total nitrogen, Calcium (Ca), Potassium (K), Magnesium (Ma), Phosphorus (P), Sulphur (S), Boron (B), Copper (Cu), Ferrous (Fe), Manganese (Mn) and Zinc (Zn) were determined in the laboratory.

(b) iii: Method of soil analysis: The following standard method Peterson (2002) was followed for the determination of soil parameters.

Measurement of soil p^H in water: Weight 10g soil into a small beaker, add 25 ml water and stir frequently during 50 minutes. Leave without stirring. Rinse the pH meter with the soil suspension and immerse the electrode in the suspension. Read the pH from the display when the reading has become stable.

(b). iii. i: Organic Matter (OM %): Organic Carbon was first determined by volumetrically wet oxidation method by Walkey and Black's (1934). The organic matter was oxidized by 1 N K_2CrO_7 and the amount of organic carbon in the aliquot was determination by titration against 1N $Feso_4$ solution in presence of diphenyl amine indicator (Nelson&Sommers, 1982). Then soil Organic matter content was calculated by multiplying the percent value of the Organic Carbon with conventional Van Bemmelen factor, 1.73 (Piper, 1950).

(b). iii. ii. Determination of K and Na:

The K and Na were measured directly from soil extracts using a flame photometer.

(b). iii.iii: Determination of Ca and Mg:

Transferred 5 ml soil extracts into a 50 ml volumetric flask using a pipette. Added 5m LaCl_3 solution (pipette), make to volume with and mix. Measured the contents of Ca and Mg by atomic absorption spectrometer (AAS). If the reading of the soil extract was higher than the reading of the highest standard solution, a larger was made dilution, e.g. 2 ml soil extract into a 50 ml volumetric flask. In this case M ammonium acetate must be added to the volumetric flask to make the total volume of 1 M ammonium acetate and soil extract equal to 5ml.

(b). iii.iv: Total Nitrogen determination: Total Nitrogen in soil had been determined by Micro Kjeldahl digestion method. Digestion was made with conc. H_2SO_4 and catalyst mixture (K_2SO_4 : $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$: Se=10:1:0.1). Nitrogen in the digest was estimated by distillation with 10N NaOH followed by titration of the distillate trapped H_2O bo indicator solution with H_2SO_4 (Bremner and Mulvaney, (1982).

(b). iii.v: Phosphorus determination: Soil P was extracted by shaking with 0.5 N NaHCO_3 solution having pH 8.5 following the method described by Olsen & Sommers, 1982). The extractable P was then determined by colorometrically using molybdate blue- ascorbic acid solution.

(b). iii.vi: Sulphur determination: Sulphur (S) was extracted by 15% CaCl_2 solution and determined by turbidimetrically using $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ and polyvenyl pyrrolidone (Page *et al.*, 1982.)

(b). iii. vii: Cu determination: Cu was measured by Atomic Absorption Spectrophotometer (AAS)

(b). iii. viii: Ferrous (Fe), Mn, Zn and Cu determination:

These elements were measured of the contents of these elements by atomic absorption spectrometer (AAS) directly in the undiluted filtrate.

2.2.2 Water quality:

(a): Water Quality analysis:

(aa): Collection of Pond and River water: During the study period a total of 5 samples from pond and 5 samples from river were collected. A sample collecting time was 11. 00 Am -12.00 Pm.1 litter air tied plastic bottle was used to collect the water samples from 20-30 cm below the surface level of pond and river water.

(ab) Analytical methods of water:

Physical condition of water:

(ab.i) Water Temperature: A centigrade thermometer with range of 0° to 120° was used to note water temperature. The temperature of water was recorded by dipping the thermometer at the depth of 10 cm below the surface of water.

(ab.ii) Transparency of water

Measurement of limit of visibility i.e. penetration of light in water done by Secchi disc. The Secchi disc was slowly lowered into the water on gradually and depth at which it disappeared noted down. Again lifted the disc and noted down the depth at which the disc reappeared was noted following Welch (1948). The average of these two reading was considered to be limit of visibility. The sinking of the disc was always viewed under a sunshade for considerable accuracy in results. The data thus obtained were expressed as Secchi disc depth in cm.

(ab.iii) Chemical Conditions of Water: p^H , DO, and Total hardness were analysed by using the following methods-

(ab.iii.i) Negative logarithm of Hydrogen Ion concentration (p^H): The value of hydrogen ion concentration (p^H) of pond and River water was determined by using a digital p^H meter (Model Hanna instrument HI 98107).

(ab.iii.ii) Dissolved Oxygen (DO): For determining Dissolved Oxygen (DO) Winkler's modified method was followed –

The sample was collected by 250 ml capacity reagent bottle with tight fitting glass stopper. The sample was treated with manganous sulphate solution, alkaline iodide solution and con. Sulphuric acid on the field. The treated sample was transferred to the laboratory and titrated with sodium thiosulphate. The volume of sodium thiosulphate used in titration up to end point gave the DO value of water expressed in milligram of oxygen per litre of water (mg/l) (Michael, 1990).

(ab.iii.iii) Total Hardness:

Taken 50 ml sample in a conical flask. Added 0.5ml buffer solution and mixed well. Put 1 to 6 drop of indicator solution (Erichrome black –T) and swirl to mix. In the presence of calcium and or magnesium when the solution will become red.

Titrated immediately with EDTA solution, mixing continuously. The end point was indicated by a colour change from red to blue. The end point is determined by the complete disappearance of this red tinge. The resultant data was expressed in mg/l (Michael 1990).

2.2.3 Techniques of Analysis of Data

Data of studied mollusc specimens and Soil parameters were analysed by using statistical methods with help of MS Excel software. Pearson correlation analysis was done to determine the relationship between Population density of mollusc and physicochemical parameters of water and soil by using a SPSS 11.5 (Statistical package for Social Sciences) Programme.

2.2.4 Determination of biodiversity indices -

(i) Method adopted to determine the Shannon –Weaver index (a measure of diversity). Among the quantitative description of diversity available, Shannon –Weaver index is based on information theory. The underlying consideration of the measures can be visualized by considering uncertainty to be synonymous with diversity. If a set of nominal scale data may be considered as random sample, then the quantitative

expression appropriate as a measure of diversity is that of Shannon (1948), often referred as Shannon -Wiener index diversity; which was calculated from the following formula:

$H' = - \sum \left(\frac{n_i}{N} \right) \log \left(\frac{n_i}{N} \right)$, n_i =importance value for each species, N = total of importance value.

(ii) Formula used to determine Pielou,s evenness index “e” $e = \frac{H'}{\log S}$

Here, e = evenness index, H' = Shannon diversity index and S = number of species.

(iii) Determination of species richness index was performed as follows:

$$D = \frac{S-1}{\log N}$$

Where, S is number of species and N is the total of importance value.

(iv) Index of dominance

The Simpson,s index of dominance (c) could be calculated following formula;

$$C = \sum \left(\frac{n_i}{N} \right)^2$$

Where n_i is the importance value for each species (number of individuals, biomass, production and so forth) and N is the total number of importance values (Odum, 1971).

Pearson correlation among population density (number/m²), temperature (0^c), rainfall (mm), Shannon - Wiener index (H'), evenness index (e), species richness (d) and Simpson index of dominance (c) were determined.

Mollusc species population density (no. /m²) in different habitat of the study area are shown in Table 2.1 On an average the maximum population density (8.56/m²) was recorded in the Gomoti river of Comilla district and minimum (3.26/m²) in the Titas river of Brahmonbaria district. In pond habitat maximum population density (11.93 /m²) was recorded in the pond of Sylhet district and minimum (1.78/ m²) in the pond of Habiganj district (Table 2.1).

In Terrestrial habitat, maximum population density (3.36/10m²) was recorded in the Lawachara Natural Park forest in the Maulvibazar district and minimum in BARD annex forest in the Comilla district (Table 2.1).

Different diversity indices of mollusc in respect of habitats are presented in the table 2.2 (Appendix table 1.V, 2.IV-3.IV and 4. VIII-13.VIII).

In pond, the highest Shannon-Weiner diversity index ($H' = 1.84$) was found in Habiganj district and lowest $H' = 0.67$ in Sylhet district; highest index of dominance ($c = 0.60$) in Sylhet district and lowest ($c = 0.18$) in Habiganj district; the highest relative diversity or evenness ($e = 0.88$) in pond of Habiganj district and lowest ($e = 0.41$) in Pond of Sylhet district, but the highest ' d ' ($d = 2.63$) value was found in the pond, Habiganj district and lowest ($d = 0.97$ in pond of Sylhet district).

Table 2.2
Different diversity indices of mollusc species in respect of habitats and districts of (North-eastern Region of Bangladesh) (Appendix table 1.V, 2.IV-3.IV; 4.VIII-13.VIII),

Habitats Biodiversity Indices	River					Pond					Terrestrial		
	TR	GR	RR	SR	KR	Comilla	B.Barria	H.ganj	M.bazar	Sylhet	BARD	L.chara	M.chara
H'	1.62	1.94	2.20	2.13	2.30	0.85	1.18	1.84	0.94	0.67	2.01	1.9	2.20
C	0.23	0.19	0.13	0.16	0.14	0.54	0.34	0.18	0.43	0.60	0.13	0.16	0.12
D	2.14	2.54	2.95	3.13	3.49	1.01	1.16	2.63	1.45	0.97	3.01	2.12	2.95
E	0.77	0.76	0.88	0.79	0.83	0.61	0.85	0.88	0.85	0.41	0.93	0.90	0.91

H' = Shannon-Wiener diversity index, C = Simpson's index of dominance, d = Margalef community diversity index or species richness, e = Evenness index (Odum, 1971),
 SR= Surma River, KR= Khushyara River, TR= Titas River, GR= Gomti River, RR= Ratna River
 B.Barria = Brahmonbaria, H. ganj = Habiganj, M.bazar = Maulvibazar,
 L. chara = Lawachara, M.chara = Malnichara and BARD= Bangladesh Academy for Rural Development.

The highest Shannon-Weiner diversity index ($H' = 2.30$) was found in the river Khushyara, Sylhet district and lowest ($H' = 1.62$) in the river Titas, Brahmanbaria district; highest index of dominance ($c = 0.23$) in Gomti river, Comilla and lowest in ($c = 0.13$) Ratna river, Habiganj district; the highest species richness ($d = 3.49$) in Khushyara river, Sylhet district and lowest ($d = 2.14$) in Titas river, Brahmanbaria district; the highest relative diversity or evenness ($e = 0.88$) in Ratna river, Habiganj and lowest in ($e = 0.77$) Titas river, B. Baria district.

In pond, the highest Shannon-Weiner diversity index ($H' = 1.84$) was found in Habiganj district and lowest $H' = 0.67$ in Sylhet district; highest index of dominance ($c = 0.60$) in Sylhet district and lowest ($c = 0.18$) in Habiganj district; the highest relative diversity or evenness ($e = 0.88$) in pond of Habiganj district and lowest ($e = 0.41$) in Pond of Sylhet district, but the highest ' $d = 2.63$ ' value was found in the pond of Habiganj district and lowest ($d = 0.97$) in pond of Sylhet district).

In terrestrial habitat the highest Shannon-Weiner diversity index ($H' = 2.20$) was found in Malnichara tea garden annex Forest, Sylhet district and lowest ($H' = 1.90$) in Lawachara national park forest, Maulvibazar district; the highest ($c = 0.16$) value was found in Lawachara national park forest, Maulvibazar district; lowest ($c = 0.12$) in Malnichara tea garden annex Forest, Sylhet district; the highest ($d = 3.01$) value was found in BARD annex forest, Comilla district) and lowest ($d = 2.12$) value in Lawachara national park forest, Maulvibazar district; the highest relative diversity or evenness ($e = 0.93$) in BARD annex forest, Comilla district and lowest ($e = 0.90$) in Lawachara national park forest, Maulvibazar district.

Pearson's correlation among land mollusc population density and soil parameter are presented in the table 4. P^H . Organic matter (OM), Calcium (Ca), Magnesium (Mg), Nitrogen (N), Ferrous (Fe), Manganese (Mn) and Zinc (Zn) revealed that population density was positively correlated with soil p^H . OM, K, Ca, Mg, N, S, Fe, Mn, but negatively correlated with P and Zn. Land mollusc population density was highly positively correlated with Mn ($P < 0.01$) level (Table 2.3).

Table 2.3
Pearson correlation of land mollusc population density and soil parameters

P.D.	1											
p ^H	.934	1										
OM	.814	.968	1									
K	.608	.851	.956	1								
Ca	.976	.833	.667	.419	1							
Mg	1.000(*)	.942	.826	.624	.971	1						
N	.033	-.325	-.553	-.773	.252	.012	1					
P	-.288	-.610	-.790	-.935	-.071	-.308	.947	1				
Fe	.955	.998(*)	.950	.817	.866	.961	-.265	-.560	1			
Mn	.257	.585	.770	.924	.038	.277	-.957	-.999(*)	.533	1		
Zn	-.925	-.729	-.533	-.261	-.986	-.917	-.410	-.097	-.770	.129	1	

*Correlation is significant at the 0.05 level (2-tailed).

P^H, was positively correlated with OM, Ca, Mg, Mn but negatively with P and Zn. Om was positively correlated with K, Ca, Mg, N (P< 0.01), Fe, Mn but negatively correlated with P and Zn. K is positively correlated with Mg, Ca, N, Fe, Mn but negatively correlated with P and Zn. Ca was positively correlated with p^H, OM, K, Mg, and Fe and negatively correlated with p^H, P and Zn. Mg was positively correlated with population density (P< 0.01), pH, OM, K, Ca, N, Fe, Mn and negatively correlated with P and Zn. N was positively correlated with population density, Ca, Mg, P and negatively correlated with p^H, OM, K, Fe, Mn and Zn. P was positively correlated with N but negatively correlated with Population density, P^H, OM, K, Ca, Mg, Fe, Mn (P< 0.01) and Zn. Fe was positively correlated with Population density, P^H (P< 0.01), OM, K, Ca, Mg, Fe, Mn but negatively correlated with N, P and Zn. Mn was positively correlated with Population density, P^H, OM, K, Ca, Mg and Zn but negatively correlated with N and P. Zn was positively correlated with Mn But negatively correlated with Population density, P^H, OM, K, Ca, Mg, Fe, N and P. Pearson's correlation among mollusc population density (River) and soil parameters are presented in the table 2.4.

Table 2.4
Pearson's correlation among Population density mollusc species and Soil parameters of Rivers

PD	1											
PH	.670	1										
OM	.395	-.362	1									
CA	.327	-.472	.852	1								
MG	.563	-.230	.958(*)	.922	1							
N	-.595	-.491	-.420	.053	-.336	1						
P	-.691	-.879	.032	.371	.009	.844	1					
CU	-.123	-.768	.595	.879	.636	.479	.769	1				
FE	-.984(*)	-.740	-.347	-.198	-.483	.709	.804	.272	1			
MN	-.572	.227	-.914	-.952(*)	-.990(**)	.231	-.068	-.690	.472	1		
ZN	-.939	-.712	-.394	-.148	-.478	.831	.861	.338	.981(*)	.441	1	

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

This table revealed that population density was positively correlated with soil P^H , OM, Ca, and Mg but negatively correlated with Fe, P, Cu, Mn and Zn. P^H was positively correlated with population density and Mn but negatively correlated with OM, Ca, Mg, N, P, Cu and Fe. OM was positively correlated with Population density, soil OM, Ca, Mg ($P < 0.05$), P, and Cu but negatively correlated with P^H , N, Fe, Mn and Zn. Ca was positively correlated with population density, P^H , OM, Mg, N and Cu but negatively correlated with P^H , Fe, Mn ($P < 0.05$) and Zn.

Mg was positively correlated with population density, soil OM ($P < 0.05$), Ca, P and Cu but negatively correlated with P^H , N, P, Fe, Mn ($P < 0.05$) and Zn. N is positively correlated with population density, Ca, Mg, P, Cu, Fe, Mn and but negatively correlated with population density, P^H , OM, and Mg.

P was positively correlated with OM, Ca, Mg, N, Cu, Fe, and Zn but negatively correlated with population density, P^H , and Mg. Cu was positively correlated with OM, Ca, Mg, N, P, Fe and Zn but negatively correlated with population density, P^H , K and N. Fe was positively correlated with N, P, Cu, Mn and Zn ($P < 0.05$) but negatively correlated with population density, P^H , OM, Ca, and Mg. Mn is positively correlated

with PH, N, Fe, P, Fe and Zn but negatively correlated with population density, OM, Ca ($P < 0.05$) and Mg ($P < 0.05$). Zn is positively correlated with N, P, Cu, Fe ($P < 0.05$) and Mn but negatively correlated with population density, P^H , OM, Ca and Mg.

Pearson's correlation among pond mollusc population density and soil parameter of ponds are presented in the table 25. Population density was positively correlated with soil P^H , OM, Ca, N, Fe and Zn ($P < 0.05$) but negatively correlated with K, and Cu. P^H was positively correlated with Population density, soil OM, K, Cu and Fe but negatively correlated with Mg, N and P. Mn and Zn OM was positively correlated with population density, K, Mg, N, P, Fe and Zn but negatively correlated with Ca, Cu and Mn.

K was positively correlated with soil P^H , OM, Cu and Zn but negatively correlated with Population density, Ca, Mg, N, P, Fe and Mn. Ca was positively correlated with Population density, soil P^H , Fe and Mn ($P < 0.05$) but negatively correlated with OM, Mg, N, P, Cu and Zn. Mg was positively correlated with Population density, OM, N ($P < 0.01$) P and Zn. Mn and Zn but negatively correlated with P^H , Ca, Cu, Fe and Mn. N was positively correlated with Population density, OM, Mg ($P < 0.05$), P and Zn but negatively correlated with P^H , K, Ca, Cu, Fe and Mn. P was positively correlated with soil OM, Mg and N but negatively correlated with Population density, P^H , K, Ca, Cu, Fe, Mn and Zn. Cu was positively correlated with soil p^H and K but negatively correlated with Population density, OM, Ca, Mg, N, P and Zn. Fe was positively correlated with Population density, soil p^H , Ca, Cu, Mn and Zn but negatively correlated with K, Mg, N and Cu. Mn was positively correlated with Population density, PH, Ca ($P < 0.01$) and Fe but negatively correlated with OM, K, Mg, N, P, Cu and Zn. Lastly Zn was positively correlated with Population density, soil OM, pH, Mg and N but negatively correlated with Ca, P and Cu.

Table 2.5
Pearson's correlation among Population density of mollusc & Soil parameter of Ponds

PD	1												
PH	.875	1											
OM	.549	.441	1										
K	-.013	.420	.268	1									
Ca	.331	.205	-.569	-.521	1								
MG	.009	-.238	.586	-.282	-.576	1							
N	.041	-.182	.629	-.217	-.609	.997(**)	1						
P	-.231	-.615	.286	-.624	-.335	.824	.784	1					
CU	-.462	.010	-.149	.873	-.484	-.352	-.310	-.557	1				
FE	.828	.653	.018	-.366	.798	-.278	-.279	-.291	-.623	1			
MN	.209	.003	-.548	-.620	.944(*)	-.549	-.596	-.153	-.561	.685	1		
ZN	.896(*)	.864	.822	.305	-.113	.201	.254	-.174	-.188	.495	-.222	1	

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

On the contrary, freshwater mollusc population density was correlated with Physico chemical parameter of river water viz. temperature, transparency, P^H , Do, and total hardness (Table 2.6). Among population density and river water and Physico chemical parameters of river water revealed that population density was positively correlated with water temperature, P^H , Do, and total hardness and negatively with transparency (Table 2.6).

Table 2.6
Correlations between population density and Physico-chemical parameters of Rivers during Study period

PD	1						
Tem.	.516	1					
Trans.	-.690	.130	1				
P^H	.275	.438	-.111	1			
DO/mg/l	.353	.328	.224	.287	1		
TH	.438	.080	-.145	.493	.868	1	

Pearson correlations with physicochemical parameter of pond water and population density revealed that population density was positively correlation with water temperature, transparency, P^H , Do, and total hardness. Population density was significant correlation with temperature ($P < 0.05$) (Table 2.7).

Table 2.7
Pearson Correlations among Population density of mollusc species and Physico-chemical parameters of pond water during the study period

P. D	1					
Temp.	.495	1				
Trans.	.819	.662	1			
p ^{II}	.207	-.469	.120	1		
DO	.328	-.020	.522	-.044	1	
Total hardness	.385	-.256	.390	.959(**)	.122	1

** Correlation is significant at the 0.01 level (2-tailed).

Pearsons correlation of Temperature, Humidity and Moisture of different seasons with the Mollusc species population densities of Malnichhara Forest shown in the (Table 2.8 and Appendix table 16.00) revealed that *A. fulica* is positively correlated with summer and Monsoon. These species showed significant correlation ($P < 0.05$) with Monsoon but negatively correlated with winter.

G. crocea was positively and significantly correlated ($P < 0.01$) with Summer and Monsoon ($P < 0.05$) but negatively correlated with Winter. *M. indica* and *E. cassida*, was positively correlated with Summer and Monsoon but negatively correlated with Winter. *C. theobaldinus* and *C. pearsoni* were positively correlated with Summer and positively significantly correlated ($P < 0.05$) with Monsoon and but negatively correlated with Winter. *G. notigena* was positively and significant correlated with Summer ($P < 0.05$) and Monsoon ($P < 0.01$) but negatively correlated with Winter. *A. (L.) gracile* was positively correlated with summer and Monsoon but negatively correlated with Winter season. *P. parvus* was positively and significantly correlated ($P < 0.05$) with summer and positively correlated with Monsoon but negatively correlated with Winter Season. *I. plicata* and, *F. alte* were positively correlated with summer and Monsoon and negatively correlated with Winter season. *C. delibrata*, *G. crocea*, *M. indica*, *P. plectostoma*, *P. parvus*, *S. diplodon*, and *S. castra* were positively correlated with summer and Monsoon but negatively correlated with winter.

Pearson's correlation of temperature, Rainfall and Humidity of different seasons with Mollusc population density of BARD annex forest, Comilla revealed that *R. bengalensis*, *G. crocea*, *S. ategia*, *C. delibrata*, *G. gemma*, *G. notigena*, *P. parvus*, *M. indica* and *F. alte* were positively correlated with Summer and Monsoon but negatively correlated with winter season (Table.2 8 and Appendix table 16.1).

G. notigena was negatively and significant correlated ($P < 0.05$) with winter season (Table 2.8 and Appendix table 16.1).

Table 2.8
Consolidated value of Pearson correlations among the climatic factors of different Seasons and Mollusc species population densities of Malnichara, Lawachhara and BARD forest. (Appendix table A.iv-C.iv and P.- i-iii)

Seasons Name of species	Season and Habitats								
	Summer			Monsoon			Winter		
	M.chara	L.chara	BARD	M.chara	L.chara	BARD	M.chara	L.chara	BARD
<i>A. fulica</i>	1.000**			.999*			-.463		
<i>A. gigas</i>		-0.72			-0.158			.678	
<i>G. crocea</i>	1.000**	.909	.904	1.000*	.942	.960	-.489	-.725	-.754
<i>M. indica</i>	.975	.901	.733	.985	.936	.830	-.649	-.738	-.917
<i>P. parvus</i>	.999*	.933	.712	.995	.961	.813	-.425	-.682	-.929
<i>A.(P.) gracile</i>	.966		.510	.978		.638		-.678	-.993
<i>G. notigena</i>	.998*		.354	1.000**		.496	-.524		-.999*
<i>F. alte</i>	.627		.911	.667		.964	-.981		-.743
<i>C. delibrata</i>		.938	.808		.964	.890		-.672	-.864
<i>S. diplodon</i>		.950			.974			-.644	
<i>S. castra</i>		.964			.984			-.605	
<i>S. ategia</i>			.875			.940			-.795
<i>R. bengalensis</i>			.945			.985			-.678
<i>G. gemma</i>			.861			.930			-.811
<i>C. theobaldinus</i>	.994			.998*			-.559		
<i>C. pearsoni</i>	.993			.998			-.569		
<i>I. plicata</i>	.984			.992			-.613		
<i>E. cassida</i>	.973			.984			-.656		
<i>P. plectopylis</i>	.948				.972			-.648	

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

During the study period it was found that mollusc species populations fluctuate differently with seasons. In terrestrial habitat, *A. (P.) gracile* was found highest ($7.5/10\text{m}^2$) in monsoon during the study period in BARD annex forest, Comilla (figure 2.2 and Appendix table 1.iv) and minimum ($0.66/10\text{m}^2$) during winter in Malnichhara tea garden annex forest (Figure 2.3 and Appendix table 3.iv).

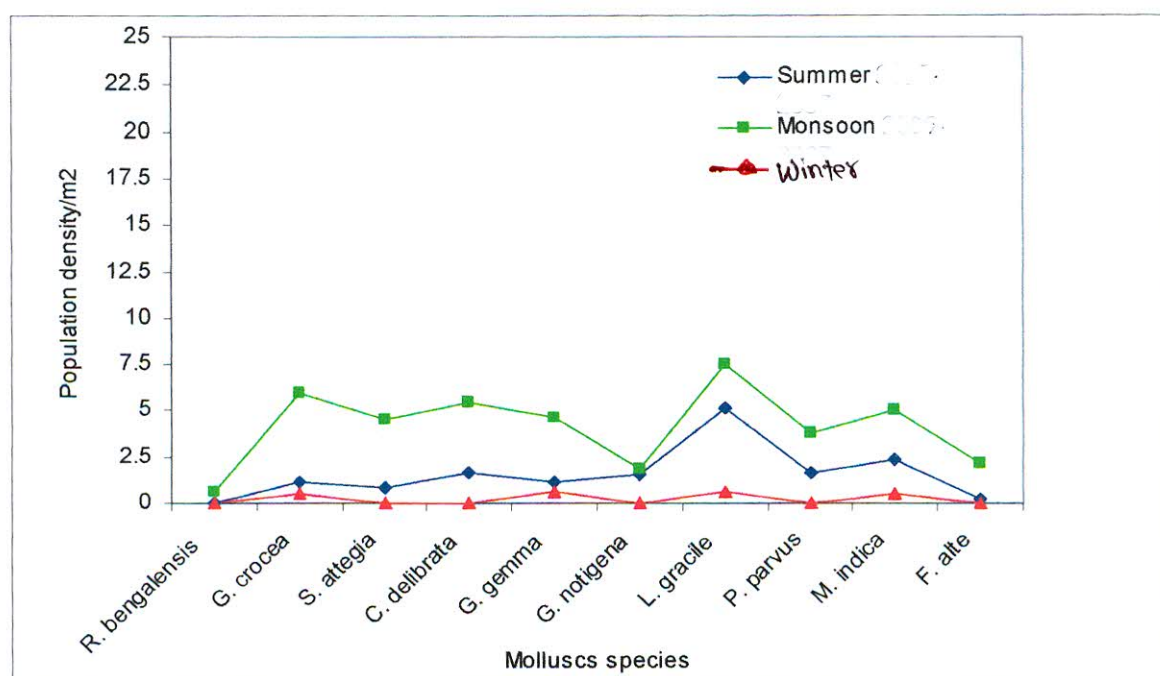


Figure 2.2
Seasonal variations of mollusc species in BARD annex forest Comilla (2005-07)

The highest population density of *R. bengaleansis* ($0.66/10\text{m}^2$), *G. crocea* ($0.66/10\text{m}^2$), *G. gemma* ($5.5/10\text{m}^2$), *G. notigena* ($4.66/10\text{m}^2$), *M. indica* ($5/10\text{m}^2$), and *F. alte* ($2.16/10\text{m}^2$) were found in BARD annex forest, Comilla (Figure 2.2 and appendix table 1. iv) and lowest *G. crocea* ($0.16/10\text{m}^2$) and *G. notigena* ($1.33/10\text{m}^2$) were found in Malnichhara tea garden annex forest, Sylhet during summer (Figure 2.3 and Appendix table 2.iv)

The highest ($8.83/10\text{m}^2$) and lowest ($0.33/10\text{m}^2$) population density of *P. parvus* were estimated in Monsoon, Lawachhara National Park Forest, Maulvibazar district (Figure 2.4 Appendix table 3. (ii)) and summer, Malnichhara tea garden annex forest, Sylhet district respectively (Figure 2.3 Appendix table 3. (iii)).

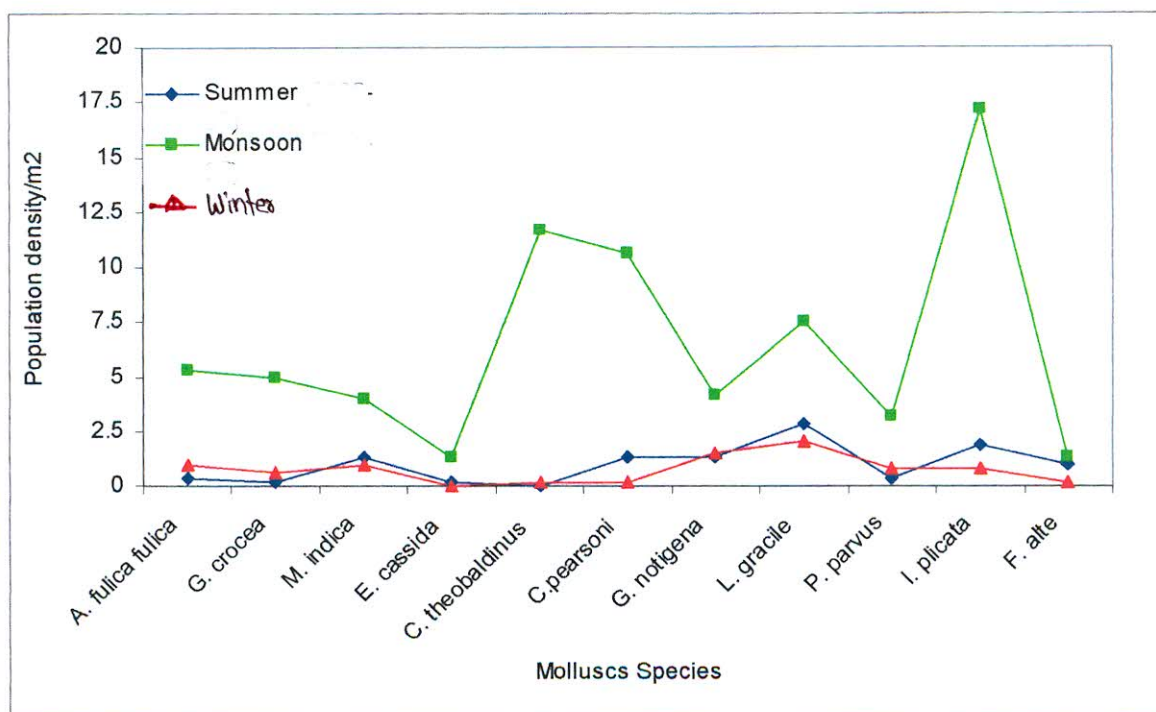


Figure 2.3
Seasonal variation of mollusc species in Malnichara tea garden annex forest Sylhet

The highest population density of *P. plectopylis* (19.16/10m²), *S. diplodon* (10.83 /10m²) and *S. castra* (12.66/10m²) during the Monsoon in Lawachhara National Park Forest, Maulvibazar district (Figure 2.4 and Appendix table 2.ii) and minimum (1.16 /10m²), (0.16 /10m²) and (0.16 /10m²) were estimated in winter of the same forest during the study period. *A. gigas* was highest (1.16 /10m²) in winter and lowest (0.33 /10m²) In monsoon, Lawachhara National Park Forest, Maulvibazar district during the study period (fig.2.4 and Appendix 2.v)

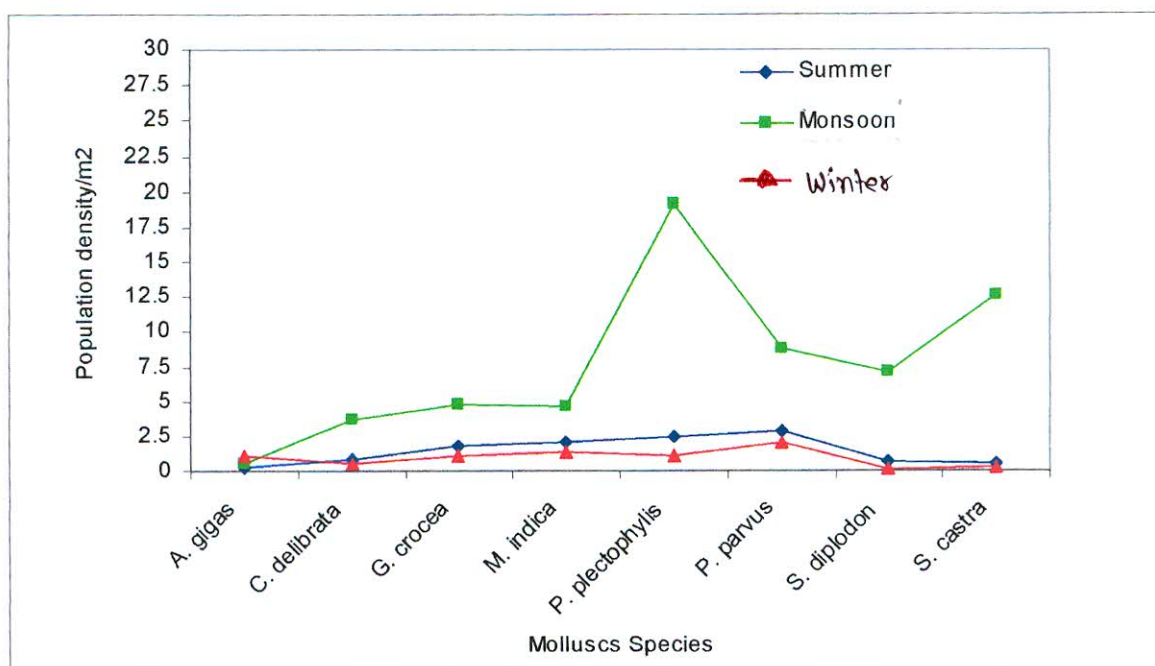


Figure 2.4
Seasonal variations of mollusc species in Lawacha National Park forest
Maulvibazar District (2005-07).

Highest population density of *A. fulica fulica* (5.33 /10m²), *C. theobaldinus* (11.66 /10m²), *C. pearsoni* (10.66 /10m²) and *I. plicata* (17.66 /10m²) were found during the monsoon and lowest (0.33 /10m²), (0.16 /10m²), (0.16 /10m²) and (0.83 /10m²) were estimated during the winter in Malnichhara tea garden annex forest, Sylhet district respectively (Figure 2.3 and Appendix table 3.iv). The highest (1.33/ 10m²) and lowest (0.16/10m²) population density of *E. cassida* was estimated in Monsoon, Malnichhara tea garden annex forest, Sylhet district and summer in the same forest (Figure 2.3 and Appendix table 3.iv).

C. theobaldinus (11.66 /10m²), *C. pearsoni* (10.66 /10m²) and *I. plicata* (17.66 /10m²) were found highest in monsoon and lowest ((0.16 /10m²), (0.16 /10m²) and (0.83 /10m²) in winter, Malnichhara tea garden annex forest respectively, Sylhet district respectively (Figure 2.3 and appendix table 3.iv).

Seasonal variations of Pond Mollusc

In respect of pond habitat, *B. bengalensis* f. *typica* was highest (20.93/ m²), in summer and lowest (0.88/ m²) in monsoon, the same pond of Brahmanbaria District (Figure 2. and appendix table 12. vii).

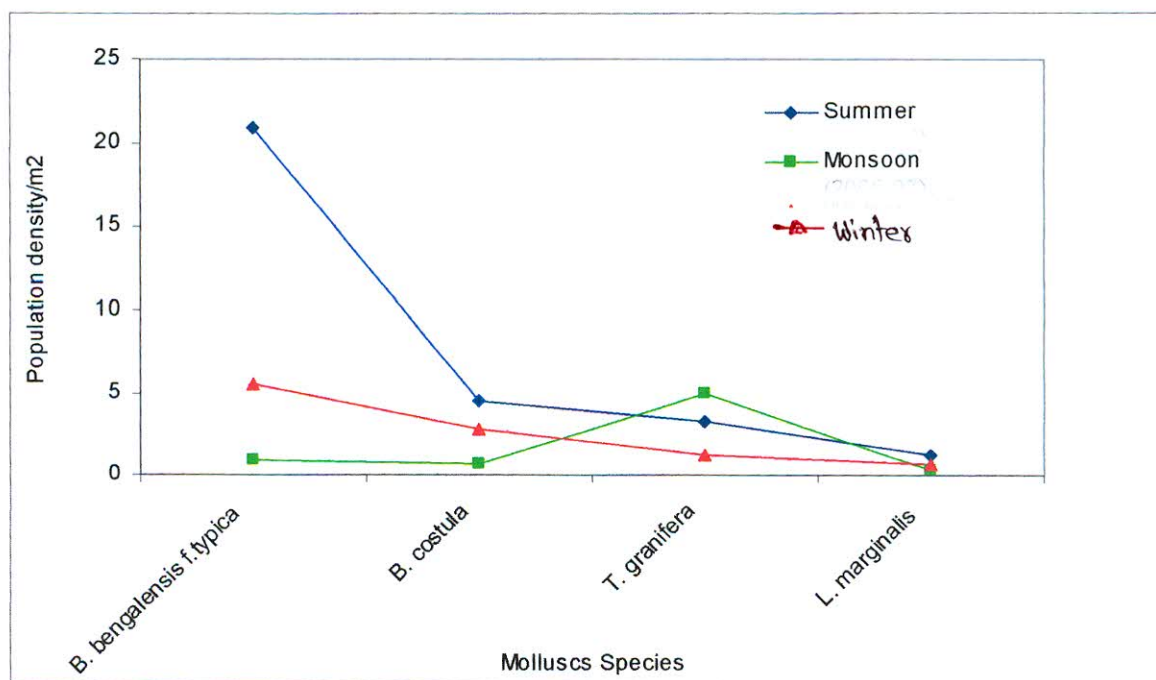


Figure 2.5
Seasonal variations of mollusc species in Pond, Brahmanbaria District (2005-07)

The highest population density of *I. exustus* was estimated (3.55/ m²) and lowest (2.10/ m²) in winter and monsoon, Pond of Sylhet district only (Figure 2.6 and appendix table 9. vii). *M. tuberculata* was found highest in winter (41.88/ m²) and lowest (0.77/ m²) in monsoon pond of Sylhet and Comilla (Figure 2.7 and appendix table 9. vii & Figure 2.7 and appendix table 13. vii) respectively.

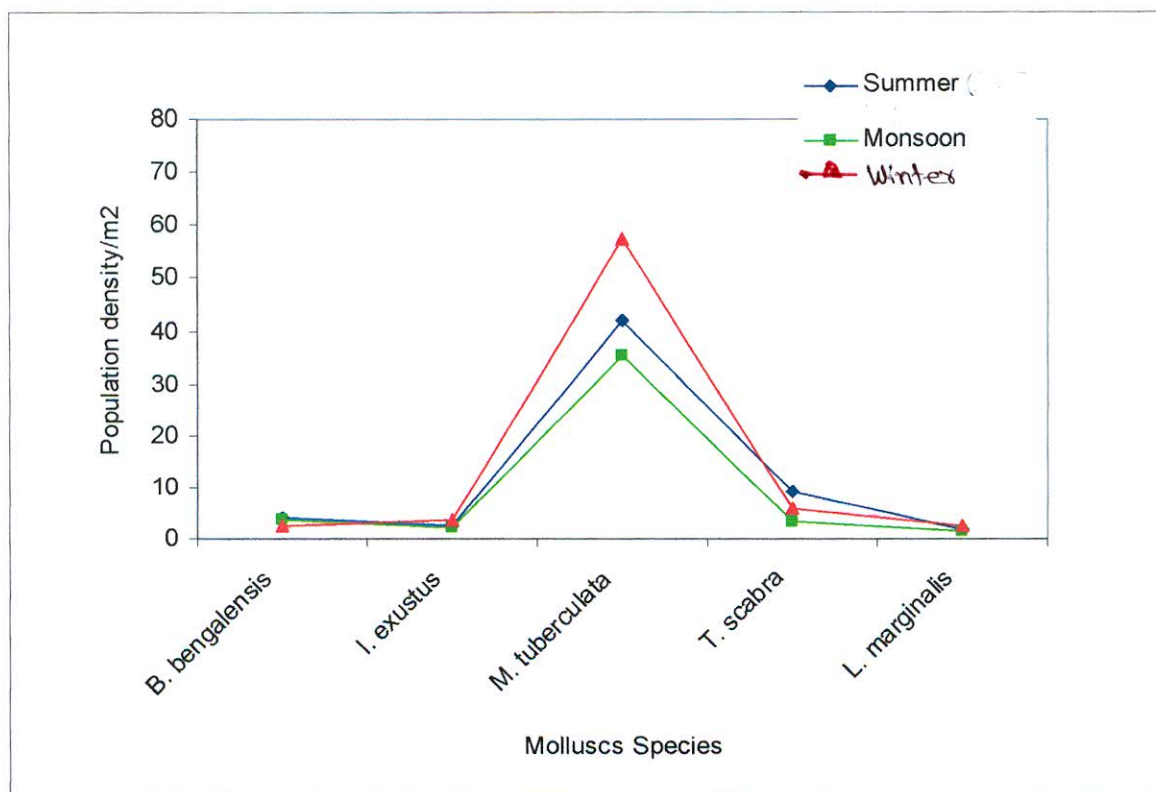


Figure 2.6
Seasonal variations of mollusc species in Pond, Sylhet (2005-07).

Population density of *T. scabra* was highest (9.33/ 1m²) in summer, pond in Sylhet (Figure 2.9 and appendix table 11.viii) and lowest (0.77/ m²) in monsoon, Pond in Habiganj (Figure 2.6 and appendix table 9.vii). The highest (4.71/m²) and lowest (0.77/m²) population density of *B. costula* was estimated in summer, pond of Comilla, (Figure 2.8 and appendix table 13.viii) and monsoon, pond of Maulvibazar (Figure 2. and appendix table 1 .vii) respectively.

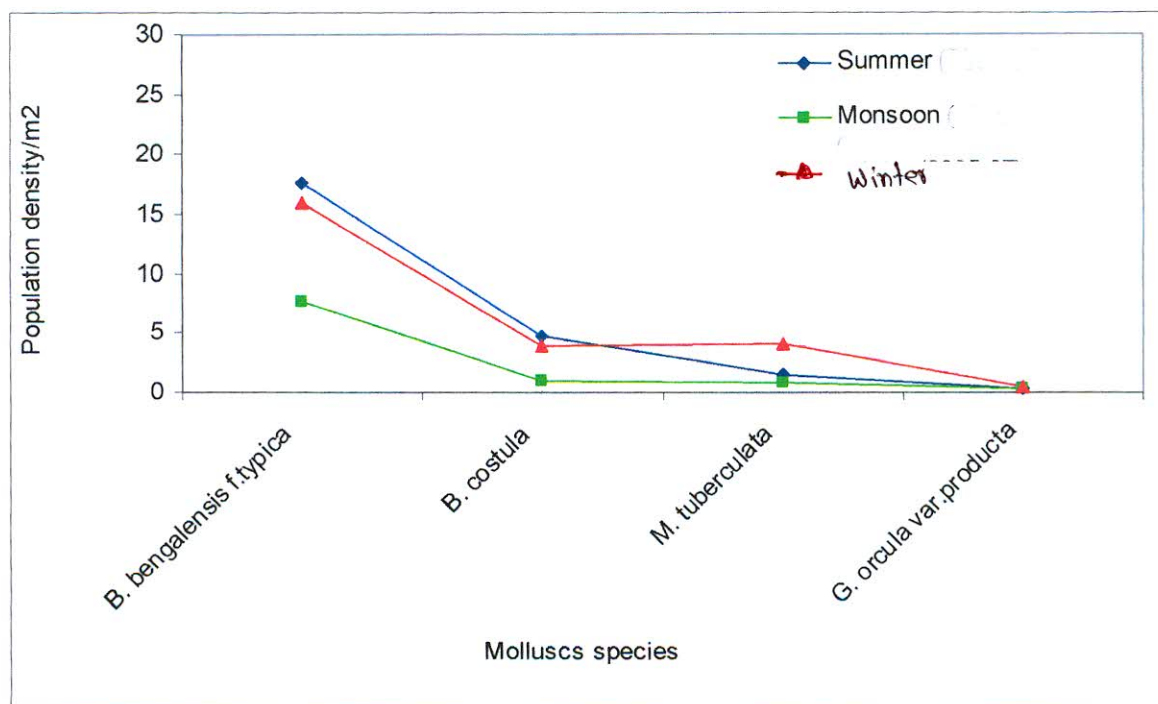


Figure 2.7
Seasonal variations of mollusc species in Pond, Comilla (2005-07)

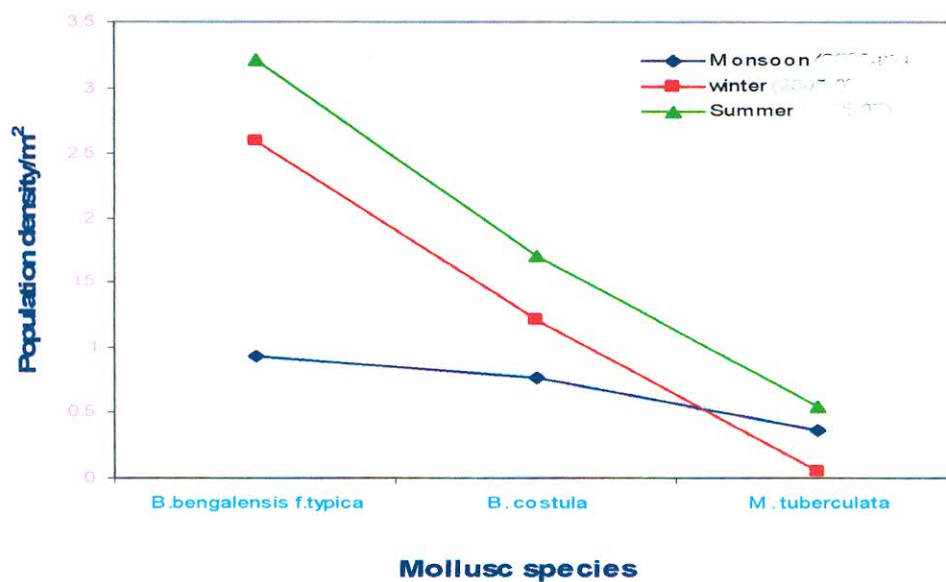


Figure 2.8
Seasonal variations of mollusc species in Pond Maulvibazar District (2005-07).

The population density of *L. marginalis* ($2.88/\text{m}^2$) and *L. corrianus* ($1.77/\text{m}^2$) were found highest in winter, pond in Habiganj (Figure 2.9 and appendix table 11. vii) and lowest ($0.33/\text{m}^2$ and $0.60/\text{m}^2$) in monsoon, each pond of Brahmanbaria and Habiganj (Figure 2.5 and appendix table 12. vii & Figure 2.9 and appendix table 11. vii).

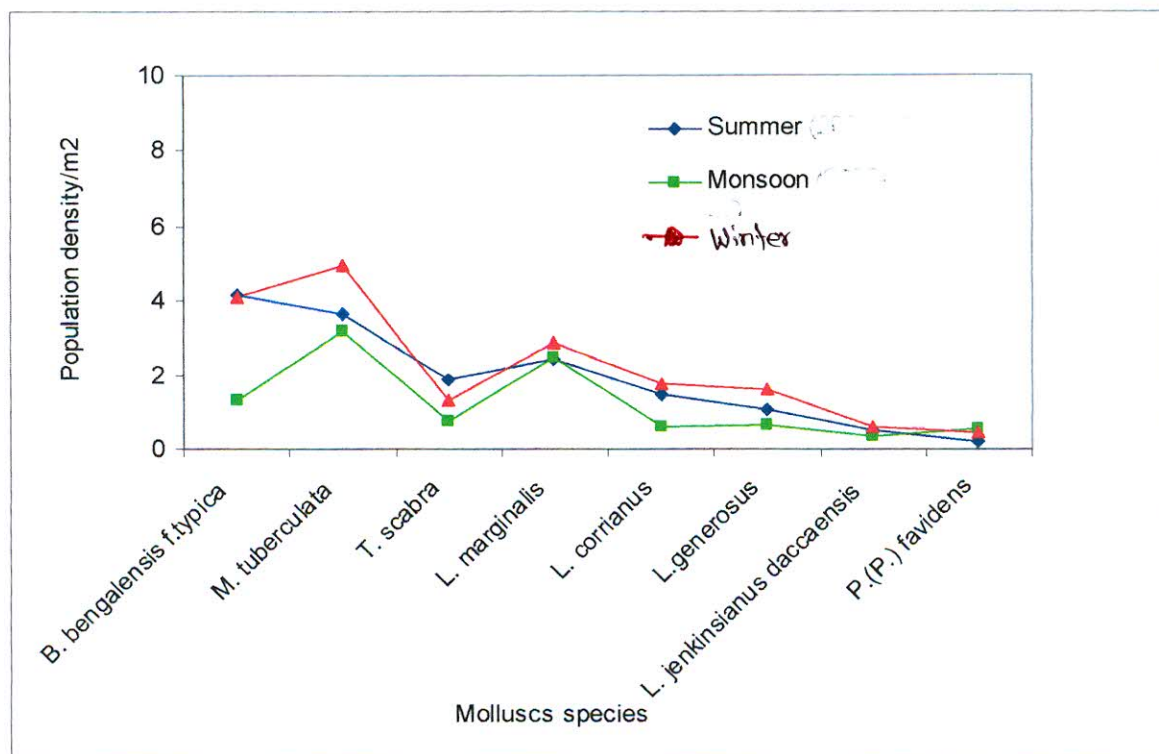


Figure 2.9
Seasonal variations of mollusc species in Pond, Habiganj.

In River habitat, the highest and lowest population density of *B. bengalensis f. typica* ($35.71/\text{m}^2$), *B. costula* ($59.94/\text{m}^2$) were estimated in summer, Surma River, Sylhet (Fig 2.10 and appendix table 5.vii) and lowest ($0.05/\text{m}^2$, $2.71/\text{m}^2$) in Monsoon each of Khushyara (Figure 2.11 and appendix table 5.vii) and Titas River (Figure 2.13 and appendix table 7.vii).

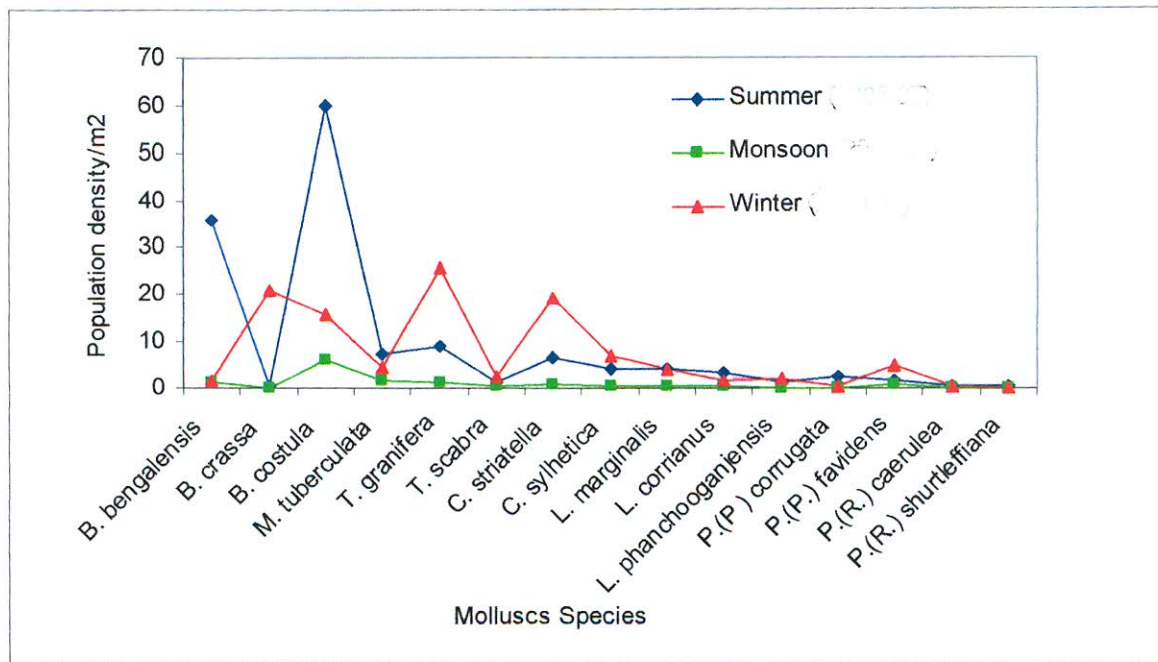


Figure 2.10
Seasonal variations of mollusc species in Surma River (2005-07)

B. crassa was highest ($35.71/m^2$) in summer, Gomti River, Comilla (Figure 2.12 and appendix table 8. vii) and Lowest ($0.11/m^2$) in monsoon, Surma River (Figure 2.10 and appendix table 4. vii), during the study period.

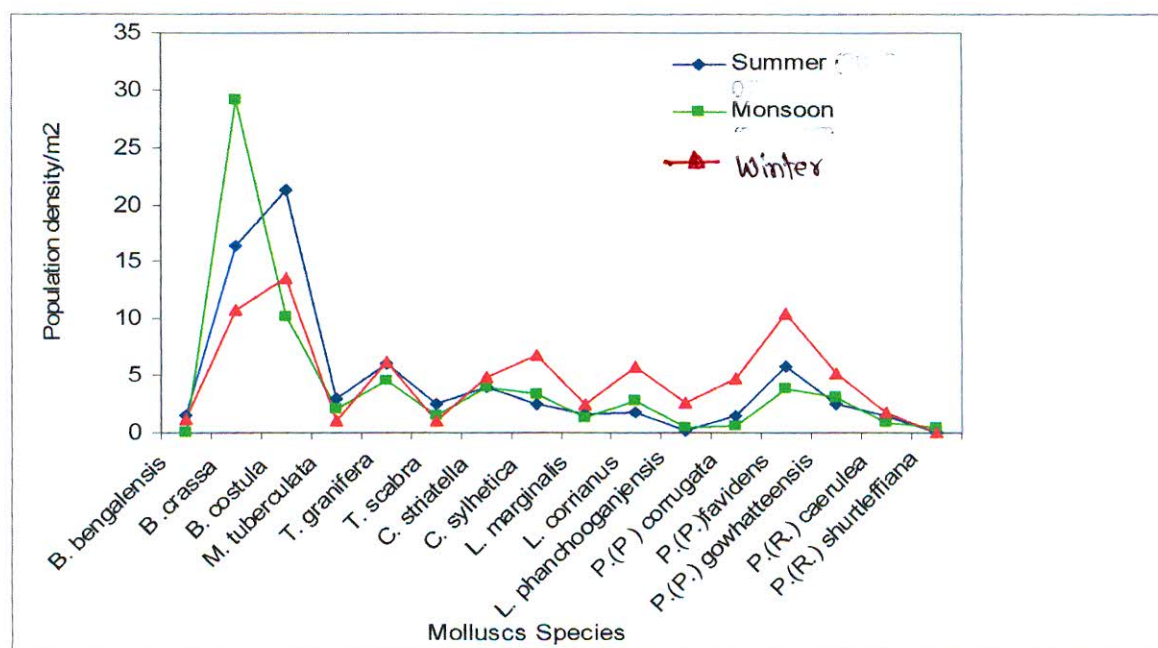


Figure 2.11
Seasonal variations of mollusc species in Khushyra River (2005-07)

The highest population density of *M. tuberculata* ($7.21/\text{m}^2$) and *T. granifera* ($8.66/\text{m}^2$) were found in summer, Surma river (Figure 2.10 and appendix table 4.vii) and lowest ($1.49/\text{m}^2$ and $0.11/\text{m}^2$) in monsoon each of Ratna and Titas river (Figure 2.14 and appendix table 7.vii; Figure 2.13 and appendix table 6.vii).

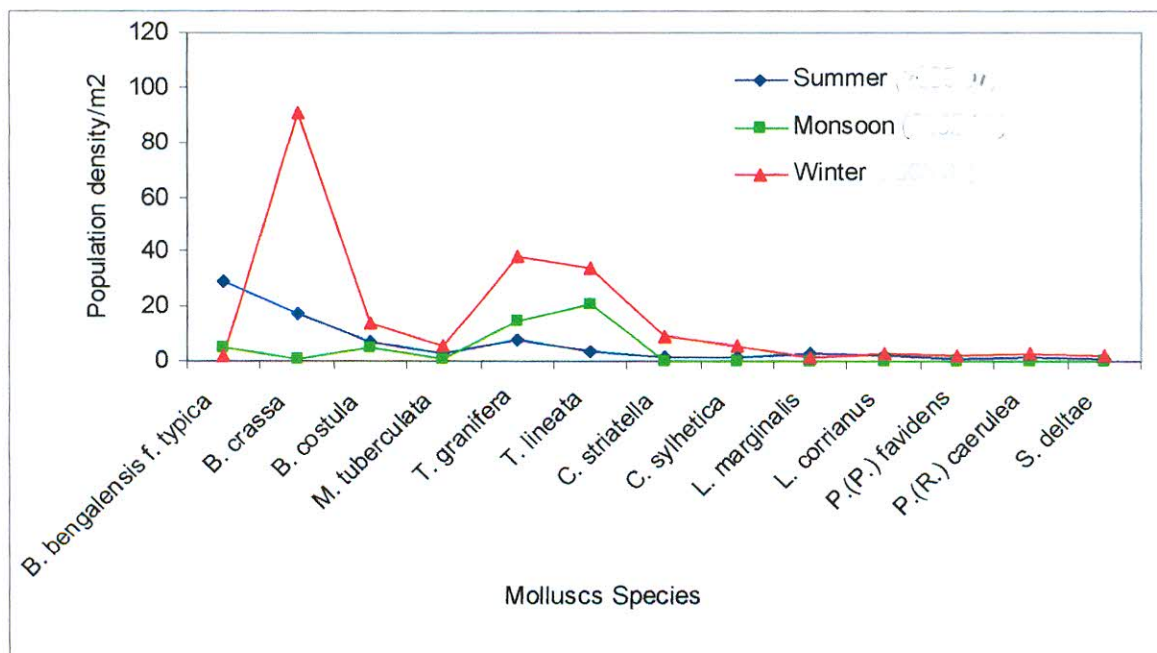


Figure 2.12
Seasonal variations of mollusc species in Gomti Rivar, Comilla (2005-07).

The highest ($4.77/\text{m}^2$) and lowest ($0.05/\text{m}^2$) population density of *P. corrugata* was estimated in winter, Khushyara river (Figure 2.11 and appendix table 5.vii) and monsoon, Surma river (Figure 2.10 and appendix table 4.vii), Sylhet district respectively. *P. favidens* was highest ($22.21/\text{m}^2$) (Figure 2.12 and appendix table 8.vii) and lowest ($0.83/\text{m}^2$) (Figure 2.10 and appendix table 5.vii) found in winter and monsoon, each of Ratna and Surma river respectively. The Maximum ($5.60/\text{m}^2$) and minimum ($0.22/\text{m}^2$) population density of *P. caerulea* was found in winter, Ratna and Surma river respectively (Figure 2.12 and appendix table 8.vii & Figure 2.10 and appendix table 4.vii.)

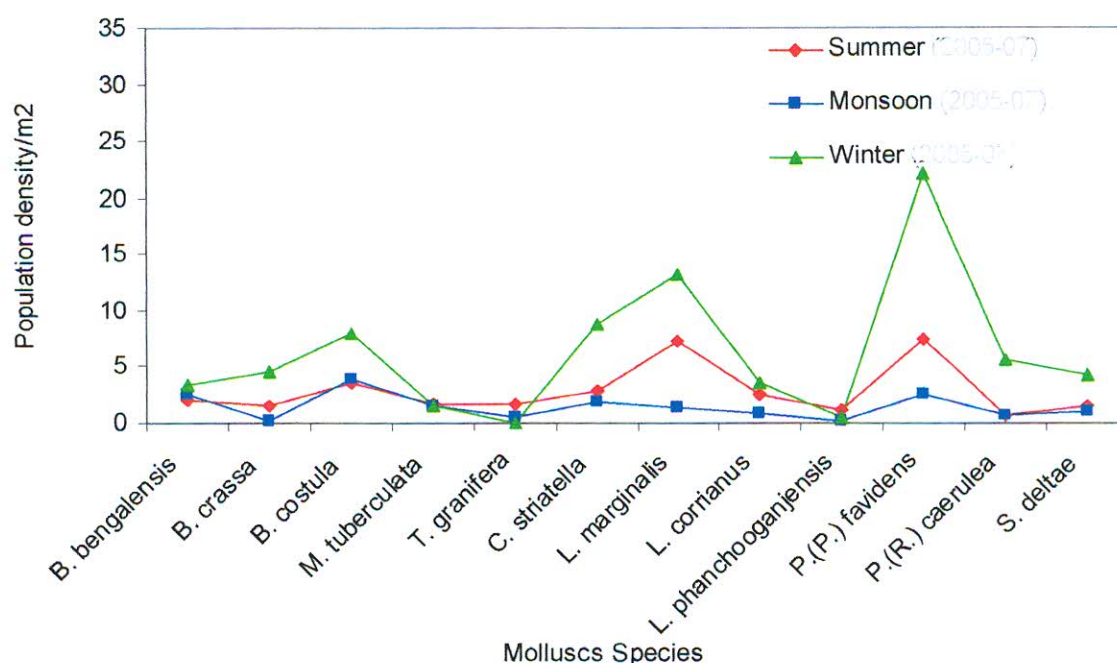


Figure 2.14
Seasonal variations of mollusc species in Ratna River in Habiganj.

P. shurtleffiana was found highest ($0.33/\text{m}^2$) and lowest ($0.05/\text{m}^2$) in summer and monsoon in Surma and Khushyara River respectively (Figure 2.10 and appendix table 4.vii & Figure 2.5 and appendix table 2.vii). The highest ($5.21/\text{m}^2$) and lowest (2.49) population density of *P. gowhatteansis* was estimated in Khushyara River, Sylhet (Figure 2.11 and appendix table 5.vii) winter and summer seasons respectively.

2.4 Discussion

Physical features of the environment such as temperature, moisture, rainfall, soil components play major roles in regulating the snails distribution and abundance. The soil types and chemical properties of soil are much important in influencing the snail population; the more importance of these factors lies with their role in promoting the growth of vegetations. Growth of vegetations not only provides a shady environment but also offers the opportunity of getting different types of foods. Food is considered as the most important factor for growth and multiplication of a species. The factors, specially the soil types and properties, that regulate the growth of vegetation, are equally important, though indirectly, in influencing the snail population.

Burch (1990) states that vegetation influence snail distribution and abundance by its effect on soil chemistry and quality of leaf litter. Snail can live even in areas of calcium poor soil if the local trees concentrate calcium in their leaves. According to Heller and Mageritz (1983) calcium carbonate is dissolved in the water that land snails either absorbed through their moist skins or drink from the upper layers of the soil. Oughton (1948) related that calcium carbonate could also be obtained from calcareous rocks, vertebrate's bones or the shells of dead molluscs. Decaying shells return calcium carbonate to the soil.

Various snail species occupy different fresh water habitats depending on the mode of life requirements such as sunshine, turbidity, substratum, etc (Prasad, 1925; Boycot, 1934 and Saha, 1998). Brownmark (1989) opine that freshwater snails generally herbivorous. Though Morton (1968) mentioned that the ingestion of sand and indigestible matter along with diatoms, fragments and decaying plants takes place during feeding. According to Patnaik and Ray (1968), Raut (1986), Jahan *et al.*, (1996) and Jahan and Rahman (2000) no single factors significantly influences the habitat of the snails.

The Northeastern region of Bangladesh (Brahmanbaria, Comilla, Habiganj, Maulvibazar, Sylhet and Sunamganj districts) is naturally reach with hills, valleys, streams, lakes, rivers, haors, plain land, and green forest. The climatic conditions of

this region is characterized by moderately high temperature, heavy rainfall, and often excessive humidity which indicate that this region of Bangladesh provides good habitat for molluscan species. But except some sporadic reports of some mollusc species previously during the long time before (1880-1921) by Godwin-Austen (1908, 1914, 1920), Gude (1921) and Preston (1915) no detailed work on distribution and abundances of Terrestrial and freshwater molluscs had been reported from that area.

Accordingly, three forest (Terrestrial habitats), five Rivers (Lotic habitats) and five ponds (Lentic habitats) of the study area were surveyed purposively during the tenure of two years (2005-2007) to determine influences of soil components and physico-chemical parameters of water on distribution, population density and to estimate biodiversity indices of mollusc species. During the two years surveys (2005-2007) a total of seventy two (72) species were explored from the studied area. Out of which 25 species were terrestrial and 47 aquatic. Among 25 terrestrial species *G. crocea*, *M. indica* and *L. (Allopeas) gracile* were ubiquitous species found in Comilla, Habiganj, Maulvibazar, Sylhet and Sunamganj district. *G. notigena* was found in three districts viz. Comilla, Habiganj and Sylhet districts. *Austenia gigas*, *Sivella castra*, *Sesara dipledon*, *S. pfeiffere*, and *Chamalaycaeus (Dicharax) crenatus* were found in Lawachara National Park Forest Maulvibazar. Slug *Meghematium* sp. was found in Maulvibazar only. *Euaustenia cassida* was found in Malnichara tea garden annex Forest and Sylhet govt. college annex hill in Sylhet district. *Succinea daucina* and *Sittala attega* were found in terrestrial habitats of Comilla district only.

Among 47 aquatic mollusc species, *B. bengalensis*, *B. costula*, *M. tuberculata*, *T. granifera*, *L. marginalis*, *L. corrianus*, *P. favidens* were ubiquitous species throughout the study area. *N. gangetica*, *S. deltae*, *B.(D.) cerameopoma*, *B.(D.) pulchella* were encountered in Gomoti river, Comilla only. *L. indawgyensis* was only found in Chatla Beel and the Surma River. *P. (P.) favidens* var. *viridula*, *P. (P.) gowhattensis*, *P. (R.) andersoniana* were found in single habitat (Khushiyara river). *Radix persica* was found in Paddy field at Companyganj in Sylhet district. *Physa acuta* was found in polluted ditches in Srimongal, (Maulvibazar district).

In course of the present study in the Districts of the North-eastern region of Bangladesh viz. Comilla, Maulvibazar, Sylhet it was found that land mollusc depend on rainfall, temperature and soil parameters (Table 2.8 and appendix table 16.ii). In above districts land mollusc population densities were positively correlated with soil P^H , Organic matter, Potassium (K), Calcium (Ca), Magnesium (Mg), Nitrogen (N), Ferrous (Fe) and Manganese (Mn) but not significant at 0.05% level. On the other hand mollusc population densities were negatively correlated with P, and Zn (Table 2.3). Magnesium was highly positively correlated with mollusc population densities and significant at 0.01% level. Yearly average rainfall, temperature and humidity, and soil parameters are major factors influencing population densities of land mollusc. In Malnichara Tea garden annex Forest, Sylhet it was found that *A. fulica* and *G. crocea* population densities were positively correlated with climatic factors of Summer and Monsoon seasons at 0.05% and 0.01% significant level but negatively correlated with winter. *M. indica*, *E. cassida*, *C. theobaldinus* and *G. notigena* population densities were positively correlated with climatic factors of Summer and Monsoon seasons ($P < 0.01$) and negatively correlated with Winter. *P. parvovus* population densities were positively correlated with climatic factors of Summer and Monsoon seasons but significant at 0.05% level. *C. pearsoni*, *A. (L) gracile*, *I. plicata* and *F. alte* were positively correlated with climatic factors of Summer and Monsoon season and but not significant at 0.05% and 0.01% level (Table 9). In Lawachara National forest, *C. delibrata*, *G. crocea*, *M. indica*, *P. plectopylis*, *P. parvus*, *S. diplodon* and *S. castra* were positively correlated with climatic factors of Summer and Monsoon seasons but not significant at 0.05% and 0.01% level. On the other hand *A. gigas* population densities were positively correlated with Winter and negatively correlated with Summer and Monsoon seasons. In BARD annex forest *R. bengalensis*, *S. attega*, *C. delibrata*, *G. gemma*, *G. notigena*, and *P. parvus* was positively correlated with climatic factors of Summer and Monsoon seasons but significant at 0.05% and 0.01% level but negatively correlated with winter.

Jahan, *et al.*, (1992) reported that yearly average total rainfall, egg-laying frequency, breeding period, temperature and percentage of K in soil are major factors influencing population density of *A. fulica* and play major role in ecology of *A. fulica* occurring in

Bangladesh. Percentages of Ca, Mg, and Mn have positive correlation with the population density but not significant at 5% level. On the other hand, Percentage of Fe, NH_4N and P have insignificant negative correlation at 5% level. Though the snails are found in all possible niches irrespective of soil types it is evident that Ca and some extent Mg play vital role in regulating the density of snail's population. The impact of different soil factors on the distribution and multiplication of land mollusc varies with the species. In eastern Virginia Burch (1955) recorded increased number of land snails with increased amount of Ca, Mg, K and organic contents in soils. In Britain, Boycott (1934) listed 8 to 12 species as obligatory calciphiles, 11 more species as nearly so, and 45 species of land pulmonates indifferent to a calcareous substrate. Bisop (1977) suggest that litter feeding animals may relate to the carbon to nitrogen ratio and the calcium content of litter. The need of calcium in the diet of land snails has also been proved experimentally by Oldham (1929; 1934); Schmidt (1955) and Lozek (1962). Van Cleave (1953) suggest that the presence of snails is an indication of available lime supply. The snails and slugs are extremely adopted to a wide range of soil p^{H} , (Carrick, 1942; Burch; 1955; Karlin 1956; Raut, 1981)

The population density and habit preference of land snails in Great Britain, including a number of species also found in Maine have been discussed by Boycott (1929, 1934) and Peak (1978). Boycott also dealt with slugs in his paper. During the observation of two consecutive years it was found that in Monsoon rainfalls very high in the Northeastern region and mollusc species were found abundantly in these districts. In summer rainfall occurred sporadically, mollusc species were also found occasionally. In winter rainfall was very scanty or nil and temperature was low. So, land, mollusc species were not found generally. These findings agree with that of Jahan (1992).

Among the three forests considered Lawachara National Park reserved forest was densely vegetated and harbours very rich ($3.36/10\text{m}^2$) of mollusc species densities. On the contrary Malnichara Tea garden annex Forest vegetation was medium and herein mollusc densities were considerably low ($2.70/10\text{m}^2$). More over, BARD annex forest, Comilla district vegetation was less than other two forests having minimum densities

of mollusc species (1.99/10m²). These findings are also in agreement with Burch and Peare (1990) and Jahan (1992).

Seasonal variation of freshwater mollusc density showed that *B. bengaleansis f. typica*, *Brotia costula*, *M. tubercula*, *Parressya shurtleffiana* were found highest in summer. *B. crassa*, *T. granifera*, *Corbicula striatella*, *C. sylhetica*, *L. marginalis*, *L. phanchooganjensis*, *P.(P.) favidens*, *P.(P.) gowhattensis* and *P.(R.) caerulea* were highest in winter season. *Scapula deltae* was found in monsoon only. Pond habitat showed the same result. All recorded species except *Scapula deltae* were found scarcely in monsoon. Khan *et al.*, (1984) showed that *B. bengaleansis* was lower in August (monsoon). He argued that the heavy mortality of old age snails took place in this month and due to heavy rainfall in the studied spot (Lake) was flooded; thereby removing the snails as well as vegetations from the littoral zone. The present finding is similar to that of Khan, s (1984) finding.

Jahan *et al.*, (1999) showed that abundance of *M. tuberculata* was highest in pond in the month of June at Rajshahi, but the present findings showed that abundance of *M. tuberculata* was highest in winter in pond habitat whereas in case of river habitat it was maximum in summer. It seems that these variations in the population densities were due to the variations of rainfall and water level of the two areas of Bangladesh as the monsoon comes in the eastern region of the country much ahead of the western part (Rajshahi region). Which revealed that the snail population is highly influenced by rainfall and prevailing moisture of the habitat. Subba Rao and Mitra (1982) and Singh (2006) also noted the similar trends of fluctuations in the population densities of gastropods in respect of seasonal variations.

In the Pond habitat, Brahmonbaria, Comilla, Habiganj, Maulvibazar, Sylhet and Sunamganj districts it was found that mollusc population densities were positively correlated with soil P^H (P<0.05), OM, Ca, N, Fe and Zn but negatively correlated with K, Mg, P (P<0.05), Cu and Mn (Table 2.5). Whereas in the River habitat, Brahmonbaria, Comilla, Habiganj, Maulvibazar, Sylhet and Sunamganj districts it was

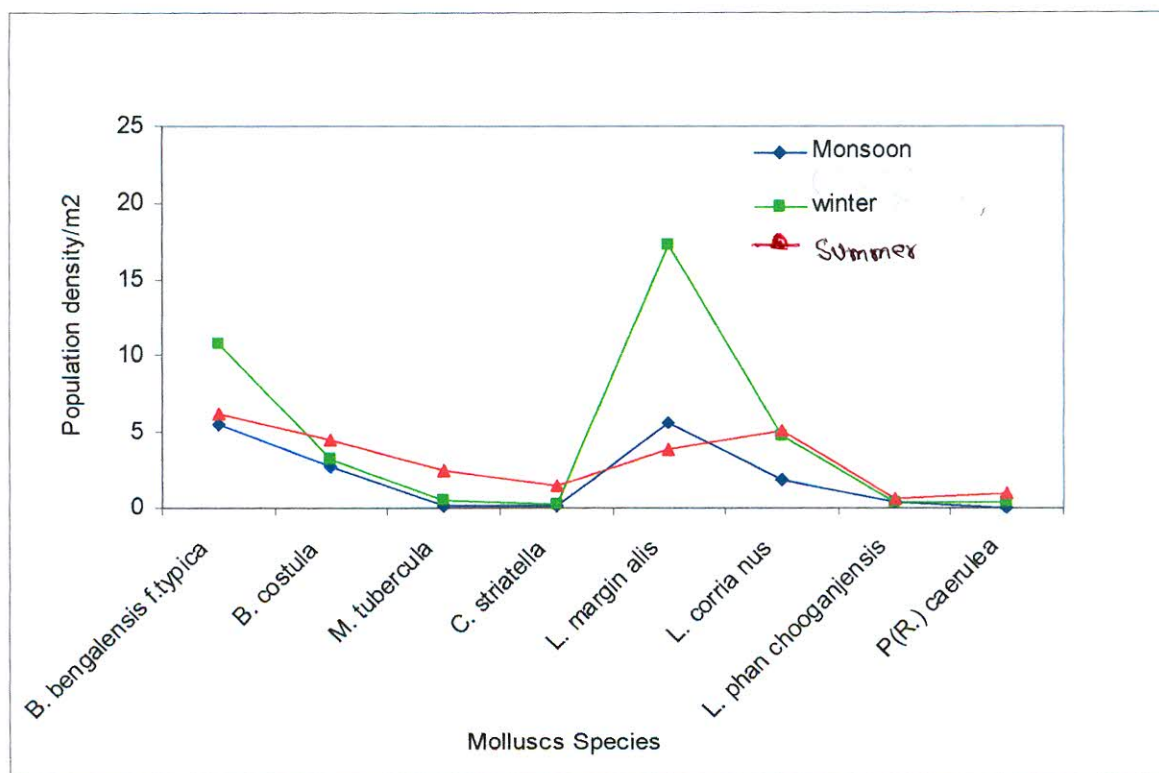


Figure 2.13
Seasonal variations of mollusc species in Titas River, Brahmanbaria (2005-07)

S. cabra was found highest ($2.44/\text{m}^2$) in summer, Khushyara river and minimum ($0.66/\text{m}^2$) in monsoon, Surma river, Sylhet (Figure 2.11 and appendix table 5.vii). *C. striatella* and *C. sylhetica* were estimated highest ($19.33/\text{m}^2$ & $6.88/\text{m}^2$) in winter, Surma river, Sylhet (Figure 2.10 and appendix table 4. vii) and lowest ($0.77/\text{m}^2$, $0.11/\text{m}^2$) in monsoon, each of Surma and Titas river, Sylhet and Brahmanbaria (Figure 2.10 and appendix table 4.vii & 2.13 and appendix table 7.vii).

Highest population density of *L. marginalis* ($17.33/\text{m}^2$) was estimated in winter, Titas River, Brahmanbaria (Figure 2.13 and appendix table 7.vii) and lowest ($0.05/\text{m}^2$) in monsoon Gomti river (Figure 2.12 and appendix table 2.vii). *L. phanchooganjensis* was found highest ($2.66/\text{m}^2$) in winter, Khushyara river (fig.2.11 and appendix table 5.vii) and lowest ($0.22/\text{m}^2$) in summer and monsoon each of Khushyara and Ratna river (Figure 2.11 and appendix table 5.vii & 2.12 and appendix table 8. vii) respectively.

found that mollusc population densities were positively correlated with soil P^H , OM, K, Ca, Mg and N but negatively correlated with P, Cu, Fe, Mn and Zn (Table 2.4).

Population density of pond mollusc was positively correlated with physico-chemical parameter of water Temperature, Transparency, P^H , DO and Total hardness. P^H has significant correlation ($P < 0.05$) with Total hardness (Table 2.7). Minimum and Maximum values of transparency had been found 27.33 ± 1.00 cm in monsoon (Appendix Table 15.1) and 51 ± 1.00 cm, summer and 48.5 ± 0.07 (Winter) and 31 ± 1.00 in monsoon (Appendix 15.2) pond and rivers respectively.

On the other hand, aquatic mollusc (River) Population density was positively correlated with physico-chemical parameters of water Temperature, P^H , Do and Total hardness and negatively correlated with transparency (Table 2.6). Transparency is dependant on the presence or absence of aquatic vegetations. So the present finding supports that snail population is highly dependent on aquatic vegetation

The pond mollusc species population was negatively correlated with Mg but positively correlated with Mg in case of River water. After all, River mollusc species density was more than Pond mollusc species. It might be due to the washout of rocky stones, and huge amount of organic matters contained runoff from the vast basin support the rich biodiversity in the river.

Temperature is a critical environmental factor in the ecology of most organisms (Andrewartha and Birch, 1954; Precht *et.al.* 1973; Wiser, 1973; Rahman and Jahan, 1979 and Ahmed and Raut, 1991). Maximum water temperature during summer months was reported by Das and Bhuiya (1974), Ismail *et.al.* (1984) and Patra and Azadi (1987) in Bangladesh; Gonapati (1940), George (1964) and Vyas and Kumar (1968) from India. On the contrary, minimum water temperature during winter months was also recorded by George (1964, Verma (1969) in India; Khan *et. al.*, (1990) Begum *et. al.*, (1994) and Saha (1998) in Bangladesh. So, along with other physico-chemical factors temperature plays an important role in the

aquatic medium. The present findings revealed that the temperature of all water bodies (Rivers and ponds) usually declined from November and reached minimum in December and there after increase steadily reaching maximum during April to September. The range of water temperature (in case of pond and river) from 26.35 ± 2.84 to $29.32 \pm 2.19^\circ\text{C}$ has been recorded during the study period and maximum has been noted in summer (Appendix 18 & 19). Accordingly, it was found that the population densities and life activities of the mollusc species relate with the fluctuation of temperature in respect of season.

The P^{H} values of fresh water habitats in different regions of the globe range from 6.0 to 9.3 depending on the nature of the habitats and variation of seasons (Atkins and Harris 1924; Patnaik & Ray, 1968 and Ali *et al.*, 1980). P^{H} intricately entangled in the complex biological system of a water body and indirectly its snail fauna. Carpenter (1923) pointed out that acid peaty water of P^{H} 6 or less contained no snails and *Lymanaea peregra* soon died in water having P^{H} 5-6 in Britain. Raut (1989) stated that the development of *L. leutola* was highly influenced by P^{H} of water and even beyond the range of 6.0-9.5 eggs of the snail did not hatch. Saha (1998) calculated mean value of P^{H} of water of the ponds studied ranged between 6.83 to 8.48. The calculated mean value of p^{H} of water of the pond and rivers during present investigation reveals that p^{H} range 8.1 ± 0.25 , 8.43 ± 0.27 and $7.95 \pm 1.15 - 8.42 \pm 0.06$ respectively (Table 18 & 19) which is very favourable for the propagation of snail fauna. The number of snail species tended to decrease with a decrease in P^{H} . The drop in species number was particularly noticeable at about P^{H} 6.0 and no species occurred in lakes Norway with P^{H} below 5.2. Total hardness, P^{H} , macro vegetation in the water and substratum showed a high correlation with snail fauna and were considered as primary factor of direct importance to the snails (Qkland, 1983). Hardness of water refers to the concentration of divalent metal ions in water expressed as mg/l of equivalent calcium carbonate. The total hardness is usually related to total alkalinity. Where the total hardness value is lesser than total alkalinity value the hardness is due to carbonates.

hardness is due to carbonates. Hossain (2002) investigated that hardness of water of Altadighi ranged 30.6 to 99 mg/l with on average of 56.2 ± 16.0 and 59.1 ± 10.6 mg/l from below surface and bottom water respectively. Islam *et al.*, (1979) suggested that pond water having hardness of 15 mg/l or above is satisfactory for growth of fish. According to Klein (1972), Sawyer (1960) water with less than 50-150 ppm hardness is moderately hard; 150-300 ppm is hard and above 300 ppm is considered very hard. Trivedly and Raj (1972) opined that water containing about 110 ppm hardness may be considered moderately hard. They further added that the acceptable limit of total hardness (as CaCO_3) is 200 mg/l, which can be used for drinking purposes. On the basis of above classification the water of the studied Ponds (53.5 ± 5.34 to 63.33 ± 2.84 mg/l) (Table 1) and Rivers (44.83 ± 4.86 to 80.5 ± 7.81 mg/l) respectively (Table 2), is moderately hard. Which favours the mollusc species to propagate effectively.

Calcium concentration and P^{H} level are important factors for determining presence and well being of snails (Boycott, 1936; Hubendick 1947; Aho, 1966, 1978; J. Qkland, 1969, 1979 a b; Qkland & Qkland 1979). According to Qkland (1983) the decline in species number corresponds with decreasing value of the total hardness and P^{H} . The present study revealed that population density of mollusc, positively correlated with P^{H} and Total hardness of river water (Table 2.7).

Species diversity tends to be low in physically controlled ecosystem (i.e. subjected to strong physio-chemical factors) and high in biological controlled ecosystems. Higher diversity means longer food chain and more cases of symbiosis (mutualism, parasitism, commensalisms, and so forth) and greater possibilities for negative feedback control which reduces oscillation and hence, increase stability. Evenness or equability is the apportionment of individuals among the species. Evenness may also be referred to as homogeneity or relative diversity and measure of dominance indicates the heterogeneity in the dispersion of individuals. Both evenness (e) and diversity index (H') behave inversely to the index of dominance, high values of

formers indicates a low concentrations of dominance (Odum, 1971).

Alam *et al.*, (1999) Studied the diversity of the macro zoo benthos of five zones (viz.1, 2,3,4, & 5) of intertidal area of Halishahar coast, Chittagong, Bangladesh. In sample mean of 1990 and 1991 Shannon-Wiener diversity index (H') were 1.636 ± 0.071 , 3.131 ± 0.067 , 3.376 ± 0.071 , 2.697 ± 0.055 , and 1.569 ± 0.082 in the zones 1,2,3,4 and 5 respectively. In the sample mean of 1990 and 1991 species evenness (J) were 0.615 ± 0.048 , 0.805 ± 0.004 , 0.841 ± 0.004 , 0.741 ± 0.008 and 0.591 ± 0.012 in the zones 1,2,3,4 and 5 respectively.

Jahan *et al.*, (2000) measured species diversity (H'), evenness (e) and Community dominance (c) in respect of different aquatic habitats of Rajshahi Metropolitan city. They estimated that species diversity; evenness and index of dominance were 0.68, 0.79 and 0.21 in Pond habitat respectively. The highest value for evenness and index of diversity for canal were calculated as $e=0.89$ and $H'=0.73$ respectively. The lowest value ($c=0.11$) and the highest value ($c=0.29$) for the index of dominance were estimated in case of canals and Paddy fields respectively. The minimum index of Evenness ($e=0.71$) and index of diversity ($H'=0.57$) obtained from paddy field. Khan *et al.*, (1996) worked on Community structure and ecology of macro benthic invertebrates fauna of Lake Kaptai, Bangladesh. They measured Community structure at four depths of two stations. The diversity value (H') ranged between 2.3 and 3.4 at margin to 7 m. depths and between 1.4 and 2.6 in the profundal and evenness ranged 0.64 to 0.73 at margin to 7 m. depths and between 0.47 and 0.63 in the profundal zone.

Diversity indices (H') (2.20, 2.30 and 1.93), Simpson indices of Dominance (C) (0.14, 0.16 and 0.14), evenness (e) (0.88, 0.79 and 0.81) were obtained from the collected samples from River Ratna, Kushiara and Surma respectively. Values and trends of the obtained indices from the present investigation are more or less similar with that of macrobenthic community of Lake Kaptai, Bangladesh as reported by Khan *et al.*, (1996).

Diversity indices (H') (1.84, 1.18, 0.94, 0.85 and 0.67), Simpson indices of Dominance (c) (0.18, 0.34, 0.43, 0.54 and 0.60), Species richness (d) (2.63, 1.16, 1.45, 1.01 and 0.97) and evenness (e) (0.88, 0.85, 0.85, 0.61 and 0.41) were calculated for Ponds of Habiganj, B. baria, Maulvibazar, Comilla and Sylhet respectively. This finding was more or less similar to those of Jahan *et al.*, (1996) for the aquatic habitats of Rajshahi city corporation area. In case of river habitats the minimum index of dominance ($c=0.13$), species richness ($d=2.14$), evenness ($e=0.65$) and minimum index of diversity ($H'=1.62$) were estimated from the collected samples of river Ratna, Titas and, Gomti respectively. Again maximum index of dominance ($c=0.26$), both species richness ($d=3.49$) and maximum index of diversity ($H'=2.30$), and evenness ($e=0.88$) were estimated from the collected samples of river Gomti, Khushyara and Ratna respectively. In terrestrial habitat it revealed that the minimum index of dominance ($C=0.12$) Malnichara tea garden annex forest, both species richness ($d=2.12$) and, index of diversity ($H'=1.90$) and evenness ($e=0.87$)) were estimated from the collected samples of Malnichara tea garden annex forest, Lawachara forest, and BARD forest respectively. Again maximum index of dominance ($c=0.16$), species richness ($d=3.01$), both evenness ($e=0.91$) and index of diversity ($H'=2.20$) were estimated from the collected samples of Lawachara forest, Malnichara tea garden annex forest, BARD forest, and Malnichara tea garden annex forest respectively.

1) Lower index of dominance (ranged from 0.13 to 0.23) and higher evenness index (ranged from 0.77 to 0.88) with higher diversity index (ranged from 1.62 to 2.30) indicates the cohabitation of maximum number of species with moderate population densities in river (Lotic) habitat. Which is evident from the table (2.1 and 2.4) showing the number of species recorded in each river (8-16) and population densities (3.26 to $8.54/m^2$). Whereas, lower index of dominance (ranged from 0.12 to 0.16) and higher evenness index (ranged from 0.87 to 0.93) with higher diversity index (ranged from 1.90 to 2.20) indicates the cohabitation of maximum number of species with moderate population densities in terrestrial habitat. Which is evident from the table (2.1

2.2

and $\wedge$) showing the number of species recorded in each forest (8-11) and population densities (2.00 to 3.36/ 10 m²). Higher value of evenness (e) explains the co-habitation of maximum number of existence of species in the community of the locality. On the contrary, the higher value of index of dominance indicates that species paucity prevails in the habitats. Maximum numbers of species in the community intensify the competition for the environmental requisite. Consequently, more species diversity pull down the population density in the locality concerns. On the other hand, the presence of minimum number of species in a specific area inspires increased population densities through facilitating the availability of environmental requisite resources (Pramanik, 1992). These findings are more or less to that of Pramanik's opinion. Evenness and diversity indicates behave inversely to the index of dominance but pond in Maulvibazar showed that community index (c) was not inversely related to evenness. It was contradictory to Odum's (1971) proposition. Due to time and inadequate logistic support it may be that accurate sampling was not done up to the mark of satisfaction. Nevertheless, it deserve further intensive survey to clarify the situation arose in the present study. However, it might be pointed out that evenness or equitability notes the distribution of individuals among the species present in the community uniformly or not. This distribution might be restricted due to prevailing environmental exposed. Finally, it might be concluded that the favorable weather, physico-chemical parameter of soil and water, and vegetation of Bangladesh are comfortably harbouring suitable number of mollusc species.

CHAPTER 3

ECONOMIC STATUS OF MOLLUSCAN FISHERY OF THE NORTH-EASTERN REGION OF BANGLADESH

Chapter 3

Economic status of molluscan fauna of the North-eastern Region of Bangladesh

3.1 Introduction

The fresh water molluscs play a vital role in fresh water environment. They need to be considered as a part of whole fresh water community, particularly in its role in food chain linking up to edible fish which are such an important resource of protein for human population. Not only many aquatic animals thrive on them but also serve as food for many parts of the country (Ramakrisna *et al.*, 2007). The use of fresh water mollusc as protein rich food is very much practice in a number of countries viz. Philippines (Talavera and Faustino, 1933; India (Rao and Dey, 1984). Thailand (Kaewajam, 1986); Mexico (Garica-Cubas, 1989; Valdes Ganzalez, 1989), Taiwan and Formosa (Wu, 1989); and Philippines (Pagulayan and Cruze, 1989).

Molluscs are important as human food, poultry, and shrimp food and source of edible lime. A wide variety of mollusc like snail, mussels, cockles, oysters, clams, cuttle fish, squids and octopus are considered a delicacy all over the world, particularly in the Indo-Pacific region, Europe and the American snails are a special delicacy to the French. However snails are also an important item in the diet of frogs, lizards, birds and Mammals (Siddique *et al.*, 2007).

The importance of certain fresh water mollusc as the agents of spreading helminthes disease of man and domestic animals in the sub-continent is well documented (Sewell, 1921; Mukherjee, 1966; Pandey and Agarwall, 1978; Raut, 1986). As vectors they are instrumental in the transmission of many larval bivalves, parasitic on gills of fishes.

The peoples of Manipur, Arunachal Pradesh, Bihar, Jhar Khand, Meghalaya, Mizorum, Orissa and West Bengal cosume *Angulyagra oxytropis*, *B. bengalensis*, *B. dissimilis*, *B. costula*, *Cipangopaludina lecythis*, *L. marginalis*, *L. generosus*, *L. phenchooganjensis*, *L. corrianus*, *P. globosa*, *P. theobaedi*, *P. blanfordiana*, *P. conica*, *P. pustula*, *P. regulata*, *Parreysia (Parreysia) burmanus*, *P. (P.) favidens*, *P.*

(*P.*) *sikimensis*, *P.* (*P.*) *caerulea* *P.* (*P.*) *occata*, *Solenaia soleniformes*, and *Trapzoideus exolezens exolezen* (Ramkrishna *et al.*, 2007).

Terrestrial molluscs are also eaten. The people of France consume 5 million pounds of escargot (*Helix asperas*, Muller) every year (Borquin *et al.*, 1991). The fresh water snails are suitable and one of the cheapest food for prawn culture, because, snails contains about 37.5 to 68.2% protein, 6.3 to 10.8% fat and 3 to 6.2% glycogen (Muley, 1975). Saha (1998) experimented on *B. bengalensis* and *P. globosa* and observed that 29 tribes are consuming this snail in Bangladesh.

P. globosa and *B. bengalensis* are an important food items for African magur (*Clarias griepinus*) and fresh water prawn (*Macrobachium rosenbergii*), brakish water prawn (*Pinnaeus monodon*) Jahan and Zaman (1986) and (Jahan and Rahman 2000). The snails *P. globosa* is one of the major food used by the farmers from June to November when they grow, golda *M. rosenbergii* (Ahmed *et al.*, 2000).

Shells of fresh water mollusc are used in manufacturing shell-buttons ornaments and also in slake lime production of slake lime industries in North Bihar, India (Rao & Dey, 1984). Shell grit, dust and residual pieces are used in preparation of poultry food and mosaic tiles respectively.

The above discussions show that both terrestrial and fresh water mollusc are of much economic importance in the perspective of Bangladesh economy.

3.1.1 Aims and Objectives

The aim of the present investigation was ascertained to assess the role of molluscan species in the economy of North-eastern region of Bangladesh and the specific objectives of this part were as follows:

- i) To identify the people who consume mollusc species with their socio-economic status and mode of consumption,
- ii) To find out the extends of snail species in different array of economy.
- iii) To discourse the developed marketing system of molluscan fauna in the Northeastern region of Bangladesh.
- iv) To estimate the total amount of money transaction in snailing seasonally.

3.2 Materials and Methods

Surveys were conducted on the use of fresh water mollusc species from all possible sites of different district in the North-eastern region of Bangladesh during the study period 2005-07 on the assessment of commercial value of mollusc species. The observations were made, to interview the snailer (who catch snails) for their own consumption and are associated with snailing and marketing of snail species. Interview schedules were used to collect various information i.e. name of snail, name of people, total catch of snail, uses of snails, price of snails and their marketing channels etc. by using appropriate questionnaires from Shasidal, Chandina, Comilla, Chunarugat, Habiganj, Srimongal, Maulvibazar and Sylhet in a systematic way. A total of 30 interviews were taken from the tribal peoples and different types of snails traders, such as Baparies, Aratders, Prawn farmers, Cat fish farmers and Pungus fish farmer of that area above questionnaires. Among the total interviewee 20 were tribal peoples and 10 interviewee were snail traders, Baparies and Snail heap traders. In addition, this interview surveys were performed to assess the landing of snails for four times fortnightly during the harvesting season at Shasidal Railway station annex market.

3.3 Result

Utilization of snails: In course of the study it was found that snails are being utilized in the North-eastern region of Bangladesh as human food, Pungas and Catfish food, poultry food, prawn food, medicine for human being, households utensils, playing tools, trade materials, fish bait and pest controlling agent.

As human food: Utilization of fresh water edible snails as food by the people of Bangladesh varied from tribe to tribes. In the studied area tribal people like Garo, Hagonj Khasia, Kharia Manipuri, Munda, Murong, Marak, Orang, Sangma, Saontal, Tripura, and Telegu live in Habiganj, Sylhet, Maulovibazar and Sunamganj districts. They consume *P. globosa*, *B. bengalensis*, *B. dissimilis*, *Brotia costula* and *Paludomus conica*.

The tripura take *P. globosa* (Local name Sikamuk), *B. bengalensis*, *B. costula* and *P. conica*. They boil above species and add to pepper, coriander, turmeric and salt. Later it is fried. The Orang takes only *P. globosa*, *B. costula* and *P. conica*. On the contrary, the munda take only *P. globosa* and *B. costula*. The Monipuri and the Garo take *P. globosa*, *B. bengalensis* and *B. costula* only. The monipuri community used to cut *B. costula* from upper side and then they boil it and take the fleshy part out of the body to mix with green pepper for delicious food. They are also used to boil *B. costula* then fry with pepper, coriander, turmeric and salt. The flesh of each species is used separately for Jhol preparation. Different kinds of vegetables are necessary for the preparation of this type of curry. In addition to salt, mustard oil and other spices are also used for preparation of this curry.

As Pungas and catfish feed: In Brahmanbaria and Comilla district there are several fish farms. The farmer cultivated only pungas fish (*Pangasias pangasias*). They used *P. globosa*, *B. bengalensis*, *L. marginalis*, *L. corrianus*, *P. favidens* and *P. corrugata* as feed for pungas and catfish.

The African magur, (*Clarias gariepinus*) take *B. bengalensis*, *P. globosa* and *L. marginalis*. The farmer of this fish farm use *P. globosa*, *B. bengalensis*, *B. costula*, *L.*

marginalis, *L. corrianus*, *P. favidens* and *P. corrugata* as food of the above species on the basis of availability.

As poultry foods: The domestic ducks and duckling are fed with *P. globosa*, *B. bengalensis*, *B. costula*, *L. marginalis*, *L. corrianus*, *P. favidens* and *P. corrugata* almost throughout the year. Shell powder is being used as the ingredient of poultry food. There is a crushing factory situated at Chandina upazilla, Comilla. The factory authority purchase the mollusc shell from the snail collector from the hinter land of Kasba, (Brahmanbaria district), Nagais beel, Brahmonpara, Muradnagar, Homna, Daudkandi, Laksam and Chaudagram Upazillas of Comilla District. More over, empty shell is sold to the shell-crushing factory. The crushing factory owners purchase the empty shell at the rate of Tk. 4.5-5.5/kg and sells to the poultry food factories at the rate of Tk.6.5-7.5. On an average the crushing mill owners earn Tk.140, 000 per month. Sometimes they give money to shell collectors in advance.



Figure 239: Empty shell heap



Figure 240: shell powder



Figure 241: containg shell powder.



Figure 242: Empty shell heap

As prawn food: *P. globosa* and *B. bengalensis* are used as supplementary feed in the prawn farm, *P. monodon* and *M. rosenbergii* farm. Accordingly, marketing system of snail has been developed throughout the snails growing and prawn farming areas of the country. But there is no big snails market in the studied areas.

There is a small snail market situated in the Shashidal Railway station annex under Brahman para upazilla, Comilla. This is a temporary market. Its duration is of two months during November and December. Not only freshwater snail but also empty shell is sold in the market. There is no prawn farm in the studied area but the Aratder purchase *P. globosa*, *B. bengalensis* from the Snailer and sells to Gher farmer in the prawn growing area.

Used as medicine for human being: The snails, *B. bengalensis* and *P. globosa* are used for the remedy of conjunctivitis. Washing eye with clear body fluid of snails used in conjunctivitis. (Chattopadya 1992, Khan *et al.*, 2005)

A good number of cattle diseases are being recovered and controlled by using different fresh water mollusc species. *Pila globosa* is used in recovering from shamuk pacha disease of cattle. The tea garden labours (sonaton cast) use *P. globosa* for the recovery of the patient from dysentery.

As house hold utensils: The shells of certain species of fresh water mollusc are used as house holds utensils mostly by the village people. The shell of *L. marginalis*, *L. corrianus*, *L. jenkinsianus* and *L. phenchooganjensis*, are used as spoon and scrapper by village women.

The Poddar (Gold smith) uses the shell of *L. marginalis* as pot for keeping the mixture of borax ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) and ammonium chloride (NH_4Cl). In this pot mixture remains unchanged for long time.

As playing tools: The children in village play with the shells of mollusc. In cooking they use the shell of *L. marginalis*, *L. corrianus*, *L. jenkinsianus* and *L. phenchooganjensis*, as spoon, the shell of *P. globosa* as pot and the shells of *B. bengalensis* and *B. costula* as small containers.

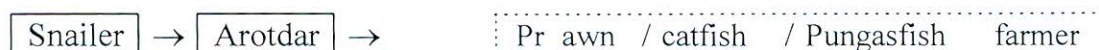
As trade materials : The molluscs are sold in the market as source of food. The shells of mollusc are burnt and converted into lime for chewing betel and nut. The washing of the houses are also performed with the help of this lime. It is also applied in the soil in some areas to neutralize the acidic soil. The prawn gher owner as well as Pond farmers uses this lime in the ‘Gher’ and Pond to neutralize the acidic soil.

Other uses of freshwater mollusc as fish bait.: The flesh of *P. globosa* and *Lamellidens* sp. is used as bait for catching various fishes like *Anabas testudineus*, *Puntius puntius*, *Channa punctatus*, *C. maurilus* etc.

As pest controlling agent: The meat of *P. globsa* and *L. marginalis* are left for the period of 4.8 hours into poisonous fluid and then the same is cut into small pieces. These pieces are offered to the rats at the different spots within their foraging area. Such kind of poisoned meat piece is also considered as bait for catching rats by using cage and keeping them at the rat’s hole in the crop field to control rats.

Marketing system: A marketing system has been developed throughout the snail growing and prawn farming areas of the country. But there is no big market in the study area. There is a small snail market situated in Shashidal Railway Station annex Market, under Brahmonpara upazilla, Comilla. This is a temporary market. Its duration is one or two month only in the late autumn season.

Marketing channel of snails



Snailers are mostly children and women. They catch *P. globosa*, *B. bengalensis*, *B. dissimilis*, *L. marginlis*, *L. corrianus* from hinter land of Kasba, (Brahmanbaria district), Nagais beel, Brahmonpara, Muradnagar, Homna, Daudkandi, Laksam and Chaudagram Upazillas of Comilla District. The snailers sell directly to the Aratder at the rate of Tk. 3.00-4.00 per Kg. The Aratder then sell them to the prawn/cat fish/Pungus fish farmer at the rate of Tk. 7-8 per kg.

Approximately daily Tk. 1500 to 2000 is usually transacted from November to December. Approximately Tk. 2, 64,000 is usually transacted in one season (2 months) (Table 15).

Table 3.1
In one season trading of mollusc species and transaction of Taka (approx)

Dealers	Snail trading period (day)	Purchase rate Tk./kg	Selling rate Tk./kg.	Amount	Approximate Tk. transaction/season	Profit
Snailers	60		3.00 $\xrightarrow{3.50}$ 4.00	24 metric ton	84,000	-
Aratder		3.00 $\xrightarrow{3.50}$ 4.00	7.00 $\xrightarrow{7.50}$ 8.00	24 metric ton	180,000	96,000.00
Total transaction					264,000.00	

Interview with members of different tribal casts of the North-eastern Region



Figure 243: Interview with members of Tripura tribe at Rema-Kalenga sanctuary, Habiganj



Figure 244: Interview with members of Orang tribe at Rema-Kalenga sanctuary, Habiganj



Figure 245: Interview with members of Munda tribe at Rema-Kalenga sanctuary, Habiganj



Figure 246: Interview with members of Munipori cast at Nipobon para, Kadimnagar, Sylhet



Figure 247: Interview with members of Garo at Kallagram village, Kadimnagar, Sylhet



Figure 248: Members of tripura tribe, Sonbari village at Rema-Kalenga sanctuary, Habiganj

Snails catching and processing



Figure 249: Boys are catching snails



Figure 250: Snail catching for duck farm

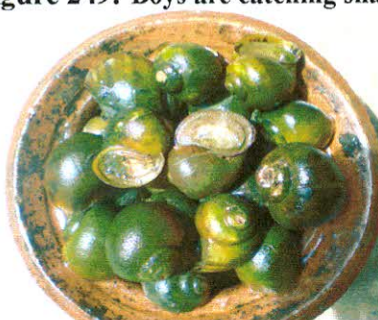


Figure 251: *P. globosa* in earthen pot



Figure 252: *B. costula* in earthen pot

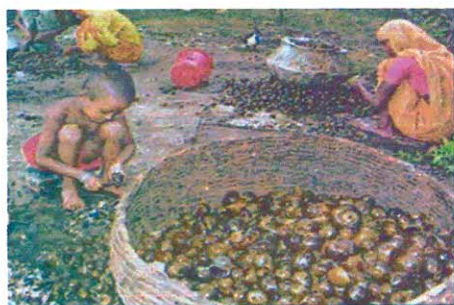


Figure 253: Snail processing



Figure 254: Snail processing

3.4 Discussion

The results of the present studies bring to a focus that the fresh water molluscs *Bellamya bengalensis*, *Pila globosa*, *Brotia costula*, *Indoplanorbis exustus*, *Lamellidens marginalis* and *L. corrianus* are very much involved in economy of Bangladesh. The use of this mollusc as food, medicine, house hold utensils, ornament, playing tools and trade materials are very much practised by the people belonging to different families irrespective of caste and creed in the above mentioned area.

The use of *B. bengalensis*, *Pila globosa*, *B. costula* and *P. conica* as food for tribal peoples, which is 1.08% of the total population (Statistical pocket book, 2000). During the present study period through out North-eastern Region it has been found that Khasia, Monipuri, Morang, Sanma, Marak (Sub tribe of Garo), Hajong, Tripura, Orang, Munda, Saontal, and Kharia tribes consumer mollusc flesh. Saha (1998) showed Banshi, Bawn, Bunn, Chak, Chakma, Coach, Garo, Hajong, Harijon, Khasia, Khyang, Khomi, Lushia, Mahatoo, Marma, Manipuri, Munda, Murans, Mugo, Pahari, Pankoo, Rajbanshi, Rakhain, Saontal, Tanchanghya, Tipra, Tripura, Urang, Uria in Bangladesh are habituated to consume the molluscan flesh. Islam (2006) showed 37 tribes in Bangladesh are habituated to take the molluscan flesh as food.

Very recently, mollusc species have been found to be harvested for food in shrimp farms in the Southern region of Bangladesh. It is also used as food for cat fish (IUCN, 2005). Mollusc species are used as food for Pangus fish (*Pangasius pangasius*). Jahan and Zaman (1996) experimentally found that *P. globosa*, *B. bengalensis* and *Lamellidens marginalis* play vital role as supplementary food to enhance the production rate of *Penaeus monodon*. *Pila globosa* is suitable protein rich food item for prawn culture, because snails contain about 4.745 to 5.594 k. cal. /g energy in dry weight basis. There fore, the use of snail meat is wide spread in Bangladesh. A prawn farmer uses 24 to 30 kg snail meat daily in an acre of shrimp culture area (Ahmed 1998). *P. globosa* has already been accepted as one of the effective supplementary

foods for prawn in the district of Chittagong, Cox's bazar, Jessore, Satkira, Khulna and Bagerhat, where *P. mondon*, *M. rosenbergii* are extensively cultivated.

Saha (1998) investigated for snail trading in Gala market, Godaraghat of Fakirhat Thana in the district of Bagerhat and found that in one season approximately Tk. 3, 53, 00000 was transacted. Islam (2006) estimated that annually a total of 28,686,68 ton snails are being harvested from the hinterland areas (Rajshahi, Noagaon, Natore, Pabna, Sirajgonj, Meherpur, Kustia, Chuadanga, Alamdanga, Magura, Rajbari, Faridpur, Madaripur, Shariatpur, Gopalganj, Manikgonj, Jessore, Narail and Barisal). The araders of Aranghata, Daulatpur and Khulna earned tk. 5,07,48,616.94 in the year 2005 in snail (*P. globosa*) trading (Jahan *et al.*, 2008).

Islam (2009) found that in Arongghata snail market in Khulna district approximately Tk 20, 73, 61737.90 was transacted in one year. The present study revealed that during the month of November and December almost 24 tons of snails are collected and sold in Shasidal Railway Station annex market under Brahmonpara upazilla, Comilla and about taka 2,64,000.00 is being transacted seasonally. The aratders of Arangghata, Daulatpur, Khulna earned tk. 5,07,48,616.74 in the year 2005 in snail (*P. globosa*) trading (Jahan *et al.*, 2008).

Saha (1998) pointed out that marketing channel of *P. globosa* in prawn farmer consists of four steps snail collector → Beparies → Aratder → Prawn farmer/Catfish/Pangus fish farmer. Whereas, Islam (2006) found that marketing channel of *P. globosa* consists of four series: (i) Snailer → consumer (Prawn farmers); (ii) Snailer → Aratder → Consumer; (iii) Snailers → middlemen → Aratder → Consumer; and iv) Snailers → First middleman → Second middleman → Aratder → consumer. But in course of present study it was revealed that marketing channels was of three steps: Snailers → Aratder → Consumers (Prawn, Catfish and Pangus fish farmers).

Gher farmers have traditionally used the meat from the fresh water apple snail (*P. globosa*) as a food for the prawn. A gher farming was in great demand for snail meat and the growing and the harvesting of snails intensified so much so that they disappeared from many local wetlands.

The estimated annual harvest of *P. globosa* from various beel, canals and rice field in Bangladesh in 1999 was 365, 849 tons (CARE 2004). Kabir *et al.*, 2005 opined that the mean harvesting rates of snail in Chanda Beel (Gopalganj District) were 0.56 to 0.76 ton/ hector/ annum.

The above discussion accounts for that fresh water mollusc have been playing a significant role in the national economy of Bangladesh. The natural snail populations in the wetlands of the country are exclusive source to meet up such high demands. If such over exploitation of the snail population continues certainly the species populations will go under threat. Which claims for commercial culture and scientific management to ensure the sustainable biodiversity of these economically and ecologically important biological resources?

CHAPTER 4

GENERAL DISCUSSION

Chapter 4

General Discussion

Molluscs are soft bodied, bilaterally symmetrical, coelomate metazoans, often secondarily altered to a symmetrical condition without evidence of metamerism. In majority of cases the animals are protected by a calcareous shell, which may either be a single piece, or of more than one piece secreted by the mantle, the fold of body wall. The features of the Phylum are the ventral body wall modified into a muscular organ for locomotion, the foot, pharynx commonly with a radula and gills; heart with an open circulatory systems and the organ metanephridia. It is a collective name for familiar animals such as chitons, tusk shells, conch shells, slugs, mussels, clams, squid and octopus. It is a highly diversified group of animals differing in size, as well as habit and habitat. Originating in the sea it spread to freshwater and on to land. In India, mollusc are recorded from diverse habitat, from deep sea (3000m) of Andaman and Nicobar Islands to high elevation (5000m) of the Himalayas. Our neighboring country India has extensive works on faunistic survey of mollusc but such works are scanty in Bangladesh. The numbers of Indian land mollusc are about 1500 species under 140 genera and 34 families. On the contrary, there are 285 aquatic mollusc species under 57 genera and 21 families were reported in India (Dey, 2006).

In comparison to the extend of works carried out in India Bangladesh is far behind in studying the distribution, abundance and bioeconomics of mollusc, the important biological resources. So far Ahmed (1990) recorded 301 Mollusc species under 151 genera and 79 families of 16 orders from the Coastal belt of Bangladesh. Jahan *et al.*, (1990, 1998) recorded 42 molluscs' species from the Intertidal zones of Sundarbans. Later 20 lands, 22 freshwater and 437 brackish and marine mollusc species belonging to 210 genera, 105 families, 23 orders under 4 classes have been recorded from Bangladesh (Siddiqui *et al.*, 2007). Faunistic survey of mollusc in the North-eastern region of Bangladesh has been evaluated particularly in Brahmanbaria, Comilla,

Habiganj, Maulvibazar, Sylhet and Sunamganj districts. The survey gave birth to a comprehensive list of 72 mollusc species belonging to 41 genera, 25 families under 4 orders were collected from the study area. Of the total 72 species 46, 44, 42, 33, 24, and 20 species were recorded from Sylhet, Comilla, Maulvibazar, Habiganj, Brahmanbaria and Sunamganj districts respectively.

In context of terrestrial habitat, maximum 21 in Maulvibazar and minimum 3 species were recorded from each of Brahmanbaria and Sunamganj district. Whereas, in aquatic habitats maximum 37 and minimum 17 numbers of species were recorded from Comilla and Sylhet districts respectively (Table 1 C). Out of these 72 land and fresh water mollusc species, 37 species (*R. bengalensis*, *M. indica*, *G. crocea*, *G. gemma*, *Seasara diplodon*, *Sivella castra*, *Chloritis delibrata*, *Plectopylis* (E.) *plectostoma*, *C. pearsoni*, *B. bengalensis*, *B. Crassa*, *B. dissimilis*, *P. globosa*, *B. (Diagonostoma) cerameopoma*, *B. (D.) pulchella*, *T. scabra*, *T. lineata*, *P. conica*, *L. acuminata f. typica*, *L. acuminata f. gracilior*, *L. luteola f. typica*, *L. luteola f. ovalis*, *I. exustus*, *G. convexiusculus*, *L. marginalis*, *L. corrianus*, *L. jenkinsianus*, *L. phancooganjensis*, *P. (P.) favidens*, *P. (P.) favidens var. assamensis*, *P. (P.) corrugata*, *P. (Radiatula) caerulea*, *P. (R.z) bonneaudi*, *C. sylhetica* and *N. gangetica*) were reported previously from the same area (Blanford and Godwin-Austen 1908, Gude 1914, 1921 Preston 1915, Subba Rao 1989, Jahan 1993 and Siddiqui *et al.*, 2007).

The mollusc *M. lubrica*, *G. hookeri*, *E. cassida*, *S.* (Ariophandae); *G. notigena* (Subulinidae), *S. diplodon*, *S. castra* (Helicarionidae); *C. delibrata* (Camaenidae), *I. plicata*, *S. daucina* (Succinidae); *P. (E.) plectosoma* (Plectopilidae); *S. pfeifferi* (Streptaxidae); *Meghimatium* sp. (Philomycidae); *F. alte* (Veronicellidae); *C. theobaldinus*, *C. (D.) crenatus*, (Cyclophoridae); *B. bengalensis* race *doliaris* (Viviparidae); *P. acuta* (Physidae); *Lymnaea* (P.) *luteola f. ovalis*, *L. (P.) luteola f. gracilior*, *R. persica* (Lymnaeidae); *S. deltae* (Stenothyridae); *Scapula deltae* (Arcidae); *L. phancooganjensis*, *L. indawgyiensis*, *L. generosus*, *P. (P.) favidens var. assamensis*, *P. (P.) favidens var. marcens*, *P. (P.) favidens var. viridula*, *P. (P.) favidens*

var. *gowhattensis*, *P. (Radiatula) andersoniana*, *P. (R.) lima*, *P. (R.) bonneaudi* and *P. (R.) shurtleffiana* (Unionidae) were recorded during the present study for the first time from Bangladesh. All the 72 species recorded during the present study belonged to 25 families of which 11 (eleven) families viz. Achatinidae, Cerastuidae, Camaenidae, Plectopylididae, Streptaxidae, Philomycidae, Veronicellidae, Stenothyridae, Physidae, Arcidae, and Psammobidae were represented by single species.

In terrestrial habitat, *A. fulica*, *M. indica* and *L. (A.) gracile* were ubiquitous species. The slug, *Meghimatium* sp., was not reported in Fauna of British India and even not in any other work from the Bangladesh territory. *Meghimatium* sp. is belonging to Family Philomycidae under the order Pulmonata, class Gastropoda and is an agro-horticulture pest. It feeds on bark of trees (*Dalbergia sisso*, Bottle brush tree) and tender leaves of wild trees.

Mollusc faunal study with their occurrence, distribution and abundance highlights on diversity. The estimation of biodiversity is perhaps the great challenge for it would require millions of man days painstaking work by highly trained biologists (Agarwall, 1996). A number of methods such as: Shannon-Wiener diversity index (H'), Pielou's evenness index (e), Mergalef's species richness index (d) and Simpson index of dominance (c) have been adopted to determine the mollusc diversity in the studied North-eastern region of Bangladesh. Population densities are the key parameters in determining the diversity indices. However, population densities of mollusc species was found vary different. In the river habitat, the highest population density ($8.56/m^2$) of mollusc species was found in Gomti river, Comilla and lowest ($3.26/m^2$) in Titas river, B .Baria district (table-2). On the contrary, in the pond habitat maximum population density ($11.93/m^2$) of mollusc species was recorded in the pond of Sylhet district and minimum ($1.37/m^2$) in the pond of Maulvibazar district (table-2). On the other hand, in the terrestrial habitat, maximum population density ($3.36/10m^2$) of mollusc species was recorded in the Lawachara national park forest, Maulvibazar and

minimum (2.70/10m²) in BARD annex forest in the Comilla district (table-2). Moreover, the maximum number of species (16) was found in Khushyara River (Appendix table-E. 8) and minimum (3) was found in pond of Maulvibazar, district (Appendix table-G. 8).

The estimation of diversity indices of mollusc have some drawn back as:

The aquatic habitats of mollusc cannot be explored properly due to water depth distribution.

Identification of mollusc species was difficult during the collection due to lack of proper taxonomic knowledge.

However, Different diversity indices of mollusc in respect of habitats are presented in the table 3 (Appendix table A. (v), C (v) and D. (vii), M. (viii). The highest Shannon-Weiner diversity index ($H' = 2.30$) was found in the river Khushyara, Sylhet district and lowest ($H' = 1.62$) in the river Titas, Brahmanbaria district; highest index of dominance ($c = 0.23$) in Titas river, Brahmanbaria and lowest in ($c = 0.14$) Ratna river, Habiganj district; the highest species richness ($d = 3.49$) in Khushyara river, Sylhet district and lowest ($d = 2.14$) in Titas river, Brahmonbaria district; the highest evenness ($e = 0.88$) in Ratna river, Habiganj and lowest in ($e = 0.77$) Titas river, Brahmanbaria district.

On the other hand, in pond, the highest Shannon-Weiner diversity index ($H' = 1.84$) was found in Habiganj district and lowest $H' = 0.67$ in Sylhet district; highest index of dominance ($c = 0.60$) in Sylhet district and lowest ($c = 0.18$) in pond of Habiganj district; the highest evenness ($e = 0.88$) in Habiganj district and lowest ($e = 0.41$) in Sylhet district, but the highest richness ' $d = 2.63$ ' value was found in the pond, Habiganj district and lowest ($d = 0.97$ in pond of Sylhet district). Where as, In terrestrial habitat the highest Shannon- Wiener diversity index ($H' = 2.20$) was found in Malnichara tea garden annex Forest, Sylhet district and lowest ($H' = 1.90$) in Lawachara national park forest,

Maulvibazar district; the highest ($c = 0.16$) value was found in Lawachara national park forest, Sylhet district and lowest ($c = 0.12$) in Malnichara tea garden annex forest, Sylhet district; the highest ($d = 3.01$) value was found in BARD annex forest, Comilla district) and lowest ($d = 2.12$) value in Lawachara national park forest, Maulvibazar district; the highest evenness ($e = 0.91$) in Malnichara tea garden annex Forest in Sylhet and lowest (0.87) in BARD annex forest in Comilla district.

Pearson's correlation among land mollusc population density and soil parameter are presented in the table 2.3. P^H , Organic matter (OM), Calcium (Ca), Magnesium (Mg), Nitrogen (N), Ferrous (Fe), Manganese (Mn) and Zinc (Zn) revealed that population density was positively correlated with soil p^H , OM, K, Ca, Mg, N, S, Fe, Mn, but negatively correlated with P and Zn.

On the contrary, freshwater mollusc population density was correlated with Physico chemical parameter of river water viz. temperature, transparency, P^H , Do, and total hardness (Table 2.4). Pearson correlation with physicochemical parameter of pond water and population density revealed that population density was positively correlation with water temperature, transparency, P^H , Do, and total hardness. P^H has significant correlation with total hardness ($P < 0.01$) (Table 2.7).

Pearson correlation of Temperature, Humidity and Moisture of different seasons with the Mollusc species population densities of Malnichhara Forest (Table 2.8 and Appendix table 16.ii) revealed that *A. fulica*, *G. crocea*, *M. indica*, *E. cassida*, *C. theobaldinus*, *C. pearsoni*, *N. notigena*, *G. gracile*, *P. parvus*, *I. plicata* and *F. alte* were positively correlated with summer and Monsoon but negatively correlated with winter. Pearson's correlation of temperature, Rainfall and Humidity of different seasons with Mollusc population density of BARD annex forest, Comilla revealed that *R. bengalensis*, *G. crocea*, *S. attegia*, *C. delibrata*, *G. gemma*, *G. notigena*, *P. parvus*, *M. indica* and *F. alte* were positively correlated with Summer and Monsoon but negatively correlated with winter season (Table 2.8 and Appendix table 16.4). Pearson correlation of Temperature,

Humidity and Moisture of different seasons with the Mollusc species population densities of Lawachara Forest showed in the (Table 2.8 and Appendix table 4.1) revealed that *C. delibrata*, *G. crocea*, *M. indica*, *P. plectopylis*, *P. parvus*, *S. diplodon* and *S. castra* were positively correlated with summer and Monsoon but negatively correlated with winter. On the contrary *A. gigas* was positively correlated with summer only.

Pearson correlation shows the direct relationship among mollusc population density and climatic factors of seasons (Table 2.9) in the study area. During the observation of two consecutive years it was found that in Monsoon rainfalls was very high in the Northeastern region and mollusc species were found abundantly in these districts. In summer rainfall occurred sporadically, mollusc species were also found occasionally. In winter rainfall was very scanty or nil and temperature was low. In case of terrestrial habitat, vegetation influences the abundance of mollusc species. Among the three forests considered Lawachara National Park reserved forest was densely vegetated and harbours very rich ($3.36/10\text{m}^2$) of mollusc species densities. On the contrary Malnichara Tea garden annex Forest vegetation was medium and herein mollusc densities were considerably low ($2.70/10\text{m}^2$). More over, BARD annexes forest, Comilla district vegetation was less than other two forests having minimum densities of mollusc species ($1.99/10\text{m}^2$).

Snail is keystone species of aquatic habitat. By losing snail, the aquatic ecosystem is damaging in a rapid scale. Snail's keeps water fresh. Snails increase the productivity of water body. Several species of animals use them as their food. As snail population is declining the number of winter visitor likes, Asian open bill (*Anastomus oscitans*) is decreasing. Though there is many other causes responsible for it, losing a keystone species affect the whole ecosystem in a massive scale (Khan *et al.*, 2005). The fresh water molluscs play a vital role in fresh water environment. They need to be considered as a part of whole fresh water community, particularly in its role in food chain linking up to edible fish which are such an important resource of protein for human population. The present survey revealed that the flesh of *P. globosa* was utilized extensively in the culture

of freshwater prawn *Macrobrachium rosenbergii* and *Penaeus monodon*. On the other hand, locally *P.globosa* used to duck food. In addition to mollusc species viz *P.globosa*, *B.bengalensis* and *L. marginalis* were also used as food of cat and Pangus fishes. *I. exustus* is also used as food for duck and duckling. The present surveys reveal that a total of 24 tons snails are being harvested and landed at the Shasidal Railway station market from the hinterland of Kasba, (Brahmanbaria district), Nagais beel, Brahmonpara, Muradnagar, Homna, Daudkandi, Laksam and Chaudagram Upazillas of Comilla District where in one season approximately Taka 2,64,000 were transacted. Such extensive use of Aquatic mollusc depending on the natural population in North-eastern Region of Bangladesh will not serve the purpose in near future. Populations of various beneficial species have already been threatened which deserves the innovation of aquatic mollusc farming. The above discussion accounts that freshwater snails have been playing a significant role in the national economy of Bangladesh.

Over exploitation without any scientific management of the snail population is causing the biodiversity depletion. So the preservation and proper maintenance of the various animal resources for the protection of ecologically balanced environment and harmonious upliftment of the national economy are necessary. Firstly, it is an urgent need to develop intensive snail culture farms so that a constant supply for the prawn, catfish and African magur farms could be assured as well as the natural population of these beneficial animals could exist. Secondly, as gastropods undergoes aestivation during the dry season there should be developed certain technique to preserve the snail products for the constant supply of animal protein to the low earning people.

CHAPTER 5

SUMMARY

Chapter 5

Summary

1. In course of two consecutive years (2005-2007) 21 sampling spots covering the whole area of Brahmonbaria, Comilla, Habigong, Maulvibazar, Sylhet and Sunamganj districts of North-eastern region of Bangladesh were selected for extensive mollusc faunal survey.
2. In course of surveys a comprehensive list of 72 species belonging to 41, genera, 25 families under 4 orders of the two classes Gastropod and Bivalvia of Phylum Mollusca was prepared.
3. A total of 192 terrestrial 76 aquatic plant species were recorded from different habitats of the North-eastern region of Bangladesh.
4. Explored members were identified family *B. bengalensis* f. *typica*, *B. ellamya bengalensis* f. *doliaris*, *B. crassa*, *B. dissimilis* (Viviparidae); *Pila globosa*, *Pila virens* (Ampullaridae); *B. (Diagonistoma) cerameopoma*, *B. (Diagonistoma) pulchella*, *G. orcula* var. *producta* (Bithynidae); *T. scabra*, *M. tuberculata*, *T. granifera*, *T. lineata* (Thiaridae); *B. costula*, *P. conica* (Pleuroceridae); *L. (Pseudosuccinea) acuminata* f. *typica*, *L. (Pseudosuccinea) acuminata* f. *gracilis*, *L. (Pseudosuccinea) leutola* f. *typica*, *L. (Pseudosuccinea) leutola* f. *ovalis* *R. persica* Lymnaeidae);, *I. exustus*, *G. convexiusculus*; *S. deltae* (Stenothyridae); Family Physidae, *P. acuta*, , *Scapula. deltae* (Arcidae); *L. marginalis*, *L. jenkinsianus*, *L. jenkinsianus* sub *sp. daccaensis*, *L. phanchooganjensis*, *L. indawgyiensis*, *L. corrianus*, *L. generosus* (Unionidae); *P. (Radiatula) andersoniana*, *P. (Radiatula) bonneadi*, *P. (Radiatula) lima*, *P. (Radiatula) shurtleffiana*, *P. (Radiatula) caerulea*, *P. (Parreysia) favidens*, *P. (Parreysia) favidens* var. *marcens*, *P. (Parreysia) var. marcens*, *P. (Parreysia) favidens viridula*, *P. (Parreysia) corrugata*, *P. (P) gouhattensis* (Amblemidae); *N. gangetica* (Psammobidae); *C. striatella*, *C. sylhetica* (Corbiculidae); Family *C. theobaldinus*, *C. pearsoni*

(Cyclophoridae); *F. alte* (Veronicellidae); *G. crocea*, *G. hookeri*, *A. gigas*, *M. indica*, *M. opoparus*, *M. lubrica*, *S. attegaia*, *E. cassida* (Ariophantidae); *R. bengalensis* (Cerastuidae); *G.l gemma*, *G. notigena* and *L. (A.) gracile* (Subulimide); *A. (L.) fulica fulica* (Achatinidae); *S. pfeiffere* (Streptaxidae); *P. (Endothyra) plectostoma* (Plectopliidae); *I. plicata* and *S. daucina* (Succinidae); *S. diplodon*, *S. castra* (Helicarionidae) *C. delibrata* (Camaenidae); and *Meghimatium* sp. (Phylomicidae);

5. Among the explored species the following are being reported for the first time from the country: *B. bengalensis* f. *doliaris*, *B. (D.) cerameopoma*, *C. theobaldinus*, *C. (Dicharax) crenatus*, *C. delibrata*, *E. cassida*, *G. orcula* var. *producta*, *G. hookeri*, *G. notigena*, *I. plicata*, *L. (P.) luteola* f. *ovalis*, *L. (P.) luteola* f. *gracilior*, *R. persica* (Lymnaeidae), *L. indawgyiensis*, *L. generosus*, *Meghimatium* sp, *M. lubrica*, *P. (Endothyra) plectostoma*, *P. acuta*, *P. (Radiatula) andersoniana*, *P. (R) boneaudi*, *P. (R) shurtleffiana*, *P. (Parreysia) favidens* var. *assamensis*, *P. (P). var. marcens*, *P. (P). viridula*, *P. (P) gowhattensis*, *Scapula deltae*, *Stenothyra deltae*, , *S. attegaia*, *S. pfeiffere*, *S. daucina*, *S. diplodon*, *S. castra*, and *C. delibrata*.
6. In aquatic habitat *B. bengalensis* f. *typica* and *Corbicula striatella* are the ubiquitous species in the study area. Among the ubiquitous species, *B. bengalensis* f. *typica*, *B. costula* and *L. marginalis* were found almost every aquatic habitat. Explored *S. deltae* was found in Gomti River, Comilla district; *P. acuta* was found in drainage effluent in Srimangal, Maulvibazar district; *R. persica* was found in paddy field at Companganj upazilla Sylhet district, *B. (D.) cerameopoma*, *B. (D.) puchella* and *N. gangatica* were found in sandy bed of Gomoti River Comilla district. *P. (P.) viridula* and *P. (P) gowhattensis* was found in Khushyara and Surma river respectively in Sylhet district. *Scapula deltae*, *L. jenkinsianus* sub sp. *daccaensis* was found in Ratna and Gomti River, Habiganj and Sylhet district. *L. jenkinsianus* sub sp. *daccaensis* too found in pond of Habiganj. *C. sylhetica* only found in Gomti and Khushyara River, Comilla and Sylhet district respectively.

7. Among land mollusc *S. ategia* and *S. daucina* was found only in BARD Anex forest, Comilla. *A. gigas*, *M. opiparus*, *M. lubrica*, *C. (Dicharax) crenatus*, *S. diplodon*, *S. castra*, *P. (Endothyra) plectostoma*. *S. pfeiffere* and *Meghimatium* sp. were found only in Lawachara reserved forest, Srimongle, Maulvibazar district.
8. Among land mollusc *A. fulica fulica*, *Macrochlammys indica* and *L. (A.) gracile* were ubiquitous species found in all district of the study area; *G. hookeri* and *C. delibrata* were found in terrestrial habitat Comilla and Sylhet district.
9. A comprehensive systematic account of 72 mollusc species with their distributions and habitats has been accomplished by this effort which also provide a key for identification of the mollusc species available in Bangladesh.
10. Five ponds from each of the five districts (Pond in Brahmanbaria, Comilla, Habiganj, Maulvibazar, and Sylhet Districts), five rivers (Titas, Gomti, Ratna, Surma and Khushyara) and three terrestrial habitats (BARD annex forest, Lawachra National forest and Malnicharat garden annex forest) were selected for estimation of population densities and biodiversity indices of mollusc species inhabiting the habitats concerned.
11. In River habitat, Maximum population density ($8.56/m^2$) was estimated in Gomoti River, Comilla and minimum population density ($3.26/m^2$) in Titas River, B. baria. In pond habitat maximum population, density ($11.93/m^2$) was recorded in the pond of Sylhet district and minimum population density ($1.78/m^2$) in the Habiganj district.
12. In terrestrial habitat maximum population, density ($3.36/10m^2$) was estimated in Lawachara reserve forest, Maulvibazar district and minimum population density ($1.99/10m^2$) BARD annex forest Comilla district.
13. In the river Khushyara the highest Shannon- wiener diversity index (H') (2.30) was found in Sylhet district and lowest (1.62) in Titas River in Brahmonbaria

district and highest Margalef's species richness (d) (3.49) where the number of species was almost highest. In the pond habitat the highest Shannon -Weiner diversity index (H') (1.84) was found in the pond of Habiganj district and lowest in Sylhet district (0.97) and highest Margalef's species richness (d) (2.63) was found in pond of Habiganj and lowest species richness d (0.97) in pond of Sylhet district.

14. Among terrestrial habitat the highest Shannon -Wiener index (H) (2.20) was found in Malnichara tea garden annex forest in Sylhet district and lowest (1.90) in Lawachara national Reserved forest Maulvibazar district. Maximum Margalef's species richness (d) (2.95) was found in BARD annex forest Comilla and minimum species richness (d) (2.12) was found in Lawachara national reserved forest, Maulvibazar district.
15. Pearson correlation among population density aquatic mollusc species (Rivers) and soil parameters showed that population density is positively correlated with soil P^H , OM, Ca, and Mg, but negatively correlated with Fe, P, Cu, Mn and Zn.
16. Pearson correlation among population density aquatic mollusc species (Pond) and soil parameters showed that population density is positively correlated with soil P^H , OM, Ca, N, Fe and Zn but negatively correlated with K, and Cu.
17. Pearson correlation among population density and physico-chemical parameters of River water (Table) viz. temperature, p^H , DO and Total hardness showed population density was positively correlated with temperature, p^H , DO and Total hardness. However, negatively correlated with transparency.
18. Pearson correlation among population density and physico-chemical parameters of pond water (Table 2.7) viz. temperature, transparency, p^H , DO and Total hardness showed population density was positively correlated with temperature, transparency, p^H , DO and Total hardness. Population density possessed significant correlation ($P < 0.05$ with water temperature (table 2.7),

19. Two years mean values of air temperature ($^{\circ}\text{C}$), ^{highest}rainfall (mm) and humidity (%) was 30.75 ± 0.23 , 3909 ± 572 and 80.58 ± 0.08 of district respectively in Comilla district (Appendix table 20).
20. The mollusc species are consumed as protein –rich food by 13 groups of tribal people (Garo, Hagonj Khasia, Kharia Manipuri, Munda, Murong, Marak, Orang, Sangma, Saontal, Tripura, and Telegu) of the study area.
21. The flesh of *P.globosa* was utilized extensively in the culture of freshwater prawn *M. rosenbergii* and brackish water prawn *P. monodon*. On the other hand, locally *P.globosa* are used as duck food. In addition to mollusc species viz *P.globosa*, *B. bengalensis* and *L. marginalis* were also used as food of cat and Pangas fishes. *I. exustus* is also used as food for duck and duckling.
22. Marketing channel of mollusc species consists of three steps: Snailers, Aratder and Prawn/catfish/Pangus fish farmer. Shasidal railway station annex market under Comilla district where in one seasons (two month) of 2007 approximately Tk.2,64,000 was transacted.

Finally, it might be concluded that the favourable weather, soil components and vegetation of terrestrial lotic and lenyic habitats of Bangladesh are comfortably harbouring suitable number of mollusc species. The mollusc species of Bangladesh deserve further careful and intensive studies for appropriate use for upliftment of economy of the country.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

Chapter 6

Conclusion and Recommendations

6.1 Conclusion

Nevertheless, diversified group of mollusc are very much successful in establishing their population in lentic, lotic, estuarine, marine and terrestrial habitats throughout the globe. Till then the mollusc are dependent on the fluctuation of the physical components (temperature, rainfall, humidity and soil etc.) of environment, the nature of vegetations etc. Though the present study disclosed the presence of seventy two (72) species of mollusc, a good considerable number from the North-eastern region of Bangladesh yet more extensive surveys to be made for recording exact status of the molluscan fauna in this region. It has also been observed that the population densities of the animals are demeaning in the habitat which are frequently intervened by the humans activities and deteriorated habitats or distorting condition of habitat due to changing pattern of land uses such as deforestation, urbanization, modern industrialization, modern agriculture practice, siltation, impoundment of ponds and rivers, and erosion are the main causes of depletion of the mollusc species from this region.

Mollusc have both economic and ecological importance. Its play a vital and pivotal role in ecosystem functioning in both aquatic and terrestrial systems. Mollusc are also significant agents in maintaining ecosystem balance by playing the role of nature's cleanser in the water kingdom and thereby maintaining water quality. This natural resources have been depleting quiet alarmingly in the most recent past, as there has been no regulation imposed with regard to harvesting of snail. The present study revealed that most of the mollusc are providing the economic subservience are under the extreme threat. Accordingly, the animal needs careful scientific management for their existence to serve the human beings.

6.2 Recommendations

At present there is no bar on snail and mussel harvesting. An individual always thinks of over harvesting and his idea about over harvesting is to catch more and thereby increase his income. So it is important that all of us should be interested to create awareness or consciousness among the people. In this regards, some important recommendations for the protection of the mollusc species may be given for special consideration. These are as follows –

- 1) Mass awareness campaign; mass media like radio, television, leaflets, miking etc. must be used in wider extent for awareness building among the common people about the consequence of lowland (hinterland), its impact area and over harvesting of the molluscs species.
- 2) Over harvesting must be stopped.
- 3) Scientific study should be made before formulating commercial harvesting rule.
- 4) Development of defined management prescription and harvesting rules.
- 5) Establishment of more conservation area to protect refuge habitat. At least some major wetlands should be marked as sanctuary for mollusc species under intensive supervision of government.
- 6) Adopting practice of heliciculture that is farming of snails. Breeding period should be restricted for snailing in different water bodies, such as ponds, tanks, beels, floodplain area, haor, baor and paddy field.
- 7) Natural habitat of mollusc species should be conserved as much as possible.
- 8) Motivation or training courses on appropriate technology for snail culture should be introduced.
- 9) Uses of insecticides and pesticide in the agricultural fields should be reduced and biological control of pest should be introduced.
- 10) Water pollution by any means should be minimized and existing rules and regulation on water pollution should be effectively enforced.
- 11) Certainly sustainable uses of the mollusc species can be achieved through commercial farming.
- 12) Creation of alternative livelihood options for snails' collector
- 13) To improve the socio-economic condition of the snailer, co-operative farms should be set up and organized properly.

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APPENDICES

Appendix 1 (i): Population density of Terrestrial Molluscs in BARD ,Comilla, in the Year,2006-2007

Molluscs species	Winter 2006						Winter 2007					
	site-1	Site-2	Site-3	T#	D/m2	M±SE	site-1	Site-2	Site-3	T#	D/m2	M±SE
<i>R.bengalensis</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>G.crocea</i>	0	0	0	0	0	0	1	0	0	1	1	1
<i>S.attegia</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>C.delibrata</i>	0	0	0	0	0	0						
<i>G.gemma</i>	0	2	1	3	1.00	1	1	0	0	0	0	0
<i>G.notigena</i>	0	0	0	0	0	0		0	0	0	0	0
<i>A.gracile</i>	2	1	0	3	1.00	1		1	0	0	0	0
<i>P.parvus</i>	0	0	0	0	0	0		0	0	0	0	0
<i>M.indica</i>	0	0	0	0	0	0		1	0	1	1.00	
<i>F.alte</i>	0	0	0	0	0	0		0	0	0	0	0
Total												

Appendix 1 (ii) Population density of Terrestrial Molluscs in BARD ,Comilla, in the Year,2006-2007

Molluscs species	Summer 2006						Summer 2007					
	site-1	Site-2	Site-3	T#	D/m2	M±SE	site-1	Site-2	Site-3	T#	D/m2	M±SE
<i>R.bengalensis</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>G.crocea</i>	0	2	0	2	2	2	1	0	0	1	1	1
<i>S.attegia</i>	1	0	0	1	1.00	1	2	0	0	2	0.66	0.66
<i>C.delibrata</i>		1	2	3	1.00	1	1	0	0	1	0.33	0.33
<i>G.gemma</i>	1	0	0	1	0.33	0.33	0	2	2	4	1.33	1.33
<i>G.notigena</i>	2	0	0	2	0.66	0.66	0	1	2	3	1	1
<i>A.gracile</i>	4	0	3	7	2.33	2.33	4	2	5	11	3.33	3.33
<i>P.parvus</i>	1	1	2	4	1.33	1.33	2	0	4	6	2.00	2
<i>M.indica</i>	1	2	3	6	2.00	2		2	5	7	2.66	2.66
<i>F.alte</i>	0	0	0	0	0	0	1	1	0	2	0.66	0.66
Total												

Appendix 1 (iii): Population density of Terrestrial Molluscs in BARD ,Comilla, in the Year,2006-2007

Molluscs species	Monsoon 2006						Monsoon2007					
	site-1	Site-2	Site-3	T#	D/m2	M±SE	site-1	Site-2	Site-3	T#	D/m2	M±SE
<i>R.bengalensis</i>	1	0	0	1	0.33	0.33	3	0	0	3	1.00	1.00
<i>G.crocea</i>	5	6	11	22	7.33	7.33	3	5	6	14	4.66	4.66
<i>S.attegia</i>	2	7	3	12	4.00	4.00	5	3	7	15	5.00	5
<i>C.delibrata</i>	4	6	5	15	5.00	5.00	7	2	8	18	6.00	6.00
<i>G.gemma</i>	6	4	3	13	4.33	4.33	2	8	5	15	5.00	5.00
<i>G.notigena</i>	3	1	0	4	1.33	1.33	2	4	1	7	2.33	2.33
<i>A.gracile</i>	10	2	0	12	4.00	4.33	8	6	7	21	7.00	7
<i>P.parvus</i>	1	3	6	10	3.33	3.33	7	2	3	13	4.33	4.33
<i>M.indica</i>	2	4	5	11	3.66	3.66	5	8	6	19	6.33	6.33
<i>F.alte</i>	2	1	0	3	1.00	1.00	3	2	5	10	3.33	3.33
Total												

Appendix 1 (iv): Avenge (M) Population density with standard error of Terrestrial Molluscs in BARD ,Comilla, in the Year,2005-2007

SL	Molluscs species	Summer 2005-2007	Monsoon 2005-2007	Winter 2005-2007	Over all Season mean
1	<i>R.bengalensis</i>	0	0.66	0	0.22
2	<i>G.crocea</i>	1.16	6.00	0.5	2.40
3	<i>S.attegia</i>	0.83	4.5	0	1.64
4	<i>C.delibrata</i>	1.66	5.5	0	2.23
5	<i>G.gemma</i>	1.16	4.66	0.66	2.16
6	<i>G.notigena</i>	1.5	1.83	0	1.44
7	<i>A.gracile</i>	5.16	7.5	0.66	4.29
8	<i>P.parvus</i>	1.66	3.83	0	1.83
9	<i>M.indica</i>	2.33	5	0.5	2.46
10	<i>F.alte</i>	0.22	2.16	0	1.19
	Total				19.86
	Mean				1.99± 0.33

Appendix 1 (v): Biodiversity indices of Terrestrial Molluscs in Comilla District during 2005-2007 (Data mean of 6 seasons)

Molluscs species	Av. number of species	n/N	(n/N)2	(n/N)log n/N	e	d
<i>R. bengalensis</i>	0.22	0.011077	0.000122	-0.049878		
<i>G. crocea</i>	2.40	0.120845	0.014603	-0.255375		
<i>S. ategia</i>	1.64	0.082578	0.006819	-0.205950		
<i>C. delibrata</i>	2.23	0.112286	0.012608	-0.245536		
<i>G. gemma</i>	2.16	0.108761	0.011829	-0.241297		
<i>G. notigena</i>	1.44	0.072507	0.005257	-0.190263		
<i>A. gracile</i>	4.29	0.216012	0.046661	-0.331021		
<i>P. parvus</i>	1.83	0.092145	0.008490	-0.219709		
<i>M. indica</i>	2.46	0.123867	0.015343	-0.258702		
<i>F. alte</i>	1.19	0.059919	0.003590	-0.168657		
Total	19.86	1.00000	0.13	2.71	0.93	3.01
Men						

H= Shannon-Wiener diversity index

C=Simpson's index of dominance

d=Margalef's community diversity index or species richness

e=Evenness index (Odum 1971)

Appendix 2 (i) Population density of molluscs species of Lawachara Forest during 2005-2006

Site Species	Monsoon '05						Winter '06			Summer '06			D/m2	M±SE	T#	D/m2	M±SE	T#	D/m2	M±SE	T#
	site-1	Site-2	Site-3	T#	Den/m2	M±SE	site-1	Site-2	T#	site-1	Site-2	Site-3									
<i>A. gigas</i>	2	-	1	3	1.00	1±0.57	3	2	5	-	1	-	1	0.33	0.33±0.33	1	0.33	0.33±0.33	1	0.33	0.33±0.33
<i>C. delibrata</i>	5	2	3	10	3.33	3.33±0.88	1	-	2	1	-	2	3	1.00	1±0.57	3	1.00	1±0.57	3	1.00	1±0.57
<i>G. crocea</i>	7	3	4	14	4.66	4.66±1.20	3	1	4	-	1	3	8	2.66	2.66±0.33	8	2.66	2.66±0.33	8	2.66	2.66±0.33
<i>M. indica</i>	7	4	6	17	5.66	5.66±0.88	2	-	5	3	5	1	6	2.00	2±0.57	6	2.00	2±0.57	6	2.00	2±0.57
<i>P. plectophyllis</i>	45	20	9	74	24.66	24.66±10.65	1	-	1	1	1	-	7	2.33	2.33±1.20	7	2.33	2.33±1.20	7	2.33	2.33±1.20
<i>P. parvus</i>	21	8	7	36	12.00	12.00±4.50	1	3	9	5	9	3	12	4.00	4±0.57	12	4.00	4±0.57	12	4.00	4±0.57
<i>S. diplotodon</i>	15	12	-	27	9.00	9.00±4.58	-	1	0	1	0	-	1	0.33	0.33±0.33	1	0.33	0.33±0.33	1	0.33	0.33±0.33
<i>Sivella casra</i>	30	08	6	44	14.66	14.66±7.68	1	0	0	1	0	-	2	0.66	0.66±0.66	2	0.66	0.66±0.66	2	0.66	0.66±0.66
Total	132	57	36	225			12	7	29	17	10	15	32			32			32		

Appendix 2 (ii) Population density of molluscs species of Lawachara Forest during 2006-2007

[illegible]

Appendix 2 (iii) Average (M) Population density with standard error (SE) of Terrestrial Molluscs Species in Lawachara Forest, Maulvibazar in the Year, 2005-2007

Molluscs Species	Year (2005-07)	Summer	Year (2005-07) Monsoon	Winter	Overall Season Mean±SE
<i>A.gigas</i>		0.33±0	0.5±0.5	1.16±0.5	0.66±0.25
<i>C.delibrata</i>		0.83±0.17	3.66±0.33	0.49±0.16	1.66±1
<i>G.crocea</i>		1.83±0.83	4.83±0.17	1.16±0.16	2.60±1.12
<i>M.indica</i>		2±0	4.66±1	1.33±0.33	2.66±1.01
<i>P.plectophyllis</i>		2.49±0.16	19.16±5.5	1.16±0.5	7.60±5.79
<i>P.parvus</i>		2.83±1.17	8.83±3.17	2±1	4.55±2.15
<i>S.diplodon</i>		0.66±0.33	7.16±1.83	0.16±0.16	2.66±2.25
<i>Sivella castra</i>		0.49±0.16	12.66±2	0.33±0	4.49±4.08
Total					26.88
Mean					3.36±0.76

Appendix 2 (iv) Biodiversity indices of Terrestrial Molluscs Species, Lawachara Forest Maulovibazar District during 2005-2007 Data mean of 6 seasons)

Molluscs species	Av. number of species	n/N	(n/N)2	(n/N)log n/N	e	D
<i>A. gigas</i>	0.66	0.022502	0.000506	0.085357		
<i>C. delibrata</i>	1.88	0.064163	0.004116	0.176212		
<i>G. crocea</i>	2.94	0.100238	0.010047	0.230568		
<i>M. indica</i>	3.66	0.124786	0.015571	0.259699		
<i>P. plectophyllis</i>	8.49	0.289464	0.083789	0.358855		
<i>P. parvus</i>	4.55	0.155131	0.024065	0.289084		
<i>S. diplodon</i>	2.66	0.090692	0.008225	0.217686		
<i>Sivella castra</i>	4.49	0.153085	0.023435	0.287302		
Total	29.33	1.000000	0.16	1.90	0.90	2.12

Appendix: 3 (i) Population density of Terrestrial Molluscs in Malnichara tea garden, Sylhet in the Year, 2005-06

Molluscs Species	Year : 2005-2006													
	Winter							Summer						
	site-1	Site-2	Site-3	T#	D/m2	M±SE	site-1	Site-2	Site-3	T#	D/m2	M±SE	site-1	Monsoon
<i>A. fulica fulica</i>	1	0	2	3	1.00	1±0.57	0	1	0	1	0.33	0.33±0.33	3	Site-2
<i>G. rocea</i>	0	1	0	1	1.00	0.33±0.33	0	0	0	0	0	0	1	Site-3
<i>M. indica</i>	0	2	1	3	1.00	1±0.57	2	1	0	3	1.00	1±0.57	4	Site-2
<i>E. cassida</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	Site-3
<i>C. theobaldinus</i>	1	0	0	0	0	0.33±0.33	0	0	0	0	0	0	10	Site-2
<i>C. pearsoni</i>	0	1	0	1	1.33	0.33±0.33	1	0	0	1	0.33	0.33±0.33	7	Site-3
<i>G. notigena</i>	3	1	2	6	2.00	2±0.57	2	1	0	3	1.00	1±0.57	13	Site-2
<i>L. gracile</i>	2	0	4	6	2.00	2±2.15	4	6	2	12	4.00	4±1.15	3	Site-3
<i>P. parvus</i>	2	1	0	3	1.00	1±0.57	0	0	0	0	0	0	4	Site-2
<i>I. plicata</i>	0	0	2	2	1.66	0.66±	3	1	2	6	2.00	2±0.57	6	Site-3
<i>F. alte</i>	1	0	0		0.33	0.33±0.33	2	0	4	6	2.00	2±1.15	0	Site-2
Total														

Appendix: 3 (ii) Population density of Terrestrial Molluscs in Malnichara tea garden, Sylhet in the Year, 2006-2007

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Appendix: 3 (iii) Population density of Terrestrial Molluscs in Malmichara tea garden, Sylhet in the Year, 2005-2007

Molluscs Species	Year (2005-07)	Summer	Year (2005-07)	Monsoon	Year (2005-07)	Winter	Aver. Mean±SE
<i>A.fulica fulica</i>		0.33±0		5.33±0.67		1.00±1.00	2.22±1
<i>G.crocea</i>		0.16±0.16		5.00±3.00		0.66±0.66	1.94±1.24
<i>M.indica</i>		1.33±1.33		3.99±0.33		1.00±0	2.10±0.61
<i>E.cassida</i>		0.16±0.16		1.33±0.33		0	0.49±0.28
<i>C.theobaldinus</i>		0		11.66±0.33		0.16±0.16	3.94±2.44
<i>C.pearsoni</i>		1.33±0.33		10.66±2		0.16±0.16	3.66±2.27
<i>G.notigena</i>		1.33±0.33		4.16±2.5		1.5±0.5	2.33±0.88
<i>L.gracile</i>		2.83±1.17		7.5±2.5		2±0	4.11±1.29
<i>P.parvus</i>		0.33±0.33		3.16±0.83		0.83±0.17	1.44±0.60
<i>I.plicata</i>		1.83±0.17		17.16±10.5		0.83±0.17	6.60±5.28
<i>F.alte</i>		1±1		1.33±1.33		0.16±0.16	0.83±0.48
Total							29.66
Mean							2.70±0.53

Appendix: 3 (iv) Biodiversity indices of Terrestrial Molluscs Species, Malnichara Tea garden in Sylhet District during 2005-2007 (Data mean of 8 seasons)

Serial no.	Molluscs species	Av. number of species	n/N	(n/N) ²	(n/N)log n/N	e	d
	<i>A. fulica fulica</i>	2.22±1	0.075126	-0.005644	-0.194470		
1	<i>G. crocea</i>	1.94±1.24	0.065651	-0.004310	-0.178794		
2	<i>M. indica</i>	2.10±0.61	0.071065	-0.005050	-0.187907		
3	<i>E. cassida</i>	0.49±0.28	0.016582	-0.000274	-0.067976		
4	<i>C. theobaldinus</i>	3.94±2.44	0.133333	-0.017777	-0.268653		
5	<i>C. pearsoni</i>	3.66±2.27	0.123857	-0.015340	-0.258691		
6	<i>G. notigena</i>	2.33±0.88	0.078849	-0.006217	-0.200293		
7	<i>L. gracile</i>	4.11±1.29	0.139086	-0.193449	-0.274369		
8	<i>P. parvus</i>	1.44±0.60	0.048730	-0.002374	-0.147235		
9	<i>I. plicata</i>	6.60±5.28	0.219627	-0.048236	-0.332916		
10	<i>F. alte</i>	0.83±0.34	0.028087	-0.000788	-0.100339		
11	Total	29.66	1.00000	-0.12	2.20	0.91	2.95
	Mean	2.70±0.53					

H= Shannon-Wiener diversity index

C= Simpson's index of dominance

d= Margalef's community diversity index or species richness

e= Evenness index (Odum 1971)

Appendix table 4 (i) Density of Molluscs specimens of Surma River in Monsoon, 05

Depth Species	Site-1					Site-2					Site-3							
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	-	-	-	-	0		-	-	-	-	0	-	5	-	-	5	1.66±1.36	1.66
<i>B. crassa</i>	-	1	-	1	0.33±0.27	0.33	-	-	-	-	0	-	-	-	-	-	0	-
<i>B. costula</i>	2	4	-	6	2±0.94	2.00	2	14	3	19	6.33±3.13	6.33	11	17	4	32	10.66±3.06	11.33
<i>T. tuberculata</i>	-	-	1	1	0.33±0.27	0.33	1	4	3	8	2.66±0.72	2.66	-	-	1	1	0.33±0.27	0.33
<i>T. granifera</i>	-	-	-	-	0	-	2	5	-	7	2.33±1.18	2.33	-	4	-	4	1.33±1.08	1.33
<i>T. scabra</i>	-	--	1	1	0.33±0.27	0.33	1			1	0.33±0.27	0.33	1	3	2	6	2±0.47	2.00
<i>C. striatella</i>	-	2	-	2	0.66±0.54	0.66	2	-	-	2	0.66±0.54	0.66	3	7	-	10	3.33±1.65	3.33
<i>C. sylhetica</i>	4	1	-	5	1.66±0.98	1.66	-	2	-	2	0.66±0.54	0.66	-	-	-	-	0	-
<i>L. marginalis</i>	3	-	-	3	1±0.81	1.00	1	2	-	3	1±0.47	1.00	-	-	-	-	0	-
<i>L. corrianus</i>	6	1	-	7	2.33±0.51	2.33	-	-	-	-	0	-	-	-	-	-	0	-
<i>L. nchuganensis</i>	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-
<i>P.(P.) corrugata</i>	1	-	-	1	0.33±0.27	0.33	-	-	--	-	0	-	-	-	-	-	0	-
<i>P.(P.) javidens</i>	-	-	-	-	0	-	-	8	-	8	2.66±2.17	2.66	-	3	-	3	2±0.81	1.00
<i>P.(R.) caerulea</i>	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	--	0	-
<i>P.(R.) shurtleffiana</i>	-	-	-	-	0	-	-	-	-	-	0	--	-	-	-	-	0	-
Total	16	9	2	27			9	35	6	50			20	34	7	61		

Appendix table 4 (ii) Density of Molluscs specimens of Surma River in Monsoon, 06

Depth Species		Site-1						Site-2						Site-3					
		Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>		-	-	-	-	0		-	-	-	-	0	-	7	7	-	14	4.66±1.90	4.66
<i>B. crassa</i>		-	-	1	1	0.33±0.27	0.33	-	-	-	-	0	-	-	-	-	-	0	-
<i>B. costula</i>		-	2	-	2	0.66±0.54	0.66	5	9	1	15	5±1.88	5.00	16	13	3	32	10.66±3.20	11.33
<i>T. tuberculata</i>		1	-	-	1	0.33±0.27	0.33	2	3	4	9	3±0.47	3.00	-	3	7	10	1±0.81	3.33
<i>T. granifera</i>		4	-	-	4	1.33±1.08	1.33	1	1	-	2	0.66±0.27	0.66	-	-	7	7	2.33±1.90	2.33
<i>T. scabra</i>		-	--	-	-	0	-	-	-	-	-	0	-	-	2	1	3	1±0.47	1.00
<i>C. siriatella</i>		-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-
<i>C. sylhetica</i>		2	-	-	2	0.66±0.54	0.66	-	-	-	-	0	-	--	-	-	-	0	-
<i>L. marginalis</i>		1	-	-	1	0.33±0.27	0.33	-	-	-	-	0	-	-	-	1	1	0.33±0.27	0.33
<i>L. corrianus</i>		4	-	-	4	1.33±1.08	1.33	-	-	-	-	0	-	-	-	-	-	0	-
<i>L. phanchuganensis</i>		-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-
<i>P.(P.) corrugata</i>		-	-	-	-	0	-	-	-	--	-	0	-	-	-	-	-	0	-
<i>P.(P.) javidens</i>		-	-	-	-	0	-	-	-	-	-	0	-	-	-	4	4	1.33±1.08	1.33
<i>P.(R.) caerulea</i>		-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-
<i>P.(R.) shurtleffiana</i>		-	1	-	1	0.33±0.27	0.33	-	-	-	-	0	-	-	-	-	-	0	-
Total		12	2	1				8	13	5				23	25	23			

Appendix table 4 (iii) Population density of Molluscs specimens of Surma River in summer, 06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	30	85	5	120	40±19.24	40.00	30	-	-	30	10±8.16	10.00	57	28	24	109	36.33±8.48	36.33
<i>B. crassa</i>	-	-	-	-	0	-	1	-	-	1	0.33±0.27	0.33	-	4	-	4	1.33±1.08	1.33
<i>B. costula</i>	115	140	4	259	67.33±34.12	86.33	45	18	3	66	22±12.28	28.33	70	31	21	122	40.66±10.65	40.66
<i>T. tuberculata</i>	6	24	2	32	10.66±5.52	10.66	7	2	6	15	5±1.24	15.00	21	15	2-	38	12.66±4.57	12.66
<i>T. granifera</i>	-	5	-	5	1.66±1.36	1.66	30	10	-	40	13.33±7.20	13.33	-	-	-	-	0	-
<i>T. scabra</i>	-	-	1	1	0.33±0.27	0.33	2	-	1	3	1±0.47	1.00	-	-	-	-	0	-
<i>C. sriatella</i>	-	-	4	4	1.33±1.08	1.33	15	8	1	24	8±3.29	8.00	-	-	-	-	0	-
<i>C. sylhetica</i>	3	5	-	8	2.66±1.18	2.66	20	6	-	26	8.66±4.3820	8.66	-	-	-	-	0	-
<i>L. marginalis</i>	1	1	-	2	0.66±0.27	0.66	8	-	-	8	2.66±2.17	2.66	-	-	-	-	0	-
<i>L. corrianus</i>	2	2	-	4	1.33±0.54	1.33	10	4	-	14	4.66±2.37	4.66	-	-	-	-	0	-
<i>L. phanchuganensis</i>	-	-	-	-	0	-	7	-	-	7	2.33±1.90	2.33	-	-	-	-	0	-
<i>P.(P.) corrugata</i>	-	-	-	-	0	-	10	-	-	10	3.33±2.72	3.33	-	-	-	-	0	-
<i>P.(P.) favidens</i>	2	1	0	3	1±0.27	1.66	4	-	-	4	1.33±1.08	1.33	-	-	-	-	0	-
<i>P.(R.) caerulea</i>	1	-	-	1	0.33±0.27	0.33	2	-	-	2	0.66±0.54	0.66	-	-	-	-	0	-
<i>P.(R.) shurleffiana</i>	-	-	-	-	0	-	1	-	-	1	0.33±0.27	0.33	-	-	-	-	0	-
Total	157	258	18	-	-	-	202	54	12	-	-	-	163	91	74	-	-	-

Appendix table 4 (iv) Density of Molluscs specimens of Surma River in Summer, 07

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	47	121	5	173	57.66±27.68	57.33	28	-	1	29	9.66±7.48	9.33	87	46	49	182	60.66±10.77	60.66
<i>B. crassa</i>	-	-	-	-	0	-	-	-	-	-	3.66±1.65	-	-	1	-	1	0.33±0.27	0.33
<i>B. costula</i>	123	193	32	348	116±38.055	116.00	65	18	9	92	30.66±14.17	30.66	133	57	59	249	83±20.41	83.00
<i>T. tuberculata</i>	9	35	6	50	16.66±7.51	16.66	6	3	11	20	6.66±1.90	8.66	12	5	5	22	7.33±1.90	7.33
<i>T. granifera</i>	-	8	-	8	2.66±2.17	2.66	42	-	-	42	17.33±10.34	14.00	1	-	-	-	178.52	-
<i>T. scabra</i>	-	-	-	-	0	-	-	-	1	1	6±4.49	0.33	-	-	-	-	0	-
<i>C. striatella</i>	4	35	2	41	13.66±8.72	13.66	11	4	-	15	5±2.62	5.00	-	-	-	-	11.66±6.22	-
<i>C. sylhetica</i>	2	8	3	13	4.33±1.51	4.33	8	-	-	8	8.66±4.25	2.66	-	-	-	-	7.66±2.22	-
<i>L. marginalis</i>	-	-	3	3	1±0.81	1.00	-	-	-	-	14±6.59	-	-	-	-	-	0	-
<i>L. corrianus</i>	2	-	1	3	1±0.47	1.00	2	10	-	12	4±2.49	4.00	-	-	-	-	9.33±3.66	-
<i>L. phanchuganensis</i>	-	-	-	-	0	-	2	-	-	2	4.66±2.12	0.66	-	-	-	-	0	-
<i>P. (P.) corrugata</i>	-	1	-	1	0.33±0.27	0.33	-	-	-	-	7±3.09	-	-	-	-	-	4.33±2.12	-
<i>P. (P.) javidens</i>	2	-	1	3	1±0.47	1.00	-	-	-	-	0.66±0.54	-	-	-	-	-	6±2.62	-
<i>P. (R.) caerulea</i>	1	1-	-	2	0.66±0.27	0.66	-	-	-	-	0	-	-	-	-	-	1±0.47	-
<i>P. (R.) shurleffiana</i>	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	1.66±0.72	-
Total	190	402	53	-	-	-	164	34	22	-	-	-	233	109	113	-	-	-

Appendix table 4 (v) Population density of Molluscs species of Surma River in winter 06

Depth Species		Site-1					Site-2					Site-3							
		Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
B. bengalensis		-	-	-	-	0			-		-	0	-		-		-	0	
B.crassa		8	58	26	92	30.66±11.93	30.66	12	78	31	121	40.33±16.01	40.33	6	61	18	85	28.33±13.63	28.33
B. costula		21	8	4	33	11±4.18	11.00	25	12	4	41	13.66±4.99	13.33	15	6	24	45	15±4.24	15.00
T. tuberculata		2	15	1	18	6±4.18	6.00	5	20	1	26	8.66±4.72	8.66	3	9	-	12	4±2.16	4.00
T.granifera		21	95	26	142	47.33±19.49	47.33	25	151	26	202	67.33±34.15	67.33	18	70	18	106	35.33±14.15	35.33
T.scabra		-	-	-	-	0	-	-	-	-	-	0	-	-	1	-	1	0.33±0.27	0.33
C. striatella		40	29	36	105	35±19.49	35	52	41	36	129	43±3.85	43	36	31	14	81	0.33±0.27	27.00
C.sylhetica		15	21	-	36	12±5.09	12.00	22	37	-	59	19.66±8.77	19.66	-	18	-	18	27±5.43	6.00
L. marginalis		15	3	1	19	6.33±3.56	6.33	12	5	1	18	6±8.77	6.00	13	4	-	17	6±4.89	5.66
L. corrianus		2	2	-	4	1.33±0.54	1.66	6	-	-	6	2±1.63	2.00	4	-	-	4	5.66±3.13	1.33
L.jenkinsianus		1	-	-	-	0.33±0.27	-	1	-	-	1	0.33±0.33	0.33	2	-	-	2	1.33±1.08	0.66
L.phanchuganensis		9	1	-	10	3.33±2.32	3.33	4	2	-	6	2±0.94	2.00	2	5	-	7	0.66±0.54	2.33
P.(P.)corrugata		-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	2.33±1.18	-
P.(P.)favidens		2	2	2	6	2	2.00	22	6	2	30	10±4.98	10.00	9	3	2	14	0	12.66
P.(R.) caerulea		-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	4.66±1.78	-
P.(R.) shurleffiana		-	-	-	-	0	-	-	-	-	-	0	--	-	-	-	-	0	-
Total		136	234	96	465			186	352	101				108	208	76	392		

Appendix table 4 (vi) Population density of Molluscs species of Surma River Winter 07

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	2	7	-	9	3±1.69	3.00		-		-	0	-	20	-	-	20	6.66±5.44	6.33
<i>B. crassa</i>	1	3	2	6	3.33±0.47	2.00	9	16	38	63	21±0.54	21.00	8	-		8	2.66±2.17	2.66
<i>B. costula</i>	4	7	4	11	5±0.81	3.33	30	41	72	143	47.66±10.26	47.66	-	8		8	2.66±2.17	2.66
<i>T. tuberculata</i>	2	1	1	4	1.33±0.27	1.66	4	1	9	14	4.66±1.90	3.66	1	2	-	3	1±0.47	1.00
<i>T. granifera</i>	5	18	7	30	13.33±3.41	10.00	15	-	2	17	5.66±3.83	5.66	3	-	-	3	1.0±0.81	1.00
<i>T. scabra</i>	-	1	-	1	3.41±0.27	0.33		1	28	29	9.66±7.48	9.66	--	-	-	-	0	-
<i>C. striatella</i>	7	8	6	21	7±0.47	7.00	12	-	-	12	4±3.26	4.00	-	-	-	-	0	-
<i>C. sylhetica</i>	-	2	-	2	0.66±0.54	0.66	11	-	-	11	3.66±2.99	4.00	-	--	-	-	0	-
<i>L. marginalis</i>	-	2	1	3	1±0.47	1.00	10	6	3	19	6.33±1.65	6.33	-	1	-	1	0.33±0.27	0.33
<i>L. corrianus</i>	1	2-	-	3	1±0.47	1.00	-	2	5	7	2.33±1.18	2.33	-	1	2	3	1±0.47	1.00
<i>L. jenkinsianus</i>	-	-	-	-	0	-	2	-	-	2	0.66±0.54	0.66	1	-	-	1	0.33±0.27	0.33
<i>L. phanchuganjenensis</i>	-	-	-	-	0	-	7	6	-	13	4.33±1.78	4.33	3	-	-	3	1±0.81	1.00
<i>P.(P.) corrugata</i>	1	--	-	1	0.33±0.27	0.33	-	-	-	-	0	-	-	-	3	3	1±0.81	1.0
<i>P.(P.) javidens</i>	-	2	2	4	1.33±0.54	1.66	9	15	2	26	8.66±3.06	8.66	4	-	3	7	2.33±0.98	2.33
<i>P.(R.) caerulea</i>	-	1	-	-	0	-	-	1	-	1	0.33±0.27	0.33	2	-	-	2	0.66±0.54	0.66
<i>P.(R.) shurtleffiana</i>		-	-	-		-	-	-	-	-	0		-	-	-	-	0	-
Total	19	53	23	95			109	89	159	357			42	12	8	62		

Appendix table 4 (vii) Average population density of freshwater molluscs of different Season in the River Surma in 2005-2007

Molluscs Species	Year (2005-07) Summer	Year (2005-07) Monsoon	Year (2005-07) Winter	Overall Mean $\pm$ SE
	M $\pm$ SE	M $\pm$ SE	M $\pm$ SE	
<i>B. bengalensis</i>	35.71 $\pm$ 4.91	1.05 $\pm$ 0.03	1.61 $\pm$ 1.13	12.79 $\pm$ 11.46
<i>B. crassa</i>	0.44 $\pm$ 0.27	0.11 $\pm$ 0	21.04 $\pm$ 8.52	7.12 $\pm$ 6.84
<i>B. costula</i>	59.94 $\pm$ 11.74	5.87 $\pm$ 0.32	15.72 $\pm$ 1.92	27.14 $\pm$ 16.63
<i>M. tuberculata</i>	7.21 $\pm$ 2.11	1.66 $\pm$ 0.39	4.27 $\pm$ 1.37	4.38 $\pm$ 1.68
<i>T. granifera</i>	8.66 $\pm$ 2.59	1.33 $\pm$ 0.07	25.71 $\pm$ 13.47	12.58 $\pm$ 7.88
<i>T. scabra</i>	1.22 $\pm$ 0.55	0.60 $\pm$ 0.19	2.33 $\pm$ 1.49	1.18 $\pm$ 0.32
<i>C. striatella</i>	6.60 $\pm$ 2.47	0.77 $\pm$ 0.54	19.33 $\pm$ 11.08	8.9 $\pm$ 5.47
<i>C. sylhetica</i>	4.05 $\pm$ 0.19	0.49 $\pm$ 0.19	6.88 $\pm$ 3.85	3.80 $\pm$ 1.84
<i>L. marginalis</i>	4.21 $\pm$ 2.20	0.44 $\pm$ 0.15	4.21 $\pm$ 1.17	2.95 $\pm$ 1.25
<i>L. corrianus</i>	3.10 $\pm$ 1.17	0.60 $\pm$ 0.11	1.49 $\pm$ 0.03	1.82 $\pm$ 0.81
<i>L. phanchooganjensis</i>	1.16 $\pm$ 0.27	0	2.13 $\pm$ 0.25	1.10 $\pm$ 0.62
<i>P.(P.) corrugata</i>	2.49 $\pm$ 0.97	0.05 $\pm$ 0.03	0.22 $\pm$ 0.15	0.92 $\pm$ 0.78
<i>P.(P.) favidens</i>	1.49 $\pm$ 0.74	0.83 $\pm$ 0.27	4.82 $\pm$ 0.51	2.38 $\pm$ 1.23
<i>P.(R.) caerulea</i>	0.44 $\pm$ 0.07	0	0.22 $\pm$ 0.15	0.22 $\pm$ 1.0.12
<i>P.(R.) shurtleffiana</i>	0.33 $\pm$ 0.15	0.05 $\pm$ 0.03	0	0.12 $\pm$ 0.10
Total				87.4

Appendix 4 (viii) Biodiversity indices of Molluscs Species in Surma River, Sylhet during 2005-2007

Molluscs Species	Av. No. Species	n/N	(n/N)2	(n/N)log(n/N)	e	d
<i>B. bengalensis</i> f. <i>typical</i>	12.79±11.46	0.146339	0.021415	-0.281238		
<i>B. crassa</i>	7.12±6.84	0.081465	0.006636	-0.204280		
<i>B. costula</i>	27.14±16.63	0.310526	0.096427	-0.363156		
<i>M. tuberculata</i>	4.38±1.68	0.050114	0.002511	-0.150013		
<i>T. granifera</i>	12.58±7.88	0.143936	0.020718	-0.279003		
<i>T. scabra</i>	1.18±0.32	0.013501	0.000182	-0.058121		
<i>C. striatella</i>	8.9±5.47	0.101831	0.010369	-0.232626		
<i>C. sylhetica</i>	3.80±1.84	0.043478	0.001890	-0.136325		
<i>L. marginalis</i>	2.95±1.25	0.033753	0.001890	-0.114378		
<i>L. corrianus</i>	1.82±0.81	0.020824	0.001139	-0.080623		
<i>L. phanchooganjensis</i>	1.10±0.62	0.012586	0.000158	-0.054793		
<i>P. (P.) corrugata</i>	0.92±0.78	0.010526	0.000111	-0.047934		
<i>P. (P.) javidens</i>	2.38±1.23	0.027231	0.000742	-0.098124		
<i>P. (R.) caerulea</i>	0.22±0.12	0.002517	0.000006	-0.015063		
<i>P. (R.) shurtleffiana</i>	0.12±0.10	0.001373	0.000002	-0.011727		
Total	87.4	1.00000	$\Sigma(n/N)^2=0.162791$	$\Sigma(n/N)\log(n/N)=2.13$	0.79	3.13

Appendix 5 (i) Population density of Molluscs specimens of Khushyara River in Monsoon 05

Species	Depth	Site-1						Site-2						Site-3					
		Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>		-	-	-		0		-	-	-		0		-	-	-			
<i>B. crassa</i>		28	138	21	187	62.33±30.93	62.33	8	40	36	84	28±8.2	28	6	23	7	36	12±4.49	12.00
<i>B. costula</i>		30	24	1	55	18.33±7.21	18.33	27	18	9	54	18±4.24	18	4	5	3	12	4±0.47	4.00
<i>T. tuberculata</i>		1	7	3	11	3.66±1.73	3.66	-	14	--	14	4.66±3.81	4.66	-	4	-	4	1.33±0.73	1.33
<i>T. granifera</i>		15	13	5	33	11±2.49	11	11	8	-	19	6.33±2.68	6.33	-	9	-	9	3±2.22	3.00
<i>T. scabra</i>			1	-	1	0.33±0.27	0.33	2	7	3	12	4±1.24	4.00	-	-	-	-	0	-
<i>C. striatella</i>		9	-	-	9	3±1.73	3	-	22	-	22	7.33±1.73	7.33	-	-	-	-	0	-
<i>C. sylhetica</i>		5	12	-	17	5.66±2.84	5.66	3	4	-	7	2.33±1.73	2.33	-	2	-	2	0.66±0.54	0.66
<i>L. marginalis</i>			8	-	8	2.66±2.17	2.66	1	6	-	7	2.33±1.73	2.33	-	-	-	-	0	-
<i>L. corrianus</i>		4	13	-	17	5.66±3.13	5.66	8	-	-	8	2.66±	2.66	-	-	-	-	0	-
<i>L. phanchooganjensis</i>		-	1	-	1	0.33±0.27	0.33	-	-	-	-	0	-	-	2	-	2	0.66±0.54	0.66
<i>P.(P.) corrugata</i>		1	1	-	2	0.66±0.27	0.66	-	-	-	-	0	-	1	-	-	1	0.33±0.27	0.33
<i>P.(P.) javidensis</i>		2	5	3	10	3.33±0.72	3.33	15	12	-	27	9±3.74	9.00	-	-	-	-	0	-
<i>P.(P.) gowhateensis</i>		3	7	-	10	3.33±1.65	3.33	3	5	2	10	3.33±0.72	3.33	2	-	---	2	0.66±0.54	0.66
<i>P.(R.) caerulea</i>			-	-		0	0		-	-	-	0	-	-	1	-	1	0.33±0.27	0.33
<i>P.(R.) shurtleffiana</i>				-		0	0		-	-		0	-			-		0	
Total		98	230	33	361			78	136	50	264					10			

Appendix 5 (ii) Population density of Molluscs specimens of Khushyara River in Monsoon 06

Species	Depth			Site-1					Site-2					Site-3				
	Q1= (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)cm.	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	-	-	-				-	-	-				1	-		1		0.33
<i>B. crassa</i>	36	122	35	193		64.33	6	59	52	112			5	18	5	28		9.33
<i>B. costula</i>	22	18	3	43		14.33	21	13	4	38			9	-	1	10		3.33
<i>T. tuberculata</i>	2	3	1	6		2.66	-	6	1	7			-	-	-	-		-
<i>T. granifera</i>	24	16	3	43		14.33	-	7	1	8			-	-	-	-		-
<i>T. scabra</i>	3	-	-	3		1.00	-	7	-	7			-	-	3	3		1.00
<i>C. striatella</i>	2	5	-	7		2.66	-	5	7	12			1	15	-	16		5.33
<i>C. sylhetica</i>	-	9	-	9		3.00	-	18	-	18			7	4	-	11		3.66
<i>L. marginalis</i>	1	4	2	7		2.33	-	2	1	3			2	2	1	5		1.66
<i>L. corrianus</i>	7	13	-	20		6.66	5	11	-	16			-	-	-	-		-
<i>L. phanchooganiensis</i>	1	-	-	1		0.33	-	4	-	4			-	-	-	-		-
<i>P.(P.) corrugata</i>	2	-	-	2		0.66	-	-	-	-			3	2	-	5		1.66
<i>P.(P.) javidensis</i>	1	6	-	7		2.33	17	18	3	38			-	5	1	6		2.00
<i>P.(P.) gowhatteensis</i>	1	3	-	4		1.66	-	9	3	12			2	17	-	19		6.33
<i>P.(R.) caerulea</i>	-	1	-	1		0.33	3	1	-	4			7	3	-	10		3.33
<i>P.(R.) shurtleffiana</i>	1	-	-	1		0.33	-	-	-	-			-	-	-	-		-
Total	103	200	44	347			52	160	72	279			37	66	11	114		

Appendix 5 (iii) Population Density of Molluscs species of Khushyara River in winter, 06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (0.5- 1)m	Q3 (1- 2)m	T #	M±SE	Den/m2	Q1 (0-5) cm.	Q2 (0.5- 1)m	Q3 (1- 2)m	T #	M±SE	Den/m2	Q1 (0- 0.5)m	Q2 (0.5- 1)m	Q3 (1- 2)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	6	1	-	7	2.33±1.73	2.33	8	-	3	11	3.66±1.9	4.66	3	1	-	4	1.33±0.72	1.33
<i>B. crassa</i>	12	22	13	47	15.66±2.59	15.66	47	28	19	94	31.33±6.73	31.33	7	14	4	25	8.33±2.41	8.33
<i>B. costula</i>	56	56	-	112	37.33±15.24	37.33	2	10	-	12	4±1.73	4.00	41	17	-	58	19.33±1.73	19.33
<i>M. tuberculata</i>	2	3	1	6	2±0.47	2.00	3	-	-	3	1±0.81	1.00	1	5	1	7	2.33±1.08	2.33
<i>T. granifera</i>	14	6	3	23	7.66±2.68	7.66	10	-	-	10	3.33±2.72	3.33	7	7	4	18	6±0.81	6.00
<i>T. scabra</i>	-	2	-	2	0.66±0.54	0.66	5	2	2	9	3±1.73	3.00	6	1	-	7	2.33±1.73	2.33
<i>C. striatella</i>	2	10	1	13	4.33±2.32	4.33	12	4	2	18	6±1.73	6.0	15	5	-	20	6.66±1.73±	6.66
<i>C. sylhetica</i>	5	15	-	20	6.66±3.6	6.66	7	25	-	32	10.66±	10.66	13	2	-	15	5±3.29	5.00
<i>L. marginalis</i>	3	5	1	9	3±0.94	3.00	4	7	-	11	3.66±1.73	3.66	2	4	1	7	2.33±0.72	2.33
<i>L. corrianus</i>	4	7	2	13	4.33±1.8	4.33	3	5	-	8	2.66±1.18	2.66	13	22	-	35	11.66±5.21	11.66
<i>L. phanchooganjensis</i>	1	5	-	6	2±1.24	2.00	3	9	-	12	4±1.73	4.00	5	-	11	16	5±3.32.59	5.33
<i>P.(P.) corrugata</i>	5	1	-	6	2±1.24	2.00	-	-	-	-	0	-	3	-	11-	14	4.66±2.68	4.66
<i>P.(P.) javidens</i>	4	11	1	16	5.33±2.41	5.33	1	8	-	9	3±1.73	3.00	5	7	-	12	4±1.69	4.00
<i>P.(P.) gowhatteensis</i>	2	4	-	6	2±0.94	2.00	4	1	--	5	1.66±0.98	1.66	5	9	-	14	4.66±2.12	4.66
<i>P.(R.) caerulea</i>	-	5	3	8	2.66±1.18	2.66	10	2	-	12	4±2.49	4.00	7	3	-	10	3.33±0.65	3.33
<i>P.(R.) shurtleffiana</i>	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Total	116	153	25	294			119	101	26	236			133	97	32	262		

Appendix 5 (iv) Population Density of Molluscs species of Khushyara River in winter, 07

Depth		Site-1							Site-2							Site-3						
Species		Q1= (0-0.5)	Q2 (0.5-1)	Q3 (1-2)m	T #	M±SE	Den/m2	Q1 (0-0.5m)	Q2 (0.5-1)m	Q3 (1-2)m	T #	M±SE	Den/m2	Q1 (0-0.5m)	Q2 (0.5-1)m	Q3 (1-2)m	T #	M±SE	Den/m2			
<i>B. bengalensis</i>		-	-	-		0	-	-	-			0	-	-	-	-			-			
<i>B. crassa</i>		-	-	4	4	1.33±1.08	1.33	5	1	1	7	2.33±1.08	2.33	8	2	8	18	6±1.63	6.00			
<i>B. costula</i>	5	5	2	-	7	2.33±1.18	2.33	3	2	1	6	2±0.47	2.00	1	4	20	25	8.33±4.81	8.33			
<i>T. tuberculata</i>		-	-	-	-	0	-	4	-	-	4	1.33±1.73	1.33	-	-	-	-	0	-			
<i>T. granifera</i>	1	1	-	-	1	0.33±0.27	0.33	22	29	3	54	18±6.34	18.00	3	-	1	4	1.33±0.72	1.33			
<i>T. scabra</i>	1	1	-	-	1	0.33±0.27	0.33	-	-	-	-	0	-	-	-	-	-	0	-			
<i>C. striatella</i>	1	-	-	-	1	0.33±0.27	0.33	27	10	-	37	12.33±6.43	12.33	-	-	-	-	0	-			
<i>C. sylhetica</i>	10	17	-	-	27	9±1.73	9.00	9	19	-	28	9.33±1.73	9.33	-	-	-	-	0	-			
<i>L. marginalis</i>	4	2	-	-	6	2±1.73	2.00	7	1	-	8	2.66±1.73	2.66	2	2	-	4	1.33±0.54	1.33			
<i>L. corrianus</i>	7	6	-	-	13	6.33±3.07	6.33	8	11	-	19	6.33±2.68	6.33	-	-	--	-	0	-			
<i>L. phanchooganjensis</i>	-	4	-	-	4	1.33±1.08	1.33	3	7	-	10	3.33±1.65	3.33	-	-	-	-	0	-			
<i>P. (P.) corrugata</i>	52	6	2	-	60	20±13.09	20.00	3	3	-	6	2±0.81	2.00	-	-	-	-	0	-			
<i>P. (P.) javidens</i>	61	50	11	122	40.66±12.38	40.66	9	9	8	1	18	6±2.05	6.00		5	7	12	4±1.69	4.00			
<i>P. (P.) gowhatteensis</i>	13	17	8	38	12.66±2.12	12.66	3	3	5	4	12	4±0.47	4.00	11	8	-	19	6.33±2.68	6.33			
<i>P. (R.) caerulea</i>	-	-	-	-	-	0	-	1	1	-	2	0.66±0.27	0.66	1		-	1	0.33±0.27	0.33			
<i>P. (R.) shurtleffiana</i>	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-			
Total	155	104	25	284				104	97	10	211			26	21	36	83					

Appendix 5 (v) Population density of Molluscs species of Khushyara River in Summer06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	4	1	-	5	2.66±0.72	2.66	4	-	-	4	1.33±1.08	1.33	3	1	-	4	1.33±0.72	1.33
<i>B. crassa</i>	3	70	13	86	28.66±17.03	28.66	6	36	18	60	20±7.11	20.00	7	14	4	25	8.33±2.41	8.33
<i>B. costula</i>	32	6	2	40	13.33±1.73	13.33	64	-	3	67	22.33±1.73	22.33	41	17	-	58	19.33±1.73	19.33
<i>T. tuberculata</i>		3	1	4	1.33±0.72	1.33	-	-	-	-	0	-	5	5	2	12	4±0.81	4.00
<i>T. granifera</i>	2	23	3	28	9.33±5.58	9.33	3	-	-	3	1±0.81	1.00	5	9	4	18	6±1.24	6.00
<i>T. scabra</i>	2	-	-	2	0.66±1.73	0.66	-	5	-	5	1.66±1.36	1.66	18	7	-	25	8.33±1.73	8.33
<i>C. striatella</i>	1	7	-	8	2.66±1.73	2.66	-	3	-	3	1±0.81	1.00	15	5	-	20	6.66±1.73	6.66
<i>C. sylhetica</i>	2	-	-	2	0.66±0.54	0.66	-	11	-	11	3.66±2.99	3.66	3	-	-	3	1±0.81	1.00
<i>L. marginalis</i>	-	-	-	-	0	-	3	2	-	5	1.66±0.72	1.66	2	4	1	7	2±0.98	2.33
<i>L. corrianus</i>	--	-	-	-	0	-	-	-	-	-	0	-	3	3	--	6	2±0.81	2.00
<i>L. phanchooganjensis</i>		-	-	-	0	-	-	--	-	-	0	-	-	-	-	-	0	-
<i>P.(P.) corrugata</i>	2	7	-	9	3±1.69	3.00	3	8	-	11	3.66±1.90	3.66	-	-	-	-	0	-
<i>P.(P.) javidens</i>	2	9	1	12	4±2.05	4.00	3	7	5	15	5±0.94	5.00	4	7	-	11	3.66±1.65	3.66
<i>P.(P.) gowhatteensis</i>		-	-	-	0	-	4	11		15	5±2.62	5.00	2	9	-	11	3.66±2.22	3.66
<i>P.(R.) caerulea</i>		-	-	-	0	-	-	1		1	0.33±0.27	0.33	7	3	1	11	3.66±1.44	3.66
<i>P.(R.) shurtleffiana</i>					0		-	-		-	0		-	-		-	0	--
Total	50	126	20	196-			90	84	26	190			115	84	12	211		

Appendix 5 (vi) Population density of Molluscs species of Khushyara River in Summer07

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	3	1	-	4	1.33±0.72	1.33	5	-	-	5	1.66±1.36	1.66	2	1	-	3	1±0.47	100
<i>B. crassa</i>	5		11	16	5.33±2.59	5.33	13	45	21	79	26.33±7.85	26.33	9	17	4	30	10±3.09	10.00
<i>B. costula</i>	39	65	3	107	35.66±1.73	35.66	65	8	4	77	25.66±1.73	25.66	38	13	-	51	17±1.73	17.00
<i>T. tuberculata</i>	3	5	-	8	2.66±1.18	2.66	4	7	-	11	3.66±1.65	3.66	11	4	2	17	5.66±2.22	5.66
<i>T. granifera</i>	3	21	3	27	9±4.89	9.00	9	17	1	27	9±3.77	9.00	15	6	1	22	7.33±3.34	7.33
<i>T. scabra</i>	1	-	-	1	0.330.27	0.33	2	4	-	6	2±1.73	2.00	3	2	-	5	1.66±0.72	1.66
<i>C. striatella</i>	2	9	-	11	3.66±1.73	3.66	6	3	-	9	3±1.73	3.00	16	7	-	23	7.66±1.73	7.66
<i>C. sylhetica</i>	-	4	-	4	1.33±1.08	1.33	9	12	1	22	7.33±2.68	7.33	-	4	-	4	1.33±1.08	1.33
<i>L. marginalis</i>	-	-	-	-	0	-	5	3	-	8	2.66±1.18	2.66	5	4	1	10	3.33±0.98	3.33
<i>L. corrianus</i>	-	-	4	4	1.33±1.08	1.33	2	8	-	10	3.33±1.96	3.33	6	7	-	13	4.33±1.78	4.33
<i>L. phanchooganjensis</i>	-	-	-	-	0	-	-	2	-	2	0.66±0.54	0.66	2	-	-	2	0.66±0.54	0.66
<i>P.(P.) corrugata</i>	2		-	2	0.66±0.54	0.66	-	4	-	4	1.33±1.08	1.33	-	2	-	2	0.66±0.54	0.66
<i>P.(P.) javidensis</i>	5	15	3	23	7.66±3.03	7.66	6	11	3	20	36.66±1.90	6.66	9	13	2	24	8±2.62	8.00
<i>P.(P.) gowhatteensis</i>	-	7	-	7	2.33±1.90	2.33	-	7	-	7	2.33±1.65	2.33	-	5	-	5	1.66±1.36	1.66
<i>P.(R.) caerulea</i>	1	1	-	2	0.66±0.27	0.66	1	2		3	1±0.47	1.00	3	5	2	10	3.33±0.72	3.33
<i>P.(R.) shurtleffiana</i>	-			-	0	-	-	-	-	-	0	-	-	-	-	-	0	
Total	64	128	24	216			127	133	30	290			119	90	12	221		

Appendix 5 (vii) Average (M) Population density with Slandered error (SE) of Molluscs species of Khushyara River during 2005-2007

Serial no.	Molluscs Species	Year (2005-07) Summer		Year (2005-07) Monsoon		Year (2005-07) Winter		Overall season mean	
		River (Khushiara)	M±SE	River (Khushiara)	M±SE	River (Khushiara)	M±SE	M±SE	
01	<i>B. bengalensis</i>	1.55±0.22		0.05±0.05		1.22±1.22		0.94±0.45	
02	<i>B. crassa</i>	16.43±2.55		29.03±5.08		10.83±7.61		18.76±5.38	
03	<i>B. costula</i>	21.27±4.83		10.17±3.27		13.56±8		15.00±3.11	
04	<i>M. tuberculata</i>	2.88±1.11		2.07±1.14		1.10±0.66		2.01±0.52	
05	<i>T. granifera</i>	6.10±2.33		4.56±2.2		6.16±0.5		6.12±0.02	
06	<i>T. scabra</i>	2.44±1.11		1.46±0.02		1.05±0.95		1.66±0.41	
07	<i>C. striatella</i>	4.03±0.59		3.97±0.53		4.94±0.72		4.25±0.36	
08	<i>C. sylhetica</i>	2.55±0.78		3.43±0.7		6.77±0.66		4.29±1.27	
09	<i>L. marginalis</i>	1.66±0.33		1.39±0.27		2.47±0.51		1.93±0.27	
10	<i>L. corrianus</i>	1.82±1.16		2.78±0.01		5.21±0.99		3.47±0.97	
11	<i>L. phanchooganjensis</i>	0.22±0.22		0.42±0.09		2.66±1.11		1.10±0.77	
12	<i>P. (P.) corrugata</i>	1.54±0.66		0.53±0.2		4.77±2.55		2.28±1.27	
13	<i>P. (P.) jfavidens</i>	5.83±1.61		3.91±1.47		10.49±6.38		7.06±1.73	
14	<i>P. (P.) gowhatteensis</i>	2.49±0.39		3.16±1.47		5.21±2.44		3.62±0.81	
15	<i>P. (R.) caerulea</i>	1.49±0.16		0.87±0.76		1.83±1.5		1.4±0.27	
16	<i>P. (R.) shurtleffiana</i>	0		0.45±0.04		0		0.01±0.01	
	Mean	4.82±1.54		4.24±1.76		4.80±0.93		4.56±1.40	
	Total							73.09	

Appendix 5 (viii) Bio Diversity indices of molluscs species of Khushyara River, Sylhet during 2005-2007 (Data mean of 6 seasons)

Molluscs species	Av.number of species	n/N	(n/N)2	(n/N)log n/N	e	d
<i>B. bengalensis</i>	0.94±0.45	0.012860	0.000165	0.055987		
<i>B. crassa</i>	18.76 ±4.39	0.256669	0.065879	0.349061		
<i>B. costula</i>	15.00±3.11	.205226	0.042117	0.325004		
<i>M. tuberculata</i>	2.01±0.52	0.027500	0.000756	0.098823		
<i>T. granifera</i>	5.6±0.02	0.076617	0.005870	0.196824		
<i>T. scabra</i>	1.66±0.41	0.022271	0.003381	0.085958		
<i>C. striatella</i>	4.31±0.36	0.058168	0.003477	0.166415		
<i>C. sylhetica</i>	4.25±1.27	0.058147	0.003381	0.165415		
<i>L. marginalis</i>	1.84±0.27	0.025174	0.000633	0.092689		
<i>L. corrianus</i>	3.43±0.97	0.046928	0.002202	0.143559		
<i>L. phanchooganjensis</i>	1.10±0.77	0.015049	0.000226	0.063152		
<i>P.(P.) corrugata</i>	2.28±1.27	0.031194	0.000973	0.108166		
<i>P.(P.) jfavidens</i>	6.74±1.73	0.092215	0.008503	0.219806		
<i>P.(P.) gowhatteensis</i>	3.62±0.81	0.049527	0.002453	0.148840		
<i>P.(R.) caerulea</i>	1.4±0.27	0.019115	0.000366	0.07564		
<i>P.(R.) shurtleffiana</i>	0.151±0.01	0.002052	0.000004	0.012277		
Total	73.09	1.000000.	0.13	2.30	0.83	3.49

Appendix 6 (i) Population density of molluscs species of Ratna river in Monsoon'05

Depth Species		Site-1					Site-2					Site-3							
		Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
B. bengalensis f.typica		3	1	0	3	1.33±0.88	1.33	3	0	0	3	1.66±1.20	1.66	3	0	0	3	1.66±0.88	1.66
B.crassa		0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0.66±0.66	0.66
B. costula		3	4	1	8	2.66±0.88	2.66	8	6	3	17	5.60±1.45	5.60	4	5	2	11	3.66±0.88	3.66
T. tuberculata		4	3	2	9	3±0.57	3	4	2	3	9	3±0.57	3	3	3	2	8	2.66±0.33	2.66
T.granifera		0	0	0	0	0	0	2	0	4	6	2±1.15	2	0	0	1	1	0.33±0.33	0.33
C. striatella		3	2	1	6	2±0.57	2	2	4	5	11	3.66±0.88	3.66	4	5	3	12	4±0.57	4
L. marginalis		2	1	1	4	1.33±1.33	1.33	2	1	0	3	1±0.57	1	2	3	1	6	2±0.57	2
L. corrianus		3	1	0	4	1.33±0.88	1.33	1	0	0	1	0.33±0.33	0.33	3	1	0	4	1.33±0.88	1.33
L. phanchuganjensis		0	0	0	0	0		0	0	0	0	0	0	3	1	0	4	1.33±0.88	1.33
P.(P.)favidens		0	1	2	3	1±0.57	1	5	4	2	11	3.66±0.88	3.66	4	6	4	14	4.66±0.66	4.66
P.(R.) caerulea		2	1	0	3	1±0.57	1	1	2	0	3	1±1	1	0	0	0	0	0	0
S.deltae		0	3	0	3	1±1	1	0	2	0	2	0.6±0.66	0.66	1	0	1	2	0.66±0.66	0.66
Total		20	17	7	44			28	23	17	68			27	26	14			

Appendix 6 (ii) Population density of molluscs species of Ratna river in Monsoon;06

Depth		Site-1					Site-2					Site-3								
		Q1= (0-50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0-50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	
Species	<i>B. bengalensis</i>	3	8	8	19	6.33±1.66	6.33	5	5	0	10	3.33±1.66	3.33	0	2	0	2	0.66±0.66	0.66	
	<i>B. crassa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	<i>B. costula</i>	4	2	0	6	2±1.15	2	9	9	0	18	6±3	6	7	1	1	9	3±2	3	
	<i>T. tuberculata</i>	0	1	0	1	0.33±0.33	0.33	0	0	0	0	0	0	0	0	0	0	0	0	
	<i>T. granifera</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.33±0.33	0.33	
	<i>C. striatella</i>	0	0	3	3	1±1	1	0	0	0	0	0	0	0	0	0	1	0.33±0.33	0.33	
	<i>L. marginalis</i>	0	0	0	0	0	0	2	2	2	1	5	1.66±0.33	1.66	1	4	0	5	1.66±1.20	1.66
	<i>L. corrianus</i>	2	0	0	2	0.66±0.66	0.66	1	0	0	1	0.33±0.33	0.33	2	1	0	3	1±0.57	1	
	<i>L. phanchoogaijensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	<i>P.(P.) corrugata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>P.(P.) jfavidens</i>	0	0	0	0	0	0	0	3	10	0	13	4.33±2.96	4.33	2	0	2	4	1.33±0.66	1.33	
<i>P.(R.) caerulea</i>	3	0	0	3	1±1	1	0	0	1	1	2	0.66±0.66	0.66	0	1	1	2	0.66±0.33	0.66	
<i>S.deltae</i>	0	6	3	9	3±1.73	3	0	0	0	0	0	0	0	0	0	1	1	0.33±0.33	0.33	
Total	12	17	16	45			20	27	2	49				13	9	6	38			

Appendix 6 (iii) Population density of molluscs species of Ratna river in Winter,06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)m	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	7	4	1	12	4.0C1.73	4.00	3	9	0	12	2.64	4.00	4	6	0	10	3.33±1.76	3.33
<i>B. crassa</i>	6	15	0	21	7±4.35	7.00	6	11	1	18	6±2.88	6.00	11	25	3	39	13±6.42	13
<i>B. costula</i>	10	23	3	36	12±5.85	12	6	18	0	24	8±5.29	8.00	15	21	0	36	12±6.24	12
<i>T. tuberculata</i>	4	7	0	11	3.66±2.02	3.66	2	3	0	5	1.66±.88	1.66	3	5	1	9	3±1.55	3
<i>T. granifera</i>	-	0	0	0		0	0	0	0	0		0	0	0	0	0	0	0
<i>C. striatella</i>	9	28	0	37	12.33±8.25	12.33	4	19	5	28	9.33±4.84	9.33	5	15	3	23	7.66±2.90	7.66
<i>L. marginalis</i>	9	40	31	80	20±4.20	26.66	26	22	12	60	20±16.33	20.00	18	25	9	52	17.33±4.63	17.33
<i>L. corrianus</i>	9	14	2	25	8.33±3.48	8.33	8	3		11	.366±2.33	3.66	4	0	1	5	1.66±1.20	1.66
<i>L. phanccoogangensis</i>	0	0	0	0	0	0	0	4	0	1.33	1.33±1.33		0	0	0	0	00	00
<i>P.(P.) favidens</i>	24	96	18	138	46±25.09	46.00	15	76	10	101	33.66±31.21	33.66	16	57	6	79	26.33±15.60	26.33
<i>P.(R.) caerulea</i>	7	30	3	40	13.33±8.41	13.33	13	25	1	39	13±6.92	13.00	4	9	0	13	4.33±2.60	4.33
<i>S. deltae</i>	0	21	14	35	11.66±6.17	11.66	0	8	2	10	3.33±2.40	3.33	0	7	3	10	3.33±2.40	3.33
Total	85	278	72	435			83	196	31	310			82	172	26	280		

Appendix 6 (iv) Population density of molluscs species of Ratna river in Winter, 07

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	3	1	1	5	1.66±0.66	1.66	8	13	0	21		7	0	1	1	2	0.66±0.33	0.66
<i>B. crassa</i>	0	1	2	3	1±0.57	1	0	0	0	0		0	0	0	0	0	0	0
<i>B. costula</i>	21	3	2	26	8.66	8.66	4	9	0	13		4.33	7	1	0	8	2.66±2.18	2.66
<i>T. tuberculata</i>	0	0	0	0	0	0	0	0	1	1		0.33	0	0	0	0	0	0
<i>T. granifera</i>	0	0	0	0	0	0	0	0	0	0		0	1	0	0	1	0.33±0.33	0.33
<i>T. scabra</i>	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	00	0
<i>C. striatella</i>	1	34	13	48	16±9.64	16	6	7	7	20		8.66	0	0	1	1	0.33±0.33	0.33
<i>L. marginalis</i>	5	0	7	12	4±2.08	4	3	4	1	8		2.66	6	18	1	25	8.33±5.04	8.33
<i>L. corrianus</i>	4	8	0	0	4±2.30	4	2	3	0	5		1.66	1	04	0	5	1.66±1.20	1.66
<i>L. phanchuganensis</i>	2	0	0	2	0.66±0.66	0.66	2	0	0	2		0.66	0	0	0	0	0	0
<i>P. (P.) jfavidens</i>	2	3	0	5	1.66±1.66	1.66	3	10	0	13		4.33	36	24	4	64	21.33±9.33	21.33
<i>P. (R.) caerulea</i>	2	5	0	7	2.33±1.45	2.33	0	1	1	2		0.66	0	0	0	0	0	0
<i>S. deltae</i>	4	7	11	22	7.33±2.02	7.33	0	0	0	0		0	0	0	0	0	0	0
Total	44	62	36	142			28	47	10				51	48	7	106		

Appendix 6 (v) Population density of molluscs species of Ratna river in Summer'06

Depth Species		Site-1					Site-2					Site-3							
		Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
B. bengalensis		6	2	0	8	2.66±1.76	2.66	4	6	0	10	3.33	3.33±1.76	4	0	0	4	2±1.15	2
B. crassa		2	0	0	2	0.66±0.66	0.66	7	2	0	9	3	3±2.08	8	1	0	9	3±2.51	3
B. costula		6	2	1	9	3±1.57	3	9	8	3	20	6.66	6.66±1.85	0	0	3	3	1±1	1
T. tuberculata		0	3	3	6	2±1	2	4	6	2	12	4	4±1.15	0	0	5	5	1.66±1.66	1.66
T. granifera		2	0	1	3	1±0.57	1	5	7	0	12	4	4±2.08	4	0	3	7	2.33±1.20	2.33
C. striatella		4	2	4	10	3.33±0.66	3.33	0	0	5	5	1.66	1.66±1.66	8	5	9	22	7.33±1.20	7.33
L. marginalis		2	0	7	9	3±2.08	3	5	6	7	18	6	6±0.57	12	10	4	26	8.66±2.40	8.66
L. corrianus		2	7	0	9	3±2.08	3	3	1	1	5	1.66	1.66±0.66	5	3	1	9	3±1	3
L. phanchuganensis		1	0	0	1	0.33±0.33	0.33	1	2	0	3	1	1±0.57	2	3	0	5	1.66±0.88	1.66
P.(P.) favidens		11	3	2	16	5.33±2.84	5.33	7	0	2	9	3	3±2.08	0	15	4	19	6.33±4.48	6.33
P.(R.) caerulea		1	0	0	1	0.33±0.33	0.33	0	0	0	0	0	0	0	1	2	3	1±0.57	1
S. deltae		4	0	0	4	1.33±1.33	1.33	3	0	0	3	1	1±1	0	0	4	4	1.33±1.33	1.33
Total		41	19	18	78			48	30	20	98			43	34	35	112		

Appendix 6 (vi) Population density of molluscs species of Ratna river in Summer, 07

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	1	7	0	8	2.66±2.18	2.66	3	0	0	3	1±1	1	1	2	0	3	1±0.57	1
<i>B. crassa</i>	1	0	0	1	0.33±0.33	0.33	0	0	0	0	0	0	5		1	6	2±1.57	2
<i>B. costula</i>	8	1	2	11	3.66±2.18	3.66	13	4	0	17	5.66±3.84	5.66	4		1	5	1.66±1.20	1.66
<i>T. tuberculata</i>	0	1	4	5	1.66±1.20	1.66	0	0	0	0	0	0	0	4	0	4	1.33±1.33	1.33
<i>T. granifera</i>	0	0	0	0	0	0	1	4	3	8	7.66±0.88	7.66	1		0	1	0.33±0.33	0.33
<i>C. striatella</i>	7	0	3	10	3.33±2.02	3.33	0	0	0	0	0	0	3	2	0	5	1.66±0.88	1.66
<i>L. marginalis</i>	4	6	5	15	5±0.57	5	8	4	3	15	5±1.57	5	29	12	7	48	16±6.65	16
<i>L. corrianus</i>	1	4	0	5	1.66±0.33	1.66	6	4	1	11	3.66±1.45	3.66	2	5	0	7	2.33±1.45	2.33
<i>L. phanchuganensis</i>	0	1	0	1	0.33±0.33	0.33	4	0	0	4	1.33±1.33	1.33	0	1	1	2	0.66±0.66	0.66
<i>P.(P.) favidens</i>	17	20	3	40	13.33±5.23	13.33	5	4	3	12	4±0.57	4	20	10	8	38	12.66±3.71	12.66
<i>P.(R.) caerulea</i>	3	0	0	3	1±1	1	0	0	0	0	0	0	2	3	1	6	2±0.57	2
<i>S. deltae</i>	0	6	3	9			5	0	0	5	1.66±1.66	1.66	0	0	1	1	0.33±0.33	0.33
Total	42	46	20	108			45	20	10	75								

Appendix 6 (vii) Average (M) Population density with Standered Error (SE) of molluscs species of Ratna River in different season during 2005-2007

Sl no.	Molluscs Species	Year (2005-07) Summer	Year (2005-07) Monsoon	Year (2005-07) postMonsoon	Year (2005-07) Winter
01	<i>B. bengalensis</i>	2.10±0.52	2.49±0.94	1.60±0.05	3.43±0.33
02	<i>B. crassa</i>	1.49±0.72	0.11±0.11	0.16±0.16	4.49±4.16
03	<i>B. costula</i>	3.60±0.05	3.82±0.13	3.44	7.93±2.72
04	<i>M. tuberculata</i>	1.77±0.78	1.49±0.38	1.99±0.33	1.44±1.33
05	<i>T. granifera</i>	1.71±0.72	0.44±0.33	0.16±0.05	0.05±0.05
06	<i>C. striatella</i>	2.88±1.22	1.83±1.39	4.10±0.77	8.71±1.05
07	<i>L. marginalis</i>	7.27±1.39	1.27±0.17	2.11±0.11	13.16±8.17
08	<i>L. corrianus</i>	2.55	0.82±0.16	1.38±0.05	3.49±1.05
09	<i>L. phanchooganjensis</i>	1.10±0.11	0.22±0.22	0.55±0.11	0.44
10	<i>P.(P.) favidens</i>	7.43±2.55	2.49±0.61	2.99±0.11	22.21±13.11
11	<i>P.(R.) caerulea</i>	0.72±0.28	0.71±0.05	1.27±0.28	5.60±4.61
12	<i>S. deltae</i>	1.44±0.22	0.94±0.17	0.60±0.27	4.27±1.83
13	Total				
	Mean				

Appendix 6 (viii) Bio Diversity indices of molluscs species of Ratna River, Habigong during 2005-2007 (Data mean of 6 seasons)

Molluscs species	Av.number of species	n/N	(n/N) ²	(n/N)log n/N	e	d
<i>B. bengalensis</i>	2.67	0.063692	0.004056	-0.175388		
<i>B. crassa</i>	2.03	0.048425	0.002345	-0.146648		
<i>B. costula</i>	5.11	0.121898	0.0114859	-0.256542		
<i>M. tuberculata</i>	1.56	0.037213	0.001384	-0.122471		
<i>T. granifera</i>	0.73	0.017414	0.000303	-0.070535		
<i>C. striatella</i>	4.47	0.106631	0.011370	-0.2388680		
<i>L. marginalis</i>	7.23	0.172471	0.029746	-0.303122		
<i>L. corrianus</i>	2.28	0.054389	0.002958	-0.158358		
<i>L. phanchooganjensis</i>	0.58	0.013835	0.000191	-0.059221		
<i>P.(P.) favidens</i>	10.71	0.255486	0.065273	-0.348633		
<i>P.(R.) caerulea</i>	2.34	0.055820	0.003115	-0.161075		
<i>S. deltae</i>	2.21	0.052719	0.002779	-0.155140		
Total	41.92	1.000000	0.13	2.20	0.88	2.95

Appendix 7 (i) Population density of molluscs species of Titlas River, BrahmonBaria Monsoon'05

Depth Species	Site-1						Site-2						Site-3					
	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q1 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE
<i>B.bengalensis f.typica</i>	8	12	4	24	8	8±2.30	6	2	0	8	2.66	2.66±1.76	7	9	21	37	12.33	12.33±4.37
<i>B.costula</i>	10	0	0	10	3.33	3.33±3.33	6	1	0	7	2.33	2.33±1.85	4	2	3	9	3	3±0.57
<i>M.tubercula</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>C.striatella</i>	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0
<i>L.margin alis</i>	10	6	1	17	5.66	5.66±2.60	10	8	5	23	7.66	7.66±1.45	12	9	4	25	8.33	8.33±2.33
<i>L.corria nus</i>	3	5	7	15	5	5±1.15	0	0	0	0	0		5	0	0	5	1.66	1.66±1.66
<i>L.phan chooganjensis</i>	2	0	1	3	1	1±0.57	0	0	0	0	0		2	1	0	3	1	1±0.57
<i>P(R.) caerulea</i>	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
Total																		

Appendix 7 (ii) Population density of molluscs species of Titas River, BrahmonBaria Monsoon'06

Depth Species		Site-1						Site-2						Site-3					
		Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q1 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE
<i>B.bengalensis f.typica</i>		5	9	0	14	4.66	4.66±2.60	3	5	0	8	2.66	2.66±1.45	2	6	0	8	2.66	2.66±1.76
<i>B.costula</i>		7	4	3	14	4.66	4.66±1.20	3	4	0	7	2.33	2.33±1.20	1	1	0	2	0.66	0.66±0.33
<i>M.tubercula</i>		1	0	0	1	0.33	0.33±33	0	0	0	0	0	0	1	0	0		.33	0.33±0.33
<i>C.striatella</i>		0	0	2	2	0.66	0.66±0.66	0	0	0	0	0	0	2	1	0	3	1	1±0.57
<i>L.margin alis</i>		8	3	0	11	3.66	3.66±2.33	3	6	1	10	3.33	3.33±1.45	6	7	2	15	5	5±1.52
<i>L.corria nus</i>		2	1	0	3	1	1±0.57	1	4	0	5	1.66	1.66±1.20	1	4	0	5	1.66	1.66±1.20
<i>L.phan chooganjensis</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>OP(R.) caerulea</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																			

Appendix 7 (iii) Population density of molluscs species of Titas River, BrahmonBaria, Winter'06

Depth Species	Site-1						Site-2						Site-3					
	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q1 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE
<i>B.bengalensis f.typica</i>	3	2	1	6	2	2±0.57	2	2	1	5	1.66	1.66±0.33	0	13	0	13	4.33	4.33±4.33
<i>B.costula</i>	4	3	2	9	3	3±0.57	2	7	3	12	4	4±1.52	0	4	0	4	1.33	1.33±1.33
<i>M.tubercula</i>	0	0	0	0	0	0	1	4	2	4	1.33	1.33±0.88	1	2	0	3	1	1±0.57
<i>C.sriatella</i>	1	0	0	1	0.33	0.33±0.33	2	0	2	4	1.33	1.33±0.66	0	0	0	0	0	
<i>L.margin alis</i>	11	18	12	41	13.66	13.66±2.18	10	18	24	52	17.33	17.33±4.05	7	12	0	19	6.33	6.33±3.48
<i>L.corria nus</i>	2	10	8	20	6.666	6.66±2.40	5	15	0	20	6.66	6.66±4.40	6	3	1	10	3.33	3.33±1.45
<i>L.phan chooganjensis</i>	1	0	0	1	0.33	0.33±0.33	0	0	0	0	0	0	0	2	0	2	0.66	0.66±0.66
<i>P(R.) caerulea</i>	0	0	0	0	0	0	3	1	0	4	1.33	1.33±0.88	0	0	0	0	0	0
Total																		

Appendix 7 (iv) Population density of molluscs species of Titas River, BrahmonBaria Winter'07

Depth Species	Site-1						Site-2						Site-3					
	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q1 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE
<i>B.bengalensis f.typica</i>	4	36	11	51	17	17±9.71	7	4	26	37	12.33	12.33±6.88	9	17	56	82	27.33	27.33±14.51
<i>B.costula</i>	0	4	4	8		2.66±1.33	10	2	1	13	4.33	4.33±2.84	3	2	6	11	3.66	3.66±1.20
<i>M.tubercula</i>	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
<i>C.sriatella</i>	0	0	0	0		0	0	0	0	0	0	0	0	2	0	2	0.66	0.66±0.66
<i>L.margin alis</i>	3	1	10	14	4.66	4.66±2.72	46	24	17	87	29	29±8.73	41	15	43	99	33	33±9.01
<i>L.corria nus</i>	5	12	5	22	7.33±2.33		0	0	0	0	0		13	0	0	13	4.33	4.33±4.33
<i>L.phan chooganjensis</i>	1	0	0	1		0.33±0.33	0	0	0	0	0		1	1	0	2	0.66	0.66±0.33
<i>P(R.) caerulea</i>	0	0	0	0		0	0	0	0	0	0		0	2	0	2	0.66	0.66±0.66
Total																		

Appendix 7 (v) Population density of molluscs species of Titas River, BrahmonBaria Summer'06

Depth Species		Site-1					Site-2					Site-3							
		Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q1 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE
<i>B.bengalensis f.typica</i>		4	20	3	27	9	9±5.50	1	7	1	9	3	3±2	4	5	0	9	3	3±1.52
<i>B.costula</i>		2	4	0	6	2	2±1.15	7	5	1	13	4.33	4.33±1.76	16	2	1	19	6.33	6.33±4.84
<i>M.tubercula</i>		3	7	0	10	3.33	3.33±2.02	6	0	3	9	3	3±1.73	4	6	0	10	3.33	3.33±1.76
<i>C.sriatella</i>		3	2	0	5	1.66	1.66±0.88	4	3	1	8	2.66	2.66±0.88	2	1	0	3	1	1±0.57
<i>L.margin alis</i>		5	6	3	14	4.66	4.66±0.88	3	2	1	7	2	2±0.57	4	9	3	16	5.33	5.33±1.85
<i>L.corria nus</i>		1	4	6	11	3.66	3.66±1.45	7	9	0	16	5.33	5.33±2.72	6	12	4	22	7.33	7.33±2.40
<i>L.phan chooganjensis</i>		1	0	0	1	0.33	0.33±0.33	3	4	1	8	2.66	2.66±0.88	0	0	0	0	0	
<i>P(R.) caerulea</i>		2	0	1	3	1	1±0.57	0	4	1	5	1.66	1.66±1.20	0	2	1	3	1	1±0.57
Total																			

Appendix 7 (vi) Population density of molluscs species of Titas River, BrahmonBaria Summer'07

Depth		Site-1					Site-2					Site-3							
		Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q10 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE	Q1 (0-.05)m	Q2 (0.5-1)m	Q3 (1-2)m	To.	D/m2	M±SE
Species																			
<i>B.bengalensis</i>		6	34	8	48	16	16±9.01	2	10	2	14	4.66	4.66±2.66	0	4	0	4	1.33	1.33±1.33
<i>f.typica</i>																			
<i>B.costula</i>		7	0	0	7	2.33	2.33±2.33	8	2	0	10	3.33	3.33±2.40	21	5	0	26	8.66	8.66±6.33
<i>M.tubercula</i>		2	0	0	2	.66	0.66±0.66	4	1	0	5	1.66	1.66±1.20	5	3	0	8	2.66	2.66±1.45
<i>C.sriatella</i>		0	1	0	1	.33	0.33±0.33	0	5	0	5	1.66	1.66±1.66	3	1	0	4	1.33	1.33±0.88
<i>L.margin alis</i>		7	8	6	21	21	7±0.57	2	0	1	3	1	1±0.57	1	2	6	9	3	3±1.52
<i>L.corria nus</i>		2	5	12	19	6.33	6.33±2.96	1	0	0	1	.33	0.33±0.33	4	10	9	23	7.66	7.66±1.85
<i>L.phan chooganjensis</i>		0	1	0	1	0.33	0.33±0.33	0	0	0	0	0		0	1	0	1	.33	0.33±0.33
<i>sP(R.) caerulea</i>		0	1	2	3	1	1±0.57	0	2	0	2	0.66	0.66±0.66	0	0	1	1	.33	0.33±0.33
Total																			

Appendix 7 (vii) Average (M) Population density with Standard Errors (SE) of molluscs species of Titas River, BrahmonBaria District during 2005-2007

Molluscs Species	Year (2005-07)	Monsoon	Year (2005-07)	winter	Year (2005-07)	Summer	Ovr all mean
<i>B. bengalensis f. typica</i>		5.44±2.22		10.77±8.11		6.16±1.16	7.45
<i>B. costula</i>		2.71±0.16		3.16±0.39		4.49±0.27	3.45
<i>M. tubercula</i>		0.11±0.11		0.49±0.27		2.44±0.78	1.01
<i>C. striatella</i>		0.11±0.11		0.27±0.27		1.43±0.33	0.60
<i>L. margin alis</i>		5.6±1.61		17.33±4.89		3.82±0.16	8.91
<i>L. corria nus</i>		1.83±0.39		4.71±0.83		5.10±0.33	3.88
<i>L. phan chooganjensis</i>		0.33±0.33		0.33		0.60±0.38	0.42
<i>P(R.) caerulea</i>		0		0.33±0.11		0.94±0.28	0.42
Total							26.14

Appendix 7 (viii) Biodiversity indices of molluscs species in TitasRiver,B.Barbia during 2005-2007

No.	molluscs species	Av. number of species	n/N	(n/N)2	(n/N)log e n/N	d	e
1	<i>B. bengalensis f. typica</i>	7.45	0.285003	0.081227	-0.357751		
2	<i>B. costula</i>	3.45	0.131981	0.017419	-0.267274		
3	<i>M. tuberculata</i>	1.01	0.038638	0.001429	-0.125709		
4	<i>C. striatella</i>	0.60	0.022953	0.000526	-0.086631		
5	<i>L. marginalis</i>	8.91	0.340856	0.116183	-0.366861		
6	<i>L. corrianus</i>	3.88	0.148431	0.022031	-0.022031		
7	<i>L. phenchooganjensis</i>	0.42	0.016067	0.000258	-0.066372		
8	<i>P.(R.) caerulea</i>	0.42	0.016067	0.000258	-0.066372		
	Total	26.14	1.000000	0.24	1.62	2.14	0.77

Appendix 8 (i) Population density of Molluscs specimens of Gomti River in Monsoon, 05

Depth Species	Site-1						Site-2						Site-3					
	Q1=0-0.5)m	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)cm.	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2
<i>B.bengalensis f.typica</i>	2	1	0	3	1±0.57	1	3	8	6	17	5.66±1.45	5.66	3	6	1	10	3.33±1.45	3.33
<i>B.crassa</i>	1	2	0	3	1±0.57	1	0	3	1	4	1.33±0.88	1.33	0	0	0	0	0	0
<i>B. costula</i>	4	6	2	12	4±1.15	4	0	7	1	8	2.66±2.18	2.66	2	4	2	8	2.66±0.66	2.66
<i>M.tuberculata</i>	1	0	0	1	0.33±0.33	0.33	1	3	1	5	1.66±0.66	1.66	1	0	0	1	0.33±0.33	0.33
<i>T.granifera</i>	5	6	1	12	4±1.52	4	28	31	12	71	23.66±5.89	23.66	3	8	1	12	4±2.08	4
<i>T.lineata</i>	1	5	0	6	2±1.52	2	14	48	36	98	32.66±9.95	32.66	4	2	0	6	2±1.15	2
<i>C. striatella</i>				0	0	0				0	0	0				0	0	0
<i>C.sylhetica</i>				0	0	0				0	0	0				0	0	0
<i>L.marginalis</i>				0	0	0				0	0	0				0	0	0
<i>L. corrianus</i>				0	0	0				0	0	0				0	0	0
<i>P.favidens</i>				0	0	0				0	0	0				00	0	0
<i>P.(R.)caerulea</i>				0	0	0				0	0	0				0	0	0
<i>S.deltae</i>	1		0	1	0.33±0.33	0.33	1	0	0	1	0.33±0.33	0.33	0	0	0	0	0	0
Total	15	20	3	28			47	98	57	202			13	20	4	37		

Appendix 8 (ii) Population density of Molluscs specimens of Gomti River in Monsoon, 06

Depth Species		Site-1							Site-2							Site-3				
		Q1= 0- 0.5)m	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)cm.	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	
<i>B.bengalensis f.typica</i>		0	0	1	1	0.33±0.33	0.33	5	15	27	47	15.66±6.35	15.66	0	3	9	12	4±2.64	4	
<i>B.crassa</i>		0	0	3	3	1±1	1	1	0	2	3	1±0.57	1	0	0	0	0	0	0	
<i>B. costula</i>		3	7	6	16	5.33±1.20	5.33	1	16	4	21	7±4.58	7	3	6	10	19	6.33±2.02	6.33	
<i>M.tuberculata</i>		0	0	0	0	0	0	0	6	2	8	2.66±1.76	2.66	0	0	0	0	0	0	
<i>T.granifera</i>		9	8	2	19	6.33±2.18	6.33	78	29	28	135	45±16.50	45	1	12	0	13	4.33±3.84	4.33	
<i>T.lineata</i>		4	7	0	11	3.66±2.02	3.66	20	185	49	254	84.66±50.86	84.66	1	0	0	1	0.33±0.33	0.33	
<i>C. striatella</i>					0	0	0	0			0	0	0				0	0	0	
<i>C.sylhetica</i>					0	0	0	0			0	0	0				0	0	0	
<i>L.marginalis</i>				1	1	0.33	0.33±0.33	0			0	0	0				0	0	0	
<i>L. corrianus</i>					0	0	0	0			0	0	0				0	0	0	
<i>P.favidens</i>					0	0	0	0			0	0	0				0	0	0	
<i>P.(R.) caerulea</i>					0	0	0	0			0	0	0				0	0	0	
<i>S.deltae</i>		0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	
Total		13	22	13	48			105	251	112	468			5	21	19	45			

Appendix 8 (iii) Population density of Molluscs species of Gomti River Summer, 06

Depth \ Species	Site-1						Site-2						Site-3					
	Q1= 0-0.5m	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50) cm.	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2
<i>B.bengalensis f.typica</i>	4	7	0	11	3.66±2.02	3.66	2	3	1	6	2±0.57	2	30	56	20	106	35.33±10.72	35.33
<i>B.crassa</i>	8	35	40	83	27.66±9.93	27.66	6	13	10	29	9.66±3.75	9.66	1	0	2	3	1±0.57	1
<i>B. costula</i>	12	18	4	34	11.33±4.05	11.33	1	3	0	4	1.33±1.33	1.33	3	7	4	14	4.66±1.20	4.66
<i>M.tuberculata</i>	3	7	0	10	3.33±2.02	3.33	2	4	3	9	3±0.57	3	1	5	2	8	2.66±1.20	2.66
<i>T.granifera</i>	2	3	0	5	1.66±0.88	1.66	2	5	7	14	4.66±1.45	4.66	0	2	1	3	1±0.57	1
<i>T.lineata</i>	0	2	0	2	0.66±0.66	0.66	2	3	1	6	2±0.57	2	2	1	0	3	1±0.57	1
<i>C. striatella</i>	3	5	0	8	2.66±1.45	2.66	0	2	6	8	2.66±1.76	2.66	5	7	3	15	5±1.15	5
<i>C.sylhetica</i>	1	3	0	4	1.33±0.88	1.33	3	5	1	9	3±1.15	3	3	4	2	9	3±0.57	3
<i>L.marginalis</i>	2	1	0	3	1±0.57	1	4	6	2	12	4±1.15	4	5	7	2	14	4.66±1.45	4.66
<i>L. corrianus</i>	3	6	0	9	3±1.73	3	3	2	1	6	2±0.57	2	1	2	3	6	2±0.57	2
<i>P.favidens</i>	0	2	1	3	1±0.57	1	1	3	0	4	1.33±0.88	1.33	1	4	0	5	1.66±1.20	1.66
<i>P.(R.) caerulea</i>	1	3	0	4	1.33±0.88	1.33	3	2	0	5	1.66±0.88	1.66	3	5	1	9	3±1.15	3
<i>S.dellae</i>	0	0	0		0	0	1	0	0	1	0.33±0.33	0.33	1	2	0	3	1±0.57	1
Total																		

Appendix 8 (iv) Population density of Molluscs species of Gomti River summer, 07

Depth \ Species	Site-1						Site-2						Site-3					
	Q1= 0-0.5m	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)cm.	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2
<i>B.bengalensis f.typica</i>	2	1	0	3	1±0.57	1	4	4	3	11	3.66±0.33	3.66	89	136	161	386	128.66±21.36	128.66
<i>B.crassa</i>	10	52	90	152	50.66±23.10	50.66	17	20	22	59	19.66±1.45	19.66	0	0	1	1	0.33±0.33	0.33
<i>B. costula</i>	18	5	1	24	8±5.13	8	5	6	6	17	5.66±0.33	5.66	9	15	6	30	10±2.64	10
<i>M.tuberculata</i>	0	1	0	1	0.33±0.33	0.33	0	2	0	2	0.66±0.66	0.66	7	3	9	19	6.33±1.76	6.33
<i>T.granifera</i>	2	4	1	7	2.33±0.88	2.33	5	8	88	101	33.66±27.18	33.66	1	2	0	3	1±0.57	1
<i>T.lineata</i>	1	2	1	4	1.33±1.33	1.33	2	5	45	52	17.33±13.86	17.33	0	0	1	1	0.33±0.33	0.33
<i>C. striatella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>C.sylhetica</i>	0	2	0	2	0.66±0.66	0.66	1	0	0	1	0.33±0.33	0.33	2	0	1	3	1±0.57	1
<i>L.marginalis</i>	1	8	0	9	3±2.51	3	2	4	1	7	2.33±0.88	2.33	2	5	3	10	3.33±3.33	3.33
<i>L. corrianus</i>	1	3	0	4	1.33±0.88	1.33	1	2	0	3	0.33±0.33	0.33	3	2	4	9	3±0.57	3
<i>P.favilens</i>	0	1	1	2	0.66±0.66	0.66	0	1	0	1	0.33±0.33	0.33	1	0	0	1	0.33±0.33	0.33
<i>P.(R.) caerulea</i>	0	2	0	2	0.66±0.66	0.66	0	0	1	1	0.33	0.33	1	0	0	1	0.33±0.33	0.33
<i>S.deltae</i>	0	0	0	0	0	0	0	0	3	3	1±1	1	1	0	0	1	0.33±0.33	0.33
Total	35	80	94	209			37											

Appendix 8 (v) Population density of Molluscs species of Gomti River Winter, 06,

Depth		Site-1						Site-2						Site-3					
		Q1= 0-0.5) m	Q2 (0.5-1) m	Q3 (1-2) m	T #	M±SE	Den/m2	Q1= 0-0.5) m	Q2 (0.5-1) m	Q3 (1-2) m	T #	M±SE	Den/m2	Q1= 0-0.5) m	Q2 (0.5-1) m	Q3 (1-2) m	T #	M±SE	Den/m2
Species	<i>B.bengalensis</i> <i>f.typica</i>	0	3	1	4	1.33±0.88	1.33	7	7	0	14	4.66±2.33	14	1	0	0	1	0.33±0.33	0.33
	<i>B.crassa</i>	3	30	115	148	49.33±33.74	49.33	77	71	2	150	50±24.06	50	500	300	5	805	268.33±143.76	268.33
	<i>B. costula</i>	1	0	1	2	0.66±0.33	0.66	14	58	0	72	24±17.47	24	3	3	0	6	2±1	2
	<i>M.tuberculata</i>	1	20	0	21	7±6. 50	7	8	2	0	10	3.33±2.40	3.33	3	0	0	3	1±1	1
	<i>T.granifera</i>	16	49	100	165	55±24.43	55	67	69	5	141	47±21	47	202	82	30	314	104.66±50.92	104.66
	<i>T.lineata</i>	15	20	52	87	29±11.59	29	25	12	3	40	13.33±6.38	13.33	203	56	12	271	90.33±57.74	90.33
	<i>C. striatella</i>	2	5	28	35	11.66±8.21	11.66	12	20	10	42	14±3.05	14	12	6	5	23	7.66±2.18	7.66
	<i>C.sylhetica</i>	2	4	20	26	8.66±5.69	8.66	8	9	2	19	6.33±2.18	6.33	16	3	2	21	7±4.5	7
	<i>L.marginalis</i>	0	2	0	2	0.66±0.66	0.66	1	0	0	1	0.33±0.33		3	4	1	8	2.66±0.88	2.66
	<i>L. corrianus</i>	1	3	1	5	1.66±0.66	1.66	2	4	0	6	2±1.15	2	2	5	9	8	2.66±1.20	2.66
	<i>P.favidens</i>	0	2	4	6	2±1.15	2	0	0	0	0	0		1	7	0	8	2.66±2.18	2.66
	<i>P.(R.) caerulea</i>	0	11	15	36	8.66±4.48	8.66	2	0	0	2	0.66±0.66	0.66	4	1	0	5	1.66±1.20	1.66
	<i>S.deltæ</i>	0	1	1	2	0.66±0.33	0.66	1	0	0	1	0.33±0.33	0.33	28	3	0	31	10.33±8.87	10.33
	Total	41	150	338	529			224	252	22	498			1991	1111	69	3171		

Appendix 8 (vi) Population density of Molluscs species of Gomti River winter, 07

Depth	Site-1						Site-2						Site-3					
	Q1= 0-0.5)m	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)cm.	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2	Q1 (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m2
<i>B.bengalensis ftypica</i>	1	3	0	4	1.33±0.88	1.33	2	0	0	2	0.66±0.66	0.66	3	5	0	8	2.66±1.45	2.66
<i>B.crassa</i>	101	138	0	239	79.66±41.24	79.66	53	140	49	242	80.66±29.68	80.66	15	28	9	52	17.3±5.60	17.33
<i>B. costula</i>	3	3	1	7	2.33±0.66	2.33	53	30	15	98	32.66±11.05	32.66	21	32	8	61	20.33±6.93	20.330
<i>M.tuberculata</i>	0	0	3	3	1±1	1	0	7	33	40	13.33±10.03	13.33	4	9	6	19	6.33±1.45	6.33
<i>T.granifera</i>	4	0	40	44	14.66±2.71	14.66	0	0	0	0	0	0	5	7	17	29	9.66±3.71	9.66
<i>T.lineata</i>	3	5	13	23	7±3.05	7	68	86	10	164	54.66±22.92	54.66	9	12	5	26	8.66±2.02	8.66
<i>C. striatella</i>	2	3	11	16	5.33±2.84	5.33	2	11	2	15	5±3	5	4	13	3	20	8.66±3.17	8.66
<i>C.sylhetica</i>	1	4	0	5	1.66±1.20	1.66	7	12	1	20	6.66±3.17	6.66	1	4	0	5	1.66±1.20	1.66
<i>L.marginalis</i>	0	1	0	1	0.33±0.33	0.33	0	0	1	1	0.33±0.33	0.33	2	4	3	9	3±0.57	3
<i>L. corrianus</i>	2	9	1	12	4±2.51	2	0	1	0	1	0.33±.33	0.33	3	7	2	12	4±1.52	4
<i>P.favidens</i>	5	1	4	10	3.33±1.20	3.33	3	1	0	4	1.33±0.88	1.33	2	9	0	11	3.66±2.72	3.6
<i>P.(R.) caerulea</i>	3	2	0	5	1.66±0.88	1.66	0	0	0	0	0	0	1	4	1	6	2±1	2
<i>S.deltiae</i>	0	0	1	1	0.33±0.33	0.33	0	2	0	2	0.66±0.66	0.66	2	4	0	6	2±1.15	2
Total	125	169	74				188	290	111	589			72	138	54	264		

Appendix 8 (vii) Average (M) Population density of Molluscs species with Standard Error (SE) of Gomti River different season during 2005-2007

Molluscs Species	Year (2005-07) Summer	Year (2005-07) Monsoon	Year (2005-07) Winter	Overall Mean±SE
<i>B. bengalensis f.typica</i>	29.01±15.24	4.99±1.66	1.82±0.27	11.97±8.61
<i>B. crassa</i>	17.60±5.94	0.71±0.05	90.77±31.78	36.54±27.63
<i>B. costula</i>	6.82±1.05	4.66±1.56	13.66±4.78	8.38±2.71
<i>M. tuberculata</i>	2.71±0.27	0.82±0.05	5.32±1.55	2.95±1.30
<i>T. granifera</i>	7.38±4.94	14.55±4	38.49±30.39	20.14±9.40
<i>T. lineata</i>	3.77±2.55	20.88±8.66	33.83±10.39	19.49±8.70
<i>C. striatella</i>	1.72±1.72	0	8.71±2.38	3.47±2.66
<i>C. sylhetica</i>	1.55±0.92	0	5.32±2	2.29±1.57
<i>L. marginalis</i>	3.05±0.17	0.05	1.21±0.61	1.43±0.87
<i>L. corrianus</i>	2.05±0.28	0	2.43±0.33	1.49±0.75
<i>P. (P.) favidens</i>	0.88±0.44	0	2.16±0.61	1.01±0.62
<i>P. (R.) caerulea</i>	1.21±0.77	0	2.44±1.22	1.21±0.70
<i>S. deltae</i>	0.44	0.11±0.11	2.38±1.39	0.97±0.70
Total				111.34±3.01
Mean				8.56

Appendix 8 (viii) Biodiversity indices of Molluscs species in Gomoti River, Comilla during 2005-2007

No.	molluscs species	Av.number of species	n/N	(n/N)2	(n/N)log e n/N	d	e
1	<i>B. bengalensis f.typica</i>	11.97±8.61	0.107508	0.011558	-0.239763		
2	<i>B. crassa</i>	36.54±56.37	0.328183	0.107704	-0.365656		
3	<i>B. costula</i>	8.38±2.71	0.075264	0.005664	-0.194689		
4	<i>M. tuberculata</i>	2.95±1.30	0.026495	0.000702	-0.096198		
5	<i>T. granifera</i>	20.14±9.40	0.180887	0.032720	-0.309295		
6	<i>T. lineata</i>	19.49±8.70	0.175049	0.030642	-0.305056		
7	<i>C. striatella</i>	3.47±2.66	0.031165	0.000971	-0.108094		
8	<i>aC. sylhetica</i>	2.29±1.57	0.020567	0.000423	-0.079883		
9	<i>L. marginalis</i>	1.43±0.87	0.012843	0.000164	-0.055930		
10	<i>L. corrianus</i>	1.49±0.75	0.013382	0.000179	-0.057727		
11	<i>P.(P.) favidens</i>	1.01±0.62	0.009071	0.000082	-0.042657		
12	<i>P.(R.) caerulea</i>	1.21±0.70	0.010867	0.000118	-0.049140		
13	<i>S. deltae</i>	0.97±0.70	0.008712	0.000075	-0.041321		
	Total	111.34		$\Sigma(n/N)^2 = 0.19$	$\Sigma(n/N)\log e n/N = 1.94$	2.54	0.76

Appendix 9 (i) Population density of Molluscs species Pond, Sylhet in Monsoon' 05

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0-.5)m	Q2 (0.5-1)m	Q3 (1-2)m	T #	M±SE	Den/m ²	Q1 (0-50)cm.	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m ²	Q1 (0-50)	Q2 (50-100)	Q3 (100-200)	T #	M±SE	Den/m ²
B. <i>bengalensis</i>	3	-	-	3	1±0.81	1.00	5	5	-	10	3.33±1.36	3.33	17	1	-	18	6±4.49	6.00
f. <i>typica</i>	-	-	-	-	0	0	3	-	-	3	1±0.81	1.00	13	-	-	13	4.33±3.53	4.33
L. <i>exustus</i>	13	7	4	24	8±2.16	8.00	65	59	3	127	42.33±16.11	42.33	80	43	17	140	46.66±14.92	46.66
tuberculate																		
T. scabra	4	3		7	2.33±0.98	2.33	7	8	-	15	5±2.05	5.00	4	6	3	13	4.33±0.72	4.33
L. marginalis	6	-	-	6	2±1.63	2.00	3	4	-		2.33±0.98	2.33	-	5	-	5	1.66±1.36	1.66
Total	26	10	4	22			83	76	3	135			114	55	20	189		

Appendix 9 (ii) Population density of Molluscs species Pond, Sylhet in 'Monsoon 06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>Bbengalensis f.typica</i>	10	3	-	13		4.33	8	4	-	12		4.00	8	3	-	11		3.66
<i>I.exustus</i>	12	-	-	12		4.00	5	-	-	5		1.66	5	-	-	5		1.66
<i>T.tuberculata</i>	65	76	7	148		49.33	12	93	1	106		35.33	61	19	14	94		31.33
<i>T. scabra</i>	8	-	4	12		4.00	8	2	-	10		3.33	2	3	1	6		2.00
<i>L.marginalis</i>	5	4	-	9		3.00	-	1	-	1		0.66	-	-	-	-		-
Total	100	83	11	194			33	100	1	134			76	26	15	117		

Appendix 9 (iii) Population density of of Molluscs species Pond ,Sylhet in Winter' 06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0-.5)m	Q2 (0.5-1)m	Q3 (1-2)m	T #	M±SE	Den/m2	Q1 (0-.5m)	Q2 (0.5-1)m	Q3 (1-2)m	T #	M±SE	Den/m2	Q1 (0-.5m)	Q2 (0.5-1)m	Q3 (1-2)m	T #	M±SE	Den /m2
<i>B. bengalensis</i>	4	5	-	9	3±1.24	3.00	4	2	-	3	1±0.47	1.00	-	8	-	8	2.66±2.17	2.66
<i>f.typica</i>																		
<i>Lexusus</i>	15	4	-	19	6.33±3.66	6.33	12	-	-	12	4±3.26	4.00	10	-	-	10	3.33±2.72	3.33
<i>T. tuberculata</i>	222	142	0	364	121.33±64.91	121.33	55	15	0	70	23.33±16.41	104	50	26	0	76	25.33±14.14	25.33
<i>T. scabra</i>	12	18	-	30	10±4.32	10.00	8	7	-	15	5±2.05	5.00	-	13	-	13	4.33±3.53	4.33
<i>L. marginalis</i>	2	-	1	3	1±0.47	1.00	1	8	-	9	3±2.05	3.00	3	6	-	9	3±1.41	3
Total	477	316	57	580			174	159	20	353			97	72	20	189		

Appendix 9 (iv) Population density of of Molluscs species Pond ,Sylhet in Winter' 07

Depth Species	Site-1						Site-2						Site-3					
	Q1 (0-.5)m	Q2 (.05-1)m	Q3 (1-2)m	T #	M±SE	Den/m2	Q1 (0-.5)m	Q2 (.05-1)m	Q3 (1-2)m	T #	M±SE	Den/m2	Q1 (0-.5)m	Q2 (.05-1)m	Q3 (1-2)m	T #	M±SE	Den/m2
<i>B. bengalensis</i>	3	6	-	9	3±1.72	3.00	3	1	-	4	1.33±0.88	1.33	7	2	-	9	3±2.08	3.00
<i>f.typica</i>																		
<i>Lexusus</i>	11	3	-	14	4.66±3.28	4.66	4	-	-	4	1.33±1.33	1.33	5	-	-	5	1.66±1.66	1.66
<i>M. tuberculata</i>	68	76	12	156	52±20.13	52	96	165	12	273	91±44.23	91.00	43	50	5	98	32.66±13.90	32.66
<i>T. scabra</i>	7	12	-	19	6.33±3.48	6.33	7	6	6	19	6.33±0.33	6.33	5	7	-	12	4±2.08	4.00
<i>L. marginalis</i>	1	3	-	4	1.33±0.88	1.33	3	6	-	9	3±1.73	3.00	7	3	-	10	3.33±2.02	3.33
Total	90	100	12	202			113	178	18	309			67	62	5	114		

Appendix 9 (v) : Population density of of Molluscs species Pond ,Sylhet in 'Summer 06

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	2	5	-	7	2.33±1.45	2.33	4	-	-	4	1.33±1.08	1.33	8	2	2	12	4±1.96	3.33
<i>f.typica</i>	-	-	-	-	0	-	-	-	-	7	2.33±1.18	2.33	6	-	-	6	2±1.63	2.00
<i>L.exustus</i>	70	10	3	73	24.33±	24.33	58	76	5	139	46.33±17.39	46.33	75	63	29	167	55.66±13.77	5.33
<i>T. tuberculata</i>	12	5	4	21	7±2.05	7.00	42	12	-	54	18±10.19	18.00	12	2	4	18	6±3.05	6.00
<i>T. scabra</i>	5	-	-	5	1.66±1.36	1.66	5	-	-	5	1.66±1.36	1.66	-	3	-	3	1±0.81	1.00
<i>L. marginalis</i>	89	20	7	106	-	-	109	93	7	209	-	-	101	70	33	204	-	-
Total																		

Appendix 9 (vi) Population density of of Molluscs species Pond ,Sylhet in 'Summer '07

Depth Species	Site-1						Site-2						Site-3					
	Q1= (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2	Q1 (0- 50)	Q2 (50- 100)	Q3 (100- 200)	T #	M±SE	Den/m2
<i>B. bengalensis</i>	10	3	-	13	4.33±3.26	4.33	14	5	-	19	6.33±3.34	6.33	17	1	-	18	6±4.49	6.00
<i>f.typica</i>	12	-	-	12	-	4.00	8	-	-	8	2.66±2.17	2.66	13	-	-	13	4.33±3.53	4.33
<i>L.exustus</i>	65	76	7	148	49.33±17.47	49.33±	45	59	3	107	35.66±13.73	35.66	80	43	17	140	46.66±14.92	46.66
<i>T. tuberculata</i>	8	-	4	12	4±1.88	4.00	42	8	-	50	16.66±	16.66±10.51	-	6	3	9	3.00±1.73	6.33
<i>T. scabra</i>	5	4	-	9	3±1.24	3.00	2	4	-	6	2.00	2±0.94	-	5	-	5	1.66±1.36	1.66
<i>L. marginalis</i>	100	83	11	194	-	-	111	76	3	190	-	-	114	55	20	189	-	-
Total																		

Appendix 9 (vii) Average(M) Population density with standered error (SE) of Molluscs species Pond ,Sylhet in 2005-2007

Molluscs Species	Year (2005-07)	Summer	Year (2005-07)	Monsoon	Year (2005-07)	Winter	Average
<i>B. bengalensis</i>	4.05±1.5		3.71±0.27		2.49±0.05		3.42±0.49
<i>I. exustus</i>	2.55±1.11		2.10±0.33		3.55±1		2.73±0.42
<i>M. tuberculata</i>	41.88±9.33		35.49±3.16		98.82±40.27		45.36±4.19
<i>T. scabra</i>	9.33±9.33		3.49±0.38		5.99±0.44		6.19±1.61
<i>L. marginalis</i>	1.83±0.39		1.60±0.38		2.44±0.11		1.95±0.21
Mean							11.93±8.38
Total							59.65

Appendix 9 (viii) Diversity indices of molluscs species of Pond,in Sylhet during 2005-2007 (Data mean of 6 seasons)

molluscs species	Av.number of species	n/N	(n/N)2	(n/N)log n/N	e	d
<i>B. bengalensis f.typica</i>	3.42±0.49	0.057334	0.003287	-0.163909		
<i>I. exustus</i>	2.73±0.42	0.045766	0.045766	-0.141152		
<i>M. tuberculata</i>	45.36±4.19	0.760435	0.760435	-0.020825		
<i>T. scabra</i>	6.19±1.61	0.103772	0.103772	-0.235101		
<i>L. marginalis</i>	1.95±0.21	0.032690	0.032690	-0.111822		
Total	59.65	1.00	0.60	0.67	0.41	0.97

Appendix 10 (i) population density of Molluscs Species of Pond, Maulvibazar Monsoon'05

Depth	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																		
<i>B.bengalensis f.typica</i>	2	0	0	2	0.66	0.66±	0	2	0	2	0.66	0.66±0.66	3	1	0	4	1.33	1.33±0.88
<i>B.costula</i>	2	3	0	5	1.66	1.66±0.88	1	2	0	3	1.00	1.00±0.57	0	0	0	0	0	
<i>M.tuberculata</i>	0	0	0	0	0		1	0	0	1	0.33	0.33±0.33	2	1	0	3	1.00	1.00±0.57
Total																		

Appendix 10 (ii) population density of Molluscs Species of Pond, Maulvibazar Monsoon'06

Depth		Site-1					Site-2					Site-3							
		Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																			
<i>B.bengalensis f.typica</i>		1	4	0	5	1.66	1.66±1.20	2	1	0	3	1.00	1.00±0.57	0	0	0	0	0	0
<i>B.costula</i>		2	0	0	2	0.66	0.66±0.66	1	0	0	1	0.33.	0.33±	1	2	0	3	1	1.00±0.57
<i>M.tuberculata</i>		1	0	0	1	.033	0.33±0.33	2	0	0	2	0.66	0.66±0.66	0	0	0	0	0	0
Total																			

Appendix 10 (iii) population density of Molluscs Species of Pond, Maulvibazar Winter '06

Depth	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																		
<i>B.bengalensis f.typica</i>	6	8	0	14	4.66	4.66±2.40	3	4	0	7	2.33	2.33±1.20	1	4	0	5	1.66	1.66±1.20
<i>B.costula</i>	1	2	0	3	1.00	1.00±0.57	0	2	2	4	1.33	1.33±0.66	2	1	0	3	1.00	1.00±0.57
<i>M.tuberculata</i>	2	0	0	2	.66	.66±0.66	1	1	1	3	1.00	1.00±0	1	0	0	1	.33	0.33±0.33
Total																		

Appendix 10 (iv) population density of Molluscs Species of Pond, Maulvibazar Winter '07

Depth		Site-1					Site-2					Site-3							
		Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																			
<i>B.bengalensis</i>		2	5	0	7	3.33	3.33±1.45	4	5	0	9	3.00	3.00±1.52	1	3	0	4	1.33	1.33±0.88
<i>f.typica</i>																			
<i>B.costula</i>		3	2	0	5	1.66	1.66±0.88	3	1	0	4	1.33	1.33±0.88	2	3	0	5	1.66	1.66±0.88
<i>M.tuberculata</i>		1	1	0	2	0.66	.66±0.33	0	1	0	1	0.33	0.33±0.33	1	0	0	1	0.33	0.33±0.33
Total																			

Appendix 10 (v) population density of Molluscs Species of Pond, Maulvibazar Summer'06

Depth	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																		
<i>B.bengalensis</i>	7	2	0	9	3.00	3±2.08	7	5	0	12	4	4±2.08	6	3	0	9	3	3±1.73
<i>B.f.typica</i>																		
<i>B.costula</i>	6	3	1	10	3.33	3.33±1.45	3	0	0	3	1	1±1	2	1	0	3	1	1±0.57
<i>M.tuberculata</i>	3	1	0	4	1.33	1.33±0.88	0	1	0	1	0.33	0.33±0.33	2	0	0	2	0.66	0.66±0.66
Total																		

Appendix 10 (vi) population density of Molluscs Species of Pond, Maulvibazar Summer'07

Depth	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-0.5)m	Q20.5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																		
<i>B.bengalensis</i>	5	6	0	11	3.66	3.66±1.85	3	4	0	7	2.33	2.33±1.20	4	6	0	10	3.33	3.33±1.76
<i>B.f.typica</i>																		
<i>B.costula</i>	3	2	0	5	1.66	1.66±0.88	2	2	0	4	1.33	1.33±.66	5	1	0	6	2	2.00±1.52
<i>M.tuberculata</i>	0	1	0	1	0.33	0.33±0.33	0	0	0	0	0	0±0	2	0	0	2	0.66	0.66±0.66
Total																		

Appendix 10 (vii) Average (M) Population density with Standered Error (SE) of molluscs species of pond in Maulvibazar different Season during 2005-2007

Molluscs Species	Year (2005-07) Monsoon	Year (2005-07) Winter	Year (2005-07) Summer	Overall season mean±se
<i>B. bengalensis f.typica</i>	0.93±0.05	2.60±0.05	3.21±0.11	2.25±0.43
<i>B. costula</i>	0.77±0.11	1.21±0.33	1.71±0.05	1.23±0.19
<i>M.tuberculata</i>	0.38±0.05	0.55±0.11	0.55±0.11	0.49±0.07
Total				3.97±0.51
Mean				1.37

Appendix 10 (viii) Biodiversity indices of molluscs species of Pond,in Maulvibazar during 2005-2007 (Data mean of 6 seasons)

molluscs species	Av.number of species	n/N	(n/N)2	(n/N)log n/N	e	d
<i>B. bengalensis f.typica</i>	2.25	0.566750	0.321206	-0.321821		
<i>B. costula</i>	1.23	0.309823	0.095990	-0.363036		
<i>M.tuberculata</i>	0.49	0.123425	0.015233	-0.258220		
Total	3.97	1.00000	0.43	0.94	0.85	1.45

Appendix 11 (i) Population density of molluscs Species of Pond, Habigong' Monsoon '05

Depth Species	Site-1						Site-2						Site-3					
	Q1(0-.50m	Q2(m..5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-.50m	Q2(m..5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-.50m	Q2(m..5-1)m	Q3(1-2)m	T	D/m2	M±SE
<i>B.bengalensis f.typica</i>	5	0	0	5	1.66	1.66±1.66	7	0	0	7	2.33	2.33±2.33	0	0	0	0	0	0
<i>M.tuberculata</i>	10	4	0	14	4.66	4.66±2.90	7	3	0	10	3.33	3.33±2.02	6	3	0	9	3	3±1.73
<i>T.scabra</i>	3	0	0	3	1	1±1	0	0	1	1	0.33	0.33±0.33	4	1	1	6	2	2±1
<i>l. marginalis</i>	2	2	5	9	3	3±1	7	2	0	9	3	3±2.05	0	6	2	8	2.66	2.66±1.76
<i>L.corrianus</i>	0	3		3	1	1±1	2	1	0	3	1	1±0.57	0	0	0	0	0	0
<i>L.generosus</i>	2	3		5	1.66	1.66±0.88	0	0	0	0	0	0	2	0	1	3	1	1±0.57
<i>L.jenkinsonianus sub</i>	0	1	0	1	0.33	0.33±0.33	0	0	0	0	0	0	2	0	0	2	0.66	0.66±0.66
<i>sp.daccaensis</i>																		
<i>P(P.)favidens</i>	0	0	0		0	0	1	2	0	3	1	1±0.57	0	0	1	1	0.33	0.33±0.33
Total	22	13	5	40			24	8	1	33			14	10	5	29		

Appendix 11 (ii) Population density of molluscs Species of Pond, Habigong Monsoon '06

Depth		Site-1					Site-2					Site-3							
		Q1(0-.50m)	Q2(m..5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-.50m)	Q2(m..5-1)m	Q3(1-2)m	T	D/m2	M±SE	Q1(0-.50m)	Q2(m..5-1)m	Q3(1-2)m	T	D/m2	M±SE
Species																			
	<i>B.bengalensis</i>	4	2	0	6	2	2±1.15	3	1	0	4	1.33	1.33±0.88	2	0		2	0.66	0.66±0.66
	<i>f.typica</i>																		
	<i>M.tuberculata</i>	7	4	0	11	3.66	3.66±2.02	6	1	0	7	2.33	2.33±1.85	3	3	1	7	2.33	2.33±0.66
	<i>T.scabra</i>	1	0	0	1	0.33	0.33±0.33	1	0	0	1	0.33	0.33±0.33	1	1	0	2	0.66	0.66±0.33
	<i>l. marginalis</i>	3	4	1	8	2.66	2.66±0.88	1	1	1	3	1	1±0	1	6	1	8	2.66	2.66±1.66
	<i>L.corrianus</i>	0	0	2	2	0.66	0.66±0.66	0	1	2	3	1	1±0.57	0	0	0	0	0	0
	<i>L.generosus</i>	1	2	0	3	1	1±0.57	1	0	0	1	0.33	0.33±0.33	0	0	0	0	0	0
	<i>L.jenkinsianus</i>	0	3	0	3	1	1±1	0		0	0	0	00	0	0	0	0	0	0
	<i>sub</i>																		
	<i>sp.daccaensis</i>																		
	<i>P(P.)favidens</i>	0	1	0	1	0.33	0.33±0.33	2	2	0	4	1.33	1.33±0.66	1	0	0	1	0.33	0.33±0.33
	Total	16	16	3	35			14	6	3	23			8	10	2			

Appendix 11 (iii) Population density of molluscs Species of Pond, Habigong Summer '06

Depth		Site-1						Site-2						Site-3					
		Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE
Species																			
<i>B.bengalensis f.typica</i>		5	6	0	11	3.66	3.66±1.85	8	10		18	6	6±3.05	10	4	0	14	4.66	4.66±2.40
<i>M.tuberculata</i>		6	7	2	15	5	5±1.52	4	9	3	16	4.33	4.33±2.60	3	1	2	6	2	2±0.57
<i>T.scabra</i>		4	2	0	6	2	2±1.15	6	1	3	10	3.33	3.33±1.45	6	4	0	10	3.33	3.33±1.76
<i>l. marginalis</i>		3	4	1	8	2.66	2.66±0.88	2	4	0	6	2	2±1.15	3	6	1	10	3.33	3.33±1.45
<i>L.corrianus</i>		3	4	2	9	3	3±0.57	3	0	1	4	1.33	1.33±0.88	2	1	1	4	1.33	1.33±0.33
<i>L.generosus</i>		2	3	1	6	2	2±0.57	0	1	2	3	1	1±0.57	0	1	0	1	0.33	0.33±0.33
<i>L.jenkinsonianus sub sp.daccaensis</i>		1	0	0	1	0.33	0.33±0.33	2	0	0	2	0.66	0.66±0.66	0	0	0	0	0	0
<i>P(P.)favidens</i>		0	0	0	0	0	0	0	1	0	1	0.33	0.33±0.33	0	0	0	0	0	0
Total		24	26	6	56			25	26	9	50			24	17	4			

Appendix 11 (iv) Population density of molluscs Species of Pond, Habigong Summer'07

Species	Site-1						Site-2						Site-3					
	Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE
<i>B.bengalensis f.typica</i>	4	3	0	7	2.33	2.33±1.20	4	7	1	12	4	4±1.73	7	6	0	13	4.33	4.33±2.18
<i>M.tuberculata</i>	4	3	1	8	2.66	2.66±0.88	5	3	1	9	3	3±1.15	5	8	2	15	5	5±1.73
<i>T.scabra</i>	0	0	0	0	0	0	2	1	0	3	1	1±0.57	3	2	0	5	1.66	1.66±0.88
<i>I. marginalis</i>	0	5	2	7	2.33	2.33±1.45	3	6	0	9	3	3±1.73	0	4	0	4	1.33	1.33±1.33
<i>L.corrianus</i>	2	0	1	3	1	1±0.57	2	1	0	3	1	1±0.57		3	1	4	1.33	1.33±0.88
<i>L.generosus</i>	0	1	0	1	0.33	0.33±0.33	1	2	0	3	1	1±0.57	4	0	1	5	1.66	1.66±1.20
<i>L.jenkinsianus sub sp.daccaensis</i>	0	2	0	2	0.66	0.66±0.66	0	3	1	4	1.33	1.33±0.88	0	0	0	0	0	0
<i>P(P.favidens</i>	0	1	1	2	0.66	0.66±0.33	1	0	0	1	0.33	0.33±0.33	0	0	0	0	0	0
Total	10	15	8	33			18	23	3	44			19	23	4	46		

Appendix 11 (v) Population density of molluscs Species of Pond, Habigong Winter'06

Depth Species	Site-1						Site-2						Site-3					
	Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE
<i>B.bengalensis f.typica</i>	3	6	0	9	3	3±1.73	9	6	0	15	5	5±2.64	5	9	0	14	4.66	4.66±2.60
<i>M.tuberculata</i>	2	3	2	7	2.33	2.33±0.33	6	4	1	11	3.66	3.66±1.45	7	10	1	18	6	6±2.64
<i>T.scabra</i>	1	0	0	1	0.33	0.33±0.33	0	1	0	1	0.33	0.33±0.33	0	2	0	2	0.66	0.66±0.66
<i>I. marginalis</i>	0	0	2	2	0.66	0.66±0.66	1	4	2	7	2.33	2.33±0.88	2	7	2	11	3.66	3.66±1.66
<i>L.corrianus</i>	0	0	0	0	0	0	2	1	1	4	1.33	1.33±0.33	2	4	0	6	2	2±1.15
<i>L.generosus</i>	1	2	1	4	1.33	1.33±0.33	0	3	1	4	1.33	1.33±0.88	1	2	0	3	1	1±0.57
<i>L.jenkinsianus sub sp.daccaensis</i>	0	1	0	1	0.33	0.33±0.33	0	2	0	2	0.66	0.66±0.66	0	0	0	0	0	0
<i>P(P.favidens</i>	0	0	1	1	0.33	0.33±0.33	0	2	0	2	0.66	0.66±0.66	1	1	0	2	0.66	0.66±0.33
Total	6	12	6	24			18	23	5	46			18	35	3	56		

Appendix 11 (vi) Population density of molluscs Species of Pond, Habigong Winter'07

Species	Depth	Site-1					Site-2					Site-3							
		Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE	Q1	Q2	Q3	T	D/m2	M±SE
<i>B.bengalensis f.typica</i>		7	4	0	11	3.66	3.66±2.02	7	10	0	17	5.66	5.66±2.46	8	6	0	14	2.66	2.66±1.76
<i>M.tuberculata</i>		5	8	4	17	5.66	5.661.20	8	11	1	20	6.66	6.66±2.96	11	4	2	17	5.66	5.66±2.72
<i>T.scabra</i>		3	9	0	12	4	4±2.64	2	0	0	2	0.66	0.66±0.66	1	4	1	6	2	2±1
<i>l. marginalis</i>		4	6	0	10	3.33	3.33±1.76	3	5	2	10	3.33	3.33±3.33	5	6	1	12	4	4±1.52
<i>L.corrianus</i>		1	3	1	5	1.66	1.66±0.66	3	4	1	8	2.66	2.66±0.88	3	5	1	9	3	3±1.15
<i>L.generosus</i>		0	3	2	5	1.66	1.66±0.88	4	2	1	7	2.33	2.33±0.88	2	4	0	6	2	2±1.15
<i>L.jenkinsonius</i> sub		0	2	1	3	1	1±0.57	0	0	0	0	0	0	1	3	1	5	1.66	1.66±0.66
<i>sp.daccaensis</i>																			
<i>P(P.)favidens</i>		0	0	0	0	0	0	0	1	1	2	0.66	0.66±0.33	0	0	1	1	0.33	0.33±0.33
Total		20	35	8	63			27	32	5	64								

Appendix 11 (vii) Average (M) Population density with Standard Error(SE) of molluscs Species of Pond, Habiganj different season during 2005-2007

Molluscs Species	Year (2005-07) Summer		Year (2005-07) Monsoon		Year (2005-07) Winter		M±SE
<i>B. bengalensis f.typica</i>	4.16±0.61		1.33±0.69		4.10±0.11		3.19±0.93
<i>M. tuberculata</i>	3.66±0.11		3.21±0.44		4.99±1		3.95±0.53
<i>T.scabra</i>	1.88±1		0.77±0.33		1.33±0.89		1.32±0.32
<i>L. marginalis</i>	2.44±0.22		2.49±0.39		2.88±0.67		2.60±0.13
<i>L. corrianus</i>	1.49±0.38		0.60±0.05		1.77±0.66		1.28±0.35
<i>L.generosus</i>	1.05±0.06		0.66±0.22		1.60±0.38		1.10±0.27
<i>L.jenkinsoni</i> sub	0.49±0.16		0.33		0.60±0.27		0.47±0.07
<i>sp.daccaensis</i>							
<i>P.(P.)favidens</i>	0.22±0.11		0.55±0.11		0.44±0.11		0.40±0.09
Total	15.39		9.94		17.71		14.31
Mean							1.78

Appendix 11 (viii) Biodiversity indices of molluscs species of Pond, Habigong during 2005-2007 (Data mean of 6 seasons)

Molluscs species	Av. number of species	n/N	(n/N)2	(n/N)log n/N	e	d
<i>B. bengalensis f.typica</i>	3.19±0.93	0.222921	0.049693	-0.334590		
<i>M. tuberculata</i>	3.95±0.53	0.276030	0.076192	-0.355318		
<i>T.scabra</i>	1.32±0.32	0.092243	0.008508	-0.219845		
<i>L. marginalis</i>	2.60±0.13	0.018691	0.033011	-0.309864		
<i>L. corrianus</i>	1.28±0.35	0.089447	0.008000	-0.215934		
<i>L. generosus</i>	1.10±0.27	0.076869	0.005908	-0.197219		
<i>L.jenkinsianus sub sp.daccaensis</i>	0.47±0.07	0.032844	0.001078	-0.112194		
<i>P.(P.)favidens</i>	0.40±0.09	0.027952	0.000781	-0.099991		
Total	14.31	1.000000	0.18	1.84	0.88	2.63

Appendix 12 (i) Population density of molluscs species of Pond BrahmanBaria'monsoon '05

Depth	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE
Species																		
<i>B.bengalensis</i>	2	1	0	3	1	1±0.57	1	0	0	1	0.33	0.33±0.33	1	0	0	1	0.33	0.33±0.33
<i>f.typica</i>																		
<i>B.costula</i>	1	2	0	3	1	1±0.57	0	1	0	1	0.33	0.33±0.33	0	1	0	1	0.33	0.33±0.33
<i>T.granifera</i>	4	7	0	11	3.66	3.66±2.02	5	6	1	12	4	4±1.57	3	2	1	6	2	2±0.57
<i>L.marginalis</i>	0	1	0	1	0.33	0.33±0.33	1	0	0	1	0.33	0.33±0.33	0	0	0	0	0	0
Total	7	11	0	18			6	7	1	14			1	3	1	8		

Appendix 12 (ii) Population density of molluscs species of Pond BrahmanBaria monsoon '06

Depth Species	Site-1					Site-2					Site-3							
	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE
<i>B.bengalensis</i>	3	1	0	4	1.33	1.33±0.88	2	3	0	5		1.66±0.88	2	0	0	2	0.66	0.66±0.88
<i>f.typica</i>																		
<i>B.costula</i>	1	1	0	2	0.66	0.66±0.33	0	2	0	2		0.66±0.66	0	3	0	3	1	1±1
<i>T.granifera</i>	6	10	2	18		6±2.30	7	12	1	20	6.66	6.66±3.17	6	15	3	24	8	8±3.60
<i>L.marginalis</i>	0	0	0	0		0	1	0	0		0.33	0.33±0.33	2	1	0	3	1	1±0.57
Total																		

Appendix 12 (iii) Population density of molluscs species of Pond in BrahmanBaria'',winter'06

Depth Species		Site-1					Site-2					Site-3							
		Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE
<i>B.bengalensis</i>		9	11	2	22	7.33	7.33±2.72	5	15	3	23	7.66	7.66±3.71	7	9	2	18	6	6±2.08
<i>f.ryptica</i>																			
<i>B.costula</i>		2	3	0	5	1.66	1.66±0.88	5	6	2	13	4.33	4.33±1.20	3	4	1	8	2.66	2.66±0.88
<i>T.granifera</i>		3	0	0	3	1	1±1	4	2	0	6	2	2±1.15	2	3	0	5	1.66	1.66±0.88
<i>L.marginalis</i>		2	0	0	2	0.66	0.66±0.66	0	1	0	1	0.33	0.33±0.33	0	1	0	1	0.33	0.33±0.33
Total		16	14	2	32			14	24	5	43								

Appendix 12 (iv) Population density of molluscs species of Pond in BrahmanBaria'',winter'07

Depth Species	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	SE
<i>B.bengalensis</i>	8	6	0	14	4.66	4.66±2.40	4	7	1	12	4	4±1.73	5	6	0	11	3.66	3.66±1.85
<i>f.typica</i>																		
<i>B.costula</i>	1	4	1	6	2	2±1	3	7	1	11	3.66	3.66±1.76	2	4	2	8	2.66	2.66±0.66
<i>T.granifera</i>	1	2	0	3	1	1±0.57	0	1	0	1	0.33	0.33±0.33	3	2	0	5	1.66	1.66±0.88
<i>L.marginalis</i>	1	0	0	1	0.33	0.33±	1	2	0	3	1	1±0.57	2	2	0	4	1.33	1.33±0.66
Total																		

Appendix 12 (v) Population density of molluscs species of Pond in BrahmanBaria' summer'06

Dept Species	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE
<i>B.bengalensis</i>	10	22	2	34	11.33	11.33±15.81	15	24	1	40	13.33	13.33±6.69	15	24	0	39	13.00	13.00±17
<i>f.typica</i>																		
<i>B.costula</i>	5	2	1	8	2.66	2.66±1.20	14	08	02	24	8	8±3.46	6	2	1	9	3	3±1.52
<i>T.granifera</i>	11	0		11	3.66	3.66±3.66	10	0	00	10	3.33	3.33±3.33	9	1	0	10	3.33	3±2.84
<i>L.marginalis</i>	1	0	0	1	0.33	0.33±0.33	3	0	1	4	1.33	1.33±0.88	0	0	0	0	0	0
Total	33	34	30	97			44	40	42	122			35	45	31	111		

Appendix 12 (vi) Population density of molluscs species of Pond in BrahmanBaria' summer'07

Depth Species	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE	Q1(0-0.5)m	Q1(0.5-1)m	Q3(1-2)m	#T	D/m2	M± SE
<i>B.bengalensis f.typica</i>	10	12	4	26	8.66	8.66±2.40	8	22	7	37	12.33	12.33±4.84	15	32	9	56	18.66	18.66±6.88
<i>B.costula</i>	2	3	0	5	1.66	1.66±0.88	10	6	3	19	8.33	6.33±2.02	3	5	2	10	3.33	3.33±0.88
<i>T.granifera</i>	4	1	0	5	1.66	1.66±1.20	6	0	0	6	2	2±2	3	4	0	7	2.33	2.33±1.20
<i>L.marginalis</i>	0	1	0	1	0.33	0.33±0.33	2	0	0	2	0.66	0.66±0.66	1	0	0	1	0.33	0.33±0.33
Total	16	17	4	37			26	28	10	64			22	41	11	74		

Appendix 12 (vii) Average (M) Population density with slandered error (SE) of Molluscs species, Pond of Brahmon Baria different season during 2005-2007

Molluscs Species	Year (2005-07) Summer		Year (2005-07) Monsoon		Year (2005-07) Winter		Overall season Mean±SE
<i>B.bengalensis f.typica</i>	20.93±7.72		0.88±0.33		5.54±1.44		9.11±6.05
<i>B.costula</i>	4.49±0.05		0.66±0.11		2.77		2.65±1.10
<i>T.granifera</i>	3.33		5.05±1.83		1.27±0.28		3.21±1.09
<i>L.marginalis</i>	1.27±0.72		0.33±0.11		0.68±0.19		0.76±0.27
Total							15.73
Mean							3.93±1.80

Appendix 12 (viii) Biodiversity indices of Molluscs species of Pond,Brahmanbaria during 2005-2007 (Data mean of 6 seasons)

Molluscs species	Av.number of species	n/N	(n/N)2	(n/N)log n/N	e	d
<i>B.bengalensis f.typica</i>	9.11	0.579148	0.335412	-0.316329		
<i>B.costula</i>	2.65	0.168467	0.028381	-0.300042		
<i>T.granifera</i>	3.21	0.204068	0.041644	-0.324325		
<i>L.marginalis</i>	0.76	0.048315	0.002334	-0.146395		
Total	15.73	1.000000	0.34	1.18	0.85	1.16

Appendix 13 (i) Population density of Molluscs species of pond in Comilla Monsoon'2005

Depth	Site-1					Site-2					Site-3							
	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE
Species	15	12	0	27	9	9±4.58	8	3	4	15	5	5±1.52	11	6	3	20	6.66	6.66±2.33
<i>B.bengalensis f.typica</i>																		
<i>B.costula</i>	2	3	0	5	1.66	1.66±0.88	4	2	0	6	2	2±1.15	0	1	0	1	.33	0.33±0.33
<i>M.tuberculata</i>	2	0	1	3	1	1±0.57	1	0	0	1	0.33	0.33±0.33	0	3	0	3	1	1±1
<i>G.orcula</i>	0	0	0	0	0	0	0	2	0	2	0.66	.066±0.66	1	0	0	1	.33	0.33±0.33
<i>var.producta</i>																		
Total	19	15	1	45			13	7	4	24			12	10	3	28		

Appendix 13 (ii) Population density of Molluscs species of pond in Comilla Monsoon'2006

Depth Species	Site-1					Site-2					Site-3							
	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE
<i>B.bengalensis f.typica</i>	27	9	2	38	12.66	12.66±7.44	12	1	6	19	6.33±3.17	6.33	11	6	3	20	6.66	6.66±2.33
<i>B.costula</i>	2	1	0	3	1	1±0.57	1	0	0	1	0.33±0.330	0.33	1	2	0	3	1	1±0.57
<i>M.tuberculata</i>	1	0	0	1	0.33	0.33±0.33	0	1	0	1	0.33±0.33	0.33	0	3	0	3	1	1±1
<i>G.orcula</i> <i>var.producta</i>	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.66	0.66±0.66
Total	30	10	2	42			13	2	6	21			14	11	3	28		

Appendix 13 (iii) Population density of Molluscs species of pond in Comilla Wnter'2006

Depth	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE
Species																		
<i>B.bengalensis</i>	9	30	2	41	13.66	13.66±8.41	16	24	0	40	13.33	13.33±7.05	28	23	2	53	17.66	17.66±7.96
<i>f.typica</i>																		
<i>B.costula</i>	12	6	1	19	6.33	6.33±3.17	7	0	1		2.66	2.66±2.18	9	2	0	11	3.66	3.66±2.72
<i>M.tuberculata</i>	13	3	1	17	5.66	5.66±3.71	4	5	3	12	4	4±0.57	3	2	1	6	2	2±0.57
<i>G.orcula</i>	2	0	0	2	0.66	0.66±0.66	1	0	0	1	0.33	.33±0.33	1	0	0	1	0.33	0.33±0.33
<i>var.producta</i>																		
Total	36	39	4				28	29	4	43			41	27	3	71		

Appendix 13 (iv) Population density of Molluscs species of pond in Comilla winter'2007

Species	Depth	Site-1					Site-2					Site-3							
		Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE
<i>B.bengalensis f.typica</i>		15	45	8			22.66±11.34	16	24	0			13.33±7.05	20	23	2	15		15±6.55
<i>B.costula</i>		5	8	0			4.33±2.33	7	0	1			2.66±2.18	9	4	0	13		4.33±2.60
<i>M.tuberculata</i>		12	3	1			5.33±3.38	4	5	3			4±0.57	3	3	0	6		2±1
<i>G.orcula var.producta</i>		2	0	0			0.66±0.66	1	0	0			0.33±0.33	1	0	0	1		0.33±0.33
Total																			

Appendix 13 (v) Population density of Molluscs species of pond in Comilla Summer''2007

Depth Species	Site-1						Site-2						Site-3					
	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE
<i>B.bengalensis f.typica</i>	7	18	4	29	9.66	9.66±4.25	13	22	2	37	12.33	12.33±15.78	27	10	2	39	13	13±7.37
<i>B.costula</i>	4	6	0	10	3.33	3.33±1.76	6	3	0	9	3	3±1.73	10	4	0	14	4.66	4.66±2.90
<i>M.tuberculata</i>	3	2	1	6	2	2±0.57	1	2	0	3	1	1±10.57	3	2	1	6	2	2±0.57
<i>G.orcula var.producta</i>	1	0	0	1	0.33	0.33±0.33	1	0	0	1	0.33	0.33±10.33	1	0	1	2	0.66	0.66±0.33
Total	15	26	5	46			21	27	2	50			41	16	4	61		

Appendix 13 (vi) Population density of Molluscs species of pond in Comilla Summer'2006

Depth		Site-1					Site-2					Site-3							
		Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE	Q1(0-0.5)m	Q2(0.5-1)m	Q3(1-2)m	T#	D/m2	M±SE
Species		12	30	6	48	16	16±2.21	18	28	6	52	17.33	17.33±6.35	38	55	18		37	37±10.69
<i>B.bengalensis f.typica</i>																			
<i>B.costula</i>		2	4	0	6	2	2±1.15	17	4	6	37	9	9±4.04	15	4	0	19	6.33	6.33±4.88
<i>M.tuberculata</i>		1	3	0	4	1.33	1.33±0.88	2	0	0	2	0.66	0.66±0.66	1	2	2	5	1.66	1.66±0.33
<i>G.orcula var.producta</i>		1	0	0	1	0.33	0.33±0.33	0	0	0	0	0	0	0	0	0	0	0	0
Total		16	37	6	59			37	12	12	71			54	61	20			

Appendix 13 (vii) Average (M) Population density with Slandered Error (SE) of Molluscs species of pond Comilla different season during 2005-07

Molluscs Species	Year (2005-07) Summer	Year (2005-07) Monsoon	Year (2005-07) Winter	Overall season M±SE
<i>B. bengalensis f.typica</i>	17.55±5.89	7.71±0.83	15.93±1.05	13.73±3.04
<i>B.costula</i>	4.71±1.05	1.05±0.28	3.99±0.22	3.25±1.11
<i>M. tuberculata</i>	1.43±0.19	0.77	4.10±0.33	2.1±1.01
<i>Gabbia orcula var.producta</i>	0.27±0.16	0.27±0.05	0.43±0.01	0.32±0.05
Total				19.41

Appendix 13 (viii) Biodiversity indices of Molluscs species of Pond in Comilla during 2005-2007

No.	molluscs species	Av.number of species	n/N	(n/N)2	(n/N)log e n/N	d	e
1	<i>B. bengalensis f.typica</i>	13.73	0.707367	0.500368	-0.244894		
2	<i>B. costula</i>	3.25	0.167439	0.028035	-0.299236		
3	<i>M. tuberculata</i>	2.1	0.108706	0.011817	-0.241230		
4	<i>G. orcula var.producta</i>	0.32	0.016486	0.000271	-0.067679		
Total		19.40	1.000000	0.54	0.85	1.01	0.61

Appendix table:14 Physico-chemical parameters of Ponds during the study period (2005-2007)

Name of the Ponds	Water temp.				Transp.			p ^H			DO			TH		
	Monsoon' 6-7	Winter; 6-7	Summer' 6-7		Monsoon' 6-7	Winter; 6-7	summer' 6-7	monsoon' 6-7	winter; 6-7	summer' 6-7	monsoon' 6-7	winter; 6-7	summer' 6-7	monsoon' 6-7	winter; 6-7	summer' 6-7
Surma	31.00±0.5	22.00±1.00	32.00±1.00		35.00±1.00	46.00±2.00	43.00±1.00	7.6±0.2	8.7±0.2	8.15±0.05	8.05±0.55	8.3±0.01	7.87±0.12	66±1.50	66.5±1.5	55±5
B.baria	29.75±0.25	18.5±0.5	30.5±0.5		27±3	36.5±1.5	41±1	8.8±0.2	9.4±0.2	8.45±0.05	8.25±0.05	7.7±0.2	8.55±0.05	67±1	67±1	69±1
Comilla	32±2	22±1	31.0±1.5		31±1.0	41±1.00	37.5±0.50	8.55±0.05	7.65±0.15	8.1±0.1	8.00±0.2	7.77±0.2	7.65±0.15	62.5±2.5	54±6	49±1
Habiganj	29.5±.25	21.5±0.5	31.5±0.5		29±1.00	39±1.00	36±0	8.35±0.05	8.5±0.1	8.35±0.1	8.25±0.05	6.8±0.8	8±0.1	66.00±2.00	61.00±1.00	59.5±1.5
M.Bazar	31.5±0.5	23.5±.25	32.5±1		36±4	43±3	51±1	8.4±.1	8.55±.15	8.35±0.2	8.55±0.05	8.65±0.05	7.65±0.15	69±1	60±2	61±1
Sylhet																

Appendix table:15 Physico-chemical parameters of Rivers during the study period (2005-2007)

AName of the Rivers	Water temp.				Transp.				p ^H				DO			TH		
	seaso ns	monsoon' 6-7	winter;6- 7	summer' 6-7	monsoon' 6-7	winter;6- 7	summer' 6-7	monsoon' 6-7	winter;6- 7	summer' 6-7	monsoon' 6-7	winter;6- 7	monsoon' 6-7	winter;6- 7	summer' 6-7	monsoon' 6-7	winter;6- 7	summer' 6-7
Surma		28.5±0.7	19.5±0.7	31±1.41	31.00±1.00	37±1.00	35.00±1.00	8.35±0.07	8.5±0.14	8.15±0.07	8.05±0.07	8.35±0.07	8.05±0.07	8.35±0.07	7.8±0.14	69.5±0.7	87.00±1.41	83±1.41
Khusya ra		30.25±0.35	20.5±0.7	31.5±0.7	40.5±1.00	48.5±0.7	45±1.41	8.5±.1	8.35±0.05	8.1±0.01	8.35±0.05	8.45±0.05	8.35±0.05	8.45±0.05	7.6±0.2	79±1	87±1	75.5±0.7
	avera ge																	
Ratna		29.75±0.25	18.5±0.5	31±1	36±2.0	45±1	45.5±0.5	8.05±0.05	8.15±0.15	7.85±0.05	6.87±0.12	7.5±0.1	6.87±0.12	7.5±0.1	7.85±0.05	54.5±0.5	39±1	41±1
	avera ge																	
Titas		29±1	21±1	31.75±0.25	33±1.00	47±1	39±1	8.55±0.05	8.6±0.1	8.35±0.15	8.5±0.1	8.25±0.15	8.5±0.1	8.25±0.15	7.9±0.1	57±1	47±3	52±3
	avera ge																	
Gomti		31.75±	20.75±0.25	32.5±0.5	32.5±0.5	34.75±0.25	40.5±0.5	8.45±0.05	8.51±0.1	8.3±0.1	8.5±0.1	8.3±0.1	8.5±0.1	8.3±0.1	8.00±0.2	68.5±3.5	61.00±0.1	67±7
	avera ge																	

Appendix Table: 16 (i) Pearson's correlation among climatic factors of different seasons and terrestrial mollusc population density of BARD annex forest, Comilla.

	SUMMER	MONSOON	WINTER
<i>R.bengalensis</i>	.945	.985	-.678
<i>G.crocea</i>	.904	.960	-.754
S. attegia	.875	.940	-.795
<i>C.delibrata</i>	.808	.890	-.864
<i>G.gemma</i>	.861	.930	-.811
<i>G.notigena</i>	.354	.496	-.999(*)
A. (L.) gracile	.510	.638	-.993
<i>P.parvus</i>	.712	.813	-.929
<i>M.indica</i>	.733	.830	-.917
<i>F.alte</i>	.911	.964	-.743
SUMMER	1.000	.988	-.401
MONSOON	.988	1.000	-.539
WINTER	-.401	-.539	1.000

* Correlation is significant at the 0.05 level (2-tailed).

Appendix Table: 16 (ii) Pearson's correlation among climatic factors of different seasons and terrestrial mollusc population density of Lawachara reserve forest, Maulivibazar.

	Summer	Monsoon	Winter
<i>A. gigas</i>	-.072 .954 3	-.158 .899 3	.952 .198 3
<i>C. delibrata</i>	.938 .226 3	.964 .170 3	-.672 .531 3
<i>G. crocea</i>	.909 .273 3	.942 .218 3	-.725 .484 3
<i>M. indica</i>	.901 .285 3	.936 .230 3	-.738 .471 3
<i>P. plectopylis</i>	.948 .206 3	.972 .150 3	-.648 .551 3
<i>P. parvus</i>	.933 .234 3	.961 .179 3	-.682 .522 3
<i>S. diplodon</i>	.950 .202 3	.974 .146 3	-.644 .555 3
<i>S. castra</i>	.964 .170 3	.984 .115 3	-.605 .586 3
SUMMER	1.000 .3 3	.996 .055 3	-.373 .757 3
MONNISON	.996 .055 3	1.000 .3 3	-.452 .701 3
WINTER	-.373 .757 3	-.452 .701 3	1.000 .3 3

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed)

Appendix Table: 16 (iii) Pearson's correlation among climatic factors of different seasons and terrestrial mollusc population density of Malnichara Tea garden annex forest, Sylhet.

	SUMMER	MONSOON	WINTER
<i>A. fulica</i>	1.000(**)	0.999(*)	-.463
<i>G. crocea</i>	1.000(*)	1.000(*)	-.489
<i>M. indica</i>	.975	.985	-.649
<i>E. cassida</i>	.973	.984	-.656
<i>C. theobaldinus</i>	.994	.998(*)	-.559
<i>C. pearsoni</i>	.993	.998(*)	-.569
<i>G. notigena</i>	.998(*)	1.000(*)	-.524n
<i>L. (A.) gracile</i>	.966	.978	-.678
<i>P. parvus</i>	.999(*)	.995	-.425
<i>I. plicata</i>	.984	.992	-.613
<i>F. alte</i>	.627	.667	-.981
SUMMER	1.000	.999(*)	-.464
MONSOON	.999(*)	1.000	-.510
WINTER	-.464	-.510	1.000

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Appendix: 17 (i) Chemical properties of Soil in Comilla, Maulovibazar and Sylhet Districts during the study period

Name of the Spot	Ph	OM	K	Ca	Mg	N	P	S	Fe	Mn	Zn
Malnichara anex forest Sylhet	7.10	1.17	0.29	4.30	0.85	10.00	20.00	12.20	46.00	17.00	3.00
Lawachara reserved forest, Maulovibazar	8.80	2.98	0.48	4.34	0.87	0.25	3.21	14.57	47.50	17.70	1.34
BARD anex forest, Comilla	6.70	1.32	0.36	4.20	0.83	0.11	8.5	16.80	45.5	17.50	14.80

Appendix: 17 (ii) Chemical properties of Soil in Rivers in Sylhet, Maulvibazar, Habiganj, B.Baria and Comilla

Name of the spot	p ^H	OM	Ca	Mg	N	P	Cu	Fe	Mn	Zn
		%		Meq/100gm soil				µg / mg soil		
Titas River	5.45±0.05	4.17±0.33	6.85±0.05	2.46±0.33	0.15±0.05	63.33±1.65	2.43±0.00.06	245.4±2.9	27.00±1.4	3.82±0.07
Gomti River	7.25±0.25	6.87±0.62	7.77±0.02	4.04±0.06	0.05±0.01	17.9±0.19	2.08±0.12	82.71±2.41	9.35±1.15	0.56±0.03
Ratna River	6.2±0.03	4.75±0.05	4.75±0.25	2.16±0.04	0.06±0.1	29.08±0.09	1.7±0.09	210.15±4.95	35.65±0.55	2.56±0.07
Surma River	8.25±0.25	1.57±0.04	3.34±0.05	1.15±0.05	0.09±0.01	15.1±0.1	1.34±0.05	150±15	44.6±1.4	1.92±0.18

Appendix: 17 (iii) Chemical properties of Soil in Pond Sylhet, Maulvibazar, Habiganj, B.Baria and Comilla

Name of the spot	p ^H	OM	K	Ca	Mg	N	P	Cu	Fe	Mn	Zn
		%			Meq/100gm soil				µg / mg soil		
Pond in Maulvibazar	7.00±0.2	1.95±0.05	19±0.01	2.25±0.25	.14±0.04	0.05±0.03	14.00±1.00	7.95±0.45	96.5±1.5	10.37±0.12	0.87±0.03
Pond in Habiganj	6.1±0.4	1.65±0.15	21±0.03	3.12±0.37	2.3±0.3	0.08±0.01	24.5±3.5	0.87±0.07	57.85±2.35	53.32±0.92	0.50±0.07
Pond in B.Baria	6.85±0.05	0.52±0.37	21±0.04	3.75±0.15	1.28±0.07	.05±0.02	17.62±1.9	9.8±0.27	108.5±1.5	53.7±1.3	0.57±0.08
Comilla	6.7±0.1	2.25±0.05	0.56±0.04	2.15±0.25	2.26±0.14	0.9±0.1	29.8±0.42	0.79±0.06	49.77±2.47	9.7±0.1	1.26±0.24

Appendix table: 18 Physico-chemical parameters of Ponds during the study period (2005-2007)

Name of the Ponds	Temperature	transparency	pH	DO	TH
B.baria	28.5±3.25	41.33±3.29	8.15±0.31	8.07±0.12	62.5±3.75
Comilla	28.5±3.88	34.83±4.12	8.83±0.27	8.19±0.22	62.5±3.75
Habiganj	28.33±3.5	36.5±2.92	8.1±0.25	7.8±0.1	53.5±5.34
M.bazar	27.5±3.05	34.67±2.97	8.40±0.5	7.61±0.51	62.00±2.08
Sylhet	29.33±3.19	43.33±4.33	8.43±0.06	8.28±0.31	63.33±2.84

Appendix table: 19 Physico-chemical parameters of Rivers during the study period (2005-2007)

Name of the Rivers	Temperature	transparency	pH	DO	TH
Surma	26.33±3.49	34.33±1.77	8.33±0.10	8.06±0.15	79.83±5.29
Khusyra	27.41±3.47	44.67±2.31	8.31±0.11	8.13±0.26	80.5±3.40
Ranaj	26.41±3.97	42.17±3.09	7.95±1.15	7.4±0.28	44.83±4.86
Titas	27.25±3.22	39.67±4.06	8.5±0.07	8.21±0.17	52±2.88
Gomoti	28.33±3.79	35.91±2.39	8.42±0.06	8.26±0.14	65.5±2.29

Appendix table: 20 Monthly maximum and minimum temperatures , humidity and Annual Average Rainfall of North-eastern Region of Bangladesh.

Parameters	Temperature	Min. aver.	Rainfall (mm)(Annual average)	Humidity (%)
Districts	Max. aver.			
Brahmanbaria	30.48±0.28	20.90±0.03	2066±208.49	80.58±0.08
Comilla	30.48±0.28	20.90±0.03	2141.5±542.5	80.58±0.08
Habiganj	30.6±0.70	19.62±0.31	2341.45±163.15	79.75±0.75
Maulvibazar	30.6±0.70	19.62±0.31	2124.48±160.5	79.75±0.75
Sylhet	30.75±0.28	21.12 ±0.3 8	3909±572 .1	76.25±0.25
Sunamganj	30.75±0.28	21.12 ±0.3 8	3909±572 .1	76.25±0.25

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