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Studies on the Freshwater Sponges of Banglades

Islam, Muhammad Rafiqul

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By
MUHAMMAD RAFIQUL ISLAM
B.Sc. (Hons.), M.Sc.

INSTITUTE OF BIOLOGICAL SCIENCES
RAJSHAHI UNIVERSITY
RAJSHAHI 6205
BANGLADESH

June 2009

Dedicated To

Respected Alhazz ***Md. Nurul Islam***

And

Respected Alhazza ***Mrs. Sakhina Khatoon***

My Beloved Parents

DECLARATION

I hereby declare that the entire work submitted as a thesis towards the fulfillment for the Degree of **Doctor of Philosophy** in the Institute of Biological Sciences, University of Rajshahi, is the outcome of my own investigation.

I further mention that the work embodied in this thesis has not already been submitted in substance for any other degree by myself.

Muhammad Rafiqul Islam
Candidate
June 2009.

CERTIFICATE

This is to certify that the thesis entitled "Studies on the Freshwater Sponges of Bangladesh" is suitable for submission for the Degree of Doctor of Philosophy of Rajshahi University, as to its style and content.

Md. Sohrab Ali
Professor
Department of Zoology
University of Rajshahi
Rajshahi 6205

Dr. Md. Abdul Mannan
Professor
Department of Zoology
University of Rajshahi
Rajshahi 6205

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ABSTRACT

Field survey was carried out in different locations of Bangladesh in search of Freshwater Sponge. A total of eight species belonging to five genera are described with illustrations and notes on their ecology. The encountered genera and species are: (i) *Corvospongilla bhavnagarensis* Soota, Pattanayak and saxena, (ii) *Corvospongilla* sp. (iii) *Eunapius crassissimus* Annandale, (iv) *Eunapius carteri* Bowerbank, (v) *Pectispongilla aurea* Annandale, (vi) *Radiospongilla cinerea* Carter, (vii) *Spongilla alba* Carter and (viii) *Spongilla lacustris* Linnaeus. The developmental stages and physiology of *E. carteri* is also reported. Global distribution of the genera of Family Spongillidae reported from Bangladesh are also taken into account.

CHAPTER-1
Introduction

Sponges are a group of aquatic non-chordates generally known as 'Porifera' meaning pore bearers. The sponges occupy a significant position zoologically not only for their sedentary nature but also as a representing group, the possible first step in the formation of metazoans.

Lower invertebrates play a vital role in the food chain. Recent biochemical study reveals its pharmacological values (Myers 1998). Homeopathic medicine 'Spongia' is a product of freshwater sponge (Boricke 1965).

Freshwater sponges are common animals of most aquatic ecosystems. They utilize flagellate choanocytes to pump water through a series of canals. Incoming water enters through ostia, passes through choanocyte chambers and exits through the osculum. Bacteria are filtered from incoming water and large volumes of water can pass through a sponge in a 24-hour period. Due to their simple morphological construction, many cells come into direct contact with the surrounding water as the sponge pumps. Thus, a sponge's mode of feeding results in high levels of exposure to any compound present in the ecosystem. Their role as indicator species of water is important, as they are capable of much morphological modification as a result of certain alternations in the environment (Soota 1991). So sponges are model laboratory organisms to explore the biological consequences of environmental pollution (Hill and Hill 2000).

According to World Trade Organization (WTO) we will not be able to claim any species as our own, if they are not recorded properly from our territory. So, in this alarming situation the total flora and fauna of our country should be explored and recorded properly. First research record on sponges of our territory dates back to 1911 by Annandale. Since then published works on sponges are few.

Annandale (1906-1919) worked on the freshwater sponge fauna of India and began to build the modern foundation on knowledge of spongillid taxonomy.

Soota (1991) recorded Indian freshwater spongillids and cited Annandale and others scientists. In his work he has referred to the sponge fauna of different states of India and also mentioned their global distribution.

Pattanayak (1998) reported 16 species under 9 genera from west Bengal. He reported most works of Annandale and Soota.

From Bangladesh 22 species under seven genera of freshwater sponge were described (Ali and Chakraborty 1992, Das 2009, Islam 2008, Islam, *et al.* 2008, Islam and Chanda 2008, Chanda 2008).

To determine the present status of freshwater sponge species, field level survey is a crying need of the time. This influenced the investigator to find out the actual status of freshwater sponges of Bangladesh.

Sponge: An overview

The body of sponge consists of a jelly-like mesohyl sandwiched between two thin layers of cells. While all animals have unspecialized cells that can transform into specialized cells, sponges are unique in having some specialized cells that can transform into other types, often migrating between the main cell layers and the mesohyl in the process. Sponges do not have nervous, digestive or circulatory systems. Instead most rely on maintaining a constant water flow through their bodies to obtain food and oxygen and to remove wastes, and the shapes of their bodies are adapted to maximize the efficiency of the water flow. All are sessile aquatic animals and, although there are freshwater species, the great majority are marine (salt water) species, ranging from tidal zones to depths exceeding 8,800 metres (5.5 mi). While most of the approximately 9,000 known species feed on bacteria and other food particles in the water, some host photosynthesizing micro-organisms as endosymbionts and these alliances often produce more food and oxygen than they consume. A few species of sponges that live in food-poor environments have become carnivores that prey mainly on small crustaceans (Kabir 2008).

Sponges are known for regenerating from fragments that are broken off, although this only works if the fragments include the right types of cells. A few species reproduce by budding. When conditions deteriorate, for example, when temperatures drop, many freshwater species and a few marine ones produce gemmules, "survival pods" of unspecialized cells that remain dormant until conditions improve and then either form completely new sponges or re-colonize the skeletons of their parents. However most sponges reproduce sexually, releasing sperm cells into the water. In viviparous species the cells that capture most of the adults' food capture the sperm cells but, instead of digesting them, transport them to ova in the parent's mesohyl. The fertilized eggs begin development within the parent and the larvae are released to swim off in search of places to settle. In oviparous species both sperm and egg cells are released into the water and fertilisation and development take place outside the parent's body (Kabir 2001).

Sponges use various materials to reinforce their mesohyl and in some cases to produce skeletons, and this forms the main basis for classifying sponges. Calcareous sponges produce spicules made of calcium carbonate. Demosponges reinforce the mesohyl with fibers of a special form of collagen called spongin, most also produce spicules of silica, and a few secrete massive external frameworks of calcium carbonate. Although glass sponges also produce spicules made of silica, their bodies mainly consist of syncytia that in some ways behave like many cells sharing a single external membrane, and in others like individual cells with multiple nuclei. Probably because of their variety of construction methods, demosponges constitute about 90% of all known species, including all freshwater ones, and have the widest range of habitats. Calcareous sponges are restricted to relatively shallow marine waters where production of calcium carbonate is the easiest. The fragile glass sponges are restricted to polar regions and the ocean depths where predators are rare, and their feeding systems very efficiently harvest what little food is available. Fossils of all of these types have been found in rocks dated from 580 to 523 million years ago. In addition Archaeocyathids, whose fossils are common in rocks from 530 million years ago but not after 490 million years ago, are now regarded as a type of sponge.

It is generally thought that sponges' closest single-celled relatives are choanoflagellates, which strongly resemble the cells that sponges use to drive their water flow systems and capture most of their food. It is also generally agreed that sponges do not form a monophyletic group. In other words, they do not include all and only the descendants of a common ancestor, because it is thought that Eumetazoa (more complex animals) are descendants of a sub-group of sponges. However, it is uncertain which group of sponges is closest to Eumetazoa, as both calcareous sponges and a sub-group of demosponges called Homoscleromorpha have been nominated by different researchers. In addition, a study in 2008 suggested that the earliest animals may have been similar to modern comb jellies. Since comb jellies are considerably more complex than sponges, this would imply that sponges had mobile ancestors and that they greatly simplified their bodies as they adapted to a sessile filter feeding lifestyle. Chancelloriids, sessile, bag-like organisms whose fossils are found only in rocks from the Cambrian period, increase the uncertainty as it has been suggested that they were sponges but their external spines resemble the "chain mail" of the slug-like Halkieriids.

The few species of demosponge that have entirely soft fibrous skeletons with no hard elements have been used by humans over thousands of years for several purposes, including as padding and as cleaning tools. However by the 1950s these had been over-fished so heavily that the industry almost collapsed, and most sponge-like materials are now synthetic. Sponges and their microscopic endosymbionts are now being researched as possible sources of medicines for treating a wide range of diseases. Dolphins also apparently use sponges as tools while foraging.

Features of a sponge body are shown diagrammatically in the figure 1 below:

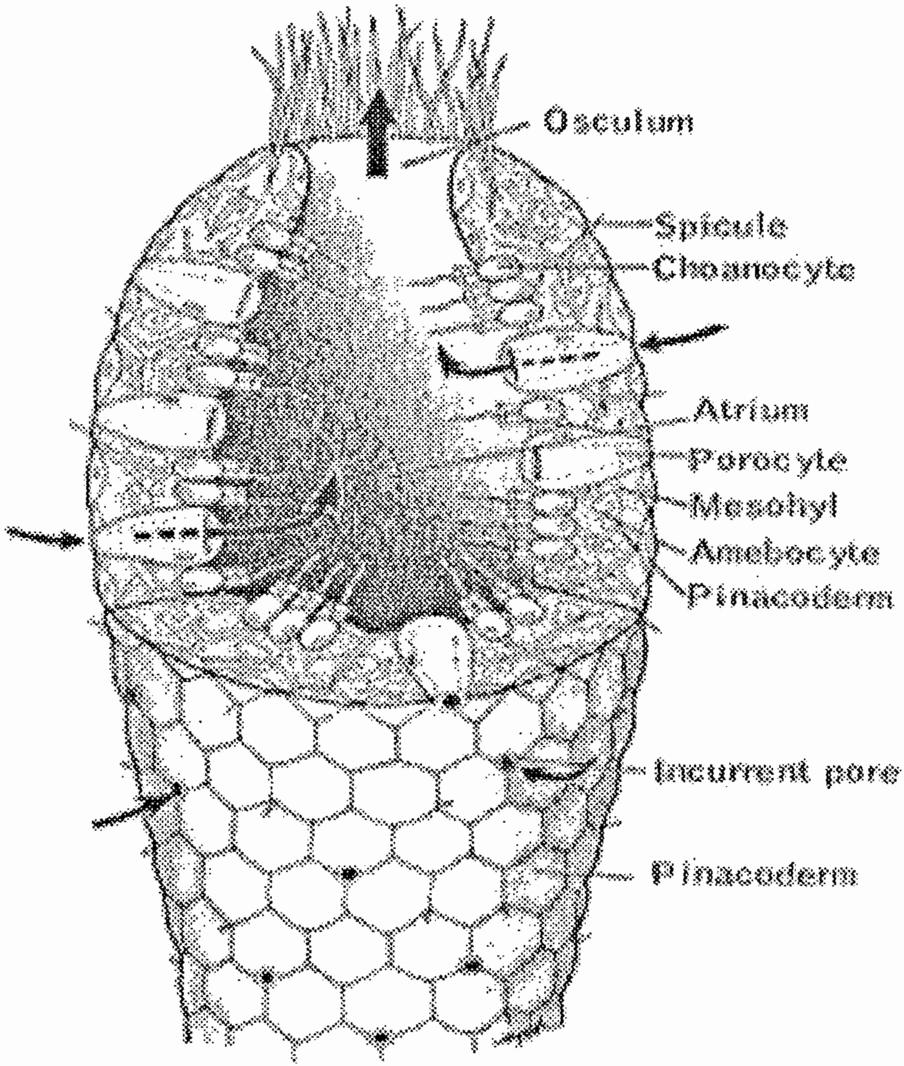


Figure 1. Diagram of the body of a sponge (downloaded)

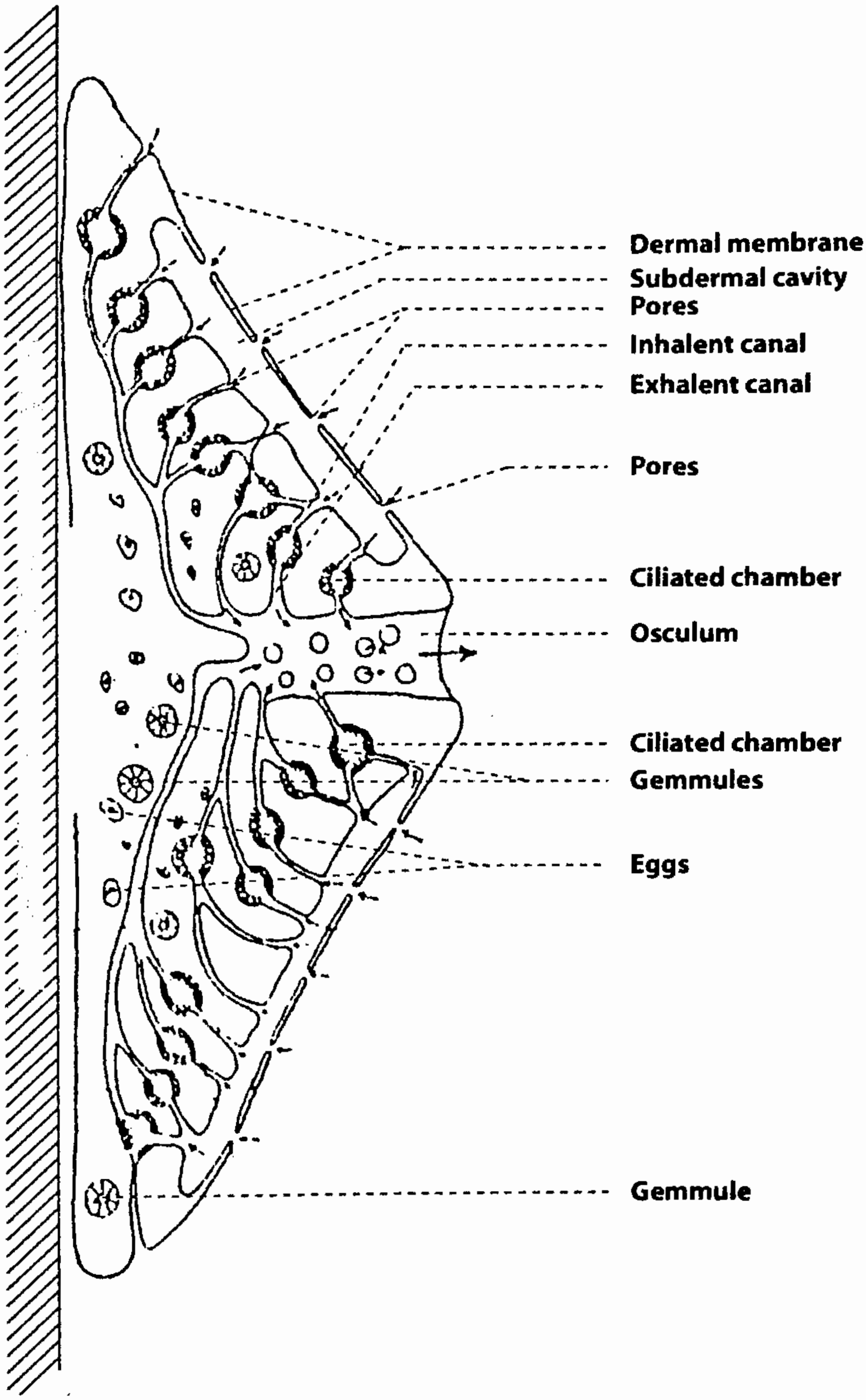


Figure 2. Cross section of a freshwater sponge (adopted from Annandale, 1911 with slight modification).

Bangladesh and wetlands: An overview

Bangladesh

Geological evidence indicates that much of Bangladesh was formed between 1 to 6.5 million years ago during the tertiary era. Human habitation in this region, therefore, is likely to be very old with the evidence of Palaeolithic civilization dating back to about 1,00,000 years.

Bangladesh has an area of 148,393 sq km and occupies the apex of the arch formed by the Bay of Bengal into which all the rivers flowing through the country drain. Bangladesh has one of the most complex river systems in the world numbering about 230 with their tributaries having a total length of about 24,140 km. The climate of Bangladesh is characterised by high temperature and high humidity, heavy rainfall and marked seasonal variations. Daily temperature ranges from 10° C to 12° C in the cool months and in the other months it varies between 28° C and 40° C. Soil of Bangladesh may be divided into three main categories, namely hill soils (Chittagong and Sylhet regions), terrace soils (Barind and Madhupur tracts) and alluvial and flood plain soils.

Figure 3. Satellite Image of Bangladesh showing main land, water bodies and the delta.

Bangladesh contains greater biodiversity than that of many countries.

The landscape of Bangladesh looks like a magical tapestry in green woven intricately by nature. Across the tropic of cancer it lies in the north-eastern part of South Asia between latitudes 20° 34' and 26° 38' north and longitudes 88° 01' and 92° 41' east. The country is bordered by India on the west, north and the northeast, Myanmar on the southeast and the Bay of Bengal on the south. Strategically located Bangladesh is virtually a bridge between south and Southeast Asia. It has a landmass of 1,48,393 sq. km criss-crossed by a network of several major rivers, their numerous tributaries and canals forming a lace of interconnecting channels. In fact, Bangladesh is the largest riverine delta in the world. The extensive river systems are fundamental to the country's economy and the people's way of life. Its low flat alluvial deltaic plains present an enchanting vista of vast verdant green fields sweeping the horizon. Bangladesh has some of the world's most fertile agricultural lands accounting for abundant growth of various crops. The north-eastern and south-eastern parts of the country are dotted with small hills and ridges, their average elevations being 244m and 610m respectively. The highest peak 'Bijoy' in the south-east end of Bandarban district is 1230 meters above the sea level. Thus with its variegated topographical features Bangladesh appears like a vibrant motif splashed with enchanting beauty and serenity.

Topography configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial produce the landscape. Although Bangladesh is a small country, it has a considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers. On the south, there is a highly irregular deltaic coastline of about 600 km fissured by many estuarine rivers and channels flowing into the Bay of Bengal. The alluvial plain is part of the larger plain of Bengal, which is sometimes called the Lower Gangetic Plain. Elevations of the plains are less than 10m above the sea level; elevation further declines to a near sea level in the coastal south.

The hilly areas of the southeastern region of Chittagong, the northeastern hills of Sylhet and highlands in the north and northwest are of low elevations. The Chittagong Hills constitute the only significant hill system in the country. It rises steeply to narrow ridgelines (average 36m wide), with elevation ranging between 600 and 900m above mean sea level. In between the hilly ridges lie the valleys that generally run north to south. West of the Chittagong hills is a narrow, wet coastal plain lying parallel to the shoreline.

Wetlands

The Ramsar definition has been adopted and is being used in Bangladesh. Based on biological and physical characteristics, 39 categories of wetlands were globally identified; of which 30 are natural and nine man-made. However, wetlands of Bangladesh can be classified on the basis of their hydrological and ecological functions and land type.

Geographical distribution of the total area under wetlands in Bangladesh has been variously estimated at seven to eight million hectares, which is about 50% of the total land surface.

According to Akonda and Khan 1994 Types of wetlands and their areas (in sq. km) are open waters: Rivers 7,497, Estuaries and mangrove swamps, 6,102, Beels and haors 1,142, Inundable floodplains, 54,866, Kaptai Lake, 688 and closed water: Ponds, 1,469, Baors (Oxbow Lakes), 55, Brackish-water farms, 1,080, Total, 72,899.

The vast floodplain of the Meghna is an earlier build-up of the lower course of the Old Brahmaputra. Haor basin, a 'large gentle depressional feature' is bounded by the Old Brahmaputra floodplain in the west Meghalaya Plateau's foothills in the north and by the Sylhet High Plain in the east. Its greatest length, both E-W and N-S direction is just over 113 km. Numerous lakes (Beels) and large swamps (Haors) cover this saucer-shaped area of about 7,250 sq km. The sinking of this large area into its present saucer-shaped seems to be intimately connected with the upliftment of Madhupur Tract.

The Ganges-Brahmaputra delta is one of the largest delta in the world. It is noteworthy that the Bangladesh portion of the delta alone occupies about 46,620 sq km that is approximately a little less than one-third of the country's land area (about 32%) including the rivers. The area south of a line drawn along the Ganges and the Padma as far as the lower course of the Feni river in the southeast belongs physiographically to the delta of the Ganges, Brahmaputra (Jamuna) and Meghna rivers. This vast deltaic land can be subdivided into five units, viz. Moribund Delta, Central Delta Basins, Immature Delta, Mature Delta and Active Delta. The Ganges is by far, the greatest builder of the delta and has deposited the sedimints of nearly four-fifths of the total.

Pleistocene upland extends from the Lalmai hills of Comilla district and adjacent low hills in the east through Dhaka and Rajshahi divisions to West Bengal in India. The river systems of the Meghna and the Jamuna trisect the Pleistocene upland, giving rise to three blocks of high lands that exhibit smooth rolling topography. The Barind Tract, the Madhupur Tract (Madhupur Garh), and the Tippera Surface form the three blocks. The Ganges limits the western and the Buriganga and the Dhaleshwari, two distributaries of the Jamuna, the southern extremities of the Pleistocene uplands. In the northern most strip of Rajshahi Division, Pleistocene upland merges with the piedmont of Himalayas and in the district of Mymensing it slopes down to the alluvial plains. Pleistocene upland covers an area of about 10% of Bangladesh, with an average elevation of more than 15m above MSL (mean sea level).

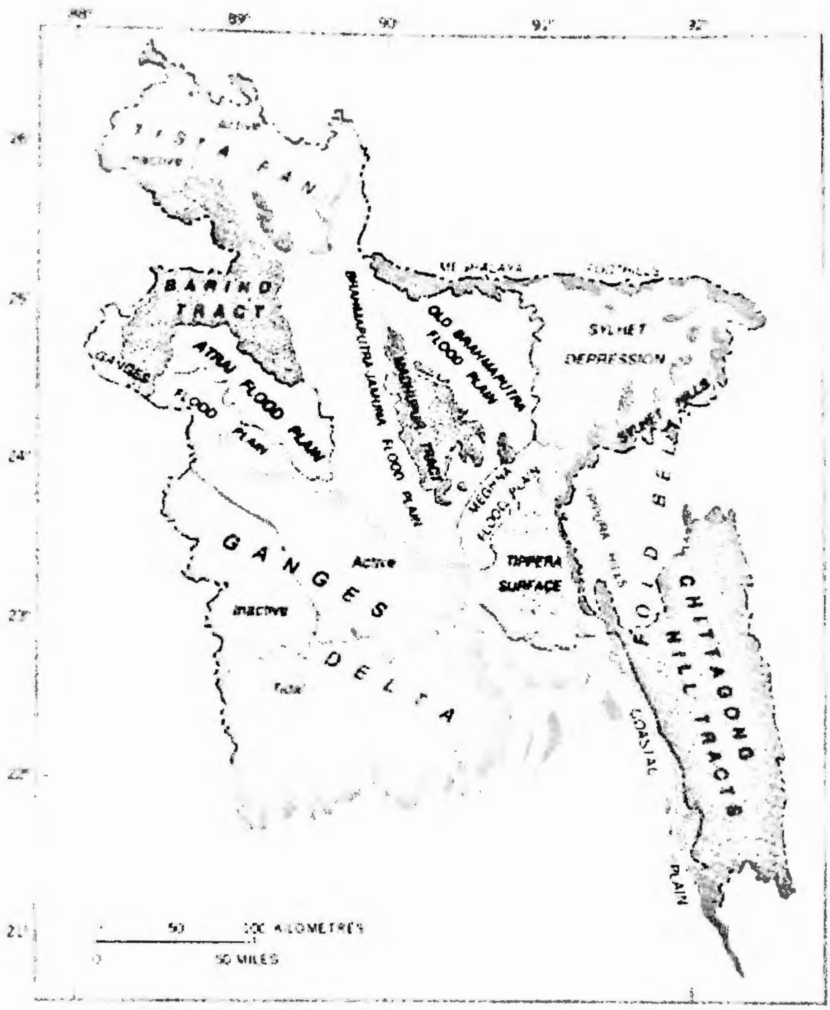


Figure 4. Geological map of Bangladesh.
(Source: Rashid, 1991)

The eastern and northern frontier hilly region represents the hill areas of Bangladesh and comprise two main sub regions – Chittagong Hill Tracts and foot hills of the Shillong Massif. The Chittagong Hill tracts, the only extensive hill area of the country, full of hills, hillocks, valleys and forests, is quite different in aspect from other parts of Bangladesh. The region lies in the southeastern part of the country bordering Myanmar in the southeast and the Indian states of Tripura in the north and Mizorarm in the east. Generally, the hill ranges and river valeys are longitudinally aligned. The coastal plain is partly sandy and partly composed of saline clay; it extends from the Feni river to Cox's Bazar and varies in width from 1 to 16 km. The region has a number of offshore islands and one coral island, St. Martin's island, off the coast of Myanmar. The central portion of the Chittagong Hill Tracks hosts an artificial lake, the Kaptai lake. It covers an area of about 767 sq km in the dry season and about 1,036 sq km in the monsoon.

The foot hills of the Shillong Massif are subdivided into three major tectonic unit from west to east – the Garo Hills, Khasi Hills and Jaintia Hills and lies almost entirely on Indian territory. The southern fringes of this highly elevated block merely form a narrow strip of hills and hillocks in Bangladesh territory (Chowdhuary 2003).

Geographic position, physiographic and topographic variations, hydrographic vastness and climatic peculiarities made Bangladesh an ideal home for Freshwater Sponges.

CHAPTER-2

Review of Literature

Barnes and Bell (2002) described that Sponges assemblages were sampled in four coastal study regions (Malindi, Kenya; Quirimba Archipelago, Northern Mozambique; Ingaca Island, Southern Mozambique and Anakao, Madagascar) in the west Indian Ocean. Sponge species were counted in multiple 0.5m^2 quadrats at depths of between 0 and 20 m at a number of sites within localities of each region. Despite the relatively small areas sampled, sponge samples comprised a total of 130 species and 70 genera of the classes Demospongiae and Calcarea. Sponges are clearly a major taxon in these regions in terms of numbers of species, percentage cover or biomass, although their ecology in the west Indian Ocean is virtually unknown. Nearly half of the genera, e.g. *Iotrochota,* found were species with a so-called Tethyan distribution. Most of the other genera were cosmopolitan, e.g. *Clathria*, but some were cold water (*Coelosphaera*), Indo-Australian (*Ianthella*) or circum-African (*Crambe*). Many of the species encountered in that study occurred in at least two study regions, many in more and could occupy large areas of substratum. Some of these, e.g. *Xestospongia exigua*, are commonly found throughout the Indo-west Pacific region where they also occupy much space. The endemicity of the shallow water sponge faunas in East Africa (20-25%) seem to be high within the Indo-Pacific realm but are lower than northern Papua New Guinea. The tropical regions (Kenya and Northern Mozambique) were more species than subtropical regions (southern Mozambique and Madagascar) but not significantly more diverse. Although latitude was not a major influence on sponge community patterns, hard substratum assemblages did form a cline from the tropics to Southern Mozambique, linked by Madagascar. Substratum nature (habitat) was most important in influencing the suite and number of species present. Sponge assemblages of soft substrata were much more dissimilar, both within and between habitats, than those on hard substrata.

Bell (2002) reported the effect of water flow rate on the regeneration rate of the temperate sponge *Cliona celata.* He observed that two sites experiencing fast and slight current flow respectively at Longh Hyne, Co. Cork, Ireland. Faster regeneration rates were found in sponges living in high current area, which may be due to an increased amount of potential food material per unit time and the possibility of entrained water flow.

A structurally preserved specimen of a freshwater sponge (Spongillidae. gen. et sp indet) is described from finely laminated, siliceous clayey lake sediments of late Oligocene age of the locality Rott (Siebengebirge near Bonn, Germany). The preservation is caused by an early stabilization of the needle skeleton by phosphate minerals. The phosphate replaced the soft parts of the sponge body in its shape (without preserving cellular details) and figures the original structure of the body with central cavity (spongocoel), canals and possibly flagellate chambers (Braun 2001).

Coma *et al.* (2002) observed that the natural respiration rates of suspension feeders in temperate ecosystem were still poorly known. This lack of information constrains their understanding of the functioning and dynamics of benthic marine ecosystems in temperate areas. They examined the *in situ* seasonal variation in respiration rate of three benthic suspension feeders (a sponge, an ascidian, and a gorgonian) in northwestern Mediterranean sublittoral communities using a recirculating flow respirometry system. The *in situ* technique is shown to be highly applicable to seasonal studies of the physiological energetics of benthic suspension feeders. Respiration rates of the three species varied two- to threefold through the annual cycle, exhibiting a marked seasonal pattern but showing no daily cycle or significant day-to-day variability within months. The respiration rate of the sponge and ascidian, active suspension feeders, increased with temperature. The respiration rate of the gorgonian a passive suspension feeder did not correlate with temperature. They estimated a Q10 of 1.1, which indicates that respiration rate in this species is not highly dependent on temperature. Synthesis of new tissue of some Mediterranean benthic suspension feeders, such as gorgonians, does not correlate with temperature, which allowed them to isolate the effects of temperature and synthesis of new tissue on respiration rate. Synthesis of new tissue increased respiration rate of the gorgonian by approximate 40%. The low rate of synthesis of new tissue during summer, together with the contraction of polyps and the low Q10, explains the low respiration rates of the gorgonian observed during the period of the highest temperature. These low respiration rates support the hypothesis that energy limitations may underlie summer dormancy in some benthic suspension feeding taxa in the Mediterranean.

Coutinho *et al.* (1998) reported that Porifera (Sponges) represents the lowest metazoan phylum, probably already existing prior to the 'Cambrian explosion' Based on amino acid sequences deduced from cDNAs that code for structural proteins, the monophyly of Metazoa was established. Now they analyzed for the first time a promoter of a sponge gene for its activity in a heterologous cell system from higher metazoa. The promoter of the homeobox gene EmH-3 was cloned and squenced from a genomic library of the freshwater sponge *Ephydatia muelleri*. For the determination of functional promoter activity, transient transfection experiments in mouse NIH 3T3 cells were performed; the promoter was fused with the luciferase reporter gene. The data revealed that a 401 nt long promoter fragment, comprising several binding elements for metazoan transcription factors showed the highest activity, while the 175 bp long promoter segment, comprising solely the TATA- and Cap boxos, showed only 25% of that activity. This result demonstrates that the sponge promoter is activated by factors present in mammalian cells and supports the view that Porifera, together with the other metazoan phyla, are of mopnophyletic origin.

Davy *et. al*. (2002) described that symbioses between sponges and algae are abundant in the nutrient-poor waters of tropical reefs, yet very little is known of the nutritional interactions that may promote this abundance. They measured nitrogen flux between the sponge *Haliclona cymiformis* and its symbiotic partner, the rhodophyte *Ceratodictyon spongiosum*, and assessed the potential importance of this flux to the symbiosis. While the association can take up dissolved inorganic nitrogen (DIN) as ammonium and nitate from the surrounding sea water, enrichment of the water with nitrate did not affect its rates of photosynthesis and respiration. Much of the DIN normally assimilated by the alga is waste ammonium excreted by the sponge. A nitrogen budget for the symbiosis shows that the nitrogen required for algal growth can potentially be provided by sponge catabolism alone but that only a small amount of nitrogen is available for translocation back to the sponge in organic compounds. The stable isotope composition (delta 15N) was consistent with the sponge supplying excretory DIN to its algal partner, while the results also suggested that this DIN limits nitrogen deficiency in the alga. If the observations are typical of sponge-alga symbioses, then the supply of excretory nitrogen could be a major reason why so many algae form symbioses with sponges on coral reefs.

De Santo and Fell (1996) reported that a survey of Connecticut lakes and rivers revealed the presence of species of freshwater sponge viz. *Spongilla lacustris*, *Ephydatia muelleri*, *Eunapius fragilis*, *Anheteromeyenia ryderi*, *A.argyrosperma*, *Corvomeyenia carolinensis* and *Corvospongilla novaeterrae* in order of decreasing frequency of occurrence. *C. carolinensis* has not been reported previously beyond its type locality in south Carolina. In addition, microscleres of *S. lacustris*, *Anheteromeyenia* – like megascleres, *E. muelleri* like magascleres, and smooth megascleres (amphioxeas), which could not be assigned to particular species were found in surface sediments from lake cores, *S. lacustris* inhabiting small rivers which produce brown, thick capsuled gemmules during the summer and yellow, thin capsuled gemmules during the fall. The thick capsuled gemmules are tolerant of desiccation and populations of *S. lacustris* and *E. muelleri* survived severe drying of their habitats during the summer.

Dunagan (1999) reported *Eospongilla morrisonensis* gen. et sp.nov, the oldest described freshwater sponge (Demospongea:Spongillidae), was found in the Upper Jurassic (Oxfordian/Kimmeridgian to Tithonian) Morrison Formation, east-central Colorado, USA. *E. morrisonensis* occurs within the well-developed lacustrine carbonate succession of the Morrison Formation, and is represented by two micritic body fossils with calcite-replaced magascleres that range in length from 180 to 300 mum and in diameter from 20 to 35 mum. Megascleres are simple oxeas and strongyles and lack apparent ornamentation, possibly due to the digenetic replacement. The oxeas are straight but the strongyles display a slight curvature. Microscleres are absent; gemmoscleres were not observed.

Efremova *et al.* (2002) reported that Lake Baikal, a unique habitat for a great number of endemic species, is the largest freshwater reservoir in the world which is still largely unaffected by anthropogenic pollution, except for some shore regions with industrial activity. The Expressions of a biomarker of exposure heat shock protein (Hsp 70) and a biomarker of effect (DNA single-strand breaks) were measured for the first time in endemic Baikalian sponge species (*Baikalospongia intermedia, Lubomirskia fusifera,* and *Lubomirskia abietna*). Tissue cubes of *B. intermedia* and dissociated cells of *L. fusifera* and *L. abietina* reacted to temperature stress (10-16°C above ambient temperature) with a time-dependent increase in expression of Hsp70. In *B. intermedia,* the effects of model pollutants (lead, copper, and zinc, and the organochlorines tetrachloroguaiacol (TCG), and pentachlorophenol (PCP), and of the wastewater from the final refinement and aeration reservoirs of the Baikalsk Pulp and Paper Plant (BPPP), located at the shore of the southern basin of Lake Baikal. The expression of Hsp70 and the extent of DNA damage were investigated. It was found that lead and zinc but not copper cause a strong induction of Hsp70 in this sponge, while the frequency of DNA single-strand breaks increased after exposure to all these heavy metals tested. Induction of DNA single-stand breaks was also observed after exposure to TCG and PCP, but these compounds did not (consistently) enhance Hsp70 expression. Wastewater taken from the final water aeration pond of BPPP caused a concentration-dependent increase in Hsp70 expression in *B.intermedia*. However, there was no difference in the basal levels of Hsp70 between sponges collected in the shallow water at an unpolluted site near Baikalsk City and at a polluted site where the wastewaters of BPPP are discharged into the lake. There was also no clear difference in the wastewater concentration dependent induction of Hsp70 expression among sponges collected at these sites, indicating no adaptation to continuous stress exposure.

Fabricius and Dommisse (2000) suggested that Coastal reef communities dominated by zooxanthellate alcyonacean octocorals extract large quantities of suspended particulate matter (SPM) from the water column. Concentrations of SPM in water parcels, tracked by a certain drogue, were measured before and after passing over two strips of soft coral dominated, near-shore reefs apprx. 200m long, and over two adjacent sand-dominated strips for comparison. The reefs were covered with 50% zooxanthellate octocorals, 7% hard corals, 15% turf algae with bioeroding sponges underneath, and 1% other filter feeders (sponges, tunicates and bivalves). Downstream of the reef communities, chlorophyll, particulate organic carbon and particulate phosphorus were significantly depleted. The depletion of chlorophyll averaged 35% of the standing stock, whereas the net depletion of particulate organic carbon and particulate phosphorus was 15% and 23%, respectively. Rates of depletion were similar for the two reef sites and 3 sampling periods, and were independent of upstream particle concentration. In contrast concentrations of particulate nitrogen and phacopigments were similar before and after passage across the reef sites. On the sandy sites, downstream concentrations of particulate nutrients, chlorophyll and phacopigments were all similar to upstream concentrations. The net import to particulate organic carbon into the reef was estimated as 2.5 +

1.1g/cm^2. Less than 20 % of this carbon import could be explained by area- specific rates of removal by sponges, tunicates, bivalves and hard corals, suggesting that soft corals were the primary sink of carbon. The data suggest that detritus and other small SPM (<10 m particle size) are an important food source for alcyoniid-dominated reef communities in high turbidity regimes.

There is an urgent need to discover new antimalarials, due to the spread of chloroquine- resistance and the limited number of available drugs described by Fattorusso *et al*., (2002) In the last few years, artemisinin, the endoperoxide sesquiterpene lactone derived from *Artemisia annua* and its derivatives proved to be very active against *Plasmodium falciparum*. These compounds are characterized by an endoperoxide pharmacophore that is critical for their antimalarial activity. There are several reports, of marine organisms, that can be another natural source of stable cyclic peroxides, with selective antifungal or antibacterial activity. With the aim of identifying new bioactive molecules, they evaluated *in vitro* the antimalarial activity of the major cycloperoxides extracted from the sponge *Plakortis simplex*. The six-membered endoperoxide compounds plakonin and dihydroplakortin but not the five-membered cycloperoxide plakortin E, inhibited the growth of cultured *P. falciparum* parasites. The activity of plakortin and dihydroplakortin was significantly higher against chloroquine-resistant than chloroquine-susceptible parasites, following a pattern similar to that of artemisinin. although they were 50-fold less active. Moreover, plakortin and dihydroplakortin showed an additive effect when used in combination with chloroquine. These results support further studies on cycloperoxides of marine origin to characterize their mechanism of action and identify/synthesize new compounds with stronger antimalarial activity.

Finnerty (2001) described that Across major phylogenetic comparisons, the evolution of Hox clusters generally parallels the evolution of axial complexity. Sponges lack a fixed primary body axis and regional axial differentiation. Correspondingly, sponges appear to lack a Hox cluster. Bilaterian animals are characterized, at least primitively, by the presence of an anterior-posterior axis. In many bilaterians, the anterior-posterior axis is finely subdivided into morphologically distinct regions; e.g., consider the many distinct vaertebrae of the human vertebral column or the many distinct body segments of the fruitfly. This axial complexity is encoded in part, by the genes of the Hox cluster. Bilaterians possess form seven to upwards of forty Hox genes which sort into four monophyletic classes (anterior, group-3, central, and posterior). Cnidarians (e.g., sea anemones) display an intermediate stage of axial complexity. Unlike sponges, they possess a fixed primary body axis, known as the oral-aboral axis, with a distinct head, body column, and foot. However, the primary axis of cindarians lacks the degree of axial differentiation found in vertebrates or insects. Cnidarians possess distinct anterior and posterior Hox genes. Cnidarians appear to lack group-3 or central Hox genes. Southern mapping experiments in the sea anemone, *Nematostella* indicate linkage between an anterior Hox gene, an even-skipped ortholog, and a posterior Hox gene. The linkage of eve to a Hox gene, a condition previously described in a coral, is found in vertebrates but apparently absent in insects.

Sponges of the Aplysinidae family contain large amounts of bacteria that are embedded within the sponge tissue matrix. In order to determine the stability and specificity of the Aplysina-microbe association, sponges were maintained in reciruclating seawater aquariums for 11 days. One aquarium was left untreated, a second one contained 0.45 mum filtered seawater (starvation conditions) and the third one contained 0.45 mum filtered seawater plus antibiotics (antibiotics exposure). Changes in the microbial community were monitored using group specific 16S rRNA targeted oligonucleotide probes, by denaturing gradient gel electrophoresis and by electron microseopic observations. Furthermore, the changes in the natural product profile were monitored using high-performance liquid chromatography. The measured parameters showed that a large fraction of the sponge-associated microbial community could not be cleared under the given experimental conditions. Based on these cumulative results they postulated that a large fraction of sponge-associated bacteria had resided permanently in the *Aplysina aerophoba* mesohyl pointing to a highly integrated interaction between the host sponge and asociated microorganisms reported by Friedrich *et al.*, (2001).

Frost *et al.* (1997) described a symbiotic relationship between the freshwater sponge *Corvomeyenia everetti*, which occurs throughout eastern North America and a yellow green alga. Studying on ultrastuctural and pigment analyses place the algal endosymbiont within the class Eustigmatophyceae in the division heterokontophyta. The relationship of the alga with *C. everetti* appears to be specific and it contributes significantly to the energy budget of the host. Although the growth form of *C. everetti* is very similar to other freshwater sponges that usually have green algal symbionts, its phylogeny has been proposed to be quite distinct, suggesting convergent evolution by both algae and sponges in the development of symbiotic associations in fresh water.

Gab Alla *et al.* (2000) investigated the antibacterial and anticandidal activities of sponges collected from the southern part of the Gulf of Aqaba. Methanol extracts of ten sponge species were tested against six test microorganisms: Gram-positive bacteria *Bacillus subtilis* and *Staphylococcus aureus*; the Gram-negative bacteria *Escherichia coli* and *Proteus vulgaris* and the yeasts *Candida albicans* and *C. tropicalis*. Three species only name *Acanthella carteri, Ircinia felix* and *I. strobilinia* had broad spectrum antimicrobial activity. On the other hand, growth promotion was stimulated by *I. felix* towards *E. coli*. Investigating different bioactivity of sponges may open new avenues for introducing novel marine compounds into pharmaceutical industry. Also, screening the inhibitory or promoting activities of sponge extracts may reflect the ecological mechanisms of fouling organisms settled on the sponge substratum.

Golladay *et al.* (1997) studied limesink wetlands which are a common aquatic habitat in Southwest Georgia, USA. These wetlands are non-alluvial, occupying shallow depressions formed from dissolution of limestone bedrock and collapse of surface sands. They are seasonally inundated, with a typical hydroperiod extending from late February to early July. Little is known about factors influencing invertebrate community structure in limesink wetlands. The authors suggested that regular inundation and drying are important influences on community structure in some seasonal wetlands. They had an opportunity to examine this hypothesis in three forested limesink wetlands. Quantitative samples of invertebrates were taken monthly on benthic and wood surfaces from march 1994 through July 1995. This included a period of unusually heavy precipitation, summer and autumn of 1994, when the wetlands would normally be dry. Immediately following inundation, benthic samples were dominated by amphipods (*Crangonyx* sp.) isopods (*Caecidotea* sp.), cladocerans and copepods. Maximum total densities (1000-4000 individuals per m^{-2}) were observed within three months of inundation. During summer and autumn, densities decreased (1 to 5000 individuals per m^{-2}) and the benthos was dominated by larval chironomids. Wood surfaces were dominated by chironomids, with greatest densities (1000-3000 individuals per m^{-1}) observed in summer and autumn. Although not quantified, freshwater sponges became very abundant on wood surfaces during autumn. During the following spring (1995), invertebrate densities on sediments remained low, and few amphipods, isopods, cladocerans, or copepods were collected. Chironomids remained very abundant on wood. These results suggest that extended inundation was a disturbance to some elements of wetland invertebrate communities. Extended inundation might have caused short term reductions in populations by eliminating summer refugia (amphipoda, isopoda) or by altering environmental cues necessary for the completion of life cycles (cladocerans, copepods).

The total synthesis of two cytotoxic sponge alkaloids, hachijodines F (1) and G (2) via a common intermediate 3 was described by Goundry *et al.* (2002)

Handa *et al.* (2001) studied the aerial algae in the vicinity of the Irkutsk and Listvianka areas in the southwestern portion of Russia's Lake Baikal and found the only species of aerial algae considered to be related to the symbiotic algae of freshwater sponges, *Hemichloris* sp.

Hill *et al.* (2002) examined toxic effects of three substances (ethylbenzene. nonylphenol and bisphenol A), that are known to be hormonally active in many animals, on growth and development of two species of freshwater sponges. A common developmental abnormality was observed when sponges were treated with each of these compounds. These compounds also caused significant reductions in growth rates. Lower concentrations resulted in malformed water vascular systems in several replicates. The utility of freshwater sponge bioassays is discussed as it relates to understanding possible mechanisms of action of endocrine disrupters on aquatic invertebrates.

Using data from the North Temperate Lakes Long-term Ecological Research site in northern Wisconsin, a series of examples illustrated how landscape setting can influence the static and dynamic aspects of many physical, chemical and biological properties of lakes. (1) One important landscape attribute was the hydrologic position of a lake within the regional flow regime. Lake position determines the relative importance of groundwater and precipitation input to a lake, with lakes high in the landscape receiving a greater proportion of their input waters from precipitation, than lakes lower in the landscape. (2) Landscape position was strongly correlated with the concentration of calcium and magnesium ions. Landscape position also influences the lakes to respond to drought conditions. Lakes high in the landscape responded to a 4-year drought with decreases in calcium mass, whereas lakes low in the landscape increased in mass of calcium. During extended dry conditions, these differential responses of lakes suggest that lakes already low in calcium (i.e. in a high position in the flow system) will have further reductions in calcium concentrations. These reductions could decrease the number of lakes offering suitable condition for organisms such as crayfish and snails whose distributions are limited by calcium. (3) Landscape position also affect silica concentrations in lakes, with lakes low in the landscape having silica concentrations up to three orders of magnitude greater than lakes high in the landscape. Differences in silica concentration affect robustness of freshwater sponge spicules which can potentially alter some aspects of the dynamics of littoral zone food webs. (4) Landscape position can influence the vertical distribution of primary production. Concentrations of dissolved organic carbon are affected by landscape setting and can influence vertical light penetration, thus affecting the depth at which primary production can occur. (5) Lake area and fish species richness are correlated with landscape position; larger, species-rich lakes are low in the landscape whereas smaller lakes with fewer species tend to be high in the landscape. (6) By Taking a landscape-scale view, in addition to the more usual lake specific view, it is possible to reach a more robust understanding of lake dynamics and to avoid some of the problems associated with extrapolating from single lake. The above mentioned results were reported by Kratz *et. al*. 1997.

Loomis *et al.* (1996a) showed that post diapausing gemmules of the freshwater sponge *Eunapius fragilis* were found to contain sorbitol and glycogen as their primary carbohydrates. The sorbitol, probably acts to increase the tolerance of the gemmules against freezing and desiccation. During gemination, average sorbitol levels measured as micromoles of sorbitol per gram of fresh weight of gemmule tissue (mμ-ml/gfw)- declined from a control value of 36 mμ-mol/gfw to about 4 mμ-mol/gfw. Concomitantly, average glycogen levels increased from a control value of 29 mμ-mol/gfw to a steady static level of 62 mμ-mol/gfw. It is probable that glycogen is being synthesized at the expense of sorbitol. The break down sorbitol was associated with an increase in the activity of sorbitol dehydrogenase from undetectable levels in dormant gemmules to a maximum of 0.2 mμ-mol/gfw. cntdot mg-protein after 30 hour of exposure to 20^0C. Aldose reductase activity remained constant throughout germination.

Post diapause gemmules of the freshwater sponge *Eunapius fragilis* remained quiescent when maintained at 5^0C (Loomis *et al.*, 1996 b). Germination occurred within 48 to 72h following warming to 20^0C to 23^0C, culminating with the emergence of a new sponge from the collagoenous capsule. Both heat dissipation and oxygen consumption raised steadily during germination and eventually reached 6 times of the starting values. By comparison, energy flow was much lower over the same period of time in diapausing gemmules, clearly demonstrating metabolic depression during diapause, which suggests that gemmules may have experienced hypoxia during the more than 3 months of storage at 5^0C prior to experiments. The increase in metabolism during germination could be blocked by perfusing the gemmules with nitrogen saturated medium (nominally oxygen free). Developing gemmules were able to survive oxygen limitation for several hours at least; during that time energy flow was depressed to 6% of normoxic values.

Melao Maria da Graca G. and Rocha Odete (1998) reported that in an ecological study of the freshwater sponge, *Metania spinata* (Metaniidae), in Lagoa Dourada reservoir, river Lobo watershed, Brazil, was found substantial seasonal variation in biomass and productivity and related them to environmental variables (climatic and hydrologic). Sponges were sampled monthly by the quadrat technique from march 1989 to April

1990, at two sites near the dam in order to estimate the seasonal population dynamics. Biomass peaks were found in spring / summer, with gemmulation occurring from march to September (autumn / winter). The minimal production of *M. spinata* during the period of study was estimated as the difference between the highest and the lowest biomass, 33.54 gram Ash Free Dry Mass (gAFDM) m-2 yr-1, yielding a Productivity of Biomass (P/B) ration of 2.72.

Gemmules of *Ephydatia muelleri*, exposed to anoxic conditions (nitrogen) in sealed glass amplues, generally showed no differences from oxic controls in hatchability or hatching rate over exposure periods of 1 to 112 days. Unlike controls, hatching was totally inhibited under anoxia at +20^{0}C, which revealed that probably many freshwater sponges including *E. muelleri* can survive seasonal anoxia in the gemmule stage. High rate of gemmule survival under nitrogen gas also permits them to be stored and transported without regard for external temperature. These results are consistent with existence of an ametabolic state under anoxia, but much more detailed work is needed to prove this conjecture (Reiswig and Miller 1998).

Richelle, *et al.* (1996) showed that total genomic DNA of the four freshwater sponge species common in Belgium, *Ephydatia fluvialilis*, *E. muelleri*, *Spongilla lacustris* and *Eunapius fragilis* was isolated and restricted by the Eco R1 endonuclease. Southern blot hybridization with a radiolabelled *E. fluviatilis* homeobox (EfH-1) revealed hydridization bands in the four species studied. Two restriction fragments of 2.2 kb and 5.4 kb were identified in *E. fluviatilis* and *E. muelleri* DNAs, whereas in *S. lacustris* and *Eunapius fragilis* DNAs, only one fragment of 2.3 kb was detected. These results demonstrate the existence of homeoboxcontaining genes in the four species. With Eco R1, no differences were observed between *E. fluviatilis* and *E. muelleri*, nor between *S. lacustri* and *E. fragilis*. It is suggested that *S. lacustris* and *E. fragilis* might be taxonomically related to each other as closely as are *E. fluviatilis* and *E. muelleri*.

The protein tyrosine kinases (PTKs) diverged specifically in animal lineages by gene duplications and domain shufflings to form a large protein family comprising diverse subfamilies with distinct domain organizations and functions. On the basis of a phylogenetic tree inferred from a comparison of the shared kinase domains, they previously showed that gene duplications that gave rise to diverse subfamilies predate the divergence of parazoans and eumetazoans. There is, however, still a possibility that, although the kinase domain duplications are ancient events, the domain shufflings that gave rise to diverse subfamilies predate the divergence of parazoans and eumetazoans. There is, however, still a possibility that, although the kinase domain duplications are ancient events, the domain shufflings that gave rise to different subfamilies with distinct domain organization are more recent event than the kinase domain duplications. To clarify this problem, they have determined the complete sequences of 15 sponge PTKs and have compared the domain organizations of these sponge PTKs and those of eumetazoans. For each of ten sponge PTKs out of 15 analyzed here, a possible eumetazoan (human and *Drosophila*) ortholog has been identified. The sponge and eumetazoan orthologs are virtually identical in domain organization and belong to the same subfamily in the PTK family tree for each of ten orthologous pairs, except for one subfamily in which a considerable deletions and/or insertions of domains are observed. This result suggests that most, if not all, of the domain shufflings, together with gene duplications, are very old, going back to dates before the parazoan-eumetazoan split, the earliest divergence among extinct animal phyla described by Suga *et al.* (2001).

Periodical survey of the growth of an intertidal encrusting sponge *Halichondria okadai* was conducted on a rocky intertidal shore on the Izu Peninsula, southern Japan by Tanaka (2002). The area covered by each of 16 marked sponges was monitored, and the fusion and fission of specimens were recorded from June 1995 to June 1998. During the investigation, 15 of the original specimens managed to survive accompanying fusions or fissions and only one colony completely disappeared. Ten fusions and 23 fissions were observed in total. The maximum death rate during a semilunar period was 16.7% and cumulative mortality throughout the study period was 46.1%, indicating that the mortality of *H. okadai* is lower than that of other species previously reported. There was no particular seasonal pattern in the occurrences of fusion, fission and death of sponges. However, fissions were frequently observed in the latter half of the study period and were sometimes followed by fusions or death of specimens. Positive growth rates were often observed during warmer months, and specimens showed little growth or regression in winter. Seasonal patterns in surface area were thought to be related to seasonality in reproductive activity.

Tasdemir *et al.* (2002) investigated the detailed chemical analysis of a Philippine marine sponge *Smenospongia* sp. This study yielded four new metabolites, (1) 5-bromo-L- tryptophan (2) 5-bromoabrine, (3) 5,6-dibromoabrine and (4) 5-bromoindole-3- acetic acid in addition the pyrroloiminoquinone alkaloid, (5) makaluvamine 0 as well as (6) 5,6-dibromotryptamine, (7) aureol and (8) furospinulosin 1 were also isolated. Although 1 and 4 have been synthesized previously, this is the first report on the isolation of these compounds from a natural source. The furanosesterterpene furors, pinulosin 1 was obtained for the first time from the genus *Smenospongia*. The structures of all compounds were established by spectroscopic methods (UV, IR, ID and 2D NMR, MS, (alpha)D). The cytotoxic potential of 1-8 was evaluated in a panel of isogenic HCT-116 human colon tumor cell lines.

Volkmer and Rutzler (1997) suggested that characteristics found during a review of the type material of *Spongilla (Stratospongilla) raceki* Rutzler from New Caledonia point to a new, monotypic genus, *Pachyrotula*. This new genus is closely related to *Heterorotula* Panney & Racek and to *Houssayella* Bonetto & Ezcurra De Drago. *Heterorotula* also occurs in New Caledonia and is represented by the new species *H. caledonensis* and *H. multidentata* (Weltner). These species, along with *Oncosclera diahoti* (Rutzler), new combination, are indicators of a rare and particular freshwater sponge fauna of this island.

Hermit crabs (Decapoda: Anomura) are typically omnivorous and are common on Caribbean coral reefs. Sponges are sessile, fleshy and high in protein and energy content, yet hermit crabs do not appear to prey on them. Assays were performed with the Caribbean reef hermit crab *Paguristes punticeps* to determine whether secondary metabolites or skeletal elements of Caribbean sponges that were incorporated into artificial foods affected feeding. Of 30 sponge species assayed, 26 (87%) yielded organic extracts that deterred feeding by *P. punticeps*. There was substantial interspecific and intraspecific variability in patterns of chemical deterrence. Sponges of the families Axinellidae, Agelasidae, Apysinidae, Aplysinellidae, and Thorectidae typically yielded deterrent extracts. Three common sponge species, *Mycale laevis*, *Callyspongia* *vaginalies*, and *Niphates erecta*, were consitently non-deterrent, while ohter species, including *Spheciospongia othella*, *Chondrilla nucula*, *Callyspongia plicifera*, *Niphates digitalis*, and *Xestospongia muta*, were variably deterrent. These results are in general agreement with those of a previous survey of Caribbean sponge chemical defenses using the common reef fish *Thalassoma bifasciatum*. However, some results differed: *Geodia neptuni* and *Lotrochota birotulata* were consistently palatable to *T. bifasciatum*, but were deterrent to *P. punticeps*. Several species that were consistently deterrent to *T. bifasciatum* were variably deterrent to *P. punticeps*, including *Aplysina cauliformis*, *A. fulva*, *Ircinia strobilina*, *Amphimedon compressa*, and *Mycale laxissima*. Neither spicules (from *Agelas clathrodes*, *Ectyoplasia ferox*, and *Xestospongia muta*) nor spiculated spongin skeleton (form *A. clathrodes* and *X. muta*) deterred feeding by *P. punticeps*. Spicules and spiculated spongin were similarly non-deterrent to the fish *T. bifasciatum* in a previous survey. The results of this study further suggest that chemical defenses are important in the ecology of Caribbean sponges, while skeletal components do not serve an antipredatory function reported by Waddell and Pawlik 2000.

Yamada, (2002) described that the discovery and total synthesis of bioactive marine natural products conducted in the laboratory. Aragusterols, isolated from the Okinawan marine sponge *Xestospongea* sp., are structurally unique steroids possessing a rare 26,27-cyclo structure in the side chain. Aragusterols express potent *in vivo* antitumor activity against L1210 leukemia in mice. The synthesis of aragusterols was carried out via stereos/elective construction of the side chain and stereo controlled coupling reaction with the steroid skeleton.

Different types of advanced research work are going on with sponges throughout the world. But this is ignored in our country. The investigator tries to open a new vista and draw attention of the new researchers to come forward in this field with new ideas.

CHAPTER-3

Material and Methods

Description of collection sites

The sites for collecting Freshwater Sponges were selected as:

- In Rajshahi there were five collecting spots namely (i) West lake, Rajshahi University Campus (ii) Rajshahi Police Line pond near the Padma, (iii) Water Development Board pond, Sopura. (iv) Charghat ponds. (v) The Padma on the Rajshahi City.
- In Chapai Nawabgonj (vi) Mahananda river. (vii) Dafiaalbala pond, Sona Masjid.
- In Barisal there were mainly two collecting spots namely (viii) Kashipur fish farm ponds and (ix) Govt. B M. College campus ponds.
- In Kishorgonj: (x) Dhaleshwary river.
- In Sylhet Division: (xi) Hakaluki Haor.
- In Munshigonj: (xii) Water Development Board Training Centre pond at Bhagyokul.
- (xiii) Chalan Beel.
- (xiv) The Banar, Kapasia, Gazipur.

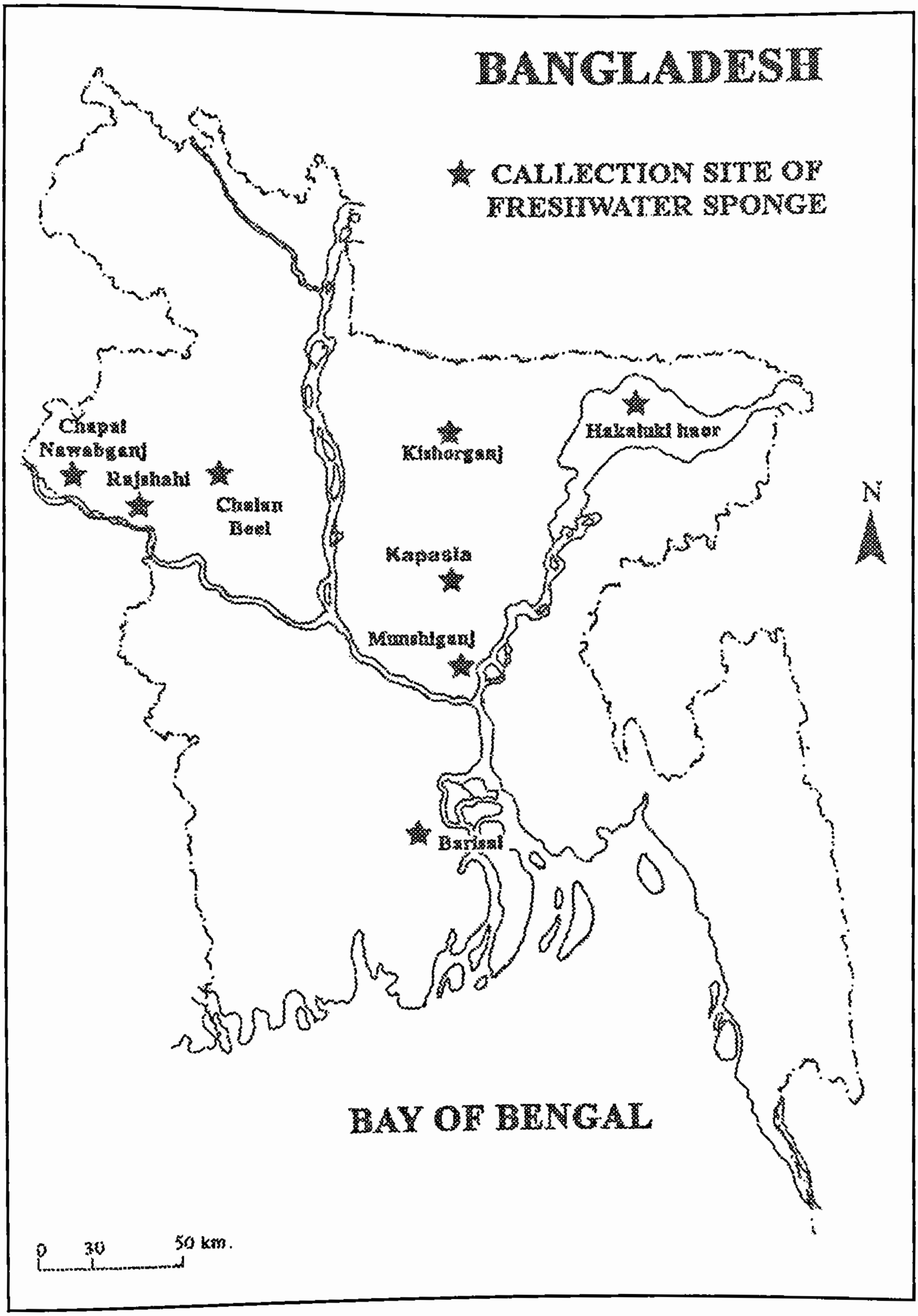


Figure 1. Sites for collecting Freshwater Sponges.

i) West lake, Rajshahi University campus, Rajshahi

The study reservoir named 'West lake' of Rajshahi University campus is in Rajshahi District, Bangladesh. It is situated in the west residential area, behind building number 75 and 76 and in front of building number 77 and 78. This lake was excavated before land acquisition for the University. Then it was a rectangular pond north-south-wardly in direction, named Nazir member's pond. After land acquisition for the University in 1951, the pond was re-excavated in 1953 according to the master plan into east-west-wardly direction. Excavated soil was utilized for building the embankment and adjacent road. Present size of the said lake is 59.7m×183m and used mainly for pisciculature and domestic purposes.

As extensive research work was carried out at Rajshahi, so the location map of study area is shown below:

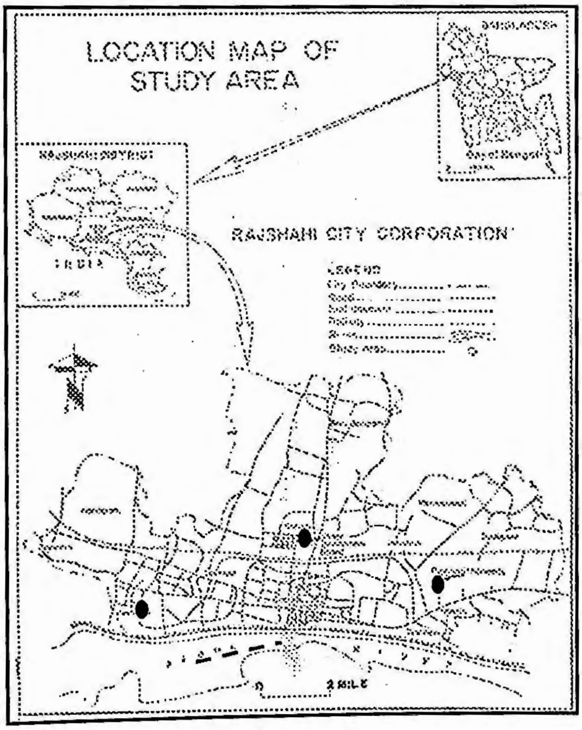


Figure 2. i) 'West Lake', Rajshahi University Campus, Rajshahi,
ii) Police line pond, Rajshahi.
iii) Water Development Board pond, Sopura.
v) The Padma on the Rajshahi City.

ii) Police line pond, Rajshahi

There is a big pond near the mosque of Rajshahi police line, but there is another one which is smaller in size and rectangular in shape. It is situated near the north gate of police line. It is separated from the Padma merely by a road and the city protecting embankment which runs from east to west. The bank of this small pond is very high in respect to nearby area and the road, which runs north southward direction up to the north gate. Its area is 12.2m×12.2m. The bank is very steepy. *Phyllanthus reticulatus* grows profusely on the bank. There is no staircase. Boulders and brick block are used instead of it. It is rain fed and in dry season water recedes nearly to its bottom. (Figure No. 2)

iii) Water Development Board pond, Sopura, Rajshahi

The Water Development Board, Rajshahi is situated at Sopura on the opposite side of the stadium near Rajshahi Railway station. A big pond is situated in front of the office building on south side but it is uninhabited by any sponges, but sponges were found in the pond situated west of the office building and Executive Engineer Quarter. The north bank has concrete embankment as a road runs East West ward, the other 3 banks are earthen bank. Staff quarters lie on the south and west bank. The east bank has the brick wall of the Executive Engineers' quarters. It is nearly a rectangular pond of 111.3m×109.7m in size. Its water is used for bathing, washing and other house hold purposes. As it is a rain-fed pond, it nearly dries out in dry season and fills up to the brim in rainy season. This pond is the harbor of many types of freshwater sponges (Figure No. 2)

iv) Charghat pond

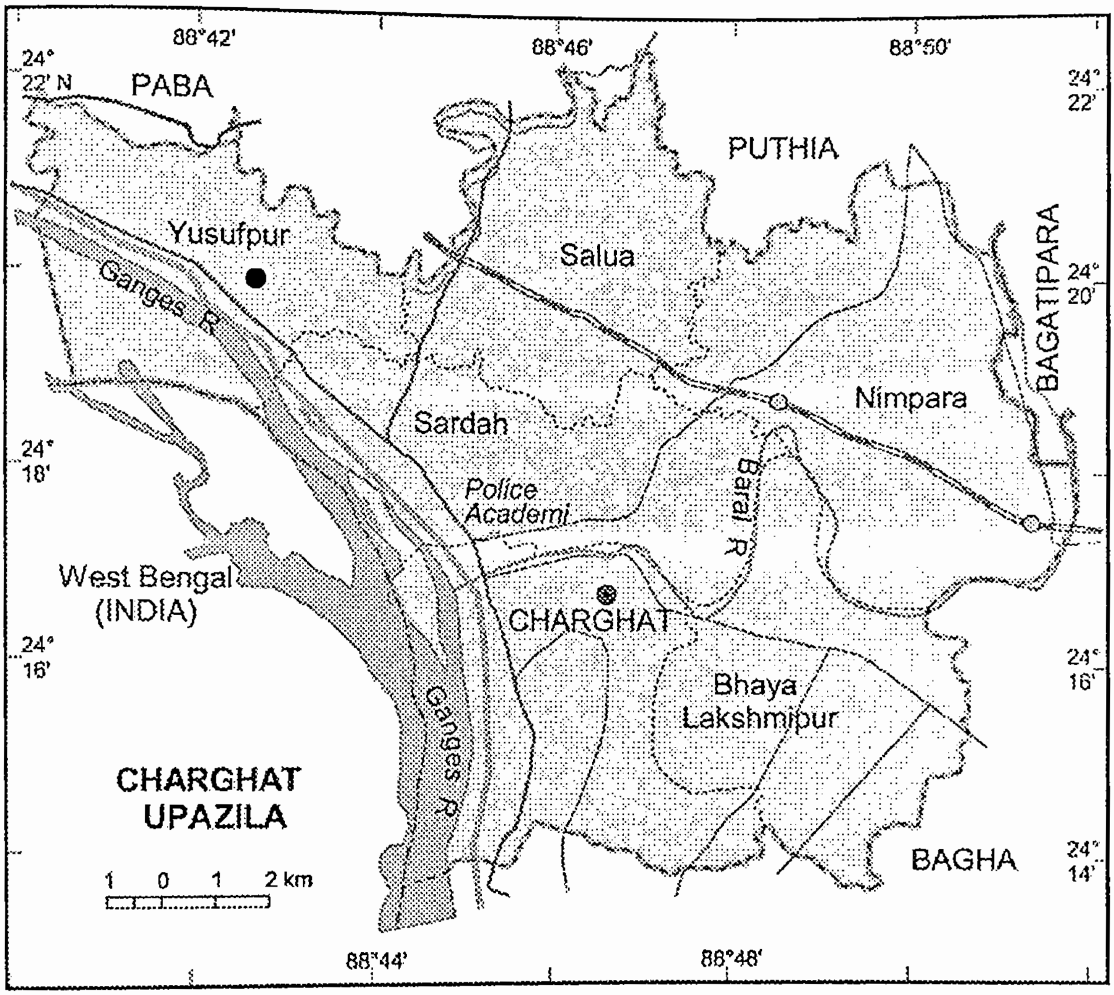


Figure 3. The Map Showing Baduria village, Yusufpur, Charghat, Rajshahi.

Generally all the ponds are used for semi intensive pisciculture now a days. It destroys the natural habitat of sponges. But a few ponds are left derelict for economic constrains. Such a pond was found in Baduria village under Charghat Upazilla of Rajshahi. Its location is about 1.5 km. away from Yousufpur College. Though the pond is rain fed, it retains water in the dry season also.

v) The Padma on the Rajshahi City

An extensive search was carried out for Freshwater Sponges from 'I' embankment to 'T' embankment in the Padma with fishermen.

vi) Mahananda river, Chapai Nawabgonj

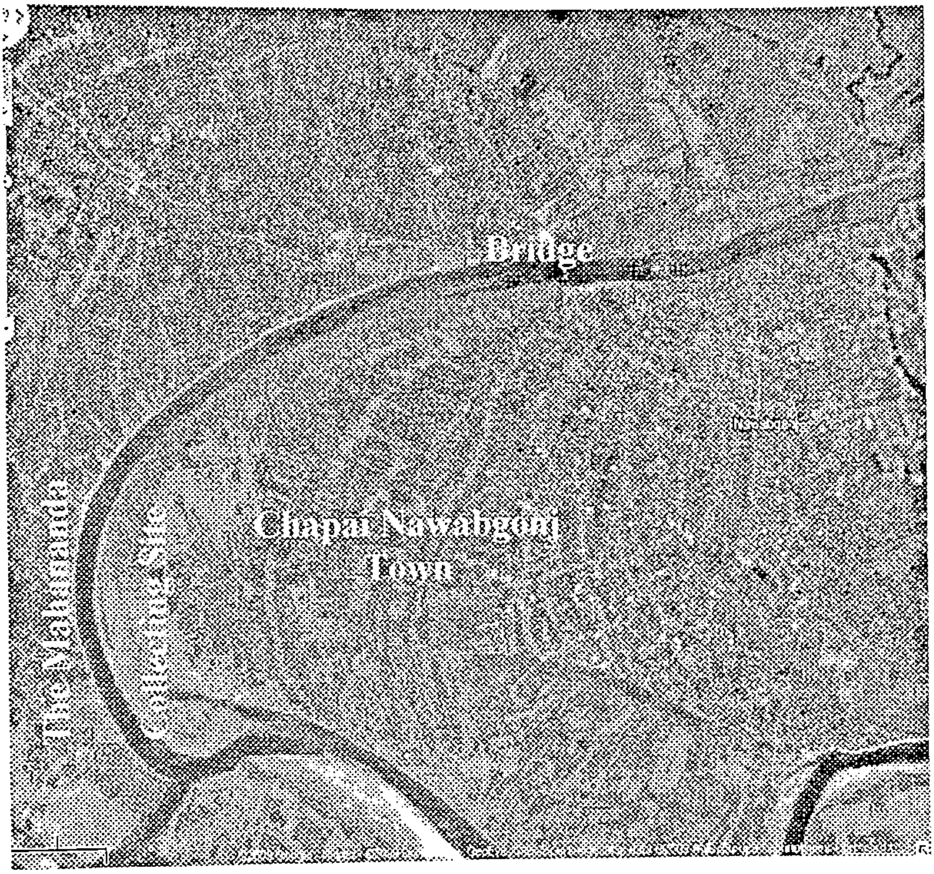


Figure 4. Mahananda river of Chapai Nawabgonj Sadar.

The Mahananda runs along the side of Chapai Nawabgonj town and it is bow shaped there. It runs from India and meets the Padma in Bangladesh at Godagari. It inundates both of its banks in the rainy season, but chars expose in dry season.

vii) Dafiaalbala pond, Sona Maszeed, Chapai Nawabgonj

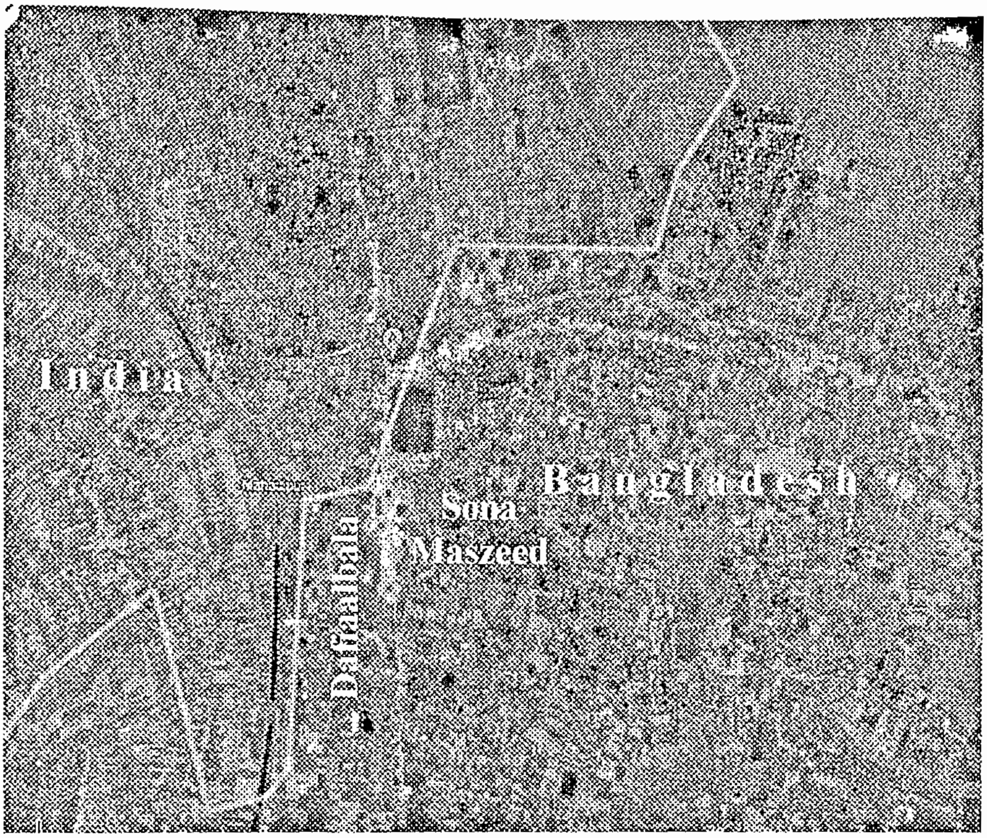


Figure 5. Dafiaalbala (Ailment dispose pond), Sona Maszeed.

This magnificent big pond is situated at the shrine of Hazrat Syed Shah Niamat Ullah (R:) It is situated 1.5km. from the land port –Sona maszeed and 0.5km. west of Sona maszeed mosque. A three storied Tahakhana (warm house), a mosque and the tomb of Hazrat Syed Shah Niamat Ullah (R:) are situated on the west bank of this pond . There is a mango orchard on the north bank. A primary school stands on the south –west corner of the pond. The south-east corner and the south bank of the pond is inhabited by rural people. Rest of the east bank is nearly barren. There is a staircase in front of the mosque and north near side of Tahakhana. It is an archeological site.

viii) Kashipur fish farm ponds

The fish farm under Ministry of Fishery and Livestock in Barisal district is situated at Kashipur. There are 11 ponds; of these two comprise 0.66 decimals, six comprise 0.33 decimals and three ponds comprise 0.15 decimals each. All the ponds are not in use for pisciculture, though sponges generally get eliminated form those water bodies where intensive pisciculture is practiced.

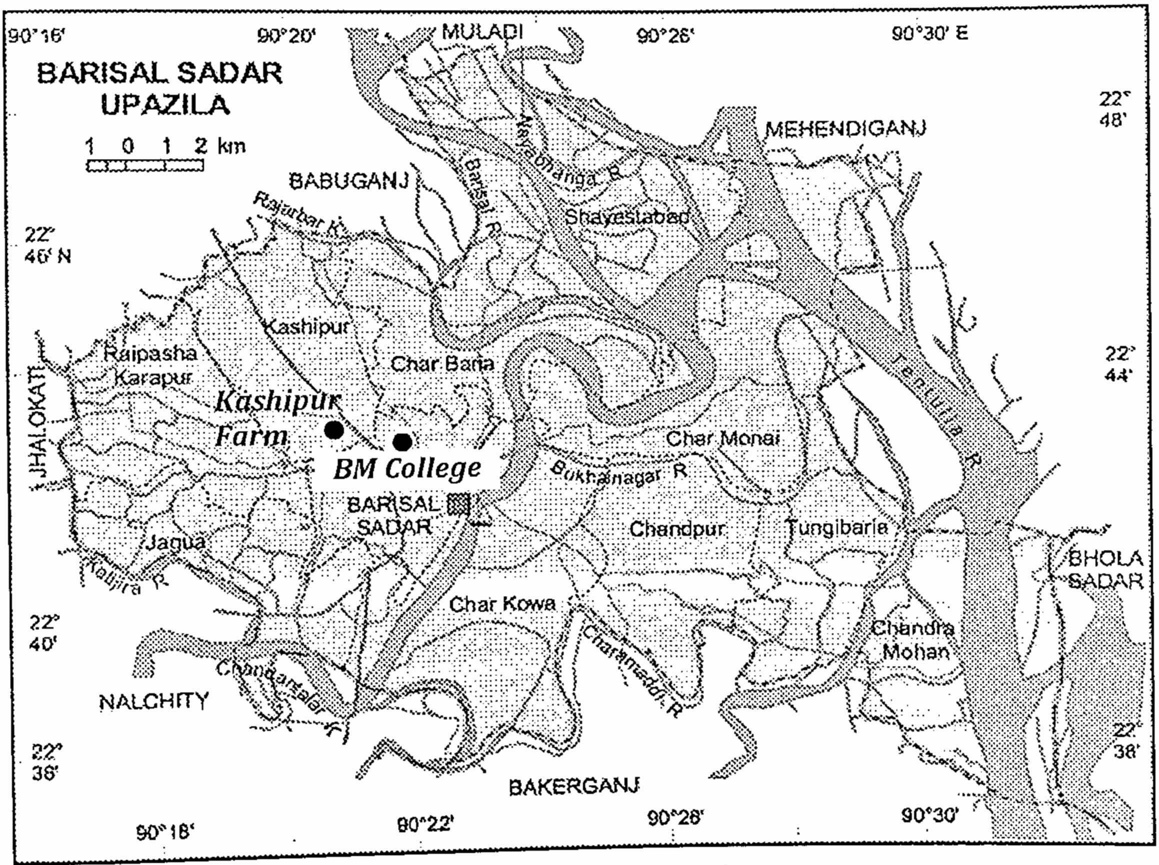


Figure 6. Map of Barisal Sadar Upzalla showing (Viii) Kashipur Fish Farm and (ix) Govt. B M. College Campus.

ix) Govt. B M College campus ponds, Barisal

Govt. B M college is the best educational institution of southern part of Bangladesh. The campus area comprises a beautiful natural environmental setting. There are 8 big to small ponds in the campus area, which are the reservoirs of huge fresh water and these ponds dug about 150 years ago. Among them two ponds have been chosen for study of the Freshwater Sponges. One of them is situated at the eastern extremity of the campus. Sergeant Jahurul Haq Muslim Students' hostel is situated at its south bank. A staircase on this side facilitates students and local people to use the pond for bathing, washing and other domestic purposes. Department of Botany, Zoology, Mathematics and Statistics are housed in a four storied building at the north bank. A road runs from north to south to link Muslim hostel at its west bank. The pond is 108.8m×78m with an average depth of 2 meters throughout the whole year. This pond is rain-fed without inlet or outlet. Presently this pond is under semi intensive/ traditional pisciculture.

The other ponds are situated just west of the first pond, only a playground away. It is called Kabi Jibananda Dus 'Hindu hostel pond' which is situated on the south bank. At the north bank there was a tin-shed used as classroom from the British period. Now the tin shed is demolished leaving its pukka base. A big pond in front of the principal's quarters is separated by a brick wall only. A road runs from north to south to link Hindu hostel with the administrative and academic buildings. A tree shed garden and `Commerce Building' lie on the west bank of the pond. A staircase was built on the south bank for the students to use the pond. This pond measures 111.3m ×74.7m with an average depth of 2m throughout the whole year. This pond is also rain-fed without inlet or outlet. This pond is also leased for pisciculture.

x) Dhaleshwary river, Kishorgonj

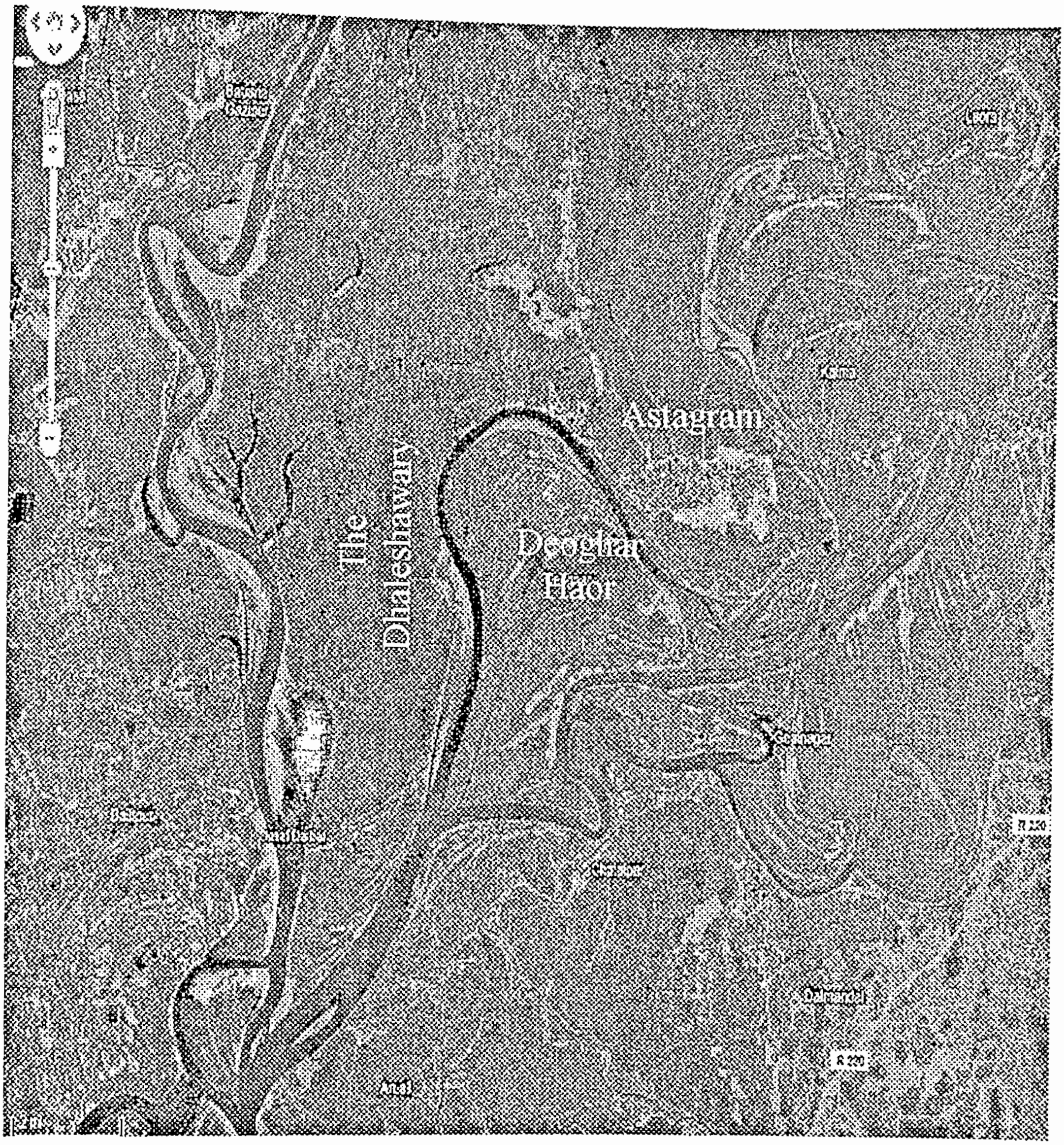


Figure 7. Collection spot near Astagram, in Deoghar Haor and in a minor river of Meghna, the Dhaleshwary.

The Dhaleshawary is sickle shaped (Figure 7) at the site of collection. But in the rainy season, the areas adjacent to riverbanks along with a vast area are inundated and transformed into a huge water body. Nutrients from the locality enrich the growth of aquatic organisms.

xi) Hakaluki Haor, Sylhet

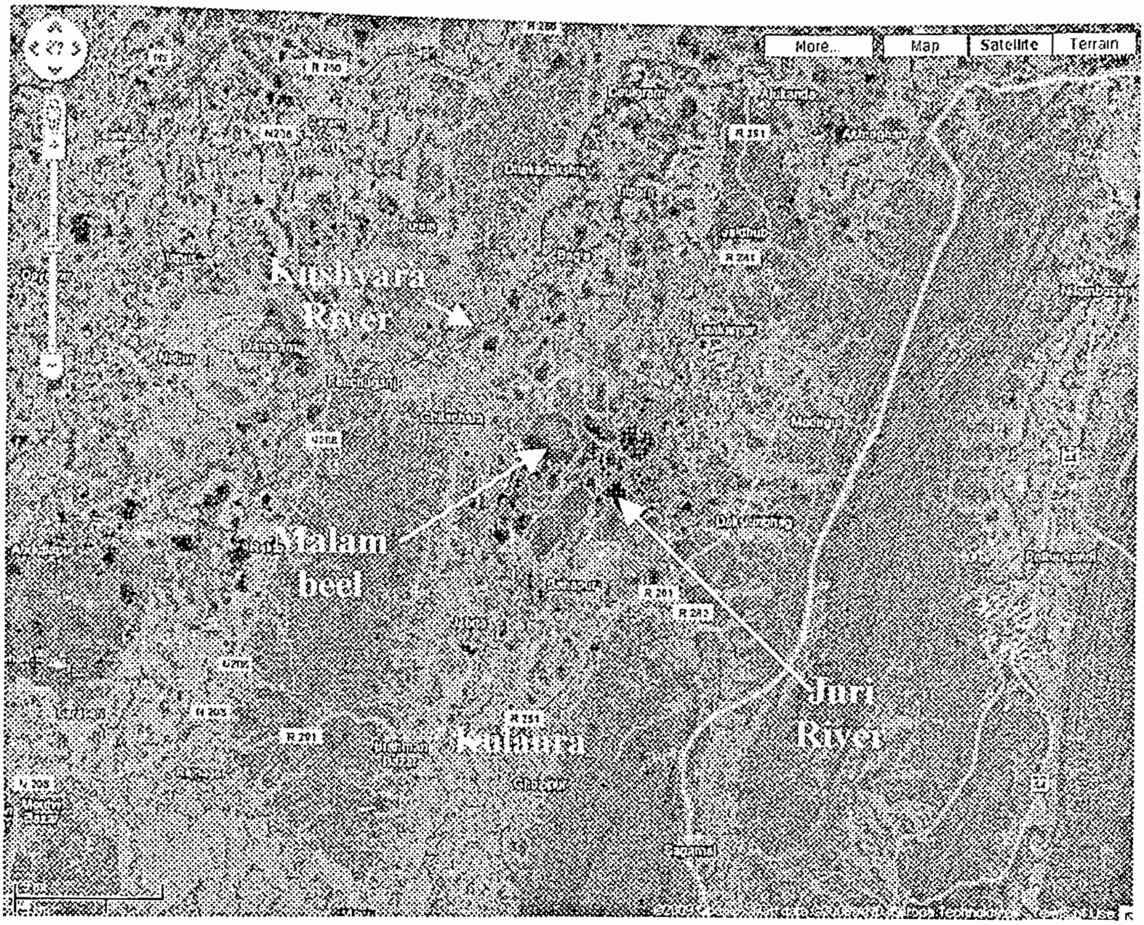


Figure 8. Hakaluki haor complex (satellite Image)

Investigation was carried out at the Hakaluki haor in Barolekha upazilla of Moulovibazar district. Hakaluki haor is the largest haor of Bangladesh. Its area is 181.15 sq.km. and comprises 238 larger and smaller beels. Among them five beels were visited; namely : (i) Jalla beel, (ii) Foala beel, (iii) Balizuri beel, (iv) Hurhury beel and (v) Northern most and the largest beel Malam beel. 40% of the total haor area lies in the Talimpur union under Barolekha Upazilla.

Area of some beels of Hakaluki Haor

1. Malam beel : 428.92 acre.
2. Jallar beel : 423.11 acre.
3. Balijuri beel : 409.92 acre.
4. Fualla beel : 333.30 acre.
5. Hurhuri beel : 121.32 acre.

(Source: Costal and Wetland Biodiversity Management Project, CWBMP, Kulaura, 2006).

xii) Water Development Board Training Center pond, Munshigonj

A pond is situated at the Water Development Board Training Center, at Bhagyakul of Sreenagar upzilla of Munshigonj district. Varieties of freshwater sponges were found in that pond. Although the pond is not very big (39.6m×23m), its depth is nearly 20m. The Padma runs about a kilometer away from the pond.

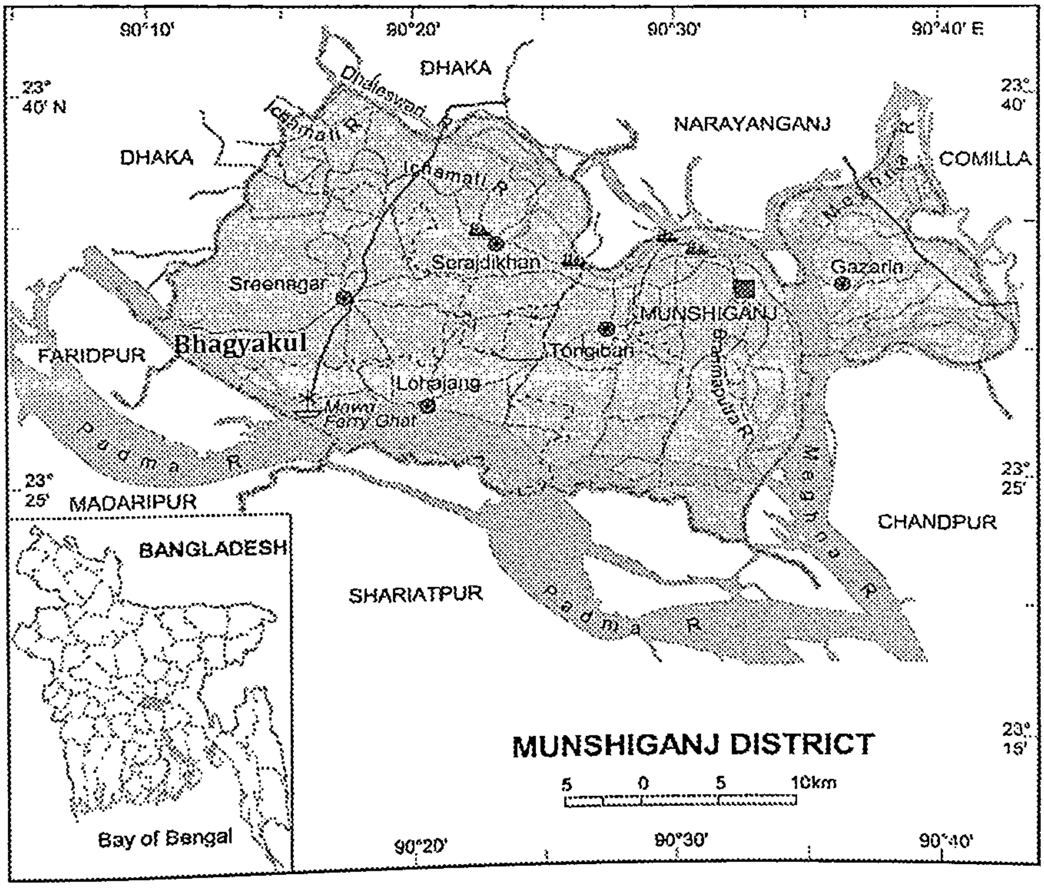


Figure 9. Water Development Board Training Centre pond at Bhagyakul, Munshigonj.

xiii) Chalan beel

Chalan beel is the largest inland depressions of marshy character and also one of the richest wetland areas of Bangladesh. It is the largest beel of the country and comprises a series of depressions (22 beels) interconnected by various channels to form more or less one continuous sheet of water in the rainy season when it covers an area of about 368 sq. km. The water enters into the Chalan beel through the rivers such as the Gumani, the Baral, the Bhadai and the Atrai etc. The water of Chalan beel drains into the Jamuna. Chalan beel is rapidly silting up. In the dry season, all the smaller and larger beels dry up except their deep centers. The outlying marginal lands are cultivated with boro and HYV (High Yield Variety) rice in the dry season. A road runs from Hatikamrul to Kachikata connecting Natore and Jamuna Bridge. It intersects the Chalan beel into two parts.

xiv) The Banar, Kapasia, Gazipur

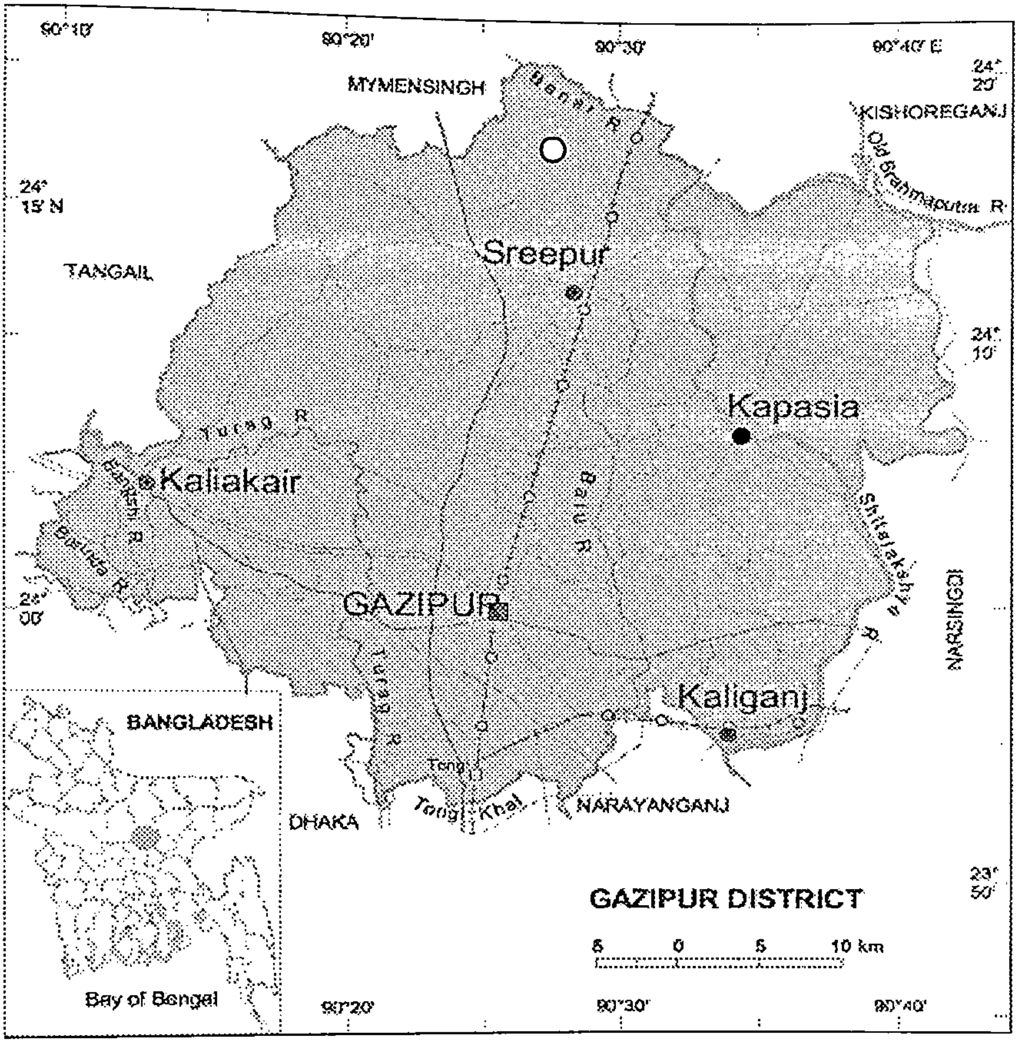


Figure 10. The Banar and the Bridge, Kapasia, Gazipur.

The Banar runs along the side of Kapasia town, Kapasia Upazilla under Gazipur district. It is adjacent to Dhaka district. The Banar meets the Dhaleshwary at its downstream. A road runs from Dhaka to Kishoreganj via Kapasia and Toke and crosses the river by a bridge. Upazilla Head Quarter and government hospital lie on the north side of the bridge.

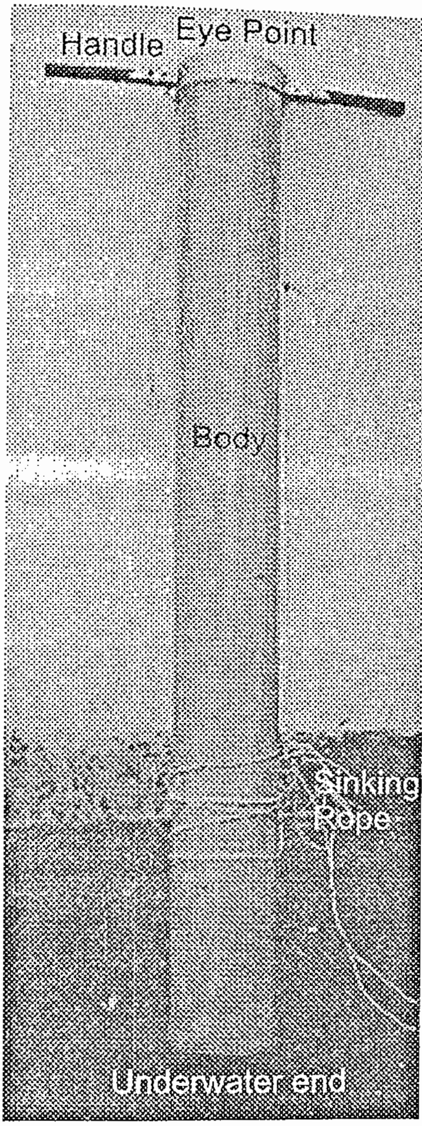
Besides this the investigator received sponges from friends and well-wishers from different parts of Bangladesh. These were from 'Chandra Sonar thal haor' of Jamalgonj upazilla under Sunamganj district, 'Deoghar haor' and 'Barobali beel' in Deoghar union of Austogram upazilla under Kishoregonj district; 'Naotana khal haor' of Madan upazilla under Netrokona district; Jugia village of Nazirpur upazilla under Pirojpur district, Perikhali of Rampal upazilla under Bagerhat district and Ashokati of Gauranadi upazialla under Barisal district.

Collection of Specimen

Freshwater sponges are entirely true aquatic organism. These are inhabitants of freshwater lakes, ponds, streams and puddles even in paddy fields and in rivers. Some freshwater sponges are found in brackish water also. They adhere themselves firmly to any suitable substratum on upper or lower surfaces below water level such as water weeds, bushes, boulders, pebbles, dam walls, molluscan shells, algal entanglements, dead woods and even on polythene. These are of variable sizes, very minute to extremely large of several meters covering the entire substratum depending on the species, age and various ecological conditions.

As the sponge grows in different depth levels of the water body, the collecting process was made according to the situation and water depth. Not only that, improvisation were adopted according to (i) Deep water (ii) Shallow water and (iii) Dry condition of the lotic and lentic water. Collection from deep water is tough but it is tougher in running water and most dificult in turbid water. Improvised apparatus were used for collection purpose; namely (i) Aquascope (ii) Harpoon (Konch) (iii) Improvised sickle (iv) Improvised Net.

Aquascope



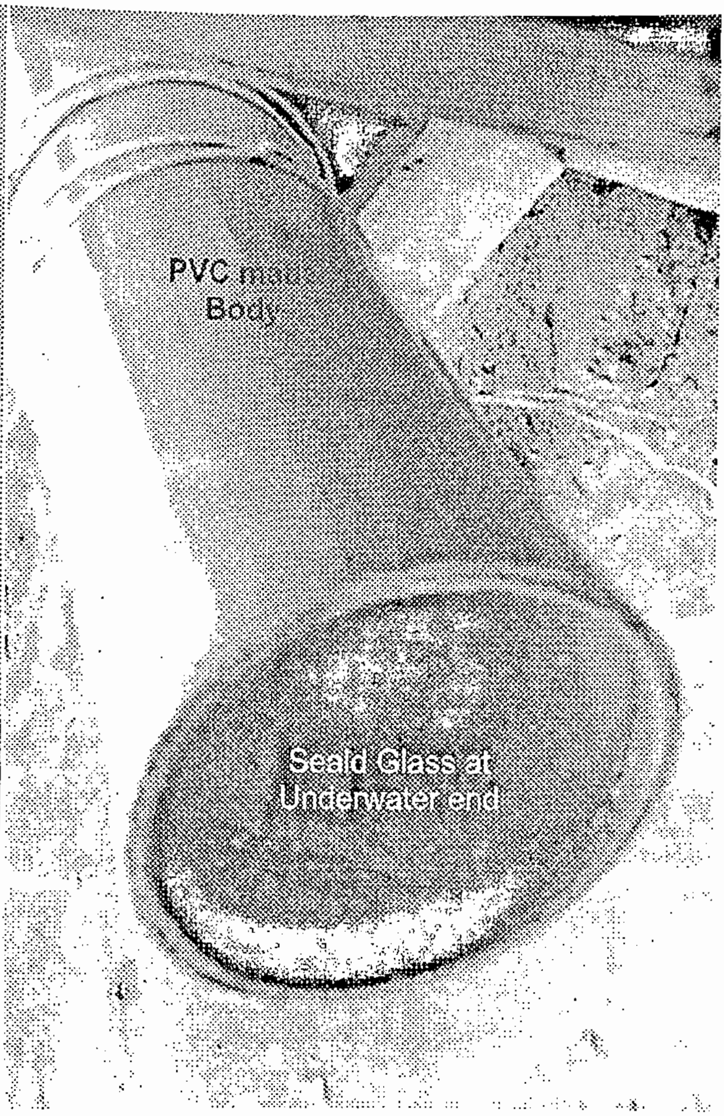


Figure 11. Aquascope

Figure 12. Aquascope, (bottom view)

It is an under water viewing apparatus for searching sponges. A 2.8m long cylindrical plastic pipe of 15cm. diameter was used to construct the aquascope. One end of the said pipe was sealed with a glass to make it watertight. The other end was fitted with a handle, made up of galvanized iron pipe of 1cm diameter and 7.5cm long on either side to facilitate the apparatus for handling. Nylon chord was fastened around the body of the aquascope to tie loads as sinker. This load counteracts the upward thrust of water. A torchlight was placed on the glass inside the pipe for better viewing. The aquascope was placed in water with glass side down, holding the handle with hands and viewing was done through the open end. This apparatus is suitable for searching sponges in clear water but not so efficient in turbid water.

Harpoon (Konch)

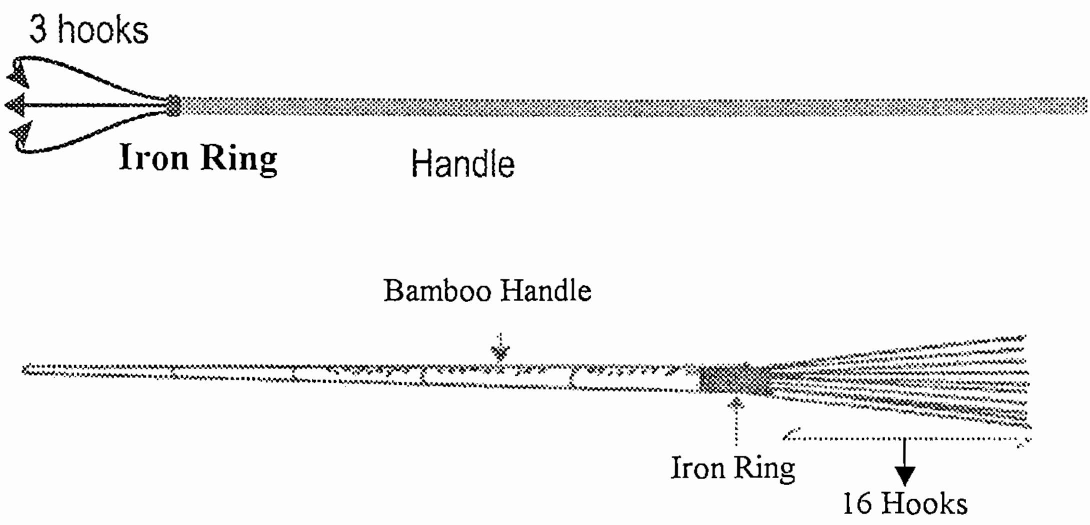


Figure 13. Harpoon

This is a fishing gear of harpoon type. It is made up of (i) a 3.8m long slim bamboo pole of 5cm. diameter, tapering gradually up to 1cm. on the upper end. (ii) 16 number of rejected/invalid bicycle spoke, each of 30.5cm. long and (iii) a flat iron ring (called HAMI) on the stout side of the bamboo pole. Intact specimen cannot be collected efficiently with this apparatus. It tears the sponge. But fragments of sponges can be collected successfully by this apparatus.

Improvised Sickle

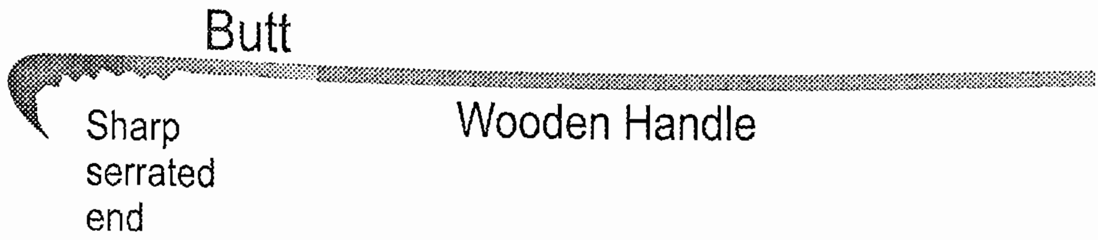


Figure14. Improvised Sickle

Blacksmith made sickle is generally used for harvesting paddy in Bangladesh. It is made up of crescent shaped flat iron whose concave side is serrated. This is the cutting edge. A wooden butt is fitted firmly with iron ring. Improvised sickle has a 3m. long bamboo handle of 5cm diameter. This apparatus is very useful in cutting bushy vegetation encrusted with sponge in eroded steep/erect bank of pond.

Improvised net

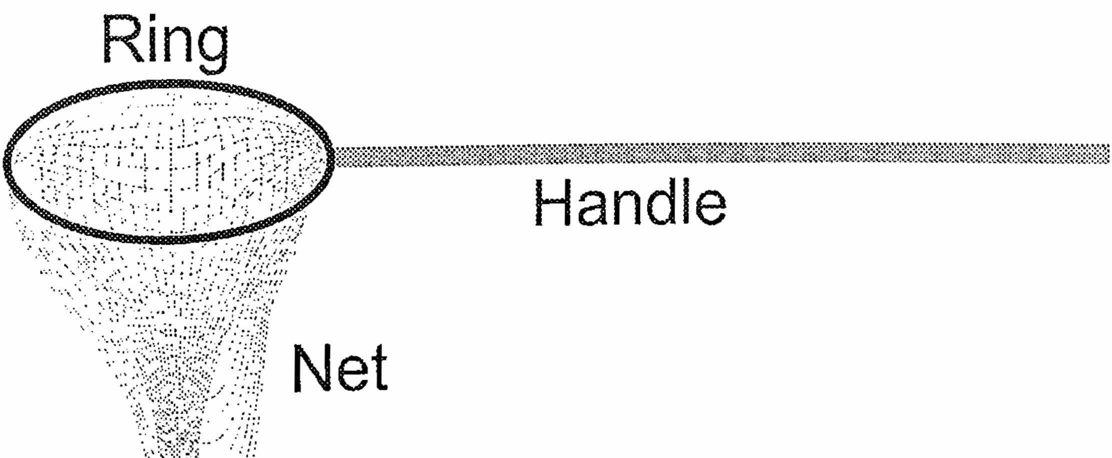


Figure 15. Improvised net

An improvised net was constructed with a piece of triangular nylon mosquito net cloth sewn with a frame of badminton racket. A 3m. long 2.5cm diameter slim bamboo pole was fastened tightly with the racket frame handle. This improvised net was used to collect sponge, encrusted twigs or bushes from water after cutting it with the improvised sickle.

Specimens were collected from the substratum by detaching them with a sharp knife or a scalpel. The specimens which grow around the stems of waterweed or the roots of aquatic plants as aufwuches (periphyton) where collected by cutting the respective stems or roots, carefully by a pair of scissors or improvised sickle and where collected by the improvised net.

The basic procedures involved in field collection and methods for preparing them for examination, have been adapted from Volkmer-Ribeiro (1981).

Preservation and Slide preparation of sponges

Annandale (1911) described precisely the preservation of Freshwater Sponges. These Fresh water sponges must be preserved dry or in very strong alcohol; formalin was never used.

Preparation of the material is different for taxonomic and histological purposes. Annandale (1911) described a somewhat complicated method for cleaning siliceous sponge spicules. According to him, by placing small fragments of the dried sponge in a test tube, pouring strong nitric acid in it and boiling over the flame of a Bunsen burner or small spirit lamp until the solid particles disappears. If the specimen is preserved in alcohol and the specimen is not dried properly i.e. if a little amount of alcohol remains within the specimen, pouring nitric acid in it causes violent reaction. Copious amount of water have to be added for washing the material and filtering it through a pure cellulose filter paper, agitating the liquid repeatedly and drying the filter paper carefully. The dried filter paper should be ignited with a match by placing it in a spirally coiled wire. The spicules released by the burning of the filter paper should be collected in a suitable receptacle. They may then be picked up with a camel's hairbrush and mounted by cover slip in Canada balsam on a glass slide.

Bowerbank (1864) described an easier and popular method, for taxonomic purpose of obtaining permanent mounts of spicules. Small pieces of the sponge body were dissolved in concentrated nitric acid by which the siliceous spicules had become freed from the matrix. Frequent shaking and a couple of washing with distilled water are needed to hasten the separation and sedimentation of the spicules. The spicules are then mounted on a glass slide in Canada balsam or DPX by a cover slip.

The author has followed the method of Bowerbank (1864).

Examination of spicules: For examining the skeleton the sponge have been cut into thin hand-sections with a sharp scalpel or a blade, dehydrated and mounted in Canada balsam.

Examination of Gemmules: Dry gemmules were placed in a watch-glass with a few drops of concentrated nitric acid. Considerable amount of water have been added when gas is given off freely from the gemmules. These gemmules were removed from the water with the help of a camel's hair brush and dehydrated with ascending grades (50%, 70%, 90% strength) of alcohol and finally absolute alcohol in succession, leaving them for at least 60 minutes in each strength of alcohol. The gemmules were cleaned with clove oil and finally mounted in Canada balsam or DPX.

Microphotography of permanent slides: Photograph of permanent slides were taken with a trinocular microscope (Model-MEDILUX-12). This facility was provided by the Department of Genetic Engineering and Biotechnology (Former Genetics & Breeding), Rajshahi University.

Photography of the whole specimen: Photograph of the raw specimens were taken with a digital camera of 5.0 megapixel (Model-OLYMPUS-FE 115), and when necessary an umbrella was used to eliminate the sunlight reflection for better quality of the photograph (Figure 16).

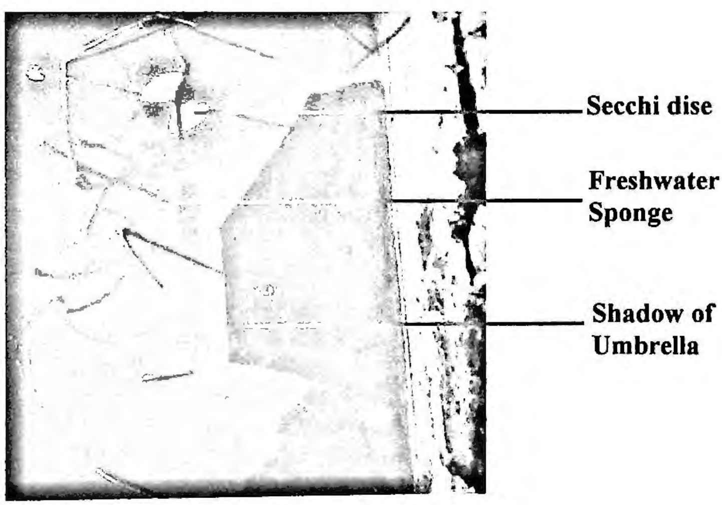


Figure 16. Freshwater Sponge seen alongside of a secchi dise in a pond of Water Development Board, Sopura, Rajshahi. Umbrella was for eliminating sunlight reflection. On 13.11.04.

Underwater Photography: Underwater photograph of *Spongilla alba* was taken from Banar river with the professionals (Figure 14, Chapter 4).

ANALYSES OF PHYSICO-CHEMICAL FACTORS OF THE PONDS

The methods for analysis of physical and chemical factors are given below:

Physical Factors

Parameters	Methods / instruments used
Temperature	Celsius Mercury Thermometer
Transparency	Sacchi disc method
Odor	Smelling
Taste	Tongue
Depth	Meter scale

Chemical Factors

Parameters	Methods / instruments used
pH	Digital pH meter
Dissolved Oxygen (DO)	Titrimetric method (Winkler)

PROCEDURE OF ANALYSIS

i) Physical condition

Temperature: A Celsius mercury thermometer with the range of 0°C to 110°C was used to note the air and water temperature simultaneously at the time of specimen collection.

Transparency: To determine transparency value, a secchi disc was slowly lowered into the water, under a shade until it had just disappeared and the depth was noted. Then the disc was slowly raised until it had just reappeared. This depth was also noted. The average of the two depths gave the transparency value expressed in centimeter (cm).

Water odor and taste: The water colors was observed visually while the odor was noted by smelling. Taste was determined by tongue personally.

Depth: The depth of the reservoirs in different sampling area had been measured by meter scale.

ii) Chemical condition

P^H (Negative logarithm of Hydrogen-ion concentration): The value of P^H was determined by a digital P^H meter (Model p^Hep, Hanna instrument).

Dissolved oxygen (DO): Winkler's method in toto was used for the estimation of dissolved oxygen. The water samples collected for DO estimation was treated with manganese sulphate solution, alkaline iodide solution and concentrated sulfuric acid on the spot. The treated sample was transferred to the laboratory and treated with sodium thio-sulphate solution. The volume of sodium thio-sulphate used in titration upto end point gave the DO value of water, expressed in milligram oxygen per liter of water (mg/l).

Physical and Chemical conditions of other places ware not studied due to some unavoidable circumstances.

Identification, Taxonomy and Description:

Specimens were identified and classified following Annandale (1911) Penney and Racek (1968) and Soota (1991)

For authentication, the investigator visited Zoological Survey of India, Kolkata of identified Freshwater sponge specimen of Bangladesh. He has done this with the kind cooperation of Dr. Joy Gopal Pattanayak, an Indian Sponge Scientist (Appendix). Global distribution of the Freshwater Sponges reported in the present study is adopted from

Manconi and Pronzato (2002). The style of Soota (1991) is followed in describing different taxa of Freshwater Sponges based on the present observations and investigation. The collected phena are kept with the Principal Supervisor for the time being. The materials will deposited in the Museum of the Department of Zoology, Rajshahi University, after acceptance of the thesis.

Physiological experiment *in situ* and *ex situ*

Freshwater sponge is the inhabitant of aquatic environment. It takes its food and oxygen through ostia and expells out all unwanted matter through oscula. To observe this phenomenon, Potassium per manganet solution was poured into the surrounding water of a Freshwater Sponge. This experiment was carried out in a cage where a Freshwater Sponge, *Eunapius carteri* was placed earlier. This cage was in the field research laboratory pond of Zoology Department of Rajshahi University.

Another specimen of the same species was taken from 'Lake' of Rajshahi University in a polythene bag with sufficient amount of water of that pond. The polythene bag was placed in the Freshwater Sponge Laboratory, Room No-317, Department of Zoology, Rajshahi University. Polythene bag was opened and placed near a open window. Potassium per manganet solution was poured into the surrounding water near the oscula of the Sponge. The experiment was performed within 30 minutes of dislocation of the sponge from 'Lake' of Rajshahi University.

Freshwater sponge (*Eunapeus carteri*) formation *in vitro*

An experiment was carried out at Freshwater Sponge Laboratory, room No. 317 of Department of zoology, Rajshahi University, on Freshwater sponge formation. This experiment was carried out *in vitro*. A petridish was placed near the window with gemmules of freshwater sponge. Sun light and natural air entered through the open window. 15 cc of pond water was poured regularly in to the petridish.

CHAPTER-4

Results And Discussion

Physical conditions

Air Temperature: Air temperature ranged from 16.75^{0}C to 38.65^{0}C during the study period at Barisal and from 14.36 to 39.21^{0}C in Rajshahi. The highest temperature were recorded in the month of May 2004 and the lowest in January, 2004 at both the areas. The temperature was always measured at 11 am (Table 1 and 2).

Water Temperature: Water temperature ranged from 14.93^{0}C to 37.50^{0}C at Barisal and 12.49^{0}C to 38.92^{0}C at Rajshahi. The highest temperature were recorded in the month of May 2004 and the lowest temperature in January 2004 at both the areas. The time of measurement was 11 AM (Table 1 and 2).

Transparency: During the period of study, transparency of water varied from 53.69cm to 19.67cm. The lowest value 19.67cm was recorded in January 2004 at Barisal and 53.69cm was the highest in May, 2004. At Rajshahi 51.52cm was the highest in May, 2004 and 20.53cm was the lowest in January, 2004 (Table 1 and 2).

Depth: During the study period, depth of the sampling water bodies varied from 134cm to 166cm. The maximum depth was recorded in the month of January. 2004 and the minimum was recorded in the month of May, 2004 at Barisal sampling sites. In Rajshahi, the mean maximum depth of the sampling site was 172cm in January and the minimum was 112cm in May, 2004 (Table 1 and 2).

Odor and Taste: During the period of study except in September 2004 all the year round the study water bodies were odorless (OL). Throughout the period of study the water was tasteless but in September, 2004, fishy taste was found, perhaps fish catching was held at that period.

The values of the physical conditions of the sampling water bodies of two districts are presented in Tables 1 and 2. Physical conditions of other collection site were not carried out, due to some unavoidable circumstances.

Chemical Conditions

P^H of water: The P^H value of water varied from 6.9 to 7.5 during the period of study. The maximum value was recorded in January, 2004 and minimum value was recorded in May, 2004 both in Barisal and Rajshahi districts.

Dissolved oxygen (DO): Dissolved oxygen content ranged from 2 mg/1 to 8.6 mg/1. The highest value was found at Kashipur pond, Barisal in May, 2004 and the lowest in Water Development Board pond, Sopura, Rajshahi in January, 2004.

Identification and taxonomy of sponges and number of species found along with collection sites:

A total of eight species under five genera have been recorded in the present study.

Their Systematic account follows-

Kingdom	: Animalia	
Sub-Kingdom	: Metazoa	
Branch	: Parazoa	
Phylum	: Porifera	Grant. 1872
Class	: Demospongiae	Sollas, 1875
Order	: Haplosclerida	Topsent, 1898
Sub-order	: Spongillina	Subord. nov.
Family	: Spongillidae	Gray, 1867

The following genera and species are encountered:

(i) *Corvospongilla bhavnagarensis* Soota, Pattanayak and saxena,

(ii) *Corvospongilla* sp. (*in det.*),

(iii) *Eunapius crassissimus* Annandale,

(iv) *Eunapius carteri* Bowerbank,

(v) *Pectispongilla aurea* Annandale,

(vi) *Radiospongilla cinerea* Carter,

(vii) *Spongilla alba* Carter,

(viii) *Spongilla lacustris* Linnaeus.

Description of taxa:

Genus I. *Eunapius* Gray, 1867

Sponges forming irregular and variably sized masses ranging from thinnish to very thick growths with or without rounded or lobose elongations; surface seldom smooth, more generally hispid. Oscula large, often opening from rounded elevations; dermal membrane well developed; skeleton formed of clear erect spicule fibres and a variable number of irregular transverse fibres, held in positions by a sufficient quantity of spongin; consistency of live sponge quite soft or fragile (Soota 1991). Gemmules covered with layers of distinct polygonal air spaces with chitinous walls. The gemmules are usually fastened together in groups, which either be free in the sponge or adhere to its support as a 'pavement layer'; sometimes, not arranged in this manner but are quite independent of one another (Annandale 1911).

1. *Eunapius carteri* (Bowerbank, 1863)

(Figure 1, 2, 3, 4, 5, 15a, b and 17; Table 4 and 6).

1863. *Spongilla carteri* Bowerbank, *Proc. zool. Soc. London.*, 1863, p. 469.

1867. *Eunapius carteri* Gray, *Proc. zool. Soc. London.*, 1867, p. 552.

1913. *Spongilla aetheriae* Annandale, *Rec. Indian Mus.*, **9**, p. 237.

1925. *Spongilla rotundacuta* Rezvoj, *Ann. Mag. nat. Hist.*, **15**, p. 80.

1964. *Spongilla carteri* var. *cava:* Tonapi, *Curr. Sci.*, **33** (4), p. 363.

1968. *Eunapius carteir:* Penney and Racek, *Bull. U.S. natn. Mus.*, No. 272, p. 23.

1978. *Spongilla carieri:* Kartha and Mookerjee, *Indian J. exp. Biol.*, **16**(8), p. 865.

1980. *Eqnapius carteri:* Dalal and Rawal, *Vidya,* **23**(2), B-Science, p. 73.

1982. *Eunapius carteri:* Soota and pattanayak, *Rec. zool. Surv. India,* **80**, p. 221.

1986. *Eunapius carteri:* Patil, *Geobios new Reports,* **5**(2), p. 167.

1987. *Eunapius carteri:* Soota, *Fauna of Orissa: State Fauna Series* **I**, p. 66 (Publ. zool. Surv. India).

Megaseleres – amphioxea, stout, fusiform, slightly curved, entirely smooth; 265 - 370μ long, 14 - 25μ wide.

Microscleres – Absent.

Gemmoscleres – resembling megaseleres in form though much smaller, more curved and sharply pointed; 145 - 210μ long, 5 - 8μ wide.

Gemmules – Spherical or flattened at the base comparatively large, very numerous in mature sponge, occurring singly throughout skeletal meshes; pneumatic layer well developed and thick, consisting of several layers of regularly arranged polygonal air spaces in which gemmoseleres embedded tangentially or irregularly (Soota 1991). A single aperture surrounded by a creater like depression in the cellular coat and provided with a forminal tubule resembling an inverted bottle in shape; measures 440 - 610μ in diameters. This tubule has not extended beyond the surface of the cellular coat, were brittle when handling.

Habit: *Eunapius* as a freshwater sponge occurs in fresh water ponds and lakes as periphyton, and sedentary in nature. It is filter feeder. The sponge has a peculiarly strong and offensive smell (Annandale, 1911).

Habitat: The usual habitat of *Eunapius carteri* is the erect stem of an aquatic weed *Alternanthera sessilis*. This sponge grows profusely at the base (root-shoot junction) and roots of the *Phyllanthus reticulatus* another aquatic plant also. Light and shade mixed in a habitat is favourable for the growth of these sponges. It was found to grow on the exposed roots of *Albizia lebbeck* in a derelect, erroded pond, but not on the roots of *Terminalia arjuna* on the same pond as observed by the investigator.

Distribution: Confined from South East, South and West Asia to Eastern Europe; probably also in Africa. In India, this species is widely represented in the plains and even extending to moderate heights (Soota 1991). *E. carteri* is widely distributed and one of the commonest fresh water sponges of Bangladesh.

Status and conservation: Though *Eunapius carteri* is the commonest freshwater sponge in Bangladesh, its habitat is shrinking day by day, as the water bodies for pisciculture are increasing. Uprooting the dry waterweeds for fuel destroys the habitat permanently. So the species are threatening and these need conservation strategy.

Economic importance: Dry specimen along with the dry weeds is used as fuel by the poor people around beel and haor area. The medicinal value is also noteworthy. According to Myers (1998) some sponges contain chemicals which have beneficial pharmaceutical effects for humans, including compounds with respiratory, cardiovascular, gastrointestinal, anti-inflammatory, anti-tumour and anti-biotic activities. Some homeopathic drugs are obtained from sponges also.

Colour in life: Yellowish brown to tan.

Remarks: Gray (1867) separated *Spongilla*, and his newly established genus *Eunapius*, by the character "areolated" and "reticulate" pneumatic coats.

2. *Eunapius crassissimus* (Annandale 1907)
(Figure 6, 7, 8, 9, 15c, d and 17)

1907. *Spongilla crassissima* Annandale, *J. Proc. Asiat. Soc. Beng.*, **3,** pp. 17 & 26.

1907. *Spongilla cressior* Annandale, *Rec. Indian Mus.* **1**, p. 389.

1907. *Spongilla arassissima* vir. *bigemmulata* Annandale, *J. Proc. Asiat. Soc. Beng.*, **3,** pp. 18 & 26.

1911. *Spongilla crassissima* var. *crassior* Annandale, *Fauna British India,* Freshwater sponges, hydroids and Polyzoa, p. 98.

1968. *Eunapius crassissimus* Penney and Racek, *Bull U.S. natn. Mus.*, No. 272, p. 30.

1975. *Spongilla crassissimus* Bhatia and Saxena: *Annales zool. Arga,* **11** (4), p. 103.

1976. *Eunapius crassissimus* Khera and Chaturvedi, *Rec. zool. Surv. India,* Misc. Publ. Occ. Paper No. 4, p. 7.

1982. *Enuapius crassissimus* Soota and Pattanayak, *Rec. zool. Surv. India,* **80,** p. 219.

1987. *Eunapius crassissimus* Soota, *Fauna of Orissa: State Fauna Series* **I,** p. 66 (Pub. Zool. Surv. India).

Megascleres: Amphistrongyla in mature form, stout, slightly curved, entirely smooth, often terminating in a minute projection. $250-310\mu$ long $6-15\mu$ wide.

Microscleres: Absent

Gemmscleres: Amphistrongyla or amphioxea, abruptly pointed, completely covered with small and irregular spines. $80-120\mu$ long, $3-9\mu$ wide.

Gemmules: Spherical, fairly abundant and normally restricted to the base of sponge. Pneumatic layer well developed and thick, comprising large polygonal air spaces, forms a continuous coat over the gemmules. Foramen always tubular not protruding out from the pneumatic layer surface.

Habit : Freshwater sponge a filter feeder occurs in ponds and freshwater water-body.

Habitat : *Eunapius crassissimus* a periphyton on *Alternanthera sessilis* erect stem and growing bud of *Barringtonia acuutangula*. When they grow on the roots of the floating water plants they assume a spherical forms while on sticks or like objects they grow spindle shaped (Annandale, 1911).

Distribution : Reportedly represented in South and tropical South-East Asia. In India, this sponge was reported from Kolkata, Sur lake (Orrisa) and Asam.

This sponge first found by the investigator in Police line pond of Rajshahi, as very weight full object of dark leaden gray colour. Also found in Hakaluki Haor.

Economic importance: In Hakaluki Haor, *Eunapius crassissimus* grow on planted *Barringtonia acutangula* saplings and other plants such as *Ficus heterophylla.* They grow on the growing parts and even on the apical bud and inhibit the growth or even kill the plants, causing serious economic damage.

Colour in life: Dark leaden gray to dull green.

Remarks: Many people believe these animals as the nest or the excreta of Palaemonidae.

Genus II. *Corvospongilla* Annandale, 1911.

Sponge forming blackish thick encrustation over a large area on the surface of an embankment, showing rough and irregular surface; consistency fragile (Soota 1991). Thick chitinous membrane at the base of the sponge.

3. *Corvospongilla bhavnagarensis* Soota, Pattanayak and Saxena, 1983 (Figure 10, 11 and 21; Table 3).

1983. *Corvospongilla bhavnagarensis* Soota *et al.; Rec. zool. Surv. India,* **81**, p. 255.

Megaseleres – slightly curved, entirely smooth amphistrongyla, rather short, not very thick, swollen terminally; 190-205 mm long 0.016-0.18 mm wide.

Microscleres – microbirotulates, terminally with four recurved hooks with smooth, slightly curved shaft 0.041-0.042 mm long, rotules 0.008-0.009 mm in diameter.

Gemmoscleres – strongly pointed, slightly curved, amphioxea covered with short acute spines; 0.043-0.045 mm long, 0.0042-0.0048 mm wide.

Gemmules – Loosely attached to sponge surface, spherical, smooth gemmules, foramen not exactly tubular but as a conical projection; 0.005-0.006 mm in diameter.

Habit: *Corvospongilla bhavnagarensis* occurs on the surface of submerged bricks as periphyton, a filter feeder and sedentary in nature in running water.

Habitat: River with current of water, under water substratum made up of bricks.

Distribution: Embankment about 4 meters away from Gorishankar Lake, Bhavnagar (Gujrat, India). Currently this species has been discovered from the Mahananda (Islam *et al.*, 2008), a contributory to the Padma which becomes inundated during the monsoon.

Status and conservation: Uncertain.

Economic importance: Not known.

Colour in life: Black in dry specimen.

Remarks: New record in Bangladesh (Islam *et al.*, 2008).

4. *Corvospongilla* sp. (*in det.*)

(Figure 12, 13 and 21)

Sponges a periphyton, very hard and firm; colour black to dark gray.

Megaseleres : Not studied.

Microscleres : Not studied.

Gemmoscleres : Not studied.

Gemmules : Not studied.

Habit: It is a periphyton and sedentary in nature.

Habitat: It is a inhabitant of lentic water.

Distribution: Collected from Dhaleshwary riverbank, Austogram, Kishoregonj.

Status and conservation: Uncertain.

Economic importance: Not known.

Colour in life: Blackish in dry specimen.

Remarks: Needs further study.

Genus III. *Spongilla* Lamarck, 1816.

Sponges generally extending from an irregular base into elongated tubular branches; or massive, frequently from dull to brilliant green colour due to presence of zoochlorellae; sometimes without particular colour due to lack of these bodies; consistency quite hard, though often brittle.

5. *Spongilla lacustris,* (Linnaeus, 1758)

(Figure 15e, f, g and 18; Table 5 and 6).

1758. *Spongia lacustris* Linnaeus, *Systema Naturae,* 10th ed., **1,** Animalia, p. 1348.

1816. *Spongilla ramosa* Lamarck, *Histoire noturelle des animaux sans vertebres,* **2,** p. 100.

1816. *Ephydatia lacustris* Lamouroux, *Histoire des polypiers coralligenes flexibles, vulgairenent nommes Zoophytes*, p. 7.

1812. *Spongilla dawsoni* Bowerbank, *Proc. zool. Soc. Lond.*, 1863, p. 467.

1863. *Spongilla paupercula* Bowerbank, *Proc. zool. Soc. Lond.,* 1893, p. 470.

1867. *Eunapius paupercula* Gray, *Proc. zool. Soc. Lond.,* 1867. p. 552.

1870. *Spongilla lieberkuhni* Nool, Flussaquarien, *Zool. Garten,* **11,** p. 173.

1877. *Spongilla jordanensis* Vejdovsky, *Vesmir,* **6,** p. 212.

1878. *Spongilla flexispina* Dawsan, *Can. Nat.,* **8,** p. 1.

1880. *Spongilla montana* Potts, *Proc. Acad. nat. Sci. Philad.,* p. 330.

1880. *Spongilla abortiva* Potts, *Proc. Acad. nat. Sci. Philad.,* p. 330.

1881. *Spongilla multiformis* Carter, *Ann. Mag. nat. Hist.* (5), 7, p. 88.

1883. *Euspongilla lacustris* Vejdovsky, *Abh. k. Bohm. Ges. Wiss.*, **12** (5), p. 15.

1883. *Spongilla mirabilis* Retzer, *Inaug. Dissert. Univ. Tubingen*, p. 21.

1911. *Spongilla lacustris* Annandale, *Fauna British India*, Freshwater sponges, hydroids and Polyzoa, p. 69.

1931. *Spongilla lacustris* var. *crustacea* Gee, *Peking nat. Hist. Bull.* 5(1), p. 38.

1931. *Spongilla lacustris* var. *fenestrata* Gee, *Peking nat. Hist. Bull.* 5(1), p. 38.

1968. *Spongilla lacustris* Penney and Racek, *Bull. U.S. natn. Mus.*, No. 272, p. 9.

1976. *Spongilla lacustris* Khera and Chaturvedi, *Rec. zool. Surv. India*, Misc. Publ. Occ. Paper No. 4, p. 17.

1982. *Spongilla lacustris* Soota and Pattanayak, *Rec. zool. Surv. India*, **80**, p. 224.

1998. *Spongilla lacustris* Pattanayak, *zool. surv. India. State Fauna Series* 3: Fauna of W. Beng. part II: 1-27.

Megascleres– slightly curved or straight amphioxea, normally fusiform, always completely smooth; 200-350 μ long, 6-20 μ wide.

Microscleres– slightly curved, amphioxea, abundant in dermal membrane and symplasm, normally completely covered with small spines or granules of more or less equal size and uniformly distributed but variable from different habitats and geographic areas, 70-130 μ long, 2-8 μ wide; in some very acid habitats 50-60 μ long and fairly thick.

Gemmoscleres–Whenever present, amphioxea or amphistrongyla, quite thick and slightly to sharply curved, normally covered with strong, curved spines, very rarely smooth; but variable like microscleres in acid habitats; 80-130 μ long, 3-10 μ wide.

Gemmules–abundant in mature sponge, scattered throughout its body, spherical and large; pneumatic layer either clearly formed, ill-defined, or totally absent; gemmoscleres, if present, embedded irregularly, foramen usually simple, or showing a shallow peripheral collar; 500-800 μ in diameter.

Habit: It is a periphyton.

Habitat: It is found generally on submerged vegetation or dead braches of trees and weeds.

Economic Importance: Dry specimen along with the dead branches of trees and weeds are used as fuel.

Distribution: According to Penney and Racek (1968), distribution restricted to Northern Hemisphere especially in cold temperate; but reported from India–Simla (Himachal Pradesh), Udhampur (Jammu), Ranchi (Bihar), Igatpuri (Maharashtra), and Mysore (Karnataka). The sponge is found in the Ganges and Brahmaputra river basins and lakes and streams of Bangladesh. The currently studied specimens were collected from Kashipur fish farm ponds, Barisal.

Economic Importance: Not studied.

Colour in life: Usually drab to bright green (presence of zoochlorellae).

Remarks: The species occurs in a variety of water condition Harrison (1974), and it is very variable as noted by Potts (1887) *vide* Annandale's (1906) quotation "... that Potts (1887) in his monograph of the Freshwater Sponges of the world, recognised six varieties in addition to the typical form".

6. *Spongilla alba* Carter, 1849
(Figure 14, 16a, b, c and 18).

1849. *Spongilla alba* Carter, *Ann. Mag. nat. Hist.*, **4,** p. 83

1906. *Spongilla lacustries* var. *begalensis* Annandale, *J. Asiat. Soc. Beng.*, **2**, p. 56.

1907. *Spongilla alba* var. *marina* Annandale, *Rec. Indian Mus.*, **3,** p. 101.

1909. *Spongilla travancorica* Annandale, *Rec. Ind. Mus.*, **3,** p. 101.

1909. *Spongilla microsclerifera* Annandale, *Proc. U. S. natn. Mus.* **37,** p. 131.

1911. *Spongilla alba* var. *bengalensis* Annandale, *Fauna British India,* Freshwater Sponges, hydroids and Polyzoa, p. 81.

1915. *Spongilla nana* Annandale, *Mem. Indian Mus.*, **5** (1), p. 31.

1919. *Spongilla alba* var. *rhdinea* Annandale, *Mem. Indian Mus.*, **5** (1), p. 85.

1968. *Spongilla alba*: Penney and Racek, *Bull. U. S. natn. Mus.*, No. 272, p. 16.

1976. *Spongilla alba*: khera and Chaturvedi, *Rec. zool. Surv. India,* Misc. Publ. Occ. Paper No. 4, p. 16.

1982. *Spongilla alba*: Soota and Pattanayak, *Rec. zool. Surv. India,* **80,** p. 224.

1987. *Spongilla alba*: Soota, *Fauna of Orissa; State Fauna Series* **I,** p. 66 (Publ. zool. Surv. India).

Megascleres-amphioxea, fusiform, slender to stout, entirely smooth, 225-140 μ long, 6-22 μ wide.

Microscleres-amphioxea, innumerable in dermal membrane and symplasm, very slender and slightly curved, completely covered with erect spines which being more prominent and longer in central region and often with knoblike inflations at their tips, 75-125 μ long, 2-3 μ wide.

Gemmoscleres-amphistrongyla, rarely amphioxea, slender, cylindrical, feebly curved and always covered with large and recurved spines which often in greater number at tips of scleres where occasionally forming several annular groupings; 78-130 μ long, 5-10 μ wide.

Gemmules-Very abundant in sponge, scattered throughout its body, usually large and spherical, pneumatic layer quite thick, clearly granular in which gemmoscleres embedded rather sparsely at irregular angles with their tips usually protruding out of layer; foramen slightly elevated but never tubular and normally with a shallow peripheral collar; 500-600μ in diameter.

Habit: It is a periphyton and sedentary in nature.

Habitat: Found in lotic water.

Distribution: This species which has been reported both from fresh and low salinity waters, is of wide occurrence having been recorded from SE Asia, Africa, Australia, South America, and U.S.A. (Florida & Louissiana), and also from India-North Salt Lake, 24-Parganas; Port Canning and Calcutta (West Bengal), Rambha and Lake Chilka (Orissa), Bombay and Igatpuri (Maharashtra), and back waters in Kerala.

Economic Importance: Not known.

Colour in life: Pale gray to off white.

Remarks: This species, considered as a good water quality indicator by Poirrier (1970) and described under several different names as shown under the synonymy, has been dealt very elaborately by Poirrier *et al.* (1987).

Genus IV *Radiospongilla* Penney and Racek, 1968.

Sponges rarely bulky; ranging from tiny cushions to huge flat encrustations with or without occasional delicate and cylindrical branches, due to presence of a specific pigment; often an emerald green colour; consistency rather firm and normally elastic.

7. *Radiospongilla cineria* (Carter, 1849)

(Figure 20)

1849. *Spongilla cinerea* Carter, *Ann. Mag. nat. Hist.* (2), **4,** p. 82.

1911. *Spongilla cinerea* Annandale, *Fauna British India,* Freshwater sponges, hydroids and Polyzoa, pp. 79 & 241.

1919. *Spongilla (Euspongilla)perviridis* Annandale, *Rec. Indian Mus.*, **16,** p. 159.

1960. *Spongilla perviridis* Penney, *Univ. S. Carol. Publs,* ser. 3, **3** (1), p. 26.

1968. *Radiospongilla cinerea* Penney and Racek, *Bull. U. S. natn. Mus.*, No. 272, p. 75.

1976. *Radiospongilla cinerea* Khera and Chaturvedi, *Rec. zool. Surv. India,* Misc. Publ. Occ. Paper No. 4, p. 14.

1982. *Radiospongilla cinerea* Soota and Pattanayak, *Rec. zool. Surv. India,* **80,** p. 22.

Megasclers– Fusiform, pointed sharply, slightly curved amphioxea, covered with tiny spines excepting terminally; 230-275µ long, 8-10µ wide.

Microscleres–absent.

Gemmoscleres–Slightly curved, abruptly pointed, amphioxea, entirely covered with rather coarse spines grouped terminally without much increasing in length; 45-60μ long, 3-4μ wide.

Gemmules– spherical; pneumatic layer well developed, consisting of clearly visible subspherical air spaces, or granular without discernible air spaces; gemmoscleres embedded in this coat strictly radially, forming a single layer, their extremities penetrating outer gemmular membrane, surface of gemmules appears distinctly hispid; foramen distinctly tubular, porous tube slender and straight, slightly surpassing in length of outer gemmular membrane, and without a surrounding conical depression.

Habit: It is a periphyton.

Habitat: Found in lentic water.

Distribution: In India–Bombay; Nasik; Bhima river, Khed; and Karla, Pune dist. (Maharashtra); Chhota Nagpur (Bihar); and Naukuchia Tal (alt. 4000 ft.) and Kumaon (U.P.). In Bangladesh it was found in a B M College pond.

Economic Importance: Not studied.

Colour in life: Ash gray to bright green.

Remarks: It is one of the rarest sponges in Bangladesh.

Genus V *Pectispongilla* Annandale, 1909

Sponges forming small encrustations; colour golden to bright yellow consistency soft and fragile.

8. *Pectispongilla aurea* Annandale, 1909

(Figure 16d, e, f and 19).

1909. *Pectispongilla aurea* Annandale, *Rec. Ind. Mus.*, **3**, p. 103.

1911. *Pectispongilla aurea* Annandale, *Fauna British India,* Freshwater sponges, hydroids and Polyzoa, p. 106.

1968. *Pectispongilla aurea* Penney and Racek, *Bull. U. S. natn. Mus.*, No. 272, p. 77.

1976. *Pectispongilla aurea* Khera and Chaturvedi, *Rec. zool. Surv. India,* Misc. Publ. Occ. Paper No. 4, p. 12.

1982. *Pectispongilla aurea* Soota and Pattanayak, *Rec. zool. Surv. India,* **80,** p. 228.

Megascleres– Fusiform and sharply pointed amphioxea, feebly curved or nearly straight, completely smooth; 270-320μ long, 13-16μ wide.

Microscleres–of two different groups: (1) amphioxea, small, slender, straight, fusiform and microspined, 45-52μ long, 1.5-2.5μ wide; (2) amphioxea, minute, rhomboidal, comparatively thick, and smooth, 22-24μ long, 3-3.5μ wide.

Gemmoscleres– Minute, with smooth, cylindrical, slightly curved shafts, typical for this genus and a bipolar but unilateral arrangement of rows of spines arising from a broad base and appearing jointed to each other by siliceous webs; 31-37μ long, shaft 2.5μ wide, comb-rows 17μ long.

Gummules– Very minute, spherical, occurring in skeletal network; pneumatic coat well formed and distinctly granular in which gemmoscleres embedded radially, but crossing across one another at slanting angles, with their comb-row pointing in all directions; foramen tubular, porus tube rather short; 190-220μ in diameter.

Distribution: In India– Only Tenmalai (Kerala). First observed in Bangladesh at Water Development Board Training Centre pond, Bhagyakul, Munshigonj.

Habit: These sponges are brightly coloured and deep golden in colour.

Habitat: Found in the pond attached with a Date-palm leaf.

Economic importance: According to Myers (1998) some sponges contain beneficial chemicals of pharmaceutical effects for humans. This type of chemical compound may be obtained from *Pectispongilla.*

Status and conservation: As *Pectispongilla* is one of the rarest sponges of Bangladesh, its habitat should be preserved.

Colour in life: Deep golden.

Remarks: It needs further study.

Observation and findings on Collection Sites

i) 'Lake' Rajshahi University Campus, Rajshahi

Specimens of *Eunapius carteri* were collected from this pond with the fishing net.

ii) Police line pond, Rajshahi

Eunapius crassissimus grown around the stem of *Phyllanthus reticulatus* and on boulders and pebbles in this pond.

iii. Water Development Board pond, Sopura, Rajshahi

Eunapeus carteri grows profusely on erect stem of *Alternanthera sessilis.*

iv. Charghat ponds

A Sponge (*Eunapeus*) found growing on the branch of a mango tree suspended over the pond (Fig. 5). The Specimen was found to grow larger in the successive year, though the colony used to be dried up in the dry season.

v. The Padma on the Rajshahi City

No Freshwater Sponges were found from ' I ' embankment to 'T' embankment (sampling area) in the Padma in the present study, although there is a report on availability of *E. carteri* (Annandale 1911). The probable cause was may be continuous disturbance in the area by both the professional and amateur fishermen.

vi. Mahananda river, Chapai Nawabgonj

The Sponge collected from the Mahananda of Chapai Nawabgonj sadar for the first time from Bangladesh. It was found in Namo nimgachi village, a suburb only 5 km off Nawabgonj town. The sponge was found on the old brick and RCC block embankment of the Mahananda. It grows on the exposed side of the bricks and blocks. In rainy season, the water is turbid, its colour becomes drab; but in winter, when the water is clear, the colour of the Sponge becomes blackish.

vii. Dafiaalbala pond, Sona Maszeed, Chapai Nawabgonj

A Freshwater Sponge was found (*Eunapeus carteri*) clinging on the staircase; though no Sponge was found on the previous year when that archaeological site was being renovated.

viii. Kahsipur fish farm ponds, Barisal

The pond is used for intensive fish culture. Three specimens of *Spongilla lacustris* were found in a pond, which was kept derelict for that year. Whereas the other ponds were used for intensive fish culture.

ix. Govt. B M. College Campus pond, Barisal

Spongilla cineria was found in the Govt. B M. college pond which was being used for semi intensive fish culture.

x. Dhaleshwary river, Kishorgonj

A big sponge clings on a submerged twig of a 'Kata' (selected and restricted small area for fishing) was collected dry from the Dhaleshawary river of village Savianagar under Austogram upazilla of Kishorgonj district (Fig. 12 and 13).

xi. Hakaluki Haor, Sylhet

In the beel area a peculiar phenomenon happens in planted Hizal sapling *Barringtonia acutangula*, sponge (*Eunapius crassissimus*) grow on it in such a way that the shoot and/or apical bud of the plant can not grow further causing stunted growth or eventually it dies (Fig. 6, 7, 8 and 9).

In early autumn (in the month of Kartik) the leaves are rotten and the naked shoots bearing sponge cause severe irritation in the skin of the fishermen, this problem also happens with Aaran plant *Ficus heterophylla.*

This is a problem sponge, causing stunted growth of some plant mentioned above. For this, study of this sponge should be carried out.

xii. Water Development Board Training Center pond, Munshigonj

Pectispongilla aurea most brilliantly coloured (deep golden) Freshwater Sponge of Bangladesh was found in the pond of Water Development Board Training Center at Bhagyokul of Sreenagar Upazilla, Munshigonj. It harboured variety of sponges. The condition of the pond was found to be congenial for the fauna.

xiii. Chalan beel

In dry season, the investigator visited a small part of the Chalan beel periphery at Handial of Chatmahor Upazilla under Pabna district. No Freshwater Sponge was found due to paddy cultivation.

xiv. The Banar, Kapasia, Gazipur

Spongilla alba was located in the river Banar under the bridge at a depth of 8 meters.

List of Figures

Figure 1. Habitat of *Eunapius carteri*, grown on the exposed roots of *Albizia lebbeck.*

Figure 2. Spiclules and Gemmules of *Eunapius carteri.* 5 × 10.

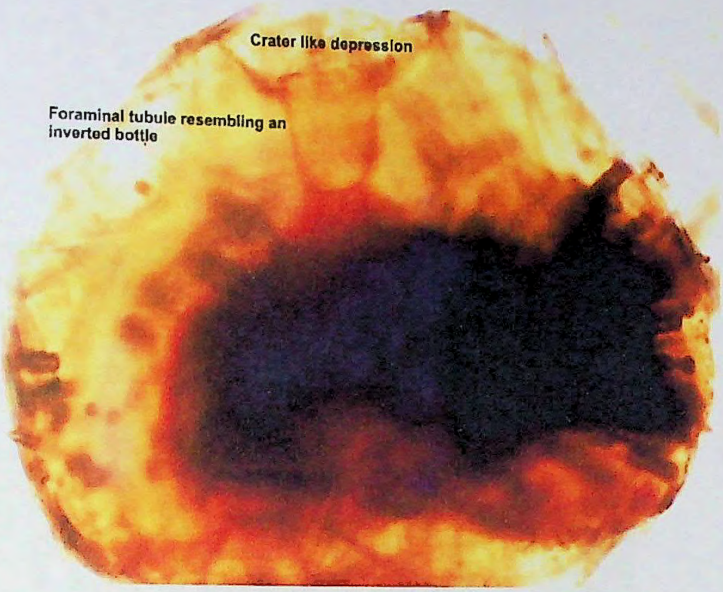


Figure 3. Gemmules of *Eunapius carteri* showing foraminal tubules and crater like depression. 5 × 40.

Figure 4. Gemmules of *Eunapius carteri* showing polygonal air spaces for propagation. 5 × 40.

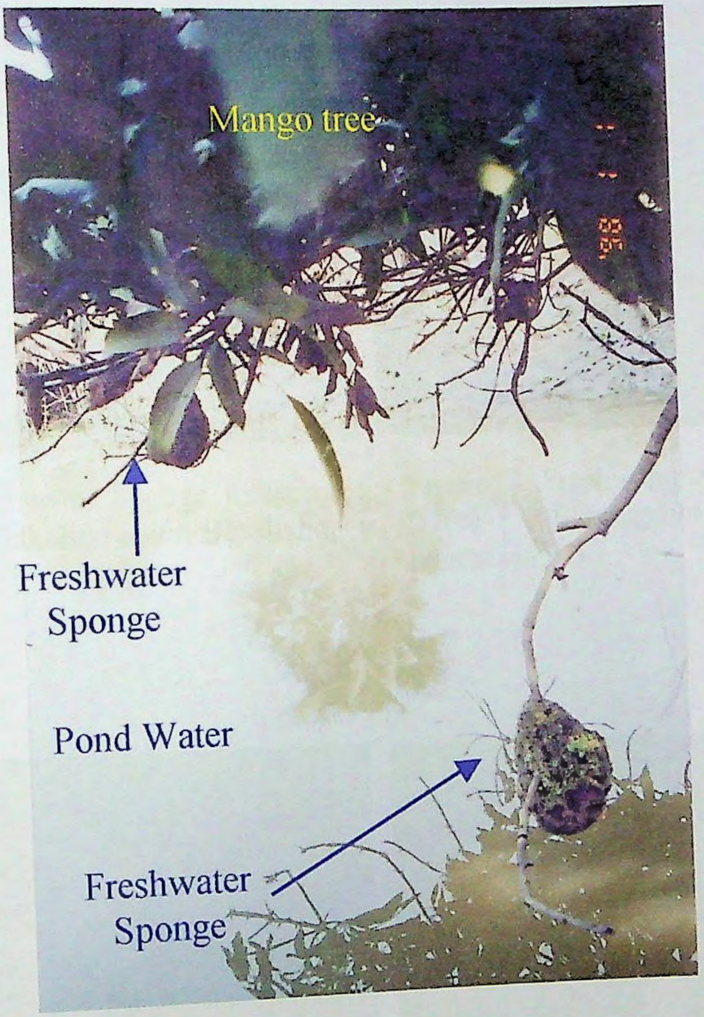


Figure 5. Freshwater Sponge clings on a twig of a mango tree on the bank of a pond at Baduria, Charghat, Rajshahi.

Infestation of plants by Freshwater sponges at Hakaluki Haor

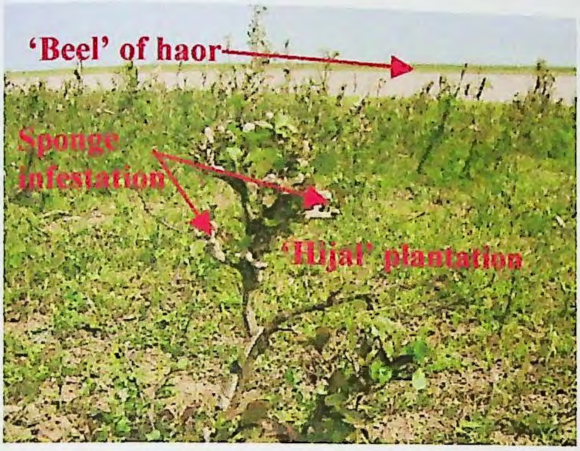


Figure 6. Freshwater Sponge infesting vegetation at Hakaluki Haor, Barolikha, Sylhet.

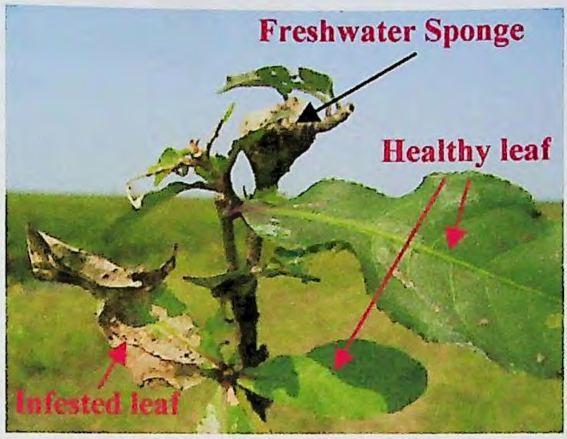


Figure 7. Freshwater Sponge infesting 'Hijal' *Barringtonia acutangula* plantation.

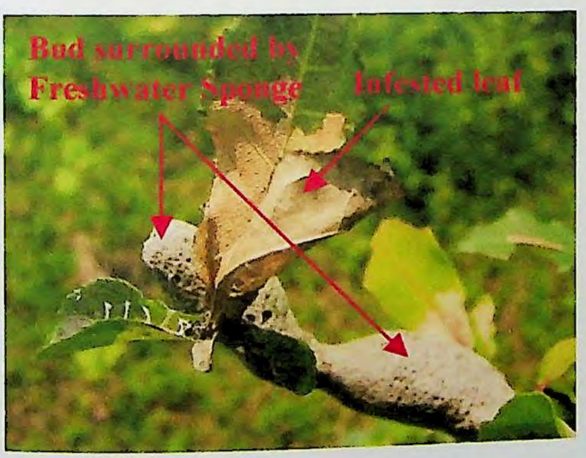


Figure 8. Freshwater Sponge formed as auwfouchs on 'Hijal' *Barringtonia acutangula* bud, stunting its growth or causing ultimate death.

Figure 9. Freshwater Sponge formed as periphyton on 'Aran' *Ficus heterophylla* plant at Hakaluki Haor, Barolikha, Sylhet.

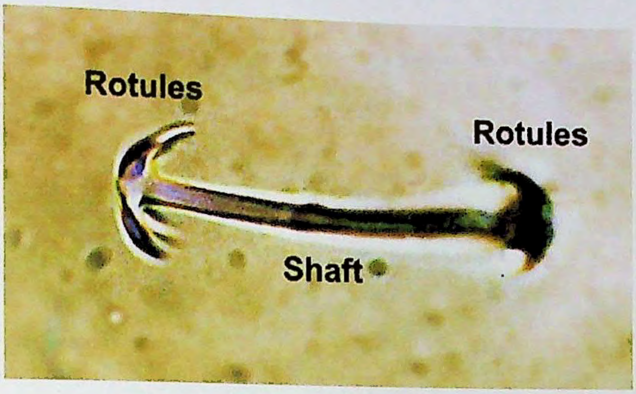


Figure 10. Microsclere magnified 10 times larger than that shown in figure eleven next.

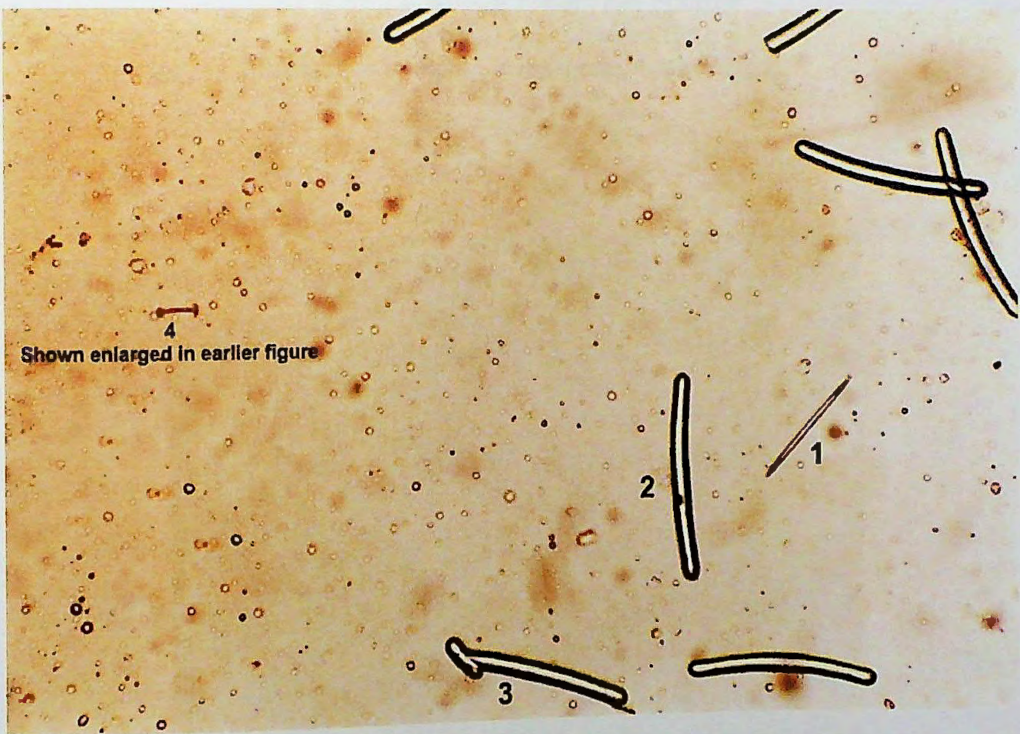


Figure 11. Different scleres of *Corvospongilla bhavnagarensis.*

(1) Immature Megasclere (2) Mature Megasclere (3) Deformed Megasclere and (4) a microsclere × 100.

Figure 12. Robust Freshwater Sponge *Corvospongilla* sp. collected form Dhalleshwary River, Austogram, Kishoregonj.

Figure 13. Magnified part of the Freshwater sponge *Corvospongilla* sp. × 3.

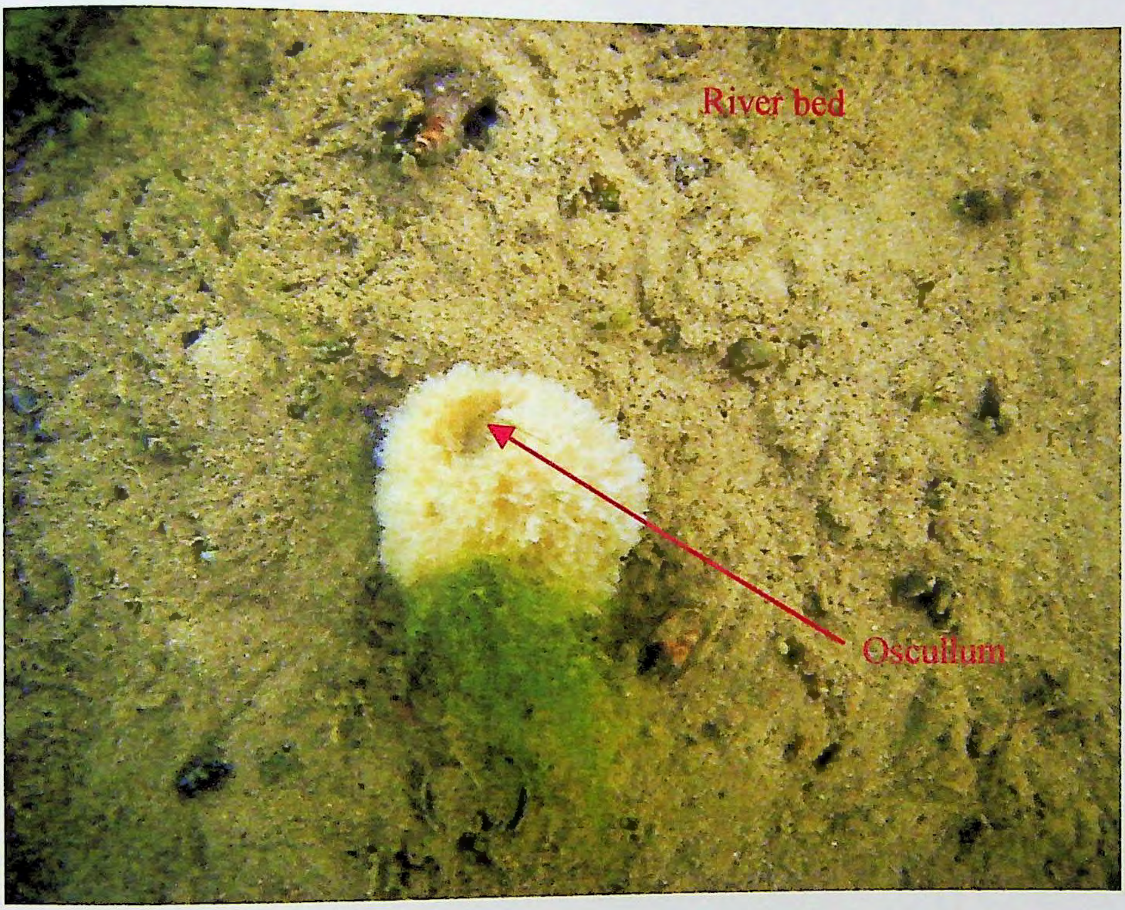


Figure 14. Under water photograph of a freshwater sponge *Spongilla alba* from Banar river, Kapasia, Gazipur.

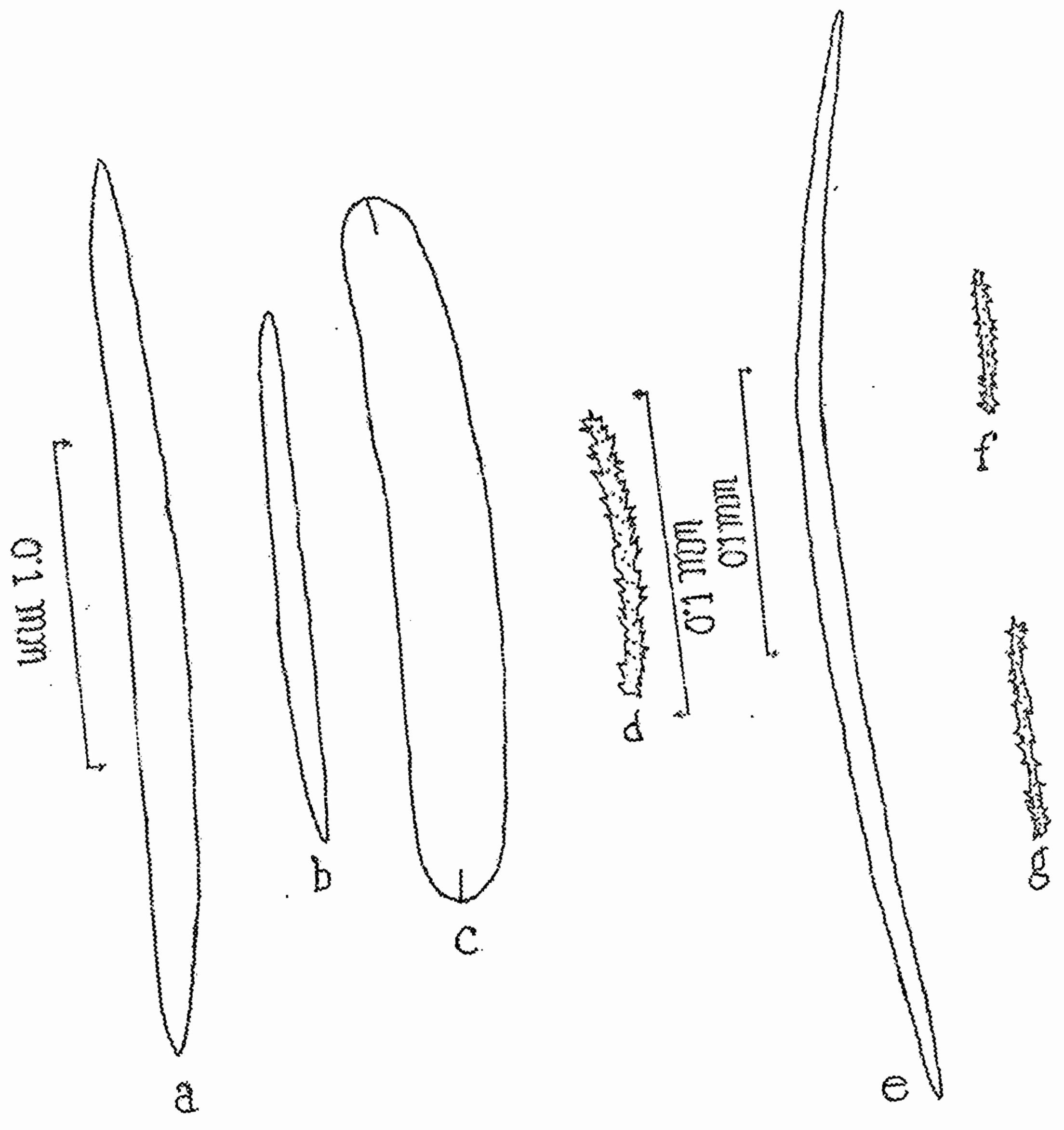


Figure 15. a and b Sclere of *Eunapius carteri* a. Megasclere, b. Gemmosclere. c and d, Sclere of *Eunapius crassissimus* c. Megasclere, d. Gemmosclere. e, f and g Sclere of *Spongilla lacustris* e. Megasclere, f. Gemmosclere, g. Microsclere.

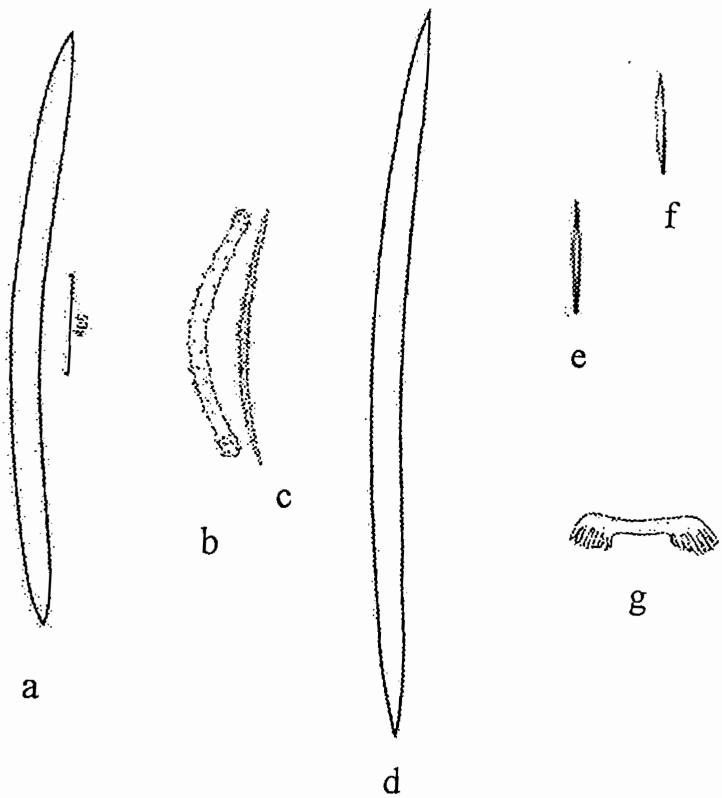


Figure 16. a –c. Sclere of *Spongilla alba* a. Megasclere, b. Gemmosclere and c. Microsclere.

d–g. Sclere of *Pectispongilla aurea* d. Megasclere, e, f. Microscleres, g. Gemmosclere.

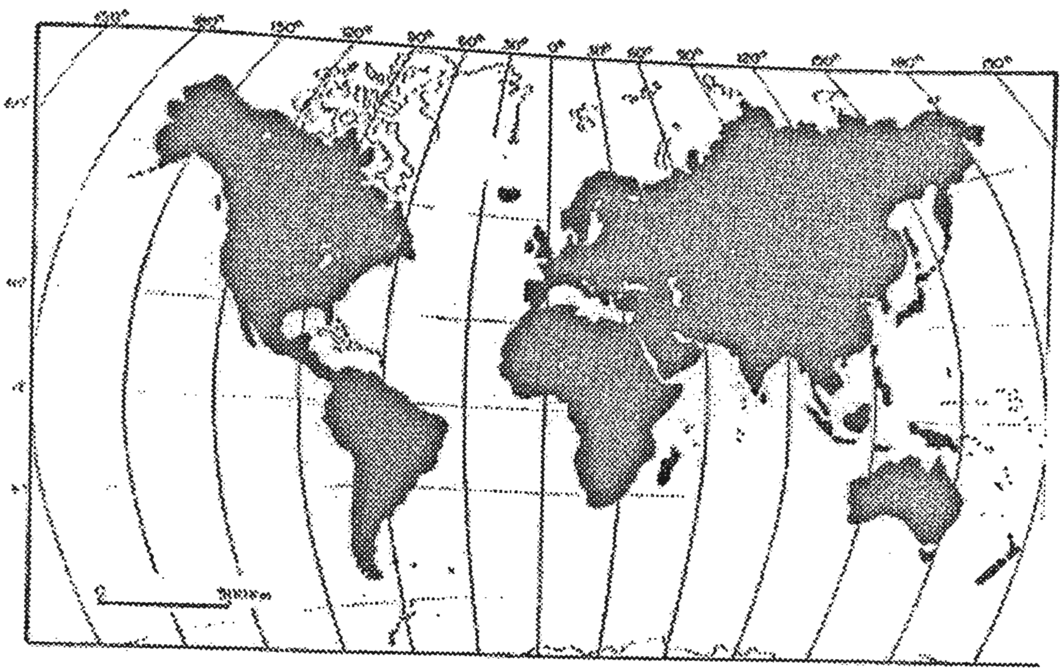


Figure 17. Global distribution of the genus *Eunapius* (black mark).

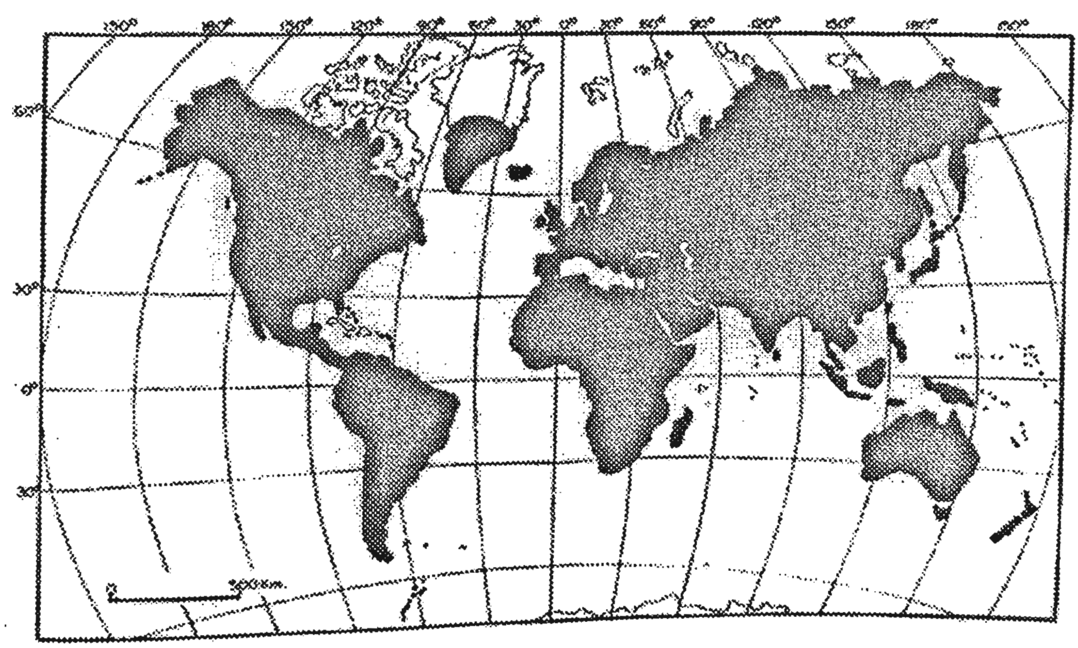


Figure 18. Global distribution of the genus *Spongilla* (black mark).

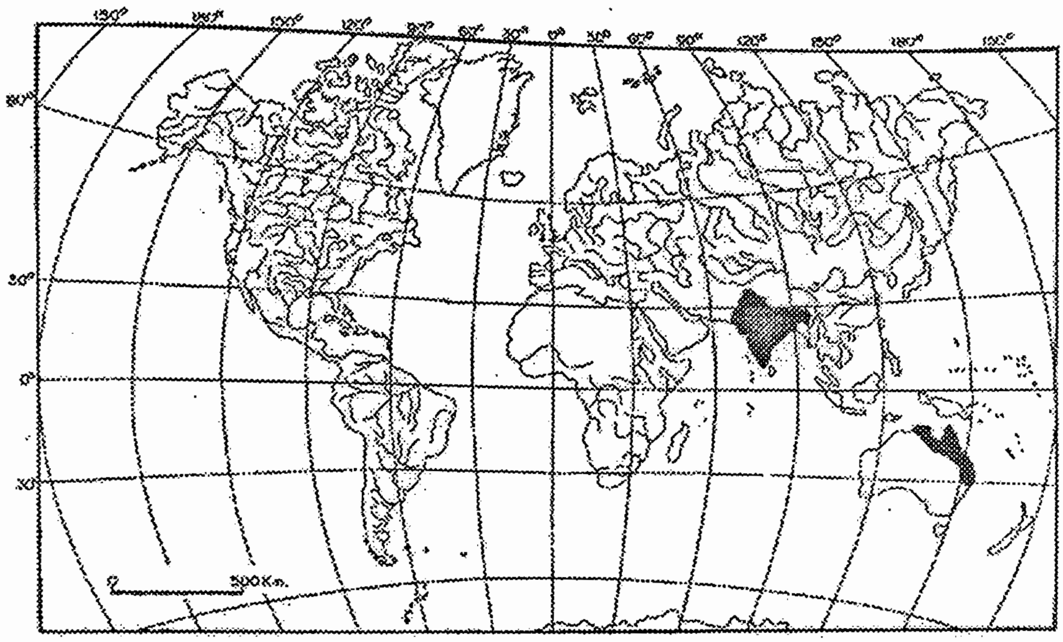


Figure 19. Global distribution of the genus *Pectispongilla* (black mark).

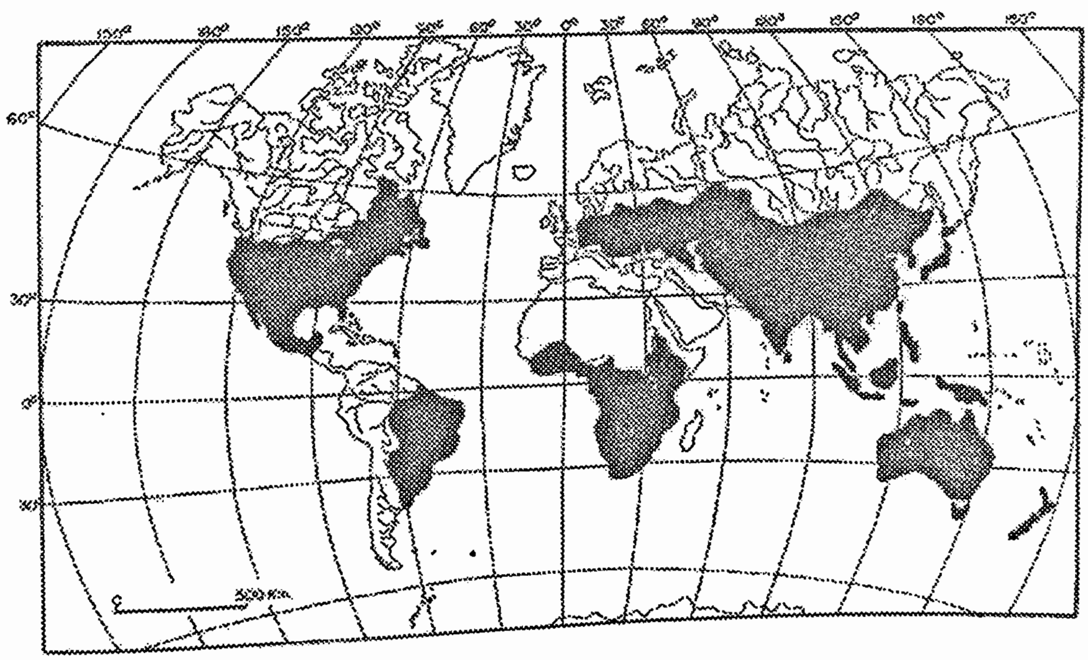


Figure 20. Global distribution of the genus *Radiospongill* (black mark).

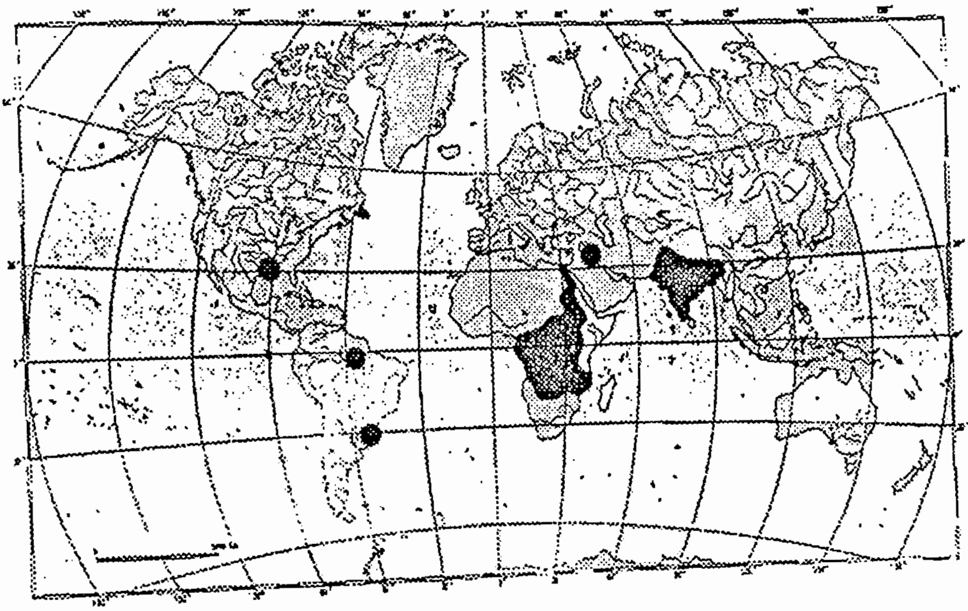


Figure 21. Global distribution of the genus *Corvospongilla* (black mark).

List of Tables

Table 1. Physical conditions of waterbodies of Barisal during October 2003 to September 2004

Parameters	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Average Air temp. (°C)	28.35	26.17	18.29	16.75	21.57	29.25	35.37	38.65	35.75	34.17	33.55	31.27
Water temp. (°C)	26.25	24.58	17.85	14.93	19.85	27.30	33.87	37.50	35.13	34.00	32.64	30.45
Transparency (cm)	19.67	21.35	29.26	32.58	39.76	42.88	45.75	53.69	31.25	30.95	20.56	21.80
Shining condition	C	S/C	S	S	S	S	S	S	S	S	S/C	S/C
Odor	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	FO
Taste	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL
Depth (cm)	166.00	164.00	160.00	158.00	154.00	148.00	147.00	134.00	137.00	143.00	151.00	166.00

TL=Taste less; OL=Odor less; S=Shiny; C=Cloudy; FO=Foul odor

Table 2. Physical conditions of water bodies of Rajshahi during October 2003 to September 2004

Parameters	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Average Air temp. (°C)	29.77	25.85	16.35	14.36	19.69	30.25	36.78	39.21	37.28	36.59	35.29	39.82
Water temp. (°C)	27.27	23.92	14.85	12.49	17.55	28.87	35.25	38.92	37.21	36.42	34.25	28.16
Transparency (cm)	20.53	22.75	30.14	33.26	41.75	42.51	45.69	51.52	33.65	36.95	25.36	21.85
Shining condition	S	S	S	S	S	S	S	S	S	S	S/C	S/C
Odor	OL	OL	OL	OL	OL	OL	OL	FO	OL	OL	OL	OL
Taste	TL	TL	TL	TL	TL	TL	TL	FT	TL	TL	TL	TL
Depth (cm)	172.00	170.00	164.00	162.00	158.00	152.00	140.00	112.00	115.00	125.00	137.00	158.00

TL=Taste less; OL=Odor less; S=Shiny; C=Cloudy; FO=Foul odor

Table 3. Measurement of spicules (in μ) of *Corvospongilla bhavnagarensis*

No. of obs.	Megascleres		Microscleres		Gemmoscleres	
	Length	Width	Shaft length	Rotules diameter	Length	Width
1.	1900	16	41	8	43	4
2.	2040	20	41	8	44	4
3.	2010	45	42	9	43	5
4.	1950	90	41	8	43	4
5.	1910	120	41	9	44	4
6.	1940	85	42	9	45	5
7.	2020	50	41	8	45	4
8.	2050	110	42	9	44	5
9.	1920	140	42	8	44	5
10.	2030	60	41	8	43	4
11.	1930	160	41	9	43	5
12.	1970	100	42	8	45	4
13.	2010	35	41	9	44	5
14.	1990	170	41	8	44	4
15.	2050	180	42	9	45	5
Average	**1981.33**	**92.07**	**41.40**	**8.47**	**43.93**	**4.47**

Table 4. Measurement of spicules (in μ) of *Eunapius carteri*

No. of obs.	Megascleres		Gemmoscleres	
	Length	Width	Length	Width
1.	265	14	145	5
2.	285	16	160	7
3.	310	22	200	6
4.	270	18	155	8
5.	290	20	180	6
6.	320	24	155	6
7.	240	20	170	5
8.	370	14	210	7
9.	310	24	150	5
10.	280	16	170	8
11.	360	25	145	6
12.	290	14	200	5
13.	350	18	190	8
14.	265	20	170	7
15.	340	25	210	8
Average	**303.00**	**19.33**	**174.00**	**6.47**

Table 5. Measurement of spicules (in μ) of *Spongilla lacustris*

No. of obs.	Megascleres		Microscleres		Gemmoscleres	
	Length	Width	Length	Width	Length	Width
1.	270	15	110	5	90	9
2.	320	18	90	3	120	10
3.	290	20	120	6	100	9
4.	310	17	70	4	80	5
5.	280	16	80	4	110	4
6.	210	8	100	5	90	7
7.	240	12	110	6	130	10
8.	300	14	120	7	100	8
9.	320	15	70	2	80	6
10.	230	10	90	3	90	4
11.	290	16	80	3	120	6
12.	330	18	130	7	110	5
13.	310	11	110	5	90	5
14.	340	15	70	3	100	10
15.	350	19	90	4	80	4
Average	**292.67**	**14.93**	**96.00**	**4.47**	**99.33**	**6.80**

Table 6. Comparative study of diameter of gemmules (in μ) of 3 Freshwater Sponges

No. of obs.	*Spongilla lacustris*	*Eunapius carteri*	*Corvospongilla bhavnagarensis*
	Diameter	Diameter	Diameter
1.	500	440	5
2.	550	500	6
3.	700	480	6
4.	600	510	5
5.	650	470	6
6.	530	600	5
7.	580	580	5
8.	620	530	5
9.	730	450	6
10.	780	460	5
11.	690	590	6
12.	710	570	6
13.	750	540	5
14.	510	520	5
15.	800	610	6
Average	**646.67**	**523.33**	**5.47**

Physiological experiment with *Eunapius carteri, in situ* and *ex situ*:

The colour of Potassium per manganet disappears completely within 30 seconds form the surrounding water of the *Eunapius carteri*. But Potassium per manganet expels out simultaneously from the osculum of the Freshwater Sponge like a ring of smoke.

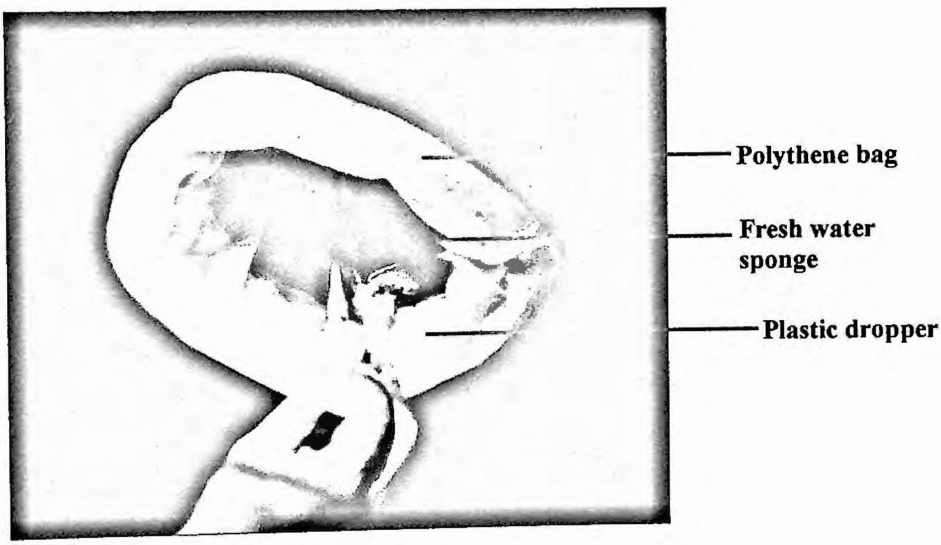


Figure 22. Physiological experiment with Freshwater Sponge. Potassium per manganet is being dropped by a plastic dropper to observe the water current produced by the animal. On 13.11.04.

Freshwater sponge (*Eunapeus carteri*) **formation *in vitro***

Spicule formation with founder cell and thickener cell was observed within six days and small freshwater sponge was emerging within 27 days of culture, which is shown below photographically:

Figure 23A. Spicules forming *in vitro* on 03.VI.04. 2.5 × 20.

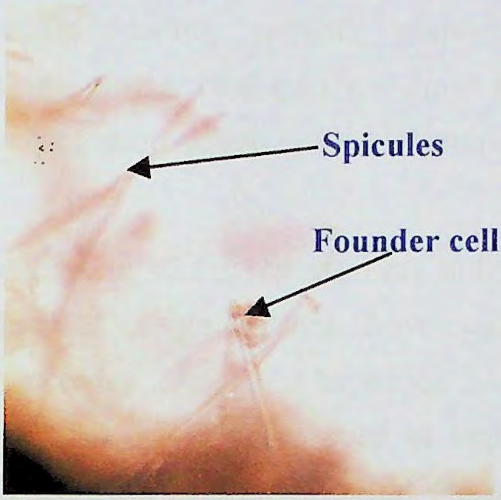


Figure 23B. Spicules formation *in vitro* on 07.VI.04. 2.5 × 20.

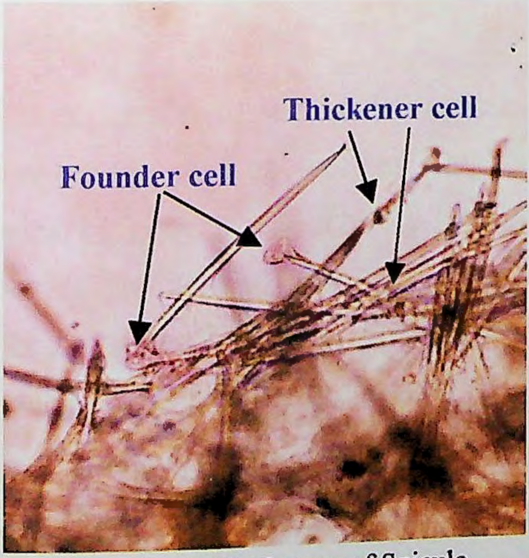


Figure 23C. Final stage of Spicule formation. Builder or founder cell and thickner selerocytes visible on 18.VI.04. 2.5 × 20.

Figure 23D. Anastomosing structure of spongin fiber growing in a Freshwater sponge, *in vitro* on 30.VI.04. 2.5 × 20.

Figure 23. Freshwater sponge (*Eunapeus carteri*) formation *in vitro*

General Discussion

In identifying the specimens entire individuals of marine specimen are necessary for (collection preservation and) taxonomic purposes, but for freshwater specimen, only parts bearing gemmules are sufficient. Sponges having gemmules are the best specimens for collection where it is difficult to ascertain their specific identity without gemmules. Gemmules and gemmosleres morphology play a vital part for diagnostic purposes, though taxonomic importance of microsclere is also noteworthy in the taxonomic work (Soota 1991).

The Sponges from the territory of Bangladesh so far reported are enlisted in the table 7 and the global distribution of the genera not shown earlier are presented in the figures 24–27. It includes 29 species of which 22 are freshwater ones. But most of the specimens are not preserved or kept in any repository for further comparison, even the source of initial report is not mentioned. The preparation of checklist of this fauna in our context is still remained urgent and challenging. The venture should be attempted immediately.

In comparison to world, 95 species under 18 genera have been reported world wide and as well as neighbouring country India have 31 species under 11 genera respectively (Penney and Racek 1968, Soota 1991). The species richness of this group of Bangladesh is worth mentioning (22 species under 8 genera). It is in conformity with the rich Biodiversity and riparian nature of the landmass.

Further the ecological niche of sponges in our water have not been determined properly. The periphytonic and symbiont/commensal efficiency of certain species are mentioned only but the role of different development phases in the food web specially when they are meroplankton are not taken in to consideration at all by the limnologist or fisheries scientist in Bangladesh.

Table 7. List of Sponges so far reported from Bangladesh

Sl. No.	Name of the Species	English name	Habit	Distribution	Ref
1.	*Grantia compressa*	Grantia Sponge	Marine, littoral	Bay of Bengal, South-East Asia to Australia and the Indo-Pacific region. Coasts of the British Isles	Chanda, 2008
2.	*Euspongia officinalis*	Bath Sponge	Exclusively marine	Bay of Bengal, Mediterranean, Bahamas, West Indies and Australia.	Chanda, 2008
3.	*Cliona celata*	Sulphur Sponge	Benthic, estuaries	Cosmopolitan, Indo-Pacific, Indian Ocean, Central and North America, shallow waters of India and Bangladesh	Hartman, 1958, Islam , 2008
4.	*Cliona orientalis*	Boring Sponge	Benthic, Estuaries.	Indian and Pacific oceans, Australia, Malay Archipelago, Vietnam, Indonesia, Maldives, India and Bangladesh.	Calcinai *et al.* 2000 Islam, 2008
5.	*Cliona vestifica*	Boring Sponge	Tidal and shallow water	Cosmopolitan, India and Bangladesh	Pattanayak, 1995, Islam, 2008
6.	*Haliclona oculata*	Finger Sponge, Dead man's fingers	deep sea water, never in shallow water	Bay of Bengal, Pacific and Indian Oceans.	Chanda, 2008
7.	*Corvospongilla bhavnagarensis*	Freshwater Sponge	Lotic water, Periphyton	Gujarat, India, Mahananda river.	Islam *et al.* 2008
8.	*Corvospongilla burmanica*	Freshwater Sponge	Lotic water, Periphyton	Myanmar, India, Bangladesh.	Islam, 2008

9.	*Corvospongilla caunteri*	Freshwater Sponge	Lotic water, Periphyton	Gujrat, West Bengal, Bangladesh	Pattanayak, 1999, Islam, 2008
10.	*Corvospongilla lapidosa*	Freshwater Sponge	Lotic water, Periphyton	Maharashtra, Gujarat, West Bengal, Bangladesh.	Islam, 2008
11.	*Dosilia plumosa*	Freshwater Sponge	Lotic water, Periphyton	Indian subcontinent, South-East Asia and the Philippines	Chanda, 2008
12.	*Eunapius calcuttanus*	Freshwater Sponge	Lotic water, Periphyton	Northern part of Bangladesh, West Bengal and Meghalaya	Chanda, 2008
13.	*Eunapius carteri*	Freshwater Sponge	Lotic water, Periphyton	South-East, South and West Asia, Eastern Europe, India and Bangladesh	Soota, 1991, Islam *et al.* 2008
14.	*Eunapius crassissimus*	Freshwater Sponge	Lotic water, Periphyton, occur in soft muddy bottom, also in alkaline water.	Ganges and Brahmaputra river valley, lakes of Bangladesh, India, South East Asia and Australia.	Chanda, 2008
15.	*Eunapius fragillis*	Freshwater Sponge	Lotic water, Periphyton, occur in soft muddy bottom also.	Ganges and Brahmaputra river valley, lakes of Bangladesh and India.	Chanda, 2008
16.	*Radiospongilla cerebellata*	Freshwater Sponge	Lotic water, Periphyton	Bangladesh, India tropical and subtropical regions of Africa, China, Indonesia, New Guinea, the Philippines, Russia and some parts of	Islam, 2008

				South-Eastern Europe.	
17.	*Radiospongilla cinerea*	Freshwater Sponge	Not turbid Lotic water, Periphyton	India and Bangladesh	Islam, 2008
18.	*Radiospongilla crateriformis*	Freshwater Sponge	Not turbid Lotic water, Periphyton	U.S.A., Mexico, Japan, China, South-East Asia, India and Bangladesh	Soota 1991, Islam, 2008
19.	*Radiopongilla hemephydatia*	Freshwater Sponge	Lentic and lotic.	Australia, Papua New Guinea, India and Bangladesh.	Soota 1991, Islam, 2008
20.	*Radiospongilla indica*	Freshwater Sponge	Freshwater	India, Indonesia, New Guinea and Philippines and Bangladesh	Pattanayak, 1999, Chanda, 2008
21.	*Spongilla alba*	Freshwater Sponge	Freshwater and low salinity waters.	India, Africa, Australia, South America, South-East Asia and Bangladesh.	Islam, 2008
22.	*Spongilla lacustris*	Freshwater Sponge	Freshwater	Ganges and Brahmaputra river basins and lakes and streams of Bangladesh, India.	Islam, and Chanda, 2008
23.	*Stratospongilla indica*	Freshwater Sponge	Freshwater	Maharashtra and the West Bengal of India, Thailand and Africa and Bangladesh.	Pattanayak, 1999, Islam, 2008
24.	*Stratospongilla sumatrana*	Freshwater Sponge	Not turbid lentic and lotic water.	Indonesia, India, Africa and Bangladesh.	Soota, 1991, Islam, 2008
25.	*Trochospongilla latouchiana*	Freshwater Sponge	Freshwater	Indian subcontinent, South-East Asia, China and Australia.	Chanda, 2008

26.	*Trochospongilla pennsylvanica*	Freshwater Sponge	Lentic and lotic water.	Southern and South-East Asia, Northern China and South to Eastern Australia, Amazon river, West Bengal and Bangladesh	Soota, 1991, Islam, 2008
27	*Trochospongilla phillottiana*	Freshwater Sponge	Lentic and lotic water.	India, Africa, China, Philippines, South-East Asia and Bangladesh.	Pattanayak, 1999, Islam, 2008
28.	*Umborotula bogorensis*	Freshwater Sponge	Freshwater	North-Western part of Bangladesh, West Bengal, Thailand, Malaysia, Indonesia and China.	Chanda, 2008
29.	*Tethya dactyloidea*	Golf ball Sponge	Marine, Estuarine.	Indian Ocean, Australia, Indo-Malayan region, Japan, South-East Coast of Arabia, India and Bangladesh	Hooper and Wiedenmayer 1994, Pattanayak, 1995, Islam, 2008.

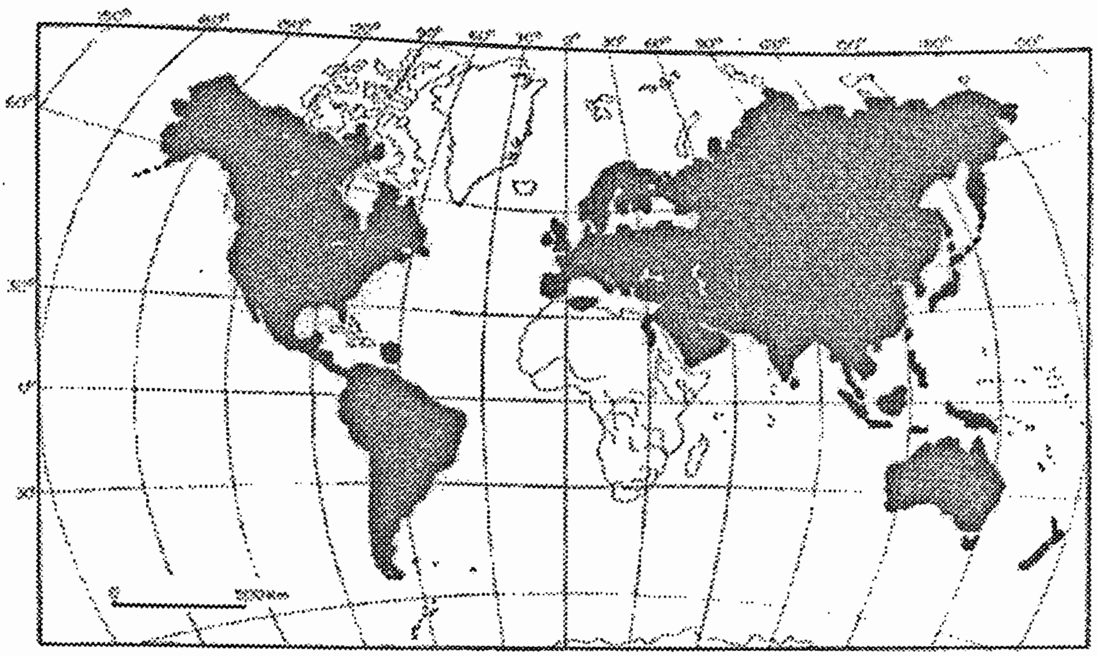


Figure 24. Global distribution of the genus *Ephydatia* (black mark).

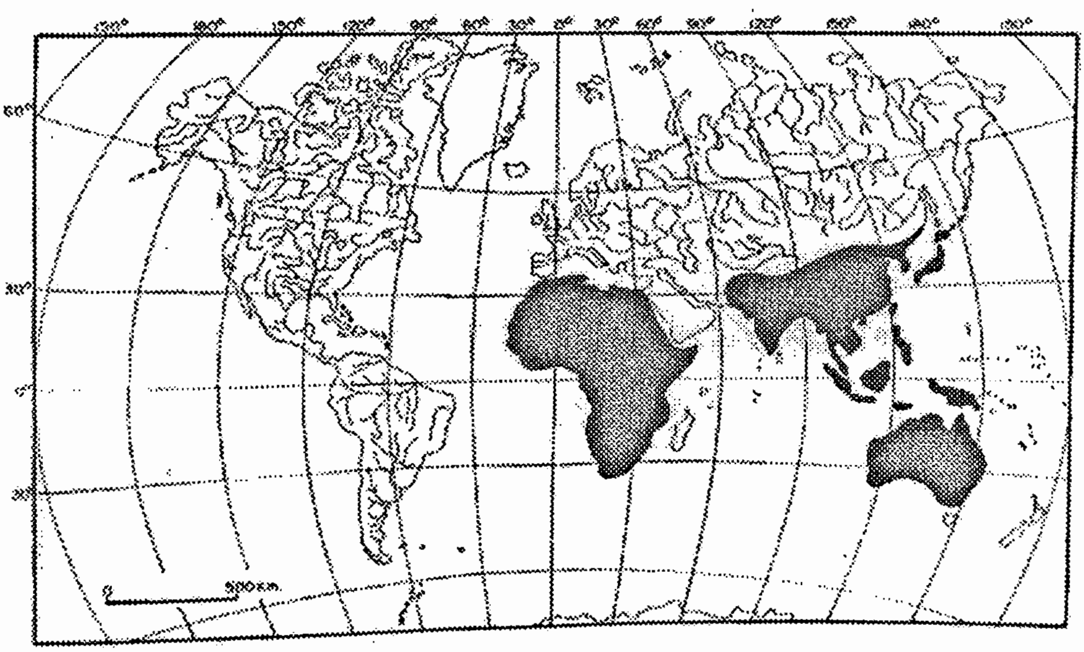


Figure 25. Global distribution of the genus *Stratospongilla* (black mark).

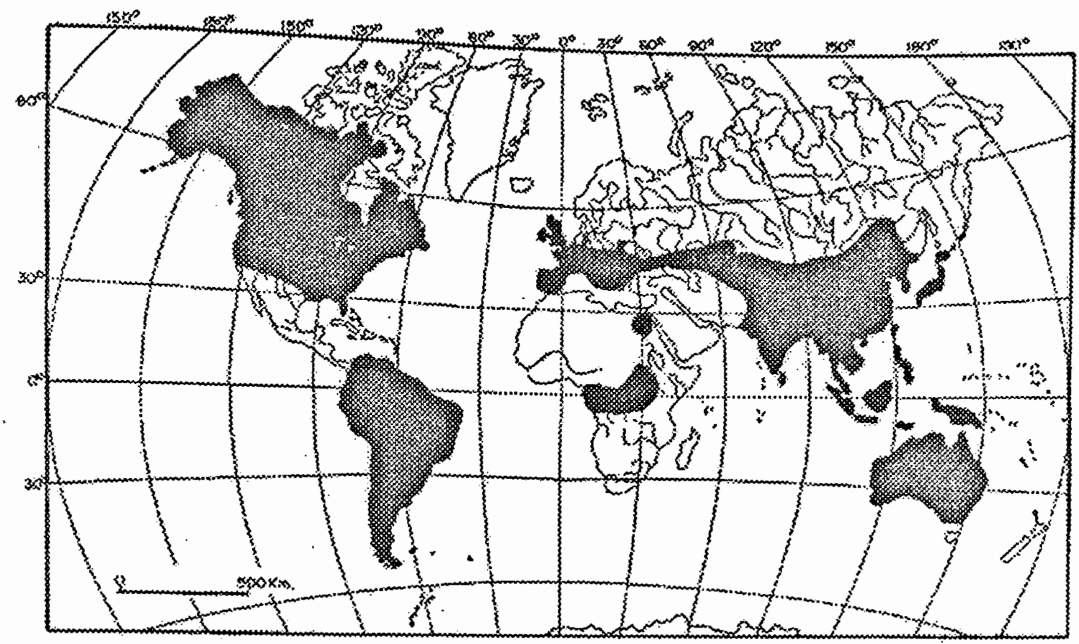


Figure 26. Global distribution of the genus *Trochospongilla* (black mark).

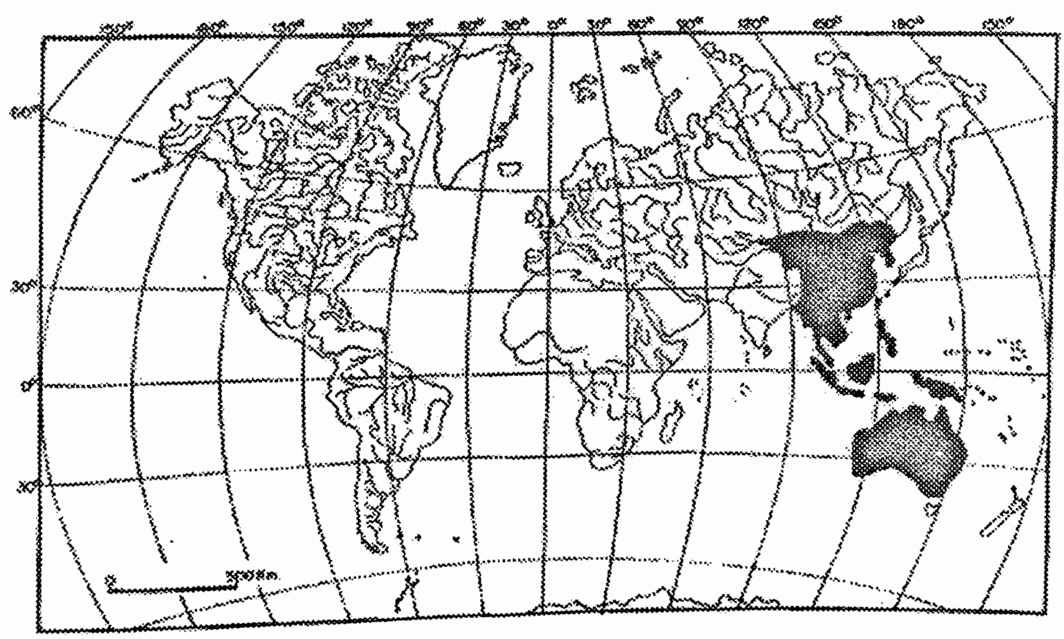


Figure 27. Global distribution of the genus *Umborotula* (black mark).

The food and feeding habit of sponges keeps the water free from carrying more debrises as well as reduces it's microbial load. They play the role of scavengers. The bad odour and spicules of adult sponges keep the predators away and ensure the symbionts'/commensals' existence providing there shelter.

The sponges are considered to be the biological indicator of clean water. They could be used to monitor pollution level of water and can be easier, cheaper and faster tool for screening and survilience of pollution in our context.

The present study shows that animals of this group can be explored to demonstrate different ecological as well as developmental phenomena before the students and also be a good model laboratory animals to test the effect of different physico-chemical conditions.

In reviewing the literature on sponges it revealed that this group has been failed to attract the investigators at large.

The Freshwater Sponges of Bangladesh are facing trouble to survive due to shrinkage of habitat resulting from degradation, deterioration and transformation of water bodies. Anthropocentric activities must be converted to Ecocentric activities to conserve this group of animal by ensuring the water quality and existence of the water bodies in our country.

CONCLUSION

Our country is very resourceful in freshwater fauna of sponges in global perspective (85:22). The study reveals that Freshwater Sponges and their colonies are facing odd situation for survival. Further research work is needed on these neglected but most important both ecologically and economically creatures to pinpoint the conserving measures.

The present study highlights the potentiality of these animals to be good model animals for both demonstration and experimentation in the laboratory.

CHAPTER-5

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APPENDIX

Certificate from India

भारत सरकार

GOVERNMENT OF INDIA

तार : जूलॉजी, कलकत्ता
Telegram : "Zoology". Calcutta
दूरभाष : निदेशक
Phone Director : 478-6893
Sr. A. O. : 478-3383
Fax No. Director : 478-6893
Sr. A. O. : 468-8595

भारतीय प्राणि – सर्वेक्षण
Zoological Survey of India
प्राणि विज्ञान भवन
Prani Vigyan Bhavan
एम ब्लॉक, न्यू अलीपुर,
M-Block, New Alipore
कलकत्ता -700 053
Calcutta - 700 053

संदर्भ सं :
Ref. No. ....

दिनांक
Date 21-7-2006

CERTIFICATE

This is to certify that Mr. Muhammad Rafiqul Islam, Ph. D fellow of Institute of Biological Sciences, Rajshahi University, Bangladesh has been working here in the General Non-chordata Section in Fire Proof Spirit Building, Zoological Survey of India from 17th July to 21st July, 2006. Some of the freshwater sponges of Bangladesh were authenticated under the supervision of Dr. Joygopal Pattanayak. He was acquainted with the methodology and recent development in the study of freshwater sponges. He also studied some of the specimens of freshwater sponges of India. This was done on the basis of the request approved by the Director, Zoological Survey of India, Kolkata vide Office order no. F.211-1/2001-Tech./9350 dated 14th July, 2006.

Ashok Kumar Singh

(ASHOK KUMAR SINGH)
Scientist – E & Officer-in-Charge
F.P.S. Building
Zoological Survey of India
Kolkata-700016