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FAUNA OF INDIAN MUSEUM TANK



ZOOLOGICAL SURVEY OF INDIA



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**FAUNA OF
INDIAN MUSEUM TANK**

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Coordinators

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PREFACE

Indian Museum tank is one of the important man-made waterbodies in Kolkata. This Museum tank and also Ballygunge Science College pond have long been used as hydrobiological demonstration and research study ponds by Zoological Survey of India (ZSI) scientists and Calcutta University researchers respectively (Nandi, 2007). Such study was initiated at the end of the nineteenth century by Anderson (1889), more than 120 years ago and intensively at the beginning of twentieth century by Annandale (1905-1911), Gurney (1906, 1907), Pruthi (1933), Sewell (1926, 1935), etc. So it has been felt to consolidate such studies forming a team of ZSI scientists in 2007 to undertake further studies to assess the richness and diversity of aquatic organisms inhabiting this tank and to prepare a comprehensive document on the Fauna of Indian Museum Tank to commemorate the celebration of such historical hydrobiological studies more than 120 years old.

Under this programme, besides taxonomical studies, we tried to include ecological and limnological studies involving researchers of various disciplines with effect from 2007. In this effort not only the species composition and diversity of aquatic animals in the tank are understood, but also the interrelationships between abiotic factors with benthic biota, effect of sun and shade on benthos as well as the present state of this tank with respect to the other waterbodies in Kolkata have been compared and evaluated by the contributors, warranting it a unique contribution.

Students and researchers in zoology, ecology and environmental science working or interested to work on similar freshwater pond ecosystems all over the country will find this volume as a useful manual for taxonomic studies and as a baseline model for hydrobiological investigation. Since most of the pond ecosystems in urban and per-urban areas are subjected to critical changes and ecological degradation, eco-restoration and biodiversity restoration should be undertaken and investigated.

We would like to thank Director, Zoological Survey of India, Kolkata, for facilities provided for the works. We also thank the authorities of the Indian Museum for allowing us to carry out survey and sampling from the tank and also for permitting us to reproduce the photograph of tank published in their document. We thank our fellow colleagues who have gladly participated in this investigation; even it is an extra work outside their assigned projects. Thanks are also due to Dr. Satyanarayana, Dr. J. G. Pattanayak, Dr. M. K. Dev Roy, Dr. Subrata Kar, Dr. Mousumi Roy, Dr. Chandra Kanta Mandal and especially Shri Santanu Mitra for their various help and cooperation in this work.

We wish to record our gratitude and appreciation to the authorities of the Indian Museum for offering such a historically important freshwater tank ecosystem to the past and present workers and also anticipated future researchers, and therefore to them, we dedicate this document.

N.C. Nandi and Rina Chakraborty

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AN OVERVIEW

INTRODUCTION

The Indian Museum, a monument of national importance in elucidating the Art and Nature of the East, recently recognized as a heritage site in Kolkata megacity, has a long history since it was carved out from the Asiatic Society as proposed by a Danish botanist, Nathaniel Wallich of this Society and readily accepted by the members on 2nd February, 1814. In fact, in May 1862, a decision was taken by the Government of India in favour of establishing a public museum in Calcutta and for that a land with a large pond was acquired on the Chowringhee Road (presently Jawaharlal Nehru Road). The tank inside the Indian Museum campus also has a high profile history of hydrobiological study by the eminent scientists of the Microscopical Society, Calcutta in 1888-89 and by the Zoological Survey of India, Kolkata from the very first decade of the twentieth century, including Dr. Thomas Nelson Annandale who studied freshwater fauna especially hydra, sponges and polyzoa from this tank. As such, it has been felt high time to ascertain what was done in the past and also to know the present state of faunal diversity of this pond. With this idea in mind, a team of ZSI scientists was formed in June, 2007 to reinvestigate on the limnology and faunal diversity of the Museum tank and to prepare a comprehensive document on it to celebrate well over century old hydrobio-historical study of this lentic waterbody towards conservation and management of this hydrobiological heritage pond (Nandi, 2007). Interestingly, this document is brought out on the eve of the Indian Museum's bicentennial which falls in 2014.

The Indian Museum Campus is a plot of land bounded by the premises No.2, Sudder Street and by the Sudder Street at the north; Chowringhee Road and by the premises No.29, Chowringhee Road (occupied by the then Bengal United Service Club and presently by Geological Survey of India) at the west; while on the southern side, it is bounded by the premises no.29, Chowringhee Road by Kyd Street and Kyd Street and on the eastern side by the premises no. 15, Kyd Street and the premises nos. 4, 3, 2, 1 Chowringhee Lane. The greater part of this land was handed over to the Board of Trustees of the Indian Museum and the rest was occupied by the Calcutta School of Art and Geological Survey of India. In the premises, there was an old bungalow built in 1790 and owned by Mr. Peter Speke, whose ground extended up to Kyd Street including the large water tank. The tank was a large sheet of water which is readily found marked on the 'Plan of Calcutta, 1972' The public had the right to access to this tank, which Mr. Speke desired to keep private. Thus, the *ghat*

was removed from the east bank to the southern side, where the boundary was formed by the then new road, the Kyd Street, named after General Alexander Kyd. The *ghat* was opened on this road and over the steps an arch was built up with perforated wall. This perforated wall allowed the water to flow freely through effectually shut out the people who came to draw water from entering the tank, which was surrounded by a high wall. After the construction of this perforated wall, the native name of this tank, *Jhinjherrie Talao* (the mesh-work tank), came into existence. However, from a drawing of Sir Charles Doyle, it appeared that the tank beside the bungalow in the campus was of much greater extent than it is now. And, since the tank is in the heart of Kolkata metropolis, it is natural that it has urban impact, influence and utilization.

The urban Kolkata comes under the interface between Active Delta and Mature Delta of Ganga Delta region. This region is formed of alluvial soils of recent origin. These soils are highly fertile. However, the bottom soil of the Museum Tank is mainly of silty mud with decomposed leaves offering suitable habitat for eutrophic oligochaetes.

Ecological history

The genesis of the megacity Kolkata, was amidst the earlier swamps and crisscrossed watercourses, which was developed over a period on a levee of the river Hooghly with its sloping eastwards. There had been tidal influence in the past in Cherangi area. However, the tank under study is man made and located in urban Kolkata within the Indian Museum Campus, having usual urban artificial environment. The management of this water body is rest with the Indian Museum Authority.

THE TANK

Morphometry

It was a large tank roughly rectangular in shape, measuring 98.75 m in length and 72 m in width. The northern boundary of this tank became somewhat irregular in the year 1965 when a six storied building had come up by filling up a portion of the northern boundary. The average maximum depth of water at the centre is ± 6 m. There is no outlet or inlet of the tank. The water level is maintained by the sub-soil water, the level of which in Kolkata lies about 1.5 m below the surface. The tank bank is almost steep and sometimes covered with aquatic weeds and marginal vegetation, and some areas of the tank are over shadowed by trees. During heavy shower the banks of the tank become overflowed and the opportunistic aquatic fauna get relieved from the tank.

Tank surroundings

The tank in the campus was of much greater extent earlier. In 1964, the Asutosh Centenary Hall and the Five Proof Spirit Building to support the Zoological Survey of India and the Anthropological Survey of India were constructed. At present, the tank is virtually surrounded by office buildings on three sides leaving some space in between where trees and bushes are found. A single-storey staff quarter is located on one side. There is also a metal road on one side for incoming and outgoing office vehicles and pathways on the bank for office goers.

Tank vegetation

The aquatic and marginal macrophytes were plenty, when the present study was initiated. The aquatic hydrophytes were *Azolla*, *Hydrilla*, *Ceratophyllum*, *Valisneria*, etc., while the marginal plants growing on moist soils at the water edge as well as floating on the water surface were *Alternanthera*, *Colocasia*, *Enhydra*, *Ipomoea*, *Marsilea*, etc. These macrophytes provided safe refuge and breeding sites to a large number of insects, mollusks and other aquatic animals.

Hydrology

A year-round limnological study of the Indian Museum tank was conducted with effect from June 2007 to May 2008 and compared the present findings with those monthly data reported by Pruthi (1933) who studied the same pond in the year 1930-1931. The study reveals that water temperature in the tank ranges from 22.5°C to 34.5°C with mean value of 30.0°C. But 77 years back the average water temperature of this pond was 28.83°C, ranging from 20.5°C to 33.0°C. A comparison of monthly water quality data with those of Pruthi (*op.cit.*) reveals that there is an average rise of 1.17°C in water temperature during the span of nearly eighty years (Roy and Nandi, 2009). The amount of dissolved oxygen in the waterbody declined from 6.26mg/l to 4.26mg/l during the last 77 years as the increase in water temperature decreased the solubility of oxygen. The values of pH of the pond also showed declination towards acidic condition (earlier annual average pH 8.29 to the present average 7.99) within this period of nearly eighty years which might be due to increased temperature as hydrological researches prove that temperature and pH are inversely proportional. Temperature rise leads to thermal expansion and warming of the surface water. Consequently, this may lead to some aquatic species extinction, if unable to adapt with the warming of water and its chemical changes in the waterbody. It is worth mentioning that epidemics of fish mortality in the tank occurred even as long back as on the 17th February, 1926 as evident from the study of Sewell (1926). During summer months fish mortality was noticed by one of us (RC) in 1980s and 1990s.

FAUNAL RESEARCHES

Previous works

This tank from the past to the present days has been a favourable study and sampling site for the zoologists. The tank has the tradition of century-old hydrobiological research which was pioneered by Anderson (1889), while working on rotifers more than 120 years ago. Annandale (1905-1911) made a marvelous contribution on Indian Museum Tank describing seven new species of freshwater sponge from this tank, and remarked that it supports appreciably more species of freshwater sponge and other aquatic fauna than any water body of similar area that has ever been investigated in Kolkata. In this respect, the remark of Dr. Thomas Nelson Annandale (1907) regarding the Kolkata tanks with reference to Indian Museum tank is worth quoting: "The best of the tanks from sponge-collector's point of view,.....*Hydra* also flourishes in this pond, but for some reasons there are no polyzoa"

Historically, Anderson (1889) made the pioneering research from Indian Museum Tank while reporting rotifer fauna from Calcutta (now Kolkata) and its environs. According to this report, he found a few examples of *Monostyla quadridenta* Ehrenberg on 23rd December, 1888 which was communicated through the Microscopical Society, Calcutta. Later on, Annandale (1905, 1906, 1907, 1911), Gurney (1906, 1907), De Man (1908) studied different groups of organisms in the Indian Museum Tank. Sewell (1926) reported 9 species of Porifera, 1 species of Cnidaria, 2 species of Oligochaeta, 14 species of Mollusca, 13 species of Crustacea, 27 species of Insect, 16 species of Pisces, 3 species of Amphibia and 1 species of Reptilia. He also reported 57 species of plants under 16 families. Sewell (1935) also gave an account of the rotifers present in the Indian Museum Tank. Tiwari and Sharma (1977) studied the species composition of the above cited tank after a period of about four decades. Subsequently, Sharma (1978-1999) made many contributions on rotifer fauna from West Bengal including this tank. It is worth mentioning that this tank had the pride of producing commendable research in India and also had the heritage of sponge as well as rotifer research and hydrobiological investigations.

Present studies

It has been felt for a long time to prepare a comprehensive account of faunal diversity of Indian Museum Tank, a cradle land of zoological researches in Kolkata, where many stalwarts had made their pioneering studies in different groups. As such an effort was made to organize specific exploratory surveys by a group of experts since June 2007 for a period of one year or more as per nature and requirement of their study. The findings of these studies are presented in Table 1 which includes 28 new records from this tank as well as consolidated reports on vertebrates inhabiting and associated from the Indian Museum Campus.

Table 1 : Key statistics on past and present report of faunal diversity from Indian Museum Tank

Major groups and Subgroups	Number of species reported in			Total	
	Earlier report	Present report			
		Collected/ Observed	Not found		New record
Protozoa (Sarcomastigophora & Ciliophora)	10	23	2	14	25
Porifera (Freshwater Sponge)	9	4	5		9
Cnidaria	1	1			1
Rotifera	40				40
Mollusca	19	14	5		19
Annelida					
Oligochaeta : Lumbricina		2		2	2 + 2
Oligochaeta : Tubificina	4	5	3	4	8
Hirudinea	4	4	1	2	5
Arthropoda : Crustacea					
Cladocera	13	7	6	-	13
Copepoda	7	6	5	4	11
Ostracoda	-	3	-	3	3
Decapoda	3	2	1	-	3
Arthropoda : Insecta	?	31		-	31
Bryozoa	3	3	1	1	4
Chordata : Vertebrata					
Wetland Vertebrates	No study	44	NA	NA	44
Terrestrial Vertebrates	No study	62	NA	NA	62
Total	113	178	31	28	250

NEW DISCOVERIES

The Indian Museum Tank has the pride of a considerable number of new discoveries at the beginning of twentieth century when Annandale (1907, 1911) made his monumental studies on sponge fauna from this tank culminating in the Fauna of British India (Annandale, 1911). Gurney (1907), Sharma (1980a) also described new species of copepod and rotifer respectively from this tank. Below is the list of new discoveries which glorified this tank (Table 2).

Table 2 : List of new discoveries from Indian Museum Tank.

Group and species	Current scientific name
PORIFERA	
1. <i>Spongilla bigemulata</i> Annandale, 1907	<i>Eunapius crassissimus</i> (Annandale, 1907)
2. <i>Spongilla crassissima</i> Annandale, 1907	As above
3. <i>Spongilla proliferans</i> Annandale, 1907	<i>Radiospongilla cerebellata</i> (Bowerbank, 1863)
4. <i>Trochospongilla latouchiana</i> Annandale, 1907	<i>Trochospongilla paulula</i> (Bowerbank, 1863)
5. <i>Trochospongilla philattiana</i> Annandale, 1907	<i>Trochospongilla philattiana</i> Annandale, 1907
6. <i>Ephyladia indica</i> Annandale, 1907	<i>Radiospongilla indica</i> (Annandale, 1907)
7. <i>Spongilla carteri</i> var. <i>mollis</i> Annandale, 1911	<i>Eunapius carteri</i> (Bowerbank, 1863)
8. <i>Spongilla carteri</i> subsp. <i>calcuttana</i> Annandale, 1911	<i>Eunapius calcuttanus</i> (Annandale, 1911)
ROTIFERA	
1. <i>Lecane (Lecane) vasishti</i> Sharma, 1980a	<i>Lecane (Lecane) vasishti</i> Sharma, 1980a
CRUSTACEA : COPEPODA	
1. <i>Diaptomus contortus</i> Gurney, 1907	<i>Heliodiaptomus contortus</i> (Gurney, 1907)

ECOSYSTEM GOODS AND SERVICES

The tank inside the premises used to play an important role of various water uses to the neighbourhood and particularly to the rows of quarters on the southern side. Besides traditional fishery, the artificial storage of water has immense role to play in fire extinguishing in the locality as happened in the recent past in the Hog Market fire. The various other usage catering ecosystem goods and services are shown in Table-3.

Table 3 : Ecosystem goods and services of the Indian Museum tank.

Ecosystem goods and services	In 1970s	In 2010
Ecosystem goods		
1. Edible water plant production	M	L
2. Fish production	M	L
3. Water supply (domestic purpose)	L	L
4. Water supply (agri-horticulture)	M	M
5. Water supply value (fire extinguishing purpose)	M	H
Ecosystem goods		
1. Natural scenario	L	L
2. Aesthetic beauty of the area	M	M
3. Cool green shade of trees surrounding the tank	M	M
4. Microclimate stabilization of the area	M	M
5. Biodiversity supports (combined aquatic and dryland)	H	H
6. Waterfowl habitat	L	L
7. Bathing and washing of utensils	L	L
8. Garbage disposal site	L	M
9. Prevention of water logging in the campus.	M	L
10. Waterfront ambience	M	M

Abbreviations used : L = Low; H = High; M = Medium

CONSERVATION AND MANAGEMENT ASPECTS

Despite providing sustenance of life, environment and resources crucial for survival of all aquatic organisms, wildlife and man, waterbodies of urban Kolkata including Indian Museum Tank suffers from encroachment and reclamation. As a matter of fact, Indian Museum Tank has undergone critical changes during the last few decades including conversion for office expansion defying the benefits and ecosystem services rendered by this tank over the years. The tank has suffered both horizontal shrinkage for official expansion as well as vertical shrinkage due to siltation. There is also pollution from domestic sewage and surface run-offs. The sediment load has increased the turbidity and organic enrichment. As a result weed infestation was profuse during May 2007, though these are under control these days. After fish mortality on 27 February, 1926 (Sewell, 1926), a large scale epidemic of mortality of fauna in the tank was recorded in August 1930 probably due to the decomposed organic matter under adverse weather conditions (Pruthi, 1933).

The above circumstances and anthropogenic activities have begun to threaten the tank ecosystem in a serious way particularly the direct effects of conversion and construction works. It is, therefore, suggested to formulate proper management plan of this important hydrobiological heritage site under the umbrella of an Integrated Area Development Network Programme (IADNP) involving ZSI for conservation and sustainable development of urban wetlands in Kolkata (Nandi, 2000, 2004, 2007) adopting the following management measures.

- Prepare an accurate map of the tank, adjacent open areas and office establishments.
- Ensure welfare of the quarter dwellers in the integrated planning process of the tank.
- Investigate and document natural and human induced stressors of the tank ecosystem.
- Identify and quantify the interdependence of ecosystems, organisms, products and processes of the tank.
- Utilize techniques and methods to prevent and restore degraded tank areas.
- Undertake environmental impact assessment and long-term cost-benefit analysis to ensure continued productivity of the tank.
- Formulate long-term management plan incorporating management mission and/ or ideal objectives.
- Design annual action plan incorporating phase-wise management activities towards achieving ideal objectives.
- Provide research support for ecological monitoring, biomonitoring and biomanipulation and also to develop effective management options.
- Review of management measures at every two years' interval and, if required, restructure the annual action plan and short-term management plan.

GENERAL REMARKS

The Indian Museum tank is a biological paradise for the study of rotifer and sponge fauna. As early in 1911, Annandale from his observations on sponge fauna of this lake aptly remarked;

“The best of the tanks from the sponge-collector’s point of view, so far as I have been able to discover, is the one in the compcund of the Indian Museum. It enjoys all the advantages of light and shed, solid supports, prolific aquatic vegetation, considerable depth, and the vicinity of human dwellings that seem to be favourable to the growth of sponges, no less than nine species of which, representing three genera and two subgenera, grow abundantly in it”

Several species of sponge are still surviving in this pond for the last one century [as evidenced from the recent findings (Pattanayak) inspite of shrinkage (both vertical and horizontal) to its present form and degradation. It is therefore felt that this pond should be declared as *“heritage pond”* in order to protect and preserve its unique biodiversity.

PLATE-I

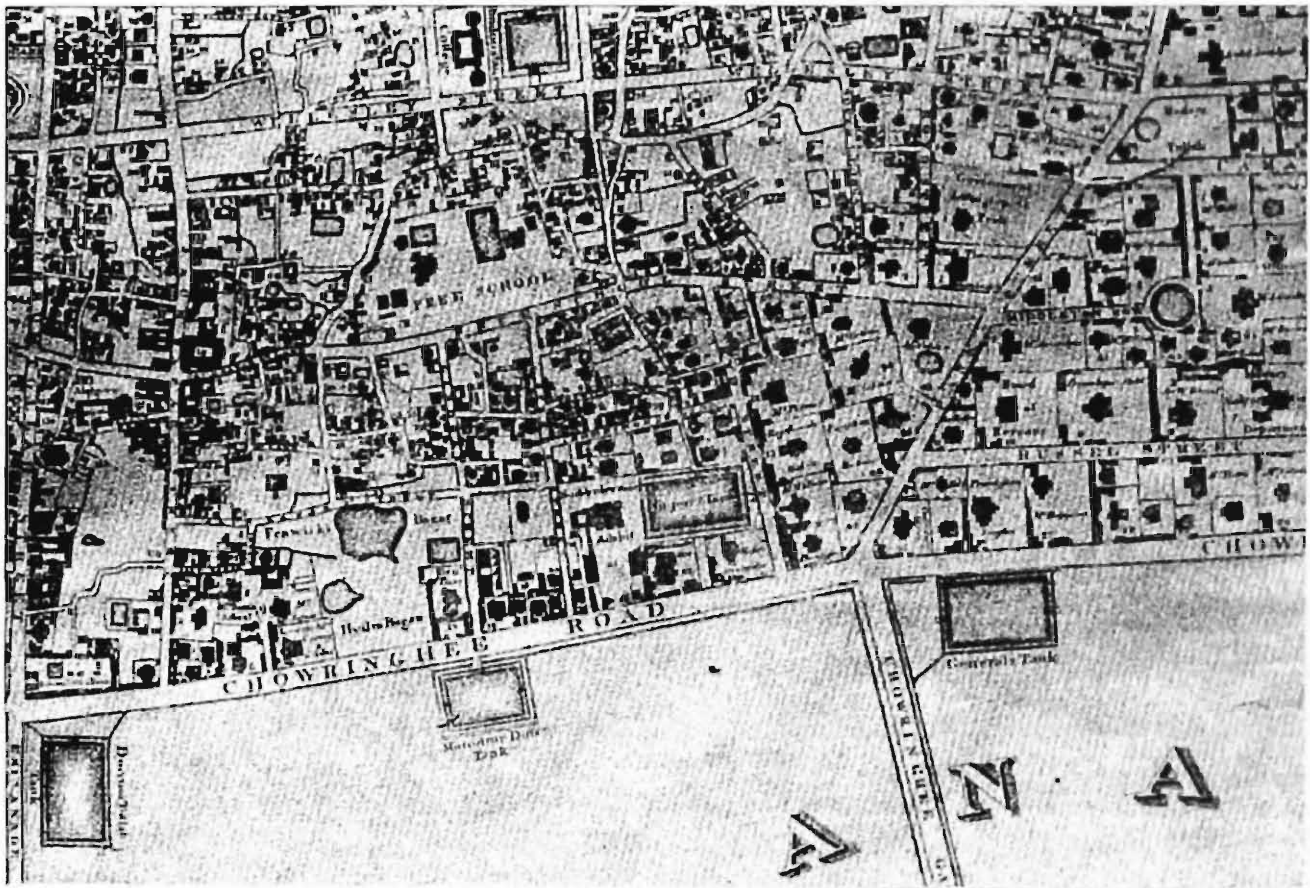


Fig. 1 : Map of Kolkata showing location of Indian Museum Tank. (Courtesy : Director, Indian Museum)

SUMMARY

An overview of the Indian Museum Tank is provided with a descriptive account of the tank and its ecological history as well as tracing the pioneering earlier works on hydro-bio-historical study from this tank. The present venture is summarized showing a total of 250 species dealt in this document along with 29 additional records on various groups of fauna. This overview also indicates the new discoveries from this tank, ecosystem goods and services of the tank in addition to necessary conservation and management measures.

LIMNOLOGY

INTRODUCTION

Most of the cities in India abound with a preponderance of typically manmade waterbodies called ponds, tanks and reservoirs. Many of these manmade waterbodies like the Indian Museum Tank (IMT) in Kolkata megacity are of historical importance. These waterbodies nowadays suffer, without exception, from different grades of environmental degradation. However, this paper aims to understand the limnological status of the tank of Indian Museum compound, Kolkata, which can be focused as a pond of hydro-historical study in eastern India (Roy and Nandi, 2009). So, efforts have been made to determine the water quality parameters as well as inter-relationship between the abiotic factors of the tank and to compare them with the earlier study made long before, nearly 80 years ago (Pruthi, 1933).

Study stations :

IMT1 : This study station is situated at the corner of eastern and southern side of the pond. In this place the water is over-shaded by tall trees. Household wastes and decomposed tree leaves are the characteristic features of this spot.

IMT2 : It is situated at the northern side of the pond and almost near a small *ghat* but rarely used by people. There is no shade of trees but some macrophytic vegetation is present there. At this point surface-runoff water flows into the tank from its bank and roads in the compound during rain.

Methods : Eleven physico-chemical parameters of water and atmospheric temperature were measured in the field and in the laboratory, chiefly following standard methods of APHA (1998) and Mukherji and Nandi (2004).

Data analysis : One year data of Indian Museum Tank, Kolkata was analyzed to evaluate the inter-relationship among 12 studied abiotic factors. Pearson's correlation coefficients were calculated through SPSS 10 software to understand the parametric relationships between the limnological parameters supposedly in interaction. The two tailed t test was used to test the correlation coefficients at 5% and 1% level of significance.

RESULTS AND DISCUSSION

Hydrology : Water quality parameters of Indian Museum Tank collected from two study stations (IMT1 and IMT2) are pooled and presented in Table 1 along with three other waterbodies in Kolkata megacity to understand the limnological status of this tank. This study indicates that the water quality of this tank is almost at par with other water bodies in Kolkata. However, variations in the water chemistry of two study stations in Indian Museum Tank for a period of one year indicate certain temporal trends (Fig. 1).

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Atmospheric temperature during the period was comparatively lower (31.08°C, 24°C-36.2°C) at IMT1 than IMT2 (31.51°C, 24.2°C-36.8°C) due to tree shades. Like-wise, average water temperature of IMT1 (29.85°C) was slightly lower than IMT2 (30.15°C). Water temperature varied from 22°C in January to 34°C in August at IMT1 whereas this showed higher fluctuation (23°C-35°C) at IMT2 of the tank. Dissolved oxygen (DO) was found to vary from 2 mg/l to 7.15mg/l in the tank, showing average value of 4.3mg/l and 4.22mg/l in IMT1 and IMT2 respectively. The average value of DO, being above 4mg/l, indicates its suitability for sustenance of aquatic life (Gray *et al.*, 2002), though lower values suggest polluted state of water body (Hasler, 1947 and Edmonson, 1966). Higher DO was observed in the month of August (7.15mg/l) at IMT1 which was higher than the other study point (6.3mg/l). Minimum concentration of DO was noticed in July (2.3mg/l at IMT1 and 2.0mg/l at IMT2). BOD ranged in between 0 mg/l and 4.2mg/l which exhibited less variation among the stations. Hydrogen ion concentration of this tank had a range of 7.2 to 8.8. Maximum values of total alkalinity were recorded in June (470.5mg/l at IMT1 and 490.5mg/l at IMT2) and minimum value (270.27mg/l) was recorded in December at IMT1 and in October-November at IMT2. Total hardness of water also showed the same trend and the values remained in between 149.94mg/l and 264.18mg/l. Transparency of water was lowest in June (41cm) due to dewatering and disturbance in the tank. The higher values were in September (184cm) at IMT1 and in February (120cm) at IMT2. In both the stations, amount of chloride content varied from 42mg/l in June to 92mg/l in November. Higher phosphate content (0.5mg/l) was observed in December at IMT1 which might be due to low water level and presumably, higher disposal of wastes. The values of nitrite content of water varied in between 0mg/l to 0.9mg/l and nitrate concentration ranged from 10mg/l to 40mg/l which exhibited less variation in between the two stations (Fig. 1).

In general, atmospheric temperature and water temperature were comparatively lower at station 1 due to the presence of tree shades. The pond was highly infested with floating macrophytes which were removed in June 2007. These aquatic weeds which covered almost 60% of the water surface prevented the light penetration and restricted the phytoplanktonic photosynthetic oxygen production for which DO concentration was recorded lowest in June-July but rapidly increased in August because of clear water, removal of floating vegetation, higher light penetration and wind flow. The DO values of both the stations indicate mostly the appropriate aerated state of the water body (Agarkar *et al.*, 1998).

According to Anitha *et al.* (2004) higher BOD values indicate the presence of untreated domestic sewage which results in accumulation of large amounts of organic matter as observed in IMT1. Higher values of pH in waterbodies are associated with wastes as well as rich growth of aquatic plants and decomposition of leaf litters. But, the pH values 7.2-8.8 in the Indian Museum Tank indicate its suitability for fish and other aquatic organisms.

Table-1 : Water quality characteristics of some water bodies in Kolkata.

Parameters	IMT		Rabindra Sarobar (RS)		Subhas Sarovar (SS)		ISI Pond	
	Range	Mean \pm Sd	Range	Mean \pm Sd	Range	Mean \pm Sd	Range	Mean \pm Sd
Water Temperature ($^{\circ}$ C)	22.00-35.00	30.00 \pm 4.14	19.2-33.1	28.29 \pm 4.08	18.67-32.93	28.31 \pm 3.73	-	
DO (mg/l)	2.00-7.15	4.26 \pm 1.27	5.1-9.98	6.85 \pm 1.23	4.81-8.94	6.26 \pm 1.12	0.45-4.79	2.38 \pm 1.22
BOD (mg/l)	0.00-5.00	1.62 \pm 1.41	4.0-10.5	6.04 \pm 1.63	5.5-13.5	8.33 \pm 2.14	-	
pH	7.20 8.80	7.99 \pm 0.41	7.41-9.48	8.23 \pm 0.51	6.81-8.83	8.04 \pm 0.52	6.6-8.4	7.3 \pm 0.26
Alkalinity	270.27-490.50	344.92 \pm 59.83	250-493	356.42 \pm 56.9	185-345	241.67 \pm 36.3		
Hardness	149.94-264.18	196.28 \pm 25.16	75.2-146.8	104.94 \pm 17.42	49.2-102.2	63.39 \pm 13.69		
Chloride (mg/l)	42.00-92.00	61.17 \pm 12.55	23.0-76.8	52.5 \pm 17.24	20.2-69.0	39.19 \pm 13.23		
PO ₄ (mg/l)	0.25-0.50	0.26 \pm 0.05	0.03-1.2	0.41 \pm 0.28	0.01-1.05	0.31 \pm 0.33	0.02-2.06	0.58 \pm 0.35
Nitrite (mg/l)	0.00-0.90	0.14 \pm 0.19	0.03-0.49	0.16 \pm 0.11	0.03-0.21	0.10 \pm 0.05		
Nitrate (mg/l)	10.00-40.00	24.60 \pm 10.58	0.3-1.1	0.54 \pm 0.23	0.22-0.88	0.43 \pm 0.21		

Source: RS and SS – Pal and Nandi (2006); ISI Pond – Mukhopadhyay and Dewanji (2005)

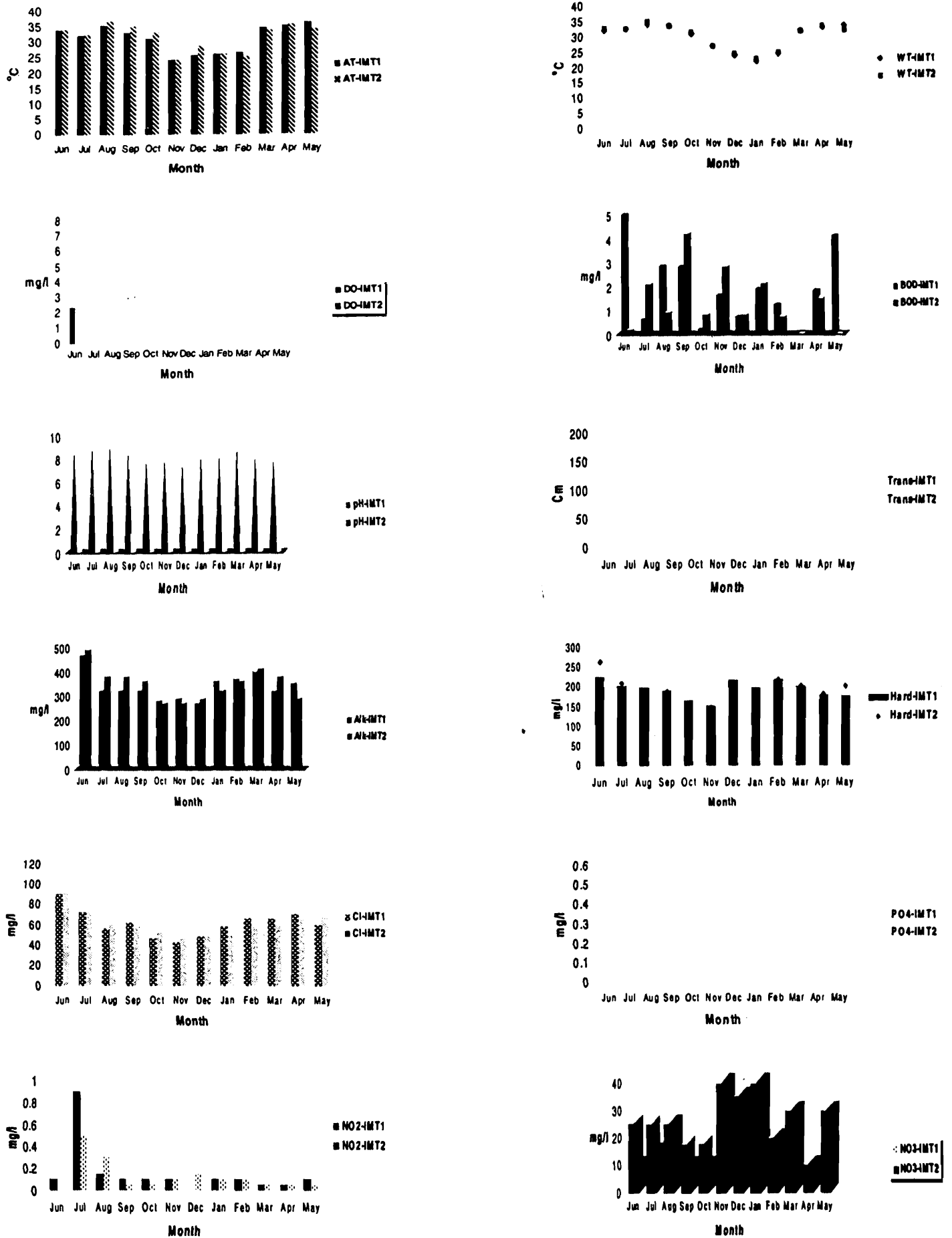


Fig. 1(a-l) : Monthwise variation of limnological parameters at two study stations of Indian Museum Tank.

Total alkalinity values were recorded highest in June when the pond was infested with weeds. According to Alikunhi (1957) the highly productive water possesses higher alkalinity which indicates that this tank was very much productive in June. Transparency was recorded lowest in June due to weed removal activities during this time. Higher chloride content in summer season confirms the finding of Kumar and Gupta (2002). Higher amount of nitrate was probably caused by the decomposition of organic matter in post monsoonal months (Kumar and Gupta, 2002).

Hydrological differences after 80 years

Limnological variation of past and present water parameters at Indian Museum Tank (Table-2) after a long gap of about 80 years from the study of Pruthi (1933) revealed the rise of 1.17°C (i.e. from 28.83°C to 30.0°C) in water temperature, 2mg/l decrease in dissolved oxygen concentration and 0.28 point fall in pH of water. Rise in water temperature and decreased level of dissolved oxygen and pH clearly indicate the slight declination in ecological condition of Indian Museum Tank due to change in climate and weather condition as well as due to greater urbanization of the surrounding environment.

Table-2 : Comparative past and present water parameters at Indian Museum Tank.

Month	Past study during 1930			Present in 2007-2008		
	WT	DO	pH	WT	DO	pH
Jan	20.5	-	7.9	22.5	5.2	7.9
Feb	25.8	-	8.25	24.65	4.15	7.9
Mar	29.8	10.36	8.6	31.8	4.65	8.5
Apr	32.8	7.5	8.2	33.25	4.05	7.65
May	32		8.3	32.75	3.7	7.55
Jun	32.2	4.06	7.95	32.3	3.3	8.2
Jul	30.8	3.75	8.75	32.5	2.15	8.375
Aug	32.2	8.6	8.75	34.5	6.725	8.55
Sep	33	8.5	8.65	33.5	4.65	8.3
Oct	31.6	3.6	8.1	31.15	3.75	7.7
Nov	24.2	4.94	7.8	26.95	3.55	7.6
Dec	21	5.02	7.95	24.15	5.25	7.6
Mean	28.83	6.26	8.27	30.00	4.26	7.99

Source : Pruthi (1933)

Statistical analysis

Pearson's correlation coefficient of abiotic factors (Table-3 and 4) revealed that 4 parameters at IMT1 (Table-3) are correlated with at least one of the 12 studied factors. In this station, water temperature exhibited significant positive correlation ($r = 0.907$, $p < 0.01$) with atmospheric temperature which indicated that with the increase of atmospheric temperature, water temperature also increased. Likewise, chloride content exhibited significant positive correlation with total alkalinity and transparency of water. Nitrate content at IMT1 decreased with the water temperature ($r = -0.568$, $p < 0.05$).

As in IMT1, water temperature showed significant positive correlation ($r = 0.923$, $p < 0.05$) with atmospheric temperature at IMT2 (Table-4). Transparency and nitrate content of water at this point (IMT2) decreased with atmospheric and water temperature. Chloride content increased with alkalinity ($r = 0.787$, $p < 0.01$), total hardness ($r = 0.758$, $p < 0.01$) and decreased with higher water transparency ($r = -0.687$, $p < 0.01$). Nitrate was significantly negatively correlated with chloride content ($r = -0.589$, $p < 0.05$) at IMT2.

Table-3 : Correlation coefficients between the abiotic factors of IMT1.

	AT	WT	DO	BOD	pH	Alk	Hard	Trans	Cl ₂	PO ₄	NO ₂	NO ₃
AT	1											
WT	0.907	1										
DO	-0.062	-0.128	1									
BOD	0.403	0.332	-0.052	1								
pH	0.523	0.534	0.004	0.153	1							
Alk	0.345	0.129	-0.415	0.506	0.447	1						
Hard	0.021	-0.207	0.041	0.125	0.352	0.543	1					
Trans	-0.022	0.121	0.182	-0.152	0.045	-0.183	-0.164	1				
Cl ₂	0.514	0.359	-0.502	0.46	0.542	0.819	0.597	-0.189	1			
PO ₄	-0.402	-0.441	0.34	-0.243	-0.507	-0.389	0.324	-0.161	-0.321	1		
NO ₂	0.099	0.237	-0.409	-0.19	-0.45	-0.078	0.085	-0.132	0.261	-0.204	1	
NO ₃	-0.55	-0.568	0.096	-0.03	-0.243	-0.012	-0.031	-0.29	-0.383	0.297	-0.056	1

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Table 4 : Correlation coefficients between the abiotic factors of IMT2.

	AT	WT	DO	BOD	pH	Alk	Hard	Trans	Cl ₂	NO ₂	NO ₃
AT	1										
WT	0.923	1									
DO	0.041	-0.113	1								
BOD	-0.158	-0.037	-0.368	1							
pH	0.307	0.236	0.272	0.054	1						
Alk	0.447	0.451	0.217	-0.206	0.486	1					
Hard	0.149	0.043	0.074	-0.432	0.278	0.735	1				
Trans	-0.641	-0.656	0.023	0.21	-0.319	-0.51	-0.335	1			
Cl ₂	0.538	0.567	-0.175	-0.343	0.097	0.787	0.758	-0.687	1		
NO ₂	0.056	0.124	-0.242	0.16	0.266	0.03	-0.018	-0.366	0.021	1	
NO ₃	-0.608	-0.643	0.367	-0.06	-0.099	-0.477	-0.251	0.39	-0.589	0.02	1

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Strong positive correlation of alkalinity with chloride was also reported by Jha and Barat (2003). Chloride concentration indicates the presence of organic waste (Thresh *et al.*, 1949) and higher pollution (Munawar, 1970) along with higher amount of alkalinity and hardness. Moss (1973) and Wetzel (1983) stated that the alkaline eutrophic waters are generally rich in bicarbonates which happen to increase the hardness of waterbody and support the present analysis of IMT2 (Table 4). Higher amount of nitrate concentration is related with lower temperature due to the decomposition of organic matter in postmonsoonal months when temperature remains much cold (Kumar and Gupta, 2002). Transparency is related with the fluctuation of water level due to evaporation in premonsoon and postmonsoon season. In overall, water condition of Indian Museum Tank is relatively better in IMT1 than IMT2 and, in general, water of this tank is at par with other waterbodies in Kolkata (Table 1), and offers suitable living conditions to considerable aquatic organisms.

SUMMARY

The physico-chemical parameters of water of Indian Museum Tank were studied for a period of one year from June 2007 to May 2008. These limnological data have been compared

with three other water bodies in Kolkata, and also with earlier study made by Pruthi (1933) from this tank about 80 years ago. The study has revealed a rise of 1.17°C in water temperature from 28.83°C to 30°C and fall of 0.28 point in pH and 2mg/l in dissolved oxygen. In general, the water chemistry of this tank is more or less at par with other water bodies in Kolkata. The parameter relationships between the limnological parameters have also been studied through Pearson's correlation coefficients.

PROTOZOA

INTRODUCTION

Perusal of literature reveals that the first published report on free-living protozoa of the Indian Museum tank was made by Mahajan and Nair (1965) who recorded four species of ciliates, viz., *Platycola decumbens* (Ehrenberg, 1830), *Pyxicola affinis* Kent, 1881, *Vaginicola crystallina* Ehrenberg, 1830 and *Metopus es* Muller, 1786. Then Nair (1966) recorded another species of freeliving ciliate, *Platycola striata* (Fromental, 1874) from this tank. While dealing with protozoan fauna of West Bengal, Das *et al.* (1993) reported ten species of freeliving protozoa from this waterbody inclusive of the above mentioned five species. Additional species reported by them from the tank were *Diffflugia globulus* (Ehrenberg, 1890), *Actinophrys sol* Ehrenberg, 1830, *Frontonia leucas* (Ehrenberg, 1838), *Oxytricha fallax* Stein, 1859 and *Aspidisca costata* (Dujardin, 1842). However, one species, viz., *Colpoda cucullus* was also recorded by them from ground moss of Indian Museum campus. Recently, Bindu (2010) also studied protozoa of this tank during her investigation on the freeliving protozoa of wetlands of Kolkata. During this study author could collect additional 14 species of ciliates (marked with asterisk) from the Indian Museum tank, Kolkata. Thus 25 species of freeliving protozoa have so far been reported from this tank. These are being dealt with in this paper with brief diagnosis.

Mention is to be made here that the first report of freeliving protozoa from freshwater pond in Kolkata dates back to 1842 when Cantor reported about the occurrence of six species based on unpublished observation of G. W. Grant. Incidentally that was the first report of freshwater protozoa from India (Das *et al.*, 1993). Subsequently Simmons (1889, 1891 a, b, c), Ghosh (1918-1929), Nair (1960, 1966, 1971), Mahajan and Nair (1965), Nair and Das (1974), Nair and Mukherjee (1968 a, b), Das (1971), Nair *et al.* (1971), Das *et al.* (1993) and Chattopadhyay and Das (1997) reported several species of rhizopods, ciliates and heliozoans from Kolkata and its nearby localities.

SYSTEMATIC ACCOUNT

Family DIFFLUGIIDAE

1. *Diffflugia globulus* (Ehrenberg, 1890)

1890. *Diffflugia globulus* Ehrenberg, In : Cash, *The British Freshwater Rhizopoda and Heliozoa*, 2 : 33, 37, pl. 21, figs. 5-9.

Diagnosis : Test hemispherical without any collar, composed of cemented quartz sand, diatoms and other foreign particles, grey to pale yellow in colour with few brown particles; pseudostome (oral aperture) terminal, large and circular in shape.

Distribution : India : West Bengal (Kolkata, Nadia and North 24-Parganas districts).

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Remarks : Inhabits freshwater and moss. This species was collected by Nair in 1967 from the Indian Museum tank, Kolkata and reported by Das *et al.* (1993).

Family ACTINOPHRYIDAE

2. *Actinophrys sol* Ehrenberg, 1830

1830. *Actinophrys sol* Ehrenberg, *Abh. Preuss. Akad, Berlin* : 42, pl. 2, fig. 4.

Diagnosis : Spherical in shape; axopodia straight, numerous and radiating, axial filaments terminating at the surface of nucleus; nucleus central; ectoplasm vacuolated, endoplasm granulated and with many small vacuoles.

Distribution : India : West Bengal (Kolkata, Haora and Hugli districts).

Remarks : Occurs in long standing still water amongst vegetation. This species was reported by Das *et al.* (1993) from the Indian Museum tank.

Family PRORODONTIDAE

3. *Prorodon teres* Ehrenberg, 1838*

1838. *Prorodon teres* Ehrenberg, *Die Infusionsthierchen als Vollkommene organismen, Leipzig* : 316, pt. 32, fig. 11.

Diagnosis : Body ovoid, anterior end slightly narrowed and posterior end considerably rounded; uniform ciliation throughout the body; oral basket made up of double trichites, cytostome round, terminal and not surrounded by heavier ring of cilia; pharyngeal tube slightly conical and with trichites, extending about one-fourth of the body length; contractile vacuole single and terminal, macronucleus spherical.

Distribution : India : West Bengal (Kolkata).

Remarks : Inhabits freshwater bodies.

Family ENCHELYIDAE

4. *Lacrymaria olor* (Muller, 1786)*

1786. *Vihrio olor* Muller, *Animalc. fluviat et. Marina. etc., Havniae et Lipsiae* : 75, pl. 10. figs. 12-15.

Diagnosis : Body elongate, posterior portion cylindrical with pointed posterior end; neck or proboscis very long, highly contractile; cytostome round and located at the summit of the proboscis; oral cone well developed; contractile vacuoles two, located on either end of cylindrical body portion; macronucleus with two rounded parts united together.

Distribution : India : West Bengal (Bankura, Bardhaman, Kolkata, Hugli. Koch Bihar, South 24-Parganas districts), Orissa and Rajasthan.

Remarks : Occurs in freshwater.

Family TRACHELIIDAE

5. *Dileptus monilatus* (Stokes, 1886)*

1886. *Amphileptus monilatus* Stokes, *Ann. Mag. nat. Hist., Lond.*, (5) 17.

Diagnosis : Body elongated, posterior end uniformly cuspidate, neck elongated, contractile and about one-fourth to one-half the length of the trunk; cytostome funnel shaped, located at the base of the neck or proboscis; macronucleus moniliform; contractile vacuoles many.

Distribution : India : West Bengal (Hugli district).

Remarks : Inhabits freshwater.

6. *Trachelius ovum* Ehrenberg, 1883*

1833. *Trache/ius ovum* Ehrenberg, *Ahd. Preuss. Akad. Wiss., Berlin*, 1835, pp. 265, 277.

Diagnosis : Body spheroidal to ellipsoid, anterior end with fingerlike proboscis curved dorsally and posterior end broadly rounded; cytostome located at the base of the proboscis; macronucleus sausage shaped; contractile vacuole many.

Distribution : India : West Bengal (Kolkata and Hugli districts), Rajasthan.

Remarks : Inhabits freshwater.

Family LOXODIDAE

7. *Loxodes magnus* Stokes, 1887*

1887. *Loxodes magnus* Stokes, *Ann. Mag. nat. Hist., Lond.*, 20, pp. 104-114, pl. I.

Diagnosis : Body very large in size (400-700 m), leaf-like, flattened, laterally compressed, anterior end beak-like and curved ventrally, posterior end rounded; ciliation on right side of the body only; macronuclei many and scattered in endoplasm; 10-20 Muller's vesicles visible.

Distribution : India : West Bengal (Kolkata, Koch Bihar, Puruliya, North & South 24-Parganas and West Dinajpur districts).

Remarks : Inhabits freshwater.

8. *Loxodes striatus* (Engelmann, 1862)*

1862. *Drepanomonas striatum* Engelmann. *Z. Wiss. Zool. Leipzig*, 11 : 382, 383, pl. 21, fig. 7.

Diagnosis : General shape and ciliation as in *L. magnus* but considerably smaller in size, posterior end pointed; macronuclei two in number; few (4-7) Muller's vesicles observed.

Distribution : India : West Bengal (North 24-Parganas district).

Remarks : Occurs in freshwater.

Family COLPODIDAE

9. *Colpoda aspera* Kahl, 1926*

1926. *Colpoda aspera* Kahl, *Arch. Protistenk., Jena*, 55 : 322, 323, fig. 10 (a-c).

Diagnosis : Body somewhat bean-shaped; cytostome present in ventral depression and located at about one-third from the anterior end; frontal dentitions 6-7 and meridians 14-16; macronucleus spherical; contractile vacuole single and posterior.

Distribution : India : West Bengal.

Remarks : Occurs in freshwater.

10. *Colpoda cucullus* Muller, 1773

1773. *Colpoda cucullus* Muller, *Verminum et Fluvialium S. animal infusor. etc. historia. Hafniae et Lipsiae*. I & II.

Diagnosis : Body typically kidney-shaped; cytostome present in ventral depression and located at about middle of the body; frontal dentitions 8-10 and meridians 29-34; macronucleus oval; contractile vacuole single and posterior.

Distribution : India : West Bengal, Andhra Pradesh, Assam, Karnataka, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh.

Remarks : This species has been reported from different habitats, viz., soil, freshwater and moss in many states of India. (Das *et al.*, 1993). This species was also recorded from the ground moss of Indian Museum campus by Das *et al.* (1993).

Family NASSULIDAE

11. *Nassula ornata* Ehrenberg, 1833*

1833. *Nassula ornata* Ehrenberg, *Abh. Preuss. Akad. Wiss., Berlin* : 169, pl. I, fig. 2.

Diagnosis : Body large, broadly oval with flat ventral and convex dorsal surface, both end broadly rounded; cytostome provided with well developed trichites and located at about one-third to one-fourth of body length from anterior end, cytopharyngeal apparatus prominent; macronucleus round or slightly elliptical and centrally located; contractile vacuole single, located little below the middle of the body.

Distribution : India : West Bengal (Kolkata, Darjeeling and Murshidabad districts), Rajasthan.

Remarks : Inhabits freshwater.

Family LEPTOPHARYNGIDAE

12. *Leptopharynx torpens* (Kahl, 1931)*

1931. *Trichopelma torpens* Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Disch.*), Jena, pt. 21 : 303, fig. 51.

Diagnosis : Body compressed, ovoid in shape, with convex right margin and more or less straight ventral margin; body surface with longitudinal furrows but without any cross striation; ventral ridges united to form a distinct beak near anterior end, pharyngeal basket lacking, presence of spines at the beginning of cytostome; macronucleus oval; contractile vacuole two, located below middle of the body; cytoplasm without green ingested food matter.

Distribution : India : West Bengal (Hugli district).

Remarks : Occurs in freshwater.

13. *Pseudomicrothorax agilis* Mermod, 1914*

1914. *Pseudomicrothorax agilis* Mermod, *Rev. Suisse Zool.*, 22.

Diagnosis : Body more or less compressed oval, smaller in dimension; body surface marked with a broad longitudinal ridge with cross striations; furrows canal like, ciliary meridian 12 (8 dorsal and 4 ventral) in number; macronucleus spherical and located at the posterior half.

Distribution : India : West Bengal.

Remarks : Inhabits freshwater.

Family MICROTHORACIDAE

14. *Microthorax pusillus* Engelmann, 1862*

1862. *Microthorax pusillus* Engelmann, *Zeitschr. F. wiss.zool.*, 11 : 347-393.

Diagnosis : Body small, ovoid with delicate keeled armour, left border slightly sigmoid and right border more or less straight; oral depression on the dorsal side at the vicinity of ventral border with a small tooth on left margin, cytopharynx lacking; macronucleus spherical; contractile vacuoles two, located below the middle half of the body.

Distribution : India : West Bengal (Kolkata, Bardhaman and Hugli districts).

Remarks : Inhabits freshwater.

Family CHILODONELLIDAE

15. *Chilodonella cucullulus* (Muller, 1883)*

1883. *Kolpoda cucullulus* Muller, *Verminum terrest.et. fluviatil S. animal infusor., etc. historia. Hafniae et Lipsiac* : 158.

Diagnosis : Body dorsoventrally flattened, cytopharynx long and straight, macronucleus oval, contractile vacuole many and scattered.

Distribution : India : West Bengal (Bankura, Bardhaman, Kolkata, Darjeeling, Hugli, Jalpaiguri and Malda district), Jammu and Kashmir, Maharashtra and Rajasthan.

Remarks : Occurs in freshwater.

16. *Chilodonella uncinata* (Ehrenberg, 1838)*

1838. *Chilodonella uncinata* Ehrenberg, *Ahh. Preuss. Akad. Wiss., Berlin* : 337.

Diagnosis : Body dorsoventrally flattened; cytopharynx wider in front, narrow behind and spirally curved; macronucleus oval and not surrounded by any clear space; contractile vacuole single and terminal.

Distribution : India : West Bengal (Kolkata, Haora and South 24-Parganas districts).

Remarks : Occurs in freshwater. Bindu (2010) reported this species from the Indian Museum tank, Kolkata.

Family PARAMECIIDAE

17. *Paramecium caudatum* Ehrenberg, 1833*

1833. *Paramecium caudatum* Ehrenberg, *Abhandl. d. Konigl. Akad. d. Wissensch. Zu Berlin* : 268, 323, pl. 3, fig. 21.

Diagnosis : Cigar-shaped, anterior end broader and rounded, posterior end gradually tapering; prebuccal cavity conspicuous leading to equatorially located buccal cavity, peristome long, broad and slightly oblique, cytopharynx moderately long with a row of very fine cilia attached to its dorsal wall; micronuclei single and compact, lying close to massive and egg-shaped macronucleus; contractile vacuoles two.

Distribution : India : West Bengal (in all districts of the state), Orissa, Rajasthan, Uttar Pradesh and Jammu and Kashmir.

Remarks : Inhabits freshwater.

Family FRONTONIIDAE

18. *Frontonia leucas* (Ehrenberg, 1838)

1838. *Bursaria leucas* Ehrenberg, *Die Infusionsthierchen als Vollkommene organismen*, Leipzig : 329, pl. 34, fig. 8.

Diagnosis : Body elongated or ovoid, rounded at both ends, body size larger; prebuccal area very shallow or absent, cytostome expansible; macronucleus ellipsoid with several micronuclei; contractile vacuole single with long radiating canals located at the middle of the body.

Distribution : India : West Bengal (Bankura, Kolkata, Haora, Koch Bihar, Maldah, Murshidabad, North 24- Parganas, Puruliya and West Dinajpur districts), Jammu and Kashmir, Rajasthan and Maharashtra.

Remarks : Occurs in freshwater. This species was collected in 1976 from the Indian Museum tank, Kolkata and reported by Das *et al.* (1993).

Family VAGINICOLIDAE

19. *Platycola decumbens* (Ehrenberg, 1830)

1830. *Vaginicola decumbens* Ehrenberg, *Ahh. Preuss. Akad. Wiss., Berlin* : 41.

Diagnosis : Lorica broadly oval, without any stalk with neck like constriction anteriorly and without any distinct collar or transverse striation, colourless to yellow in colour; attached to submerged substratum by its lateral side.

Distribution : India : West Bengal (Kolkata).

Remarks : Inhabits freshwater. Mahajan and Nair (1965) reported this species from the Indian Museum tank, Kolkata.

20. *Platycola striata* (Fromentel, 1874)

1874. *Vaginicola striata* Fromentel, *Etudes sur les Microzoaires, Paris*.

Diagnosis : Lorica without any stalk and elliptical with very short collar and usually with eight transverse striations in a regular distance, yellowish to brown in colour.

Distribution : India : West Bengal (Kolkata).

Remarks : Nair (1966) recorded this species from Indian Museum tank, Kolkata and found this species to be attached on the zoecium of a bryozoan encrustation on *Valisnaria* leaves.

21. *Pyxicola affinis* Kent, 1881

1881. *Pyxicola affinis* Kent. *A Manual of the Infusoria*, London : 727, pl. 40, figs, 28, 29.

Diagnosis : Lorica with stalk, urceolate, slightly curved at anterior end and little narrowed beneath aperture end, colourless or deep brown; animalcule when fully extended an operculum clearly visible on anterolateral surface of a conical protruberance, attached to the submerged substratum by its lateral side.

Distribution : India : West Bengal (Kolkata).

Remarks : Occurs in freshwater. This species was recorded by Mahajan and Nair (1965) from Indian Museum tank, Kolkata and subsequently by Bindu (2010).

22. *Vaginicola crystallina* Ehrenberg, 1830

1830. *Vaginicola crystallina* Ehrenberg, *Abh. Preuss. Akad. Wiss., Berlin* : 41.

Diagnosis : Lorica without any stalk, transparent, vase-like without any neck, usually with two individuals, one of them being invariably shorter; lorica attached to the submerged substratum directly with its posterior end.

Distribution : India : West Bengal (Kolkata).

Remarks : Inhabits freshwater. Mahajan and Nair (1965) reported this species from Indian Museum tank, Kolkata.

Family METOPIDAE

23. *Metopus es* Muller, 1786

1786. *Metopus es* Muller, *Animalc. Infusoria fluviat. Et marina etc., Hafniae and Lipsiae* : 126.

Diagnosis : Anterior part of the body uniquely twisted to left and much shorter than the posterior part; body characteristically sigmoid, comparatively large and slender; cytoplasm colourless, pellicular striations prominent; macronucleus single and sausage-shaped; contractile vacuole without any raising edge and located at the posterior end.

Distribution : India : West Bengal (Kolkata), Andhra Pradesh, Rajasthan.

Remarks : Occurs in freshwater. Mahajan and Nair (1965) reported this species for the first time from the Indian Museum tank.

Family OXYTRICHIDAE

24. *Oxytricha fallax* Stein, 1859

1859. *Oxytricha fallax* Stein, *Der organismus der Infusionsthier*, Leipzig, 1 : 189, pl. 12.

Diagnosis : Ellipsoidal, posterior region broadly rounded; right and left marginal rows of cirri distinctive, ventral cirri and anal cirri five each, caudal cirri short; adoral zone of membranellae restricted to anterior third or quarter of the body; macronuclei usually in two parts; contractile vacuole single, located at the anterior end.

Distribution : India : West Bengal, Rajasthan.

Remarks : This species is very common in freshwater bodies of West Bengal. As early as 1962 Nair collected this species from Indian Museum tank (Das *et al.*, 1993).

Family ASPIDISCIDAE

25. *Aspidisca costata* Dujardin, 1842

1842. *Aspidisca costata* Dujardin, *Histoire nat des zoophytes infusoires* : 446, pl. 10. fig. 1.

Diagnosis : Body more or less ovate, rounded at both ends; dorsal surface convex with five to six distinct longitudinal ridges, adoral zone poorly developed, peristome starting from the anterior end of the body extending up to the anal cirri, cirri strong and long, seven fronto-ventral and five anal cirri present; macronucleus curved and contractile vacuole single and posterior.

Distribution : India : West Bengal. (Kolkata).

Remarks : Inhabits freshwater. This species was collected by Nair in 1970 from the Indian Museum tank (Das *et al.*, 1993).

DISCUSSION

The present study reveals that 25 species of free-living protozoa have been collected so far from the Indian Museum tank (Tables 1 and 2), out of which only two are rhizopods and the rest are ciliates. Das *et al.* (1993) reported 102 species of free-living protozoa from different wetlands of Kolkata of which 3 were flagellates, 16 species were rhizopods and 83 ciliates and Indian Museum Tank was represented by 10 species. During the recent surveys in Kolkata wetlands 14 additional species were recorded from this tank by Bindu (2010), as mentioned earlier. Table 1 shows that out of 25 species recorded from Indian Museum Tank, 17 species were common in Rabindra Sarovar, followed by 10 species from Maidan Pond, while from the Table 2 it is evident that the highest protozoan diversity has been found in Rabindra Sarovar (37 species), followed by Indian Museum tank.

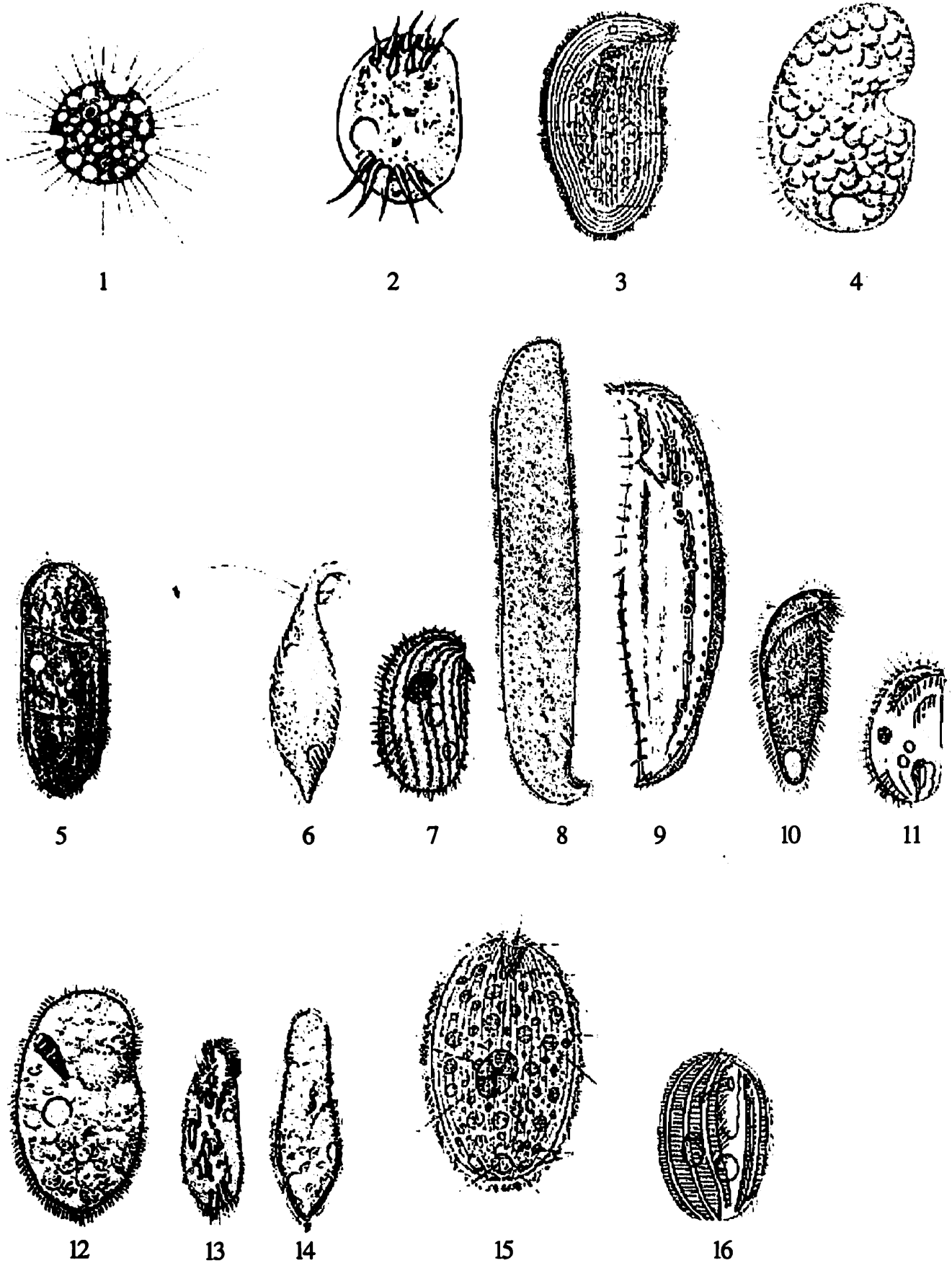


Fig. 1. *Actinophrys sol*; Fig. 2. *Aspidisca costata*; Fig. 3. *Chilodinella cucullus*; Fig. 4. *Colpoda cucullus*; Fig. 5. *Frontonia leucas*; Fig. 6. *Lacrymaria olor*; Fig. 7. *Leptopharynx torpens*; Fig. 8. *Loxodes magnus*; Fig. 9. *Loxodes striatus*; Fig. 10. *Metopus es*; Fig. 11. *Microthorax pusillus*; Fig. 12. *Nassula ornata*; Fig. 13. *Oxytricha jallax*; Fig. 14. *Paramecium caudatum*; Fig. 15. *Proroden teres*; Fig. 16. *Pseudomicrothorax agilis*.

Table 1 : Occurrence of the protozoan species in Indian Museum Tank and different wetlands of Kolkata

Names of species	Names of wetlands				
	IMT	RS	LGP	SLP	MP
1. <i>Diffugia globulus</i> Ehrenberg	+	+		+	
2. <i>Actinophrys sol</i> Ehrenberg	+	+		+	+
3. <i>Prorodon teres</i> Ehrenberg	+	+	+		
4. <i>Lacrymaria olor</i> (Muller)	+		+	+	
5. <i>Dileptus monilatus</i> (Stokes)	+	+	+		
6. <i>Trachelius ovum</i> Ehrenberg	+			+	+
7. <i>Loxodes magnus</i> Stokes	+				-
8. <i>Loxodes striatus</i> (Engelmann)	+				+
9. <i>Colpoda aspera</i> Kahl	+	+			
10. <i>Colpoda cucullus</i> Muller	+	+			
11. <i>Nassula ornata</i> Ehrenberg	+				
12. <i>Leptopharynx torpens</i> (Kahl)	+	+			
13. <i>Peudomicrothorax agilis</i> Mermod	+	+		
14. <i>Microthorax pusillus</i> Engelmann	+	+			
15. <i>Chilodonella cucullulus</i> (Muller)	+	+	+		
16. <i>Chilodonella uncinata</i> (Ehrenberg)	+	+	+		
17. <i>Paramecium caudatum</i> Ehrenberg	+	+			+
18. <i>Frontonia leucas</i> (Ehrenberg)	+	+			
19. <i>Platycola decumbens</i> (Ehrenberg)	+		+		+
20. <i>Platycola striata</i> (Fromentel)	+				+
21. <i>Pyxicola affinis</i> Kent	+	+		+	+
22. <i>Vaginicola crystallina</i> Ehrenberg	+	+	+		+
23. <i>Metopus es</i> Muller	+	+	+	+	+
24. <i>Oxytricha fallax</i> Stein	+	+			
25. <i>Aspidisca costata</i> (Dujardin)	+	+			
Total (25 species)	25	17	8	6	10

RS-Rabindra Sarovar; IMT-Indian Museum Tank; LGP-Pond in Lake garden; SLP-Saltlake pond; MP-Maidan pond

Table 2 : Occurrence of the protozoan species in different wetlands

Freeliving protozoan	Number of species occurring in selected Kolkata wetlands						
	RS	IMT	LGP	SLP	MP	MDT	WS
Groups	RS	IMT	LGP	SLP	MP	MDT	WS
Flagellates	3			-		-	
Rhizopods	6	2			2	3	3
Ciliates	28	23	8	6	10	5	3
Total	37	25	8	6	12	8	6

RS-Rabindra Sarovar; IMT-Indian Museum Tank; LGP-Pond in Lake garden; SLP-Saltlake pond; MP-Maidan pond, MDT-Mohan Das Tadak, WS-Wellington Square

SUMMARY

The present communication deals with diagnosis and distribution of 25 species of freeliving protozoa under 21 genera and 17 families occurring in the Indian Museum Tank, Kolkata. Out of these, 2 species are rhizopods and the rest are ciliates.

PORIFERA : FRESHWATER SPONGES

INTRODUCTION

Studies on the freshwater sponges of Indian Museum tank, Calcutta were made over a century ago by Annandale (1907, 1911). Since then no work is available in Calcutta except Sewell (1926). Annandale (*op. cit.*) described eight new species as *Spongilla bigemulata*, *Spongilla crassissima*, *Spongilla proliferens*, *Trochospongilla latouchiana*, *Trochospongilla phillottiana* and *Ephydatia indica*, *Spongilla carteri* var. *mollis*, and *Spongilla fragilis* sub sp. *calcuttana* besides recording two more species *Ephydatia meyeri* (Carter, 1849) and *Spongilla (Eunapius) fragilis* sub sp. *decipiens* Weber, 1890. In 1926, Sewell gave a list of species of animals recorded from Indian Museum tank, wherein 9 species of sponges viz., *Spongilla (Euspongilla) alba* Carter, *Spongilla (Eunapius) carteri* Carter, *Spongilla (Eunapius) crassissima* Annandale, *Spongilla (Eunapius) fragilis* sub sp. *decipiens* Weber, *Spongilla (Eunapius) fragilis* sub sp. *calcuttana* Annandale, *Trochospongilla latouchiana* Annandale, *Trochospongilla phillottiana* Annandale, *Ephydatia meyeri* (Carter), *Ephydatia crateriformis* (Potts) were reported.

Penney and Racek (1968) synonymised *Spongilla (Euspongilla) alba* Carter as *Spongilla alba* Carter, 1849. They merged *Spongilla carteri* var. *mollis* Annandale, 1911 and *Spongilla (Eunapius) carteri* Carter with *Eunapius carteri* (Bowerbank, 1863); *Spongilla bigemulata* Annandale, 1907, *Spongilla crassissima* Annandale, 1907 and *Spongilla (Eunapius) crassissima* Annandale with *Eunapius crassissima* (Annandale, 1907), *Spongilla fragilis* subsp. *calcuttana* Annandale, 1911 and *Spongilla (Eunapius) fragilis* sub sp. *decipiens* Weber with *Eunapius calcuttanus* (Annandale, 1911), *Spongilla proliferens* Annandale, 1907 with *Radiospongilla cerebellata* (Bowerbank, 1863); *Ephydatia indica* Annandale, 1907 and *Ephydatia crateriformis* with *Radiospongilla indica* (Annandale 1907) and *Trochospongilla latouchiana* Annandale 1907 as *Trochospongilla paulula* (Bowerbank, 1863). Therefore, from Indian Museum tank at present according to world literature only 9 species under 5 genera and one family are present as per the current status of the species.

In order to have an up to date account of the sponge fauna of Indian Museum tank, Kolkata, India a survey was undertaken during the year 2007-2008. As a result, a total of 15 lots of sponges belonging to 4 species only under 3 genera and one family were collected. These are being dealt with in this paper along with all other species so far recorded from this tank. Due to inadequate description in the literature and to facilitate identification of sponges, detailed description of all the species of Indian Museum Tank is incorporated. The classification of sponges is based on Hooper & Van Soest (2002).

LIST OF SPONGE SPECIES

Phylum PORIFERA
 Class DEMOSPONGIAE
 Subclass CERACTINOMORPHA
 Order HAPLOSCLERIDA
 Suborder HAPLOSCLERINA
 Family SPONGILLIDAE

Sponge species recorded	Occurrence in 2007-08
1. <i>Spongilla alba</i> Carter	+
2. <i>Eunapius carteri</i> (Bowerbank)	+
3. <i>E. calcuttanus</i> (Annadale)	+
4. <i>E. crassissimus</i> (Annandale)	-
5. <i>Radiospongilla cerebellata</i> (Bowerbank)	+
6. <i>R. indica</i> (Annandale)	-
7. <i>Ephydatia meyeri</i> (Carter)	-
8. <i>Trochospongilla paulula</i> (Bowerbank)	-
9. <i>T. phillotina</i> Annandale	-

DESCRIPTIVE ACCOUNT**1. *Spongilla alba* Carter**

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

Diagnosis : Sponge forming massive growth, variable sized, surface smooth with irregular projection; oscula moderate or large size, never very conspicuous; dermal membrane closely adherent to symplasm; consistency firm but brittle; colour-white.

Megascleres-feeblely curved, slender to stout and fusiform, smooth amphioxea; length range 0.265-0.330, width range 0.012-0.019 mm.

Microscleres-numerous in dermal membrane; slightly curved, very slender, amphioxea, covered with erect spines more prominent and longer in central region; length range 0.065-0.125 mm, width range 0.002-0.004 mm.

Gemmoscleres-feeblely curved, slender, cylindrical amphistrongyla; covered with large recurved spines, more numerous at the tips than near the middle of the shaft; length range 0.085-0.110 mm, width range 0.005-0.008 mm.

Gemmules-abundant, scattered throughout the body, large, spherical; pneumatic layer moderately thick granular, gemmoscleres embedded in this layer with their tips projecting

beyond outer surface of layer; foramen not tubular but cup-shaped with a shallow peripheral collar; diameter range 0.45–0.60 mm.

Distribution : India : West Bengal, Kerala, Maharashtra; Orissa and Rajasthan.

Elsewhere : Africa, Australia, South America and South East Asia.

Remarks : Sewell, 1926 recorded *Spongilla* (*Euspongilla*) *alba* Carter, 1849 from the Indian Museum tank. Presently, this species is synonymised with *Spongilla alba* Carter, 1849 (Penney and Racek, 1968).

2. *Eunapius carteri* (Bowerbank)

1863. *Spongilla carteri* Bowerbank, *Proc. Zool. Soc. Lond.*, 1863, p. 469.

Diagnosis : Sponge forming rounded or irregular and variable sized; surface hispid; oscula large, opening from rounded elevations; dermal membrane well developed; colour-greenish in live; consistency of live sponge quite soft and fragile.

Skeleton-formed of clear erect spicule fibers and a variable number of irregular transverse fibers, held in position by a sufficient quantity of spongin.

Megascleres-smooth, stout, fusiform and slightly curved amphioxea; length 0.275-(0.325)-0.355 mm, width 0.09-(0.013)-0.015 mm.

Microscleres-absent.

Gemmoscleres-like that of Megascleres but smaller in size, more curved and sharply pointed; length 0.126-(0.164)-0.205 mm, width 0.005-(0.007)-0.008 mm.

Gemmules-spherical, comparatively large, numerous, scattered singly throughout the skeletal meshes; pneumatic layer very thick, consisting of several layers of regularly arranged polygonal air spaces, gemmoscleres embedded tangentially or irregularly in this layer; foramen tubular; diameter range 0.465-(0.535)-0.615 mm.

Distribution : Cosmopolitan.

3. *Eunapius calcuttanus* (Annandale)

1911. *Spongilla fragilis* subsp. *calcuttana* Annandale, *Fauna, British India*, Fresh water sponges, hydroids and Polyzoa, p. 96.

Diagnosis : Sponge forming encrustations with variable size; surface smooth; oscula small, numerous; dermal membrane well developed; colour-light gray; consistency of live sponge very soft and fragile.

Skeleton-formed of radial and transverse spicule fibers held in position by only small quantity of spongin.

Megascleres-smooth, slender, fusiform and slightly curved amphioxea, with abruptly pointed or rounded at the tips forming a peculiar lanceolate shaped apical projections; length 0.175-(0.215)-0.235mm, width 0.009-(0.011)-0.012 mm.

Microscleres-absent.

Gemmoscleres-curved, slender, cylindrical, amphistrongyla with small spines throughout their length, which on tips of scleres recurved; length 0.080-(0.104)-0.120 mm, width 0.002-(0.003)-0.004 mm.

Gemmules-spherical, small, numerous, scattered singly throughout the body; pneumatic layer well formed, consisting of large polygonal air spaces, gemmoscleres embedded tangentially in this layer; foramen tubular and opening outward; diameter range 0.20-(0.23)-0.30 mm.

Distribution : India : West Bengal.

Remarks : Endemic.

4. *Eunapius crassissimus* (Annandale)

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

Diagnosis : Sponge forming thick encrustations with variable size; surface hispid; oscula small, star-shaped, numerous, surrounded by radiating furrows; dermal membrane well developed; colour-light gray; consistency of live sponge very hard.

Skeleton-formed of very firm spicule fibers held in position by large quantity of spongin web.

Megascleres-smooth, stout, fusiform and slightly curved amphistrongyla, with a terminal projections at the tips; length 0.250-(0.275)-0.315mm, width 0.006-(0.012)-0.015 .mm.

Microscleres-absent.

Gemmoscleres-curved, slender, cylindrical, amphistrongyla with small spines throughout their length; length 0.080-(0.106)-0.120 mm, width 0.003-(0.005)-0.009 mm.

Gemmules-spherical, moderate in number, found in the basal region; pneumatic layer thick, consisting of large polygonal air spaces, gemmoscleres embedded tangentially in this layer and forming two separate tiers above the gemmules; foramen tubular and rarely projecting beyond surface of pneumatic layer; diameter range 0.275-(0.295)-0.310 mm.

Distribution : India : Assam, Orissa and West Bengal.

Elsewhere : Australia, South and tropical South East Asia.

Remarks : Present description is based on study of type material and original description.

5. *Radiospongilla cerebellata* (Bowerbank)

1863. *Spongilla cerebellata* Bowerbank. *Zool. Soc. Lond.*, 1863, p. 465.

Diagnosis : Sponge forming small and shallow cushions to bulbous form with variable size; surface uneven with brain-like corrugations; oscula conspicuous; dermal membrane well developed; colour- dark green; consistency of live sponge soft.

Skeleton-in small and flat specimens irregular, in larger ones spicule fibers are transverse and radiating; spongin more in quantity.

Megascleres-smooth, stout, fusiform and slightly curved to straight amphioxea, sharply pointed at tips; length 0.230-(0.275)-0.330mm, width 0.010-(0.011)-0.012 mm.

Microscleres-absent.

Gemmoscleres-curved, slender, cylindrical, amphistrongyla with small spines erect and less in number on the central portion of shaft but recurved and more in number terminally; length 0.080-(0.085)-0.100 mm, width 0.002-(0.0025)-0.003 mm.

Gemmules-spherical, numerous, scattered throughout the body; pneumatic layer thick, consisting of small spherical air spaces, gemmoscleres embedded in this layer and forming two separate tiers; foramen tubular, porus tube slender and straight, extending to the level of pneumatic layer; diameter range 0.425-(0.455)-0.500 mm.

Distribution : India : Andhra Pradesh, Assam, Bihar, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu, U.P. and West Bengal. *Elsewhere*: Tropical and subtropical South and South East Asia, China to Russia extending to South-eastern Europe.

6. *Radiospongilla indica* (Annandale)

1907. *Ephydatia indica* Annandale, *J. Proc. Asiat. Soc. Beng.*, 3 : 20, 26.

Diagnosis : Sponge forming moderate encrustations with variable size; surface smooth and even; oscula not prominent; dermal membrane well developed; colour-light gray; consistency of live sponge soft.

Skeleton-formed of irregular spicule fibers cemented together by a small quantity of spongin.

Megascleres-smooth, stout, fusiform and slightly curved to straight amphioxea, sharply pointed at tips; length 0.230-(0.275)-0.350mm, width 0.010-(0.011)-0.012 mm.

Microscleres-absent.

Gemmoscleres-slender, slightly curved or straight amphistrongyla with small erect conical spines scattered on the central portion of shaft but forming flat pseudorotules and more in number terminally; length 0.060-(0.070)-0.075 mm, width 0.003-(0.0035)-0.004 mm.

Gemmules-spherical, small, numerous, scattered throughout the body; pneumatic layer well developed and thick, consisting of minute irregular air spaces, gemmoscleres embedded

in this layer radially and their distal pseudorotules not protruding from outer gemmular membrane; foramen tubular, porus tube short and straight; diameter range 0.425-(0.455)-0.500 mm.

Distribution : India : Maharashtra and West Bengal.

Elsewhere : Ranging from India to Indonesia and south-eastwards to New Guinea.

7. *Ephydatia meyeri* (Carter)

1849. *Spongilla meyeri* Carter, *Ann. Mag. Nat. Hist.*, 4 : 84.

Diagnosis : Sponge forming irregularly shaped bulky growth with variable size; surface uneven and corrugated; oscula not prominent; dermal membrane well developed; colour-light brown; consistency of live sponge firm and moderately hard.

Skeleton-formed of polyspicular radiating fibers cemented together by a small quantity of spongin and a varying number of secondary transverse fibers.

Megascleres-smooth, stout, cylindrical and slightly curved amphioxea, sharply pointed at tips; length 0.270-(0.275)-0.300mm, width 0.011-(0.011)-0.013 mm.

Microscleres-absent.

Gemmoscleres-birotulates with moderately stout shafts, shafts smooth rarely small erect sharp spines, rotules equal in diameter and flat, rotules irregularly and very much incised; length of shaft 0.027-(0.029)-0.030 mm, rotules 0.025-(0.028)-0.030 mm.

Gemmules-spherical, small, numerous, scattered throughout the body; pneumatic layer well developed, thick and irregular, consisting of minute spherical air spaces, gemmoscleres embedded in one or two layers, inner layer radially and outer layer irregularly arranged; distal rotules of outer layer protruding from outer gemmular membrane; foramen raised but simple and not tubular; diameter range 0.475-(0.555)-0.600 mm.

Distribution : India : Haryana, Kerala, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Elsewhere : China.

8. *Trochospongilla paulula* (Bowerbank)

1863. *Spongilla paulula* Bowerbank, *Proc. Zool. Soc. Lond.*, 1863, p. 453.

Diagnosis : Sponge forming encrustations growth with variable size; surface uneven; oscula relatively few but prominent; dermal membrane well developed; colour-dark brown; consistency of live sponge very rigid but often brittle.

Skeleton-formed of distinct vertical spicule fibers cemented together by spongin and irregularly arranged transverse fibers.

Megascleres-smooth, stout, cylindrical and slightly curved to straight amphioxea; length 0.230-(0.275)-0.300mm, width 0.011-(0.013)-0.015 mm.

Microscleres-absent.

Gemmoscleres-birotulates with a slender smooth shaft, rotules circular differing in diameter and flat, upper rotules considerably recurved, forming a bowl-like structure; length of shaft 0.012-(0.020)-0.025mm, 0.003-(0.004)-0.005mm thick, Upper rotules 0.009-(0.012)-0.015mm, lower rotules 0.015-(0.020)-0.025 mm in diameter.

Gemmules-spherical, numerous, scattered throughout the body and loosely held in position by skeletal network; pneumatic layer comparatively thin and granular, gemmoscleres embedded in one layer; foramen conical and short porus tube; diameter range 0.175-(0.225)-0.230 mm.

Distribution : India : West Bengal.

Elsewhere : Southern and South-East Asia north to China and south to eastern Australia, Myanmar.

9. *Trochospongia phillottiana* Annandale

1907. *Trochospongia phillottiana* Annandale, *J. Proc. Asiat. Soc. Beng.*, 3, p. 26.

Diagnosis : Sponge forming moderately large flat encrustations with variable size; surface even but hispid; oscula moderate in number but prominent; dermal membrane well developed; colour-pale yellow to light brown; consistency of live sponge hard but less brittle.

Skeleton-formed of comparatively slender spicule to form triangular meshes.

Megascleres-slightly curved, somewhat slender amphistrongyla; more or less uniformly covered with small spines; length 0.150-(0.170)-0.190mm, width 0.009-(0.010)-0.012 mm.

Microscleres-absent.

Gemmoscleres-birotulates with a slender smooth shaft, rotules circular differing in diameter, rotules much recurved, upper rotules forming a bowl-like structure; length of shaft 0.014-(0.015)-0.018mm, 0.003-(0.0036)-0.004 mm thick, Upper rotules 0.014-(0.014)-0.018 mm, lower rotules 0.019-(0.020)-0.022 mm in diameter.

Gemmules-spherical, numerous, small, restricted to base of the body, encircled by a capsule of megascleres; pneumatic layer very thin and granular, gemmoscleres embedded in one layer; foramen conical and short porus tube; diameter range 0.350-(0.270)-0.380 mm.

Distribution : India : West Bengal. *Elsewhere*: Southern and South-East Asia north to China and south to eastern Australia.

DISCUSSION

There are 31 species of freshwater sponges recorded from India till to day, of which 16 species are recorded so far from West Bengal. Interestingly, 9 species are recorded from a

single pond i.e. Indian Museum tank, Kolkata. This tank is unique in its biodiversity specially sponges. The sponges, present more than hundred years back in this tank, are still flourishing now in spite of many ecological and anthropogenic disturbances. Annandale, 1911 wrote

“The best of the tanks from the sponge-collector’s point of view, so far as I have been able to discover, is the one in the compound of the Indian Museum. It enjoys all the advantages of light and shed, solid supports, prolific aquatic vegetation, considerable depth, and the vicinity of human dwellings that seem to be favourable to the growth of sponges, no less than nine species of which, representing three genera and two subgenera, grow abundantly in it”

It may be mentioned that Sewell (1926) strengthened the above cited views of Annandale. He expressed *“Although, with the exception of the fresh water sponges, no systematic investigation of the fauna of the tank has ever been carried out, from time to time observations have been made and the occurrence of various organisms have been recorded. Below, I give a list of such records as I have been able to find”* and gave a large list of species of all the groups of animal recorded so far from Indian Museum tank. In this context, in our opinion the Indian Museum tank is excellent in its heritage features particularly in view of its biodiversity. So, it is urged that this tank should be treated as heritage pond and save its unique features.

SUMMARY

The paper deals with with 9 species of freshwater sponges so far recorded from the Indian Museum tank, Kolkata. Four species, namely *Spongilla alba*, *Eunapius carteri*, *Eunapius calcuttanus*, *Radiospongilla cerebellata* are continuing their races for more than hundred years, inspite of many environmental disturbances and pollutions.

CNIDARIA : *HYDRA VULGARIS*

INTRODUCTION

Hydra is one of the most popular laboratory animals and has greatly contributed to the development of experimental biology. The sedentary cnidarian *Hydra* occurs in many freshwaters (Campbell and Bode, 1983) and is widely used for studying various aspects of animal development, including patterning and cell differentiation (Bosch and Khalturin, 2002), regeneration (Galliot and Schmid, 2002), as well as morphogenesis (Martin *et al.*, 1997) and symbiotic relationships (Kessler *et al.*, 1988; Karntanut and Pascoe, 2005). It is also employed in assessing the toxicity of freshwater pollutants (Benson and Boush, 1983; Hyne *et al.*, 1993; Beach and Pascoe, 1998; Pollino and Holdway, 1999).

Annandale studied this species from different water bodies of Calcutta and its neighbourhoods during 1905-1911, including the Indian Museum tank, and gave a detail account of these species. Sewell (1935) also collected several examples of *Hydra vulgaris* in March and December from this tank.

SYSTEMATIC ACCOUNT

Phylum CNIDARIA

Class HYDROZOA

Order HYDROIDA

Suborder ANTHOMEDUSAE

Family HYDRIDAE

Hydroid solitary, with hollow filiform tentacles, but often moniliform distally, in one whorl under hypostome; lower part of hydranth with simple pedal disc, no perisarc except on encysted embryos without medusa phase or gonophore development, eggs and sperm developed directly in epidermis of polyps in wart-like protuberances; asexual reproduction by lateral buds, leading only to temporary colonies

Genus *Hydra* Linnaeus

Hydra vulgaris Pallas, 1766 (Phase *orientalis*, Annandale)

1766. *Hydra vulgaris*, Pallas. *Elenchus Zoophytorum* : 30.

Diagnosis : Solitary freshwater hydroids, 0.47 in (12 mm) in height, with 7-12 hollow filiform tentacles, but often moniliform distally, in one whorl under hypostome; hermaphroditic species, eggs and sperm developed directly in ectoderm of polyps in wart-like protuberances, "testis" developing on upper part of hydranth, "ovaries" on lower part, with up to eight eggs enveloped, in a chitinous embryotheca when fecundated, embryotheca with long, thin spines; asexual reproduction by lateral buds, leading only to temporary colonies; lower part of hydranth with simple pedal disc and with central pore, no perisarc except on encysted embryos.

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Colour : Variable, in summer usually pale, in winter either deep orange, dull brown and dark green.

Column : Slender and capable of great elongation, normally almost cylindrical, but when containing food often shaped like a wine-glass; surface thickly set with nettle-cells the cnidocils, giving it an almost burette appearance under the microscope; column nearly 30 mm long when extended but commonly about half of its length or even shorter.

Tentacles : Usually 4-6, occasionally 8, always slender except when contracted, becoming swollen at base and globular at tip, at rest not very much longer than the body and capable of great elongation when active.

Nettle-cells : Capsules with barbed threads variable in size, but invariably broad in proportion to their length and as a rule nearly spherical; barbed threads very long and slender bearing at base a circle of stout and prominent spines, usually 4 in number.

Reproductive organs : Reproductive organs confined to the upper parts of the body; in India eggs seldom produced, sometimes appeared, at the beginning of hot weather; eggs spherical and their shells with relatively long spines, expanded, flattened and more or less divided at the tip.

Habitat : Freshwater, fixed on plants, stones, empty shells, and insect larval tubes (Trichoptera); able to move with the help of tentacles; found in stagnant water (Annandale, 1911).

Distribution : Cosmopolitan.

Remarks : Regarding this species Annandale (1911) has pointed out : "*in Calcutta two broods can be distinguished, a cold weather brood which is larger, stouter and more deeply coloured, produce bud more freely, has larger nematocysts, and as a rule possesses 6 tentacles; and a hot weather brood which is smaller, more slender and paler, produces bud more sparingly, has smaller nematocysts and as a rule possesses 4 to 5 tentacles; only cold weather form is known to become sexually mature. There is evidence, that in those part of India which enjoy a more uniform tropical climate than lower Bengal, polyps found at all times of year resemble those found in hot weather in Calcutta, and some time produces spermatozoa and eggs.*" The winter forms (found from October to March) prefers to live near the surface of the water specially on roots of the duckweed and the lower surface of the *Lemnathemum*; while the summer form (March to October) prefers deeper waters in shady places and as a rule attaches itself to a wholly submerged plants. Both being sometimes found together at the period of transition.

Sewell (1935) reported several examples of *Hydra vulgaris* in March and December from this tank, interestingly all those specimens possessed only 5 tentacles.

ROTIFERA

The following is the compiled list of rotifer fauna comprising of 40 species belonging to 17 genera 10 families under two orders as recorded by Tiwari and Sharma (1977) and Sharma (1978-1999) from the Indian Museum Tank :

Order PLOIMIDA

Family BRANCHIONIDAE

Genus *Brachionus*

(Plate-I, Fig. 1-13)

1. *Brachionus angularis* Gosse, 1851
2. *Brachionus calyciflorus f. dorcas* (Gosse, 1851)
3. *Brachionus calyciflorus f. anuraeiformis* (Brehm, 1909)
4. *Brachionus caudatus aculeatus* (Hauer, 1937)
5. *Brachionus patulus patulus* (O.F. Muller, 1786)
6. *Brachionus rubens* Ehrenberg, 1838

Genus *Keratella*

7. *Keratella tropica* (Apstein, 1907)

Genus *Anuraeopsis*

8. *Anuraeopsis coelata* (De Beauchamp, 1932)

Genus *Platyias*

9. *Platyias quadricornis* (Ehrenberg, 1832)

Family EUCHLANIDAE

Genus *Euchlanis*

10. *Euchlanis dilatata* Ehrenberg, 1832

Genus *Tripleuchlanis*

11. *Tripleuchlanis plicata* (Levander, 1894)

Family MYTILINIDAE

Genus *Mytilina*

12. *Mytilina ventralis ventralis* (Ehrenberg, 1832)
13. *Mytilina acanthophora* Hauer, 1938

Family COLURELLIDAE

Genus *Colurella*

14. *Colurella uncinata* (O. F. Muller, 1773)

Genus *Lepadella*

15. *Lepadella (Lepadella) patella* (O.F. Muller, 1773)

16. *Lepadella (Lepadella) rhomboides* (Gosse, 1886)
17. *Lepadella (Lepadella) triptera* Ehrenbert, 1830
18. *Lepadella (Lepadella) triprojectus* Sharma, 1978

Family LECANIDAE

Genus *Lecane*

19. *Lecane (Lecane) aculeata* (Jakubski, 1912)
20. *Lecane (Lecane) crepida bengalensis* (Sharma, 1978)
21. *Lecane (Lecane) curvicornis* (Murray, 1913)
22. *Lecane (Lecane) leontina* (Turner, 1892)
23. *Lecane (Lecane) luna luna* (O.F. Muller, 1776)
24. *Lecane (Lecane) nana* (Murray, 1913)
25. *Lecane (Lecane) vasishti* Sharma, 1980
26. *Lecane (Hemimonstyla) inopinata* (Harring & Myers, 1926)
27. *Lecane (Monostyla) bulla* (Goose, 1851)
28. *Lecane (Monostyla) closterocerca* (Schmarda, 1859)
29. *Lecane (Monostyla) hamata* (Stokes, 1896)
30. *Lecane (Monostyla) lunaris crenata* (Harring, 1913)
31. *Lecane (Monostyla) quadridentata* (Ehrenberg, 1832)

Family TRICHOCERIDAE

Genus *Trichocerca*

32. *Trichocerca (Diurella) similis* (Wierzerjski, 1893)
33. *Trichocerca (Trichocerca) rattus* (Muller, 1776)
34. *Trichocerca tigris* (Muller, 1786)
35. *Trichocerca (Trichocerca) elongata braziliensis* (Murray, 1913)

Family ASPLANCHNIDAE

Genus *Asplanchna*

36. *Asplanchna brightwelli* Gosse, 1850

Family SYNCHAETIDAE

Genus *Polyarthra*

37. *Polyarthra vulgaris* Carlin, 1943

Order GNESIOTROCHA

Family TESTUDINELLIDAE

Genus *Pompholyx*

38. *Pompholyx sulcata* Hudson, 1885

Genus *Testudinella*

39. *Testudinella patina* (Hermann, 1783)

Family FILINIIDAE

Genus *Filinia*

40. *Filinia longiseta* (Ehrenberg, 1834)

Out of the 40 species of Rotifera listed above, *Lecane (Lecane) vasishti* was described as new species from Indian Museum Tank.

MOLLUSCA

INTRODUCTION

The molluscs are important components of the benthic fauna. They are soft and delicate animals, ecologically classified under two categories, viz., epifaunal forms and infauna. The epifaunal gastropods and infaunal bivalves include 199 species under 59 genera and 26 families in freshwater bodies of India (Subba Rao, 1989, 1993; Ramakrishna and Dey, 2007). Gastropods feed on algae, detrital particles and bacteria of the periphyton on submerged substrate while bivalves are filter feeder. Some of them are edible and are sold in the local markets as a resource of protein to a large number of people of West Bengal but some serve as vectors in spreading diseases in livestock as well as human beings as intermediate hosts for trematode parasites. In the present paper a total of 13 gastropod species under 6 families and a single bivalve species is dealt hereunder.

In addition to above mentioned 14 species recorded from this tank, two gastropod species viz. *Brotia (Antimelania) costula* (Rafinesque) and *Gyraulus euphraticus* (Mousson) and one bivalve species viz. *Pisidium clarkeanum* G. and H. Nevill were reported earlier in the literature (Sewell, 1935) from the Indian Museum Tank. Two more bivalves viz. *Parreysia (Radiatula) caerulea* (Lea) and *P. (R.) pachysoma* (Benson) were reported from Indian Museum Tank which were collected by Indian Museum collector and N. Annandale (Mitra and Dey, 1992). These five species are not encountered during the course of present study and are not dealt in the present paper.

SYSTEMATIC ACCOUNT

Phylum MOLLUSCA

Class GASTROPODA

Subclass PROSOBRANCHIA

Order MESOGASTROPODA

Family VIVIPARIDAE

1. *Bellamyia bengalensis* f. *typica* (Lamarck)

1822. *Paludina bengalensis* Lamarck, *Hist. nat. Anim. Sans. Vert.*, 6(2): 174.

Diagnosis : Shell thin, ovately conoid, more or less smooth; spire and body whorl almost equal in height; with three or more colour bands and with acuminate spire; whorls gradually increase, strongly inflated, last whorl broader than high; sutures impressed; aperture semicircular.

Distribution : India : Common throughout. *Elsewhere* : Bangladesh, Myanmar, Sri Lanka.

Remarks : It is a common freshwater snail of India with a number of forms/races. This species is mainly benthic in nature, also found attached to the aquatic vegetations and substratum under water.

Family AMPULLARIIDAE

2. *Pila globosa* (Swainson)

1822. *Ampullaria globosa* Swainson, *Zool. Illust.*, 2(1) : pl. xix.

Diagnosis : Shell globose, with inflated body whorl, spire depressed; suture shallow; colour bands present inside the aperture.

Distribution : India : Common throughout India except Gujarat, Himachal Pradesh, Kashmir, Punjab and southern India.

Remarks : Common freshwater snail, an inhabitant of ponds, ditches and paddy fields, lay eggs at the land water interface.

Family BITHYNIIDAE

3. *Bithynia (Digoniostoma) cerameopoma* (Benson)

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

Diagnosis : Shell ovate-oblong, with rapid and regular increasing whorls; sculpture with weak or very fine spiral striae; deeply umbilicate with distinct oblique channel, peristome continuous and slightly reflected; aperture oval and oblique; operculum calcareous with subcentral nucleus.

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

Elsewhere : Pakistan.

Remarks : Common in stagnant freshwater systems with muddy substratum and submerged vegetations.

4. *Gabbia orcula* var. *producta* (Nevill)

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

Diagnosis : Shell with rounded whorls and deep sutures, columellar margin descending at an angle.

Distribution : India : Andhra Pradesh, Assam, Bihar, Jharkhand, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Remarks : Mainly found attached to macrophytes.

Family THIARIDAE

5. *Thiara (Thiara) scabra* (Mueller)

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

Diagnosis : Shell elongate, turreted; whorls regularly increasing in size; spire as high as body whorl; sutures distinct; sculpture with vertical ribs bearing prominent spines directed obliquely outward; surface with rough spiral striations.

Distribution : India : Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Puducherry, Tamil Nadu, West Bengal.

Elsewhere : Indonesia, Java, Mauritius, Seychelles, Timor.

Remarks : It prefers streams but may also occur in lakes, ponds and river basins.

6. *Melanoides tuberculata* (Mueller)

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

Diagnosis : Shell with high spire and large body whorl; whorls 10 to 14 in number, moderately convex, evenly rounded, with dark red brown dots and flames; sculpture conspicuously with vertical ribs and spiral striae, distinct and raised on the upper whorls.

Distribution : India : Throughout except Kashmir.

Elsewhere : North Africa, South-east Asia, Malaysia, Japan, Southern China, North Australia and Pacific Islands.

Remarks : It occurs abundantly in all stagnant and slow moving freshwater bodies and occupies various habitats, even in low saline water of coastal areas.

7. *Tarebia granifera* (Lamarck)

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

Diagnosis : Shell elongately conical; sculpture with distinct spiral rows of nodules, criss-crossing ridges giving granular appearance, spire evenly descending, without spines, whorls less in number (up to 9), height of body whorl more than half the total height of the shell.

Distribution : India : Andaman and Nicobar Islands, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Tripura, West Bengal.

Elsewhere : Myanmar, Malagasy, Malaysia, Philippines, Formosa, and Pacific Islands.

Remarks : Mostly benthic, sometimes attached to aquatic vegetation.

8. *Tarebia lineata* (Gray)

1828. *Helix lineata* Gray, in Wood's *Index Test. Suppl.*, p. 24.

Diagnosis : Shell elongate, conical, rows of nodules less distinct, rather obsolete on the lower whorls, dark spiral lines distinct; apex acute.

Distribution : India : Andhra Pradesh, Assam, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh, West Bengal.

Elsewhere : Bhutan, Myanmar, Sri Lanka.

Subclass PULMONATA
Order BASOMMATOPHORA
Family LYMNAEIDAE

9. *Lymnaea (Pseudosuccinea) acuminata* f. *typica* Lamarck

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

Diagnosis : Shell thin, ovate, spire short, acuminate, last whorl much inflated, a little angular above, with a large aperture.

Distribution : India : Widely distributed.

Elsewhere : Bangladesh and Myanmar.

Remarks : Inhabits freshwater bodies with abundant aquatic vegetations.

10. *Lymnaea (Pseudosuccinea) luteola* f. *typica* Lamarck

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

Diagnosis : Shell thin and glossy, body whorl less inflated and laterally compressed a little; spire large, gradually tapering and more produced; aperture narrow, outer lip more or less straight (not expanded).

Distribution : India : Common throughout.

Elsewhere : Bangladesh, Nepal, Pakistan and Myanmar.

Remarks : Found in particular habitat, often in temporary freshwater bodies which dry in summer. Inhabits muddy bottom as well as associated with vegetation.

Family PLANORBIDAE

11. *Gyraulus convexiusculus* (Hutton)

1849. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc. Beng.*, 18(2) : 657.

Diagnosis : Shell small not more than 5 mm in diameter, discoidal, semi-transparent, whorls 4-5, last whorl subangulate at periphery; umbilicus wide, aperture ovate, lunate.

Distribution : India : Throughout.

Elsewhere : Iran to Philippines and Japan.

Remarks : Very common species, occurring in freshwater bodies, inhabits muddy and sandy bottom, as well as associated with weeds.

12. *Gyraulus labiatus* (Benson)

1850. *Planorbis labiatus* Benson, *Ann. Mag. nat. Hist.*, (2) 5 : 350.

Diagnosis : Shell depressed with 3½ whorls, obliquely striate, aperture oblique and a little descending in front, body whorl with remarkable deviation from main axis, presence of a rib inside the lip.

Distribution : India : Andhra Pradesh, Himachal Pradesh, Madhya Pradesh, Maharashtra, Mizoram, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal. *Elsewhere*: Myanmar.

Family BULLINIDAE

13. *Indoplanorbis exustus* (Deshayes)

1834. *Planorbis exustus* Deshayes in Belanger, *Voy. Indes-Orientales*, p. 417, pl. 1, figs. 11-13.

Diagnosis : Shell large, thick, discoidal, sinistral, rounded at periphery, aperture ear shaped, suture deeply impressed.

Distribution : India : Widely distributed.

Elsewhere : Bangladesh, Pakistan, Iran, Sri Lanka, Myanmar, Malay Peninsula and Archipelago, Thailand, China, Tibet and Iran.

Remarks : This species inhabits a wide variety of freshwater and low saline brackish water systems in muddy bottoms and is also associated with weeds. It is a very widely known disease transmitting vector snail, which act as the intermediate host for a large number of trematode parasites of vertebrates including livestock.

Class BIVALVIA

Subclass PALEOHETERODONTA

Order UNIONOIDA

Family UNIONIDAE

14. *Lamellidens marginalis* (Lamarck)

1819. *Unio marginalis* Lamarck, *Hist. nat. Anim. Sans. Vert.*, 4 : 79.

Diagnosis : Shell oblong ovate, valves covered with blackish brown peristracum with light brown border along ventral margin; anterior end short and narrow, posterior end roundly angular, a short post-dorsal wing present; hinge with two cardinals in right valve.

Distribution : India : Widely distributed. *Elsewhere*: Sri Lanka and Myanmar.

Remarks : This freshwater bivalves species is edible and also economically important for their pearl formation capacity (Subba Rao, 1989; Raut and Biswas, 1989; Nandi and Mukherjee, 1996; Ramakrishna and Dey, 2007).

SUMMARY

The paper deals with the molluscan diversity of Indian Museum Tank, Kolkata which presently harbors 13 gastropod and one bivalve species which is edible and economically important for pearl formation.

ANNELIDA : EARTHWORMS

INTRODUCTION

Halder (1999) published an account of 63 species from the state of West Bengal. Though aquatic oligochaetes are reported from the Indian Museum tank (Stephenson, 1923; Mukhopadhyay, 1999), knowledge on earthworms of the Indian Museum tank and its surroundings is lacking. Earthworm collection was made from the Indian Museum tank along its waterline and surroundings. As a result, four species of earthworm, viz., *Glyphidrilus tuberosus* Stephenson, *Dichogaster bolau*i (Michaelsen), *Lampito mauritii* Kinberg and *Perionyx excavatus* Perrier have been recognized from the area. *Glyphidrilus tuberosus* is dependent on the pond due to its mud dwelling habit, whereas, *Perionyx excavatus* is found in water saturated soil rich in organic matter along kitchen wash, below decaying organic matter and along the pond. *Dichogaster bolau*i is also found in decaying organic matter. *Lampito mauritii* is found in moist sandy loamy soil in the flower beds, gardens and soil below trees.

SYSTEMATIC ACCOUNT

Phylum ANNELIDA

Class OLIGOCHAETA

Order HAPLOTAXIDA

Suborder LUMBRICINA

Superfamily GLOSSOSCOLECOIDEA

Family ALMIDAE

1. *Glyphidrilus tuberosus* Stephenson, 1916

1916. *Glyphidrilus tuberosus* Stephenson, *Rec. Indian Mus.*, **12** : 349.

Diagnosis : Length 60-118 mm, diameter 2.5-3 mm; segments 221; clitellum annular, wings 20-24; setae lumbricine; genital markings small, circular to elliptical tubercles, post setal, usually arranged in 6 transverse ranks; female pores paired, slightly lateral to *b* lines, pre-setal, on 14; gizzard in segment 7, intestinal origin in 15; last pair of hearts in 11; spermathecae small spherical sacs, 2-4 on each side in segments 14 and 15.

Remarks : It is a hydrophilous species usually associated with water saturated muddy soil in paddy fields and banks of ponds and pools.

Distribution : India : West Bengal, Orissa, Tamil Nadu.

Superfamily MEGASCOLECOIDEA

Family OCTOCHAETIDAE

2. *Dichogaster bolau*i (Michaelsen, 1891)

1891. *Benhamia bolavi* Michaelsen, *Jb. hamb. wiss. Anst.*, **8** : 9.

Diagnosis : Length 19-23 mm, diameter 1-3 mm; segments 70-98; prostomium epilobous, tongue closed; clitellum 13-20, ½21; setae lumbricine; male pores minute, in seminal grooves, on setal arc of 18, at *a*; prostatic pores minute at the ends of seminal grooves on 17 and 19; female pores single, median, presetal, on 14; spermathecal pores in 7/8/9, at or near *a*; genital markings absent; oesophagus with two gizzards anterior to septum 8/9; one pair of discrete extramural calciferous gland, each gland trilobed with one vertical lobe in each of segments 15-17.

Distribution : India : Throughout.

Elsewhere : Widespread in different parts of the world.

Remarks : This species is distributed in different parts of the world due to transportation. Its original home is believed to be in West Africa. It prefers rich organic matter and is found in wide variety of habitats. This species has potential for vermiculture. It is found in a wide variety of habitats, capable of colonizing independently and has been recognized as a domicole species (Csuzdi *et al.*, 2008).

Family MEGASCOLECIDAE

3. *Lampito mauritii* Kinberg, 1867

1867. *Lampito mauritii* Kinberg, *Ofvers. K. Vetensk Acad. Forh. Stockh.*, 23 : 103.

Diagnosis : Length 95-155 mm, diameter 3-5 mm, with 157-201 segments; prostomium epilobic, tongue closed; first dorsal pore in the region 10/11-12/13; clitellum annular, 13, ½13-17; setae perichaetine; genital markings absent; combined male and prostatic pores on slightly raised porophores, at or lateral to *b*; female pores presetal within *aa*; spermathecal pores paired, in 6/7/8/9; septa present from 4/5, 7/8-12/13, muscular; oesophagus with single gizzard in 5, intestine beginning in 15, typhlosole rudimentary; last pair of hearts in 13; holandric; seminal vesicles in 9 and 12; penial setae ornamented with closely crowded circles (7-12) of triangular teeth, tip horseshoe-shaped; spermathecae paired, in 7-9, each with a median and a lateral digitiform diverticula.

Distribution : India : widespread in plains including islands of Andaman & Nicobar, Laccadive and Minicoy. **Elsewhere**: Lowlands in southeast Asia, Phillipine Islands, Hongkong, China, Mauritius, Madagascar, Zanzibar.

Remarks : The species is reported to be utilized as waste conditioners. Survival rate of this species is very poor in artificial culture beds.

4. *Perionyx excavatus* Perrier, 1872

1872. *Perionyx excavatus* Perrier, *Nouv. Archs Mus. Hist. nat. Paris*, 8 : 126.

Diagnosis : Length 30-80 mm, diameter 3-7 mm, segments 123-178; prostomium epilobic, tongue open; first dorsal pore in 4/5; clitellum annular, 13-17; genital markings absent; setae perichaetine; male pores paired, tiny, on small papillae in a single male field, near mid-vental

line in 18; each papilla with 4-9 penisetal follicles situated in a transverse groove; penial setae present; spermathecal pores two pairs, at 7/8/9, close to mid-ventral line; nephridiopores inconspicuous; spermathecae paired, large, in 8 and 9, each with few intramural seminal chambers near ental end of duct; gizzard small, in 5; prostates racemose; holonephric, nephridia avesculate.

Distribution : India : widely distributed.

Elsewhere : Widely transported but successfully colonized in tropical lowlands from Madagascar east to Hawaiian Islands.

Remarks : It breeds throughout the year and can be easily cultured. Therefore, it is largely used as waste conditioner. It is also cultured for utilisation as animal protein in poultry and fish feed. The species occurs in a variety of habitats with sufficient organic matter and moisture. No other species of earthworm is presently known to live in so many different kinds of climate (Gates, 1972).

SUMMARY

Four species of earthworms, such as, *Glyphidrilus tuberosus* Stephenson, *Dichogaster bolau* (Michaelsen), *Lampito mauritii* Kinberg and *Perionyx excavatus* Perrier have been recognized from the Indian Museum Campus including Indian Museum tank. Of these, *Glyphidrilus tuberosus* Stephenson is dependent on the Indian Museum Tank, and *Perionyx excavatus* Perrier is partially dependent on the Tank.

ANNELIDA : FRESHWATER OLIGOCHAETES

INTRODUCTION

Annandale (1905) reported *Chaetogaster bengalensis* from the Indian Museum Tank, Kolkata as the first freshwater oligochaete from Indian water. Subsequently, Stephenson (1911) recorded *Aelosoma bengalense* (= *headleyi*) from this locality. Further studies by Michaelsen (1909) revealed the occurrence of *Nais* (= *Allonais*) *paraguayensis* at this site. Mukhopadhyay (1998) in his comprehensive study on freshwater oligochaetes of West Bengal added one more species, viz., *Allonais inaequalis* (Stephenson) from this tank. During recent study by the authors, another 4 species of the freshwater oligochaete are reported from this habitat, raising their total number to eight. During the present exploration of the tank, only 5 species of freshwater oligochaete were sampled, of which four species viz., *Brachiodrilus hortensis* (Stephenson), *Limnodrilus hoffmeisteri* Claparede, *Bothrioneurum iris* Beddard and *Branchiura sowerbyi* Beddard are reported for the first time from this locality. The taxonomic account of all eight species recorded so far is provided in the present communication in which asterisk (*) indicate the species not collected during the present study. However, though *Aelosoma headleyi* Beddard 1888, recognised herein under family Aelosomatidae as the freshwater oligochaetes, but recently, taxa under this family are aligned with the Polychaeta (Wetzel *et al.*, 2007). (Classification followed after Wetzel, M.J., Kathman, R. D., Fend, S.V. and Coates, K.A., 2007)

SYSTEMATIC ACCOUNT

Phylum ANNELIDA

Class CLITELLATA

Super order MICRODRILI

Order AELOSOMATIDA

Family AELOSOMATIDAE

1. *Aelosoma headleyi* Beddard, 1888*

1888. *Aelosoma headleyi* Beddard, *Proc. zool. Soc. Lond.*, : 213.

Diagnosis : Microscopic, transparent and whitish; prostomium with sensory hairs, body wall transparent and colourless; dorsal and ventral bundles of setae beginning in II segment composed of bayonet-shaped hair setae of two different length, long and short, non-serrate 1-3 long hair setae and 2-4 short hair setae dorsally, 2-3 long hair setae and 2-5 short hair setae ventrally; mouth ventral, V-shaped; oesophagus in II and stomach in IV-½ VIII segment; budding zone commonly more than one; nephridia beginning in II segment.

Distribution : India : Andhra Pradesh, Chandigarh, Delhi, Karnataka, Kerala, Maharashtra, West Bengal.

Elsewhere : Sri Lanka.

Remarks : Found among the roots of floating aquatic plants. This species glide with the help of ventral cilia of prostomium. Swimming absent.

Order TUBIFICIDA

Family TUBIFICIDAE

2. *Chaetogaster limnei bengalensis* Annandale, 1905*

1905. *Chaetogaster bengalensis* Annandale, *J. Asiat. Soc. Beng.*, **1** : 117-120.

Diagnosis : Worm small, colourless and transparent, prostomium rudimentary; setae in bundle of 15-17, arranged in semicircles, shaft straight, prongs almost equal in length and thickness; in segment II the setae longer than those of others; position of nodules median to distal; mouth large, circular, opening ventro-terminal, obliquely forward and downward; pharynx in II-III segment, wide; oesophagus in IV segment, narrow; stomach in V-VII segment, thin walled, wide, with a ring of cells hanging into lumen of stomach around opening with oesophagus.

Distribution : India : Kerala, West Bengal.

Elsewhere : South America.

Remarks : Worms live as commensal on freshwater sponges and water snails.

3. *Allonais paraguayensis paraguayensis* (Michaelsen, 1905)*

1905. *Allonais paraguayensis paraguayensis* Michaelsen, *Z. wiss. Zool.*, **82** : 354.

Diagnosis : Small, 10 mm; light orange in colour; prostomium short, rounded; anus dorsal; dorsal setae VI segment onwards, with needles and hairs, each 1-3 per segment; hair simple; needle sickle-shaped, bifid with proximal tooth being twice as long as and thicker than bifid distal; ventral bundle of setae with 3-6 bifid crotchets having distal prongs equal in length with the proximals; clitellum V-VIII segments; nephridium located between VII and VIII segments; pineal setae present.

Distribution : India : Bihar, Kerala, Madhya Pradesh, Maharashtra, Orissa, West Bengal.

Elsewhere : Sri Lanka, Pakistan, Italy, South America.

Remarks : It lives among the roots of aquatic angiosperm. Worms swim with transverse movements rotating around their axis in fresh water.

4. *Branchiodrilus hortensis* (Stephenson, 1910)

1910. *Lahoria hortensis* Stephenson, *Rec. Indian. Mus.*, **5** : 59-77, 8 Figs. Pl. VII-VIII.

Diagnosis : Size moderate, 25 mm; segments about 100; prostomium bluntly conical, well marked; transverse pigmented bands extended over the body up to XX segments; gills

extended almost up to the hind end of the body, gradually diminishing in size posteriorly, largest being 3 times the diameter of the body; dorsal setae consisting of usually hairs and needles, two of each per bundle; first 40 hair setae hidden inside the gills, behind ones free; needle setae short and pointed, ventral setae consisting of 4-5 bifid crotches having distal prongs longer than proximal and thinner at the bases, nodules a little distal; clitellum included V-VIII segments; pineal setae 2-3 in each bundle, simple but hooked.

Distribution : India : Kerala, Madhya Pradesh, Uttar Pradesh, West Bengal.

Elsewhere : Bangladesh, Myanmar, Pakistan.

Remarks : Worms live in freshwater among the weeds. Swimming absent. This species is recorded for the first time from this tank.

5. *Allonais inaequalis* (Stephenson, 1911)

1911. *Nais pectinata* var. *inaequalis* Stephenson, *Rec., Indian Mus.*, 6 : 203-214, 3 figs.

Diagnosis : Worms light reddish brown, large; prostomium bluntly conical; dorsal bundle of setae beginning from segment VI, 1-2 hairs and 1-2 needle per bundle, hair smooth, slightly curved, needle pectinate with 1-4 intermediate teeth connected by a web, proximal tooth longer than distal; ventral setae 4-6 per bundle, those of segment II-V thinner and straighter than rest, with a slightly proximal nodulus, other having nodulus slightly distal and teeth equally long; clitellum in segment VI-VIII; nephridium beginning from VIII segment.

Distribution : India : Andhra Pradesh, Kerala, Panjab, Uttar Pradesh, West Bengal.

Elsewhere : South Africa, South America.

Remarks : Lives among aquatic vegetation and decaying vegetable matter in freshwater, also in colonies of sponges, *Eunepius carteri*. The species was reported by Mukherjee (1998) from this site and also collected during this study. It swims by active wriggling movement.

6. *Limnodrilus hoffmeisteri* Claparede, 1862

1862. *Limnodrilus hoffmeisteri* Claparede, *Mem. Soc. Phys. Hist. nat. Geneve*, 16 : 217-291. Pl. I-IV.

Diagnosis : Worm large, cylindrical, with anterior half reddish and posterior half yellowish in colour; prostomium bluntly conical; both dorsal and ventral setae starting in II segment, all of similar type, composed of 6-7 per bundle anteriorly, 3-5 in middle and 1-2 in the hind segment, thinner and shorter than the setae of the ventral bundles; nephridium beginning between VII to IX segment; clitellum in segments X-XII, opaque white.

Distribution : India : Andhra Pradesh, Assam, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, Uttarakhand, West Bengal. **Elsewhere** Bangladesh, Myanmar, Pakistan, Sri Lanka.

Remarks : These worms live burying their anterior part of the body in soft mud and wave free portion of body rhythmically in water and disappear in the mud when disturbed. This is the first record of the species from this tank.

7. *Bothrioneurum iris* Beddard, 1901

1901. *Bothrioneurum iris* Beddard, *Proc. zool. Soc. Lond.*, 1 : 81.

Diagnosis : Worms large, cylindrical and reddish, body-wall with white patches; prostomium semicircular; both ventral and dorsal bundles of setae beginning from II segment, mostly composed of 4 bifid crotchet setae; dorsal crotchets having distal prong, thinner and shorter than proximal while ventral crotchets having distal prong much thinner and longer in outer but shorter in inner bundles than the proximal prong; nephridium beginning from VIII segment. Clitellum in X-XII segments.

Distribution : India : Andhra Pradesh, Haryana, Kerala, Punjab, Tamil Nadu, West Bengal.

Elsewhere : Sri Lanka.

Remarks : Live in fresh and brackishwater. This is the first report of this species from this tank.

8. *Branchiura sowerbyi* Beddard, 1892

1892. *Branchiura sowerbyi* Beddard, *Quart. Jl. microsc., Sci.* (N.S.) 33 : 325-329.

Diagnosis : Size large, 70-80 mm; robust, dark brown anteriorly and lighter posteriorly; posterior portion whip like and without setae (achaetous); both dorsal and ventral bundle of setae starting from II segment and bifid crotchets of one type only, having both prongs equal in length, the distal prong thinner; dorsal bundles consisting of 6-7 setae in anterior, 3-5 setae in the middle and 1-2 setae in hind segments, thinner and shorter than setae of ventral bundles; nephridium begins between VII and IX segments; clitellum XI-XII segment, opaque white.

Distribution : India : Assam, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Tamil Nadu, Uttar Pradesh, West Bengal.

Elsewhere : Bangladesh, Myanmar and Sri Lanka.

Remarks : Worms live in highly polluted, foul smelling aerobic conditions along with *Limnodrilus hoffmeisteri* worms. Bury anterior half of the body in mud and wave the posterior branchial part in water.

SUMMARY

In the present paper 8 species have been reported from this tank of which 5 species are collected during present investigation, and out of which four species, *Branchiodrilus hortensis* (Stephenson), *Limnodrilus hoffmeisteri* Claparede, *Bothrioneurum iris* Beddard and *Branchiura sowerbyi* Beddard are reported for the first time from this tank.

ANNELIDA : LEECHES

INTRODUCTION

Earlier Ghosh G.C. (1998) recorded 3 species of leeches from Indian museum tank, Kolkata. These species are *Glossiphonia weberi*, *Hemiclepsis marginata asiatica* and *Helobdella nociva*. The present report is based on collection made during March 2009. In all 17 ex. of leeches have been collected from this tank. Four species have been identified, out of which 2 species *Nematobdella indica* and *Herpobdelloidea lateroculata* are recorded for the first time from this pond. However, descriptive account of all the 5 species recorded from this tank is given below.

SYSTEMATIC ACCOUNT

Phylum ANNELIDA

Class HIRUDINEA

Order RHYNCHOBDELLAE

Family GLOSSIPHONIDAE

1. *Glossiphonia weberi* Blanchard, 1897

1897. *Glossiphonia weberi* Blanchard, *Zool. Ergeb. Einer Reise in Niederlandische Ost-Indian, Max Weber*, 4 : 332 (Type Locality : Sumatra : Type-Deposition : Not known).

1977. *Glossiphonia weberi*, Chandra, *Rec. zool. Surv. India*, 73(1-4) : 189-195.

Common Name : Sumatran leech.

Diagnostic character : Body ovate-acuminate, triangular in contraction; larger form attaining a length of about 12 mm, colour varies from grayish-white to light orange but usually white in preserved state; five longitudinal rows of dark brown spots; dorsal surface bears seven longitudinal rows of prominent papillae; dorsal surface rough due to the presence of tubercles on every ring; eyes three pairs on rings 6, 7 and 8; male and female genital ducts opened by a common pore between rings 27/28; rings 70; mouth opens within the anterior sucker; crop with six pairs of sub-lobate lateral caeca, the last and the longest pair reflected posteriorly.

Habitat : This species is found in ponds, lakes and streams attached to submerged articles or free living. Water hyacinth, Valisnaria and aquatic grasses are main vegetations for attachment and resting. Leeches of this species have been collected from molluscs, aquatic beetles, amphibians and also from leaves of the aquatic plants.

Distribution : India : Widely distributed throughout India. Outside India : Pakistan, Nepal, Burma and Sumatra.

Remarks : It is recorded for the second time from this pond.

Genus *Hemiclepsis* Vejdovsky, 18832. *Hemiclepsis marginata asiatica* Moore, 1924

1924. *Hemiclepsis marginata asiatica*, Moore, *Proc. Acad. Nat.Sci., Philad.*, 76 : 343-388. (Type Locality : Srinagar, Kashmir; Type-Deposition : Z.S.I.).

Common Name : Improportioned eyed leech.

Diagnostic characters : Larger forms attained a length of about 15 mm, width of about 4 mm; colour pinkish white with dull green pigmented cells on the dorsal side; body smooth ventrally but rough dorsally; middle ring of each somite bears three pairs of larger dorsal papillae; eyes three pairs arranged in two sub-parallel columns; the first, second and third pairs of eyes lying on ring 3, 4 and 7 respectively; male and female pores opening between 29/30 and 31/32 respectively; rings 73; mouth subterminal; crop with nine pairs of lateral diverticula.

Habitat : This species is found in ponds and lakes on under surface of leaves of aquatic plants. Vegetations such as Water hyacinth, Valisnaria, Lotus, aquatic grasses, etc., are suitable habitat of this species and also found attached to *Bellamyia* and *Lymnaea* species.

Distribution : India : Himachal Pradesh, Haryana, Bihar, Assam, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka and West Bengal.

3. *Helobdella nociva* Harding, 1924

1924. *Helobdella nociva* Harding, *Ann. Mag. Nat. Hist., Ser. 9*, 14 : 489. (Type Locality and Type-Deposition : Not known).

Common Name : Claviform leeches.

Diagnostic characters : Larger forms attained a length of about 7.5 mm. and the greatest width about 1.5 mm; body translucent, dull green but usually white in preserved state; dorsal surface with five brown longitudinal stripes; papillae two pairs on dorsal side; eyes one pair on ring 4; male and female ducts opening between 28/29 and 30/31 respectively; 70 rings; mouth opening within anterior sucker; crop with six pairs of simple lateral caeca; male and female genital pore separated by two annuli.

Habitat : It inhabits streams, ponds and lakes. Chara, Hinch, Waterlily, Shaluk, Valisnaria, Water hyacinth, Canna leaves and aquatic grasses are the main vegetation offering suitable habitats of this leech.

Distribution : India : Himachal Pradesh, Orissa, Jammu and Kashmir, West Bengal and Karnataka.

Family ERPOBDELLIDAE

4. *Nematobdella indica* Kaburaki, 1921

1921. *Nematobdella indica* Kaburaki, *Rec. Indian Mus.*, 22 : 689-719. (Type Locality : Dharmapur, Himachal Pradesh; Type-Deposition : Z.S.I.).

1983. *Nematobdella indica* Chandra, *Rec. zool. Surv. India*, 80 : 281.

Common Name : Worm leech of Dharmapura.

Diagnostic characters : Larger forms attaining a length of about 20 mm and width about 3 mm; form very slender, attenuated anteriorly; colour bright buff when alive but faded away in preserved state; eyes six pairs, the first pair larger and dorsal on somite III, remaining five pairs smaller, sub-marginal on somites V to XI; gonopores separated by five annuli.

Habitat : It is found attached to the stem of aquatic worts or water hyacinth. It has been collected from under the immersed leaves of aquatic worts.

Distribution : Himachal Pradesh, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Punjab, Madhya Pradesh, Maharashtra, West Bengal and Karnataka.

5. *Herpobdelloidea lateroculata* Kaburaki, 1921

1921. *Herpobdelloidea* Kaburaki, *Rec. Indian Mus.*, 22 : 668-719. (Type Locality : Saugar, Madhya Pradesh; Type-Deposition : Z.S.I.).

1983. *Herpobdelloidea lateroculata* Chandra, *Rec. zool. Surv. India*, 80 : 281.

Common Name : Worm leech of Saugar.

Diagnostic characters : Larger forms attaining a length of about 27 mm and width of about 3 mm; form very slender, attenuated anteriorly; colour pale buff when alive but generally white in preserved state; eyes five or six pairs, the first pair larger and dorsal on somite IV, the remaining submarginal on somites V to VIII; gonopores separated by two and one-half to three annuli.

Habitat : They are found in small streams and ponds. Vegetations for attachment are Water hyacinth and aquatic grasses. They are collected from under the immersed leaves and roots of Water hyacinth.

Distribution : India : Madhya Pradesh, Manipur, Assam, Rajasthan, Maharashtra, Uttar Pradesh, Orissa, Karnataka and West Bengal.

SUMMARY

Present communication deals with 5 species of leeches belonging to 5 genera and 2 families of which 2 species viz., *Nematobdella indica* and *Herpobdelloidea lateroculata* are recorded for the first time from this tank.

CRUSTACEA : CLADOCERA

INTRODUCTION

Cladocerans commonly known as water fleas are aquatic branchiopod microcrustaceans found in almost every type of freshwater habitats. Traditionally, they have been considered as a zooplanktonic group, but most of them are benthic forms found near the littoral zone, associated to different kinds of substrate, such as, aquatic plants or rocks (Whiteside and Harmsworth, 1967; Quade, 1969). Currently, there are about 620 species of cladocera in the world (Kotov *et al.*, 2010), of which nearly 90 species belonging to 37 genera spread over 11 families occur in India (Michael and Sharma, 1988).

Very little is known about the cladocerans of Indian Museum tank. Gurney 1906 reported four species, such as, *Ceriodaphnia cornuta*, *Scapholebris kingi*, *Simocephalus vetulus* (= *S. elizabethae*) and *Chydorus sphaericus* under 2 families. In 1907, he added further six species to the list with three new records, viz., *Dunhevedia crassa*, *Pseudochydorus globosus* (= *Chydorus globosus* var. *sculptus*) and *Macrothrix goeldi* from this tank. Subsequently, Sewell (1935) recorded eleven species, out of which six species, viz., *Diaphanosoma excisum* (= *Diaphanosoma excisum* var. *longiremis*), *Moina micrura* (= *Moina dubia*), *Illyocryptus spinifer* (= *Illyocryptus halyi*), *Phreatalona protzi* (= *Alona protzi*), *Leydigia australis* and *Kurzia longirostris* (= *Pseudoalona longirostris*) were new reports from this tank.

Thus, a total of 12 species of cladocerans belonging to 12 genera and five families. The following is the list of cladocera fauna, so far reported from this tank. In this communication, those species which have been marked with asterisk indicates recent collections made and studied by the authors during 2008-2009.

SYSTEMATIC LIST

Phylum ARTHROPODA

Class CRUSTACEA

Sub-Class BRANCHIOPODA

Order CLADOCERA

Family SIDIDAE

Genus *Diaphanosoma*

1. *Diaphanosoma excisum* Sars, 1885

Family DAPHNIDAE

Genus *Ceriodaphnia*

2. *Ceriodaphnia cornuta* Sars, 1885

Genus *Simocephalus*

3. *Simocephalus vetulus* (O.F.Muller, 1776)

Genus *Scapholebris*

4. *Scapholebris kingi* Sars, 1903

Family MOINIDAE

Genus *Moina*

5. *Moina micrura* Kurz, 1874

Family MACROTHRICIDAE

Genus *Macrothrix*

6. *Macrothrix goeldii* Richard, 1897

Genus *Iliocryptus*

7. *Iliocryptus spinifer* Herrick, 1882

Family CHYDORIDAE

Subfamily CHYDORINAE

8. *Chydorus sphaericus* (O.F. Müller, 1776)

Genus *Dunhevedia*

9. *Dunhevedia crassa crassa* King, 1853

Genus *Pseudochydorus*

10. *Pseudochydorus globosus* (Baird, 1843)

Subfamily ALONINAE

Genus *Diaphanosoma*

11. *Leydigia australis* Daday, 1898

Genus *Diaphanosoma*

12. *Kurzia longirostris* (Daday, 1898)

CRUSTACEA : OSTRACODA

INTRODUCTION

Ostracods (Seed Shrimps) are bivalve crustaceans found both in fresh and marine water. There are over 1700 species of known ostracods of which about one third are freshwater forms. They inhabit a wide variety of freshwater bodies like lakes, pools, swamps, streams and heavily polluted areas (Edmondson, 1959). They are widespread, mostly free living, while benthic forms are not uncommon. A few species occur among aquatic vegetation and algal mats. They also occur as parasites in crayfishes and serve as secondary hosts for fish parasites (Victor and Fernando, 1979). They are considered to be an important component in the food chain of aquatic ecosystems and also serve as ecological indicators (Puri, 1964). Freshwater ostracods are common in India. Gurney (1907) reported *Stenocypris malcolmsoni* from lower Bengal. The present communication is the first record of 3 species under 2 genera and 1 family from Indian Musium tank.

SYSTEMATIC ACCOUNT

Class CRUSTACEA

Subclass OSTRACODA

Order PODOCOPA

Family CYPRIDIDAE

Subfamily CYPRIDINAE

1. *Paracyprretta subglobosa* (Sowerby, 1840)

1840. *Cypris subglobosa* Sowerby, In : Malcolmson, description in unpaginated explanation of pl. 47, fig. 3.

Material examined : 2 ex., Indian Musium Tank, Kolkata : 05.vi.2009, Coll. Chitra, J.

Diagnosis : Valves subglobular, tumid with the characteristic thimble-shaped depressions on surface, both anterior and posterior margins broadly rounded, dorsum convex; natatory setae of the second antenna setulate, claws pectinate, furcal rami symmetrical slender, sub terminal claws slightly more than half the length of terminal claw; colour greenish when alive.

Measurement : length : 1.43-1.45 mm; height : 0.92-0.94 mm; width : 1.18 mm.

Distribution : India : Maharashtra, West Bengal.

Elsewhere : Throughout the tropics/subtropics from Carribean Islands through West Africa, Mediterranean, southern ex-USSR, Iran, Afghanistan, Sri Lanka, Indonesia, China and Japan.

Remarks : Mostly these organisms are benthic forms clinging to submerged biota. However, the present specimens were obtained from the surface water during plankton collection.

***Strandesia indica* Hartmann 1964**

1964. *Strandesia indica* Hartmann, *Int. Rec. Gesamten Hydrobiol. Syst. Beih.* 3 : 101.

Material examined : 4 ex. Indian Musium Tank, 05.vi.2009, Coll. Chitra, J.

Diagnosis : Eyes prominent; valves sub-elliptical laterally elongated, anterior margin more broadly rounded than the posterior, left valve overlapping right valve, entire margin of the valve hairy except dorsally, dorsum convex, highly arched in the anterior region, ventral margin almost straight, valve surface sparsely hairy and punctate; maxillary spines smooth; furcal rami symmetrical, dorsal margin of both the rami have minute spines along $\frac{3}{4}$ the entire length.

Measurement : length : 0.72-0.81 mm; height : 0.30-0.39 mm; width 0.35-0.38 mm.

Distribution : India : Gujarat, Kerala, Tamil Nadu, West Bengal (Calcutta).

Remarks : The specimens of this species were collected from plankton samples of Indian Museum tank during summer.

***Stenocypris major* (Baird, 1859)**

1859. *Cypris cylindrical major* Baird, *Proc. Zool. Soc., Lond.*, : 233.

Material examined : 6 ex. Indian Musium Tank, Kolkata, 05.vi.2009, Coll. Chitra, J.

Diagnosis : Valves from above elliptical, reniform laterally, anterior and posterior margins rounded, left and right valves almost of the same size, margins of valves hairy, without prominent band of pore canals, elliptical maxillary spines faintly toothed; furcal rami asymmetrical, one ramus conspicuously armed with a series of well developed teeth, the other smooth or less heavily armed.

Measurement : Length : 1.88-2.13 mm; Height : 0.73-0.87 mm.

Distribution : India : Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu and West Bengal.

Remarks : This species was found associated with sponges as well as clinging to the aquatic macrophyte *Ipomoea aquatica* in the Indian Museum tank.

CRUSTACEA : COPEPODA

INTRODUCTION

The copepod fauna of Indian Museum Tank is represented by 11 species. These belong to 2 families under 6 genera. A perusal of literature reveals that Anderson (1889) was the first to report the group from this tank. He recorded three species, viz., *Mesocyclops* (=Cyclops) *leuckarti*, *Tropocyclops* (=Cyclops) *prasinus* and *Ectocyclops* (Cyclops) *phaleratus*. Later, Gurney (1907) while working on the Entomostraca of Indian freshwater also confirmed the occurrence of these species along with addition of three more taxa, namely, *Paracyclops* (=Cyclops) *fimbriatus*, *Microcyclops* (=Cyclops) *varicans*, and *Heliodiaptomus* (=Diaptomus) *contortus* from this site. The last named species was, however, described as new to science. Sewell (1912) further added, *Heliodiaptomus* (=Diaptomus) *cinctus* Gurney, to the list of copepod species raising their number to seven. Roy (1998) in his studies on copepod fauna of the state of West Bengal reported only 4 species from this tank including additional record of *Heliodiaptomus viduus*. During the course of present investigation, the author came across three more species, viz., *Mesocyclops rylovi*, *M. hyalinus* and *Microcyclops bicolor* hitherto unreported from this Tank.

The updated list of copepod fauna, so far recorded from this Tank, is provided below.

Order COPEPODA

Suborder CALANOIDA

Family DIAPTOMIDAE

Genus *Heliodiaptomus*

1. *Heliodiaptomus cinctus* (Gurney, 1907)
2. *Heliodiaptomus contortus* (Gurney, 1907)
3. *Heliodiaptomus viduus* (Gurney, 1916)

Suborder CYCLOPOIDA

Family CYCLOPIDAE

Genus *Mesocyclops*

4. *Mesocyclops hyalinus* (Rehberg, 1880)
5. *Mesocyclops leuckarti* (Claus, 1857)
6. *Mesocyclops rylovi* Smirnov, 1928

Genus *Microcyclops*

7. *Microcyclops varicans* (Sars, 1863)
8. *Microcyclops bicolor* (Sars, 1863)

Genus *Paracyclops*

9. *Paracyclops fimbriatus* (Fischer, 1853)

Genus *Tropocyclops*

10. *Tropocyclops prasinus* (Fischer, 1860)

Genus *Ectocyclops*

11. *Ectocyclops phaleratus* (Koch, 1838)

CRUSTACEA : DECAPODA

INTRODUCTION

Present knowledge on malacostracan decapod of Indian Museum tank is based on the reports of Gurney (1907), De Man (1908) and Deb (1998). Gurney (1907) was the first to report *Atya* sp. from this tank. Later on, De Man (1908) recorded *Macrobrachium lamarrei* which was also reported by Sewell in 1912. Recently, Deb (1998) recorded the brachyuran crab *Sartoriana spinigera* (Wood-Mason, 1871) from the same habitat. However, during the course of present study, except the first species, the last two malacostracans were collected, examined and studied. All these three species constitute the basis of this present communication.

SYSTEMATIC ACCOUNT

Class CRUSTACEA

Subclass MALACOSTRACA

Order DECAPODA

Infraorder CARIDEA

Superfamily ATYOIDEA

Family ATYIDAE

1. *Atya* sp.

Remarks : This species was recorded earlier from almost the dried up edges of the tank by Gurney (1907). The specific year-round survey is required to ascertain the existence of this species in this tank.

Superfamily PALAEMONOIDEA

Family PALAEMONIDAE

2. *Macrobrachium lamarrei* (H. Milne Edwards, 1837)

1837. *Palaemon lamarrei* H. Milne Edwards, *Hist.Nat. Crust.*, 2 : 397.

Diagnosis : Rostrum equal to or slightly longer than antennal scale and slightly upturned distally; rostral formula $\frac{6-9+0-2+1}{4-8}$ with 1 or 2 post-obital teeth; upper margin with a gap between proximal portion of 6 – 9 teeth and distal portion of 1 subapical tooth; often this gap filled by 1 or 2 teeth; carpus of second pereopod longer than merus; palm not swollen, fingers shorter than palm; a non-hairy *appendix masculina* present in the second pleopod of male.

Distribution : India : Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattishgarh, Jharkhand, Kerala, Maharashtra, Manipur, Orissa, Punjab, Tamil Nadu, Tripura, West Bengal.

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Elsewhere : Pakistan, Nepal and Bangladesh.

Remarks : This is one of the oldest known and widely distributed species of the genus *Macrobrachium* in India.

Infraorder BRACHYURA

Family PARATHELPHUSIDAE

3. *Sartoriana spinigera* (Wood-Mason, 1871)

1871. *Paratelpusa spinigera* Wood-Mason, *J. Asiat. Soc. Bengal*, 40 : 197.

Diagnosis : Carapace broad, convex, its length about two-thirds its maximum width; cervical groove deep, running towards the outer ends of the post-orbital crests; front nearly one-third of its greatest width, free edge sharp and little concave; orbits small; antero-lateral borders of carapace well-arched, sharp, entire or crenulate, epibranchial spine situated far back; epigastric crests conspicuous and rugulose; chelipeds unequal in both sexes, upper edge of arm bearing an acute spine at its far end, inner corner of carpus strong, stout and sharply pointed; legs stout, not longer than cheliped in either sex; sixth segment of male abdomen with concave sides.

Distribution : *India* : Assam, Meghalaya, West Bengal, Tripura, Bihar, Uttar Pradesh, Uttarakhand, Punjab and New Delhi.

Elsewhere : Iran, Pakistan, Bangladesh, Sri Lanka and Myanmar.

Remarks : Wood-Mason (*op. cit.*) recorded this crab from tanks of Calcutta (Kolkata). Deb (*op. cit.*) reported to have examined a large number of specimens of this species from Indian Museum Tank. During the present study also, this crab was noticed in good numbers. Even, this crab was found living commensally with freshwater sponge *Eunapius carteri* (Bowerbank, 1863). It is a very common species throughout the state of West Bengal, often causing considerable damage to paddy fields.

SUMMARY

Two species of prawn, *viz.*, *Atya* sp. and *Macrobrachium lammarei* and one species of crab *Sartoriana spinigera* were recorded so far from Indian Museum Tank, Kolkata. Of these, only the last two species could be collected during the present study.

INSECTS

INTRODUCTION

The greatest diversity in form and habit is exhibited by the insects which occupy every kind of freshwater habitat and also represent all the functional feeding groups, including predators, shredders, grazers, (or scrapers), filter feeders, gatherers, piercers and parasites (Mackie, 1998). However, the present report deals with only a list of insect diversity hitherto known from Indian Museum Tank (IMT).

The following is a systematic list of 32 species of insects belonging to six orders which was collated and compiled from the collections made by the author during 2007-2008 and also by consulting Sewell (1935) and West Bengal State Fauna volumes on insects.

Class INSECTA

Order HEMIPTERA

Family BELOSTOMATIDAE

Genus *Diplonychus*

1. *Diplonychus* (= *Sphaerodema*) *annulatus* Fabricius

Family MESOVELIIDAE

Genus *Mesovelia*

2. *Mesovelia vittigera* Horvath

Family HYDROMETRIDAE

Genus *Hydrometra*

3. *Hydrometra vittata* Stal

Family GERRIDAE

Subfamily GERRINAE

Genus *Limnogonus*

4. *Limnogonus fossarum* (Fabricius)¹

Genus *Gerris*

5. *Gerris spinolae* Lethierry and Severin

Family NEPIDAE

Genus *Laccotrephes*

6. *Laccotrephes tristis* Stal

Genus *Ranatra*

7. *Ranatra varipes* Stal

Genus *Naucoris*

- 8.
- Naucoris sordidus*
- Distant

Genus *Thurselinus*

- 9.
- Thurselinus clathratus*
- Distant

Family PLEIDAE

Genus *Plea*

- 10.
- Plea indistinguenda*
- Matsumura
- ²

- 11.
- Plea liturata*
- (Fieber)
- ³

Genus *Helotrephes*

- 12.
- Helotrephes indicus*
- Distant

Genus *Micronecta*

- 13.
- Micronecta issa*
- Distant

Order COLEOPTERA

Suborder ADEPHAGA

Family DYTISCIDAE

Subfamily NOTERINAE

Genus *Canthydrus*

- 14.
- Canthydrus laetabilis*
- (Walker)

- 15.
- Canthydrus morsbachi*
- (Wehncke)

Genus *Potaminus*

- 16.
- Potaminus (Helichus) pallelus*
- Greouv.

Genus *Luciola*

- 17.
- Luciola vespertina*
- Fabricius

Subfamily LACCOPHILINAE

Genus *Laccophilus*

- 18.
- Laccophilus anticatus*
- Sharp

Suborder POLYPHAGA

Family HYDROPHILIDAE

Subfamily HYDRAENINANE

Genus *Hydraena*

- 19.
- Hydraena tenjikuana*
- Sato

Subfamily HYDROCHINAE

Genus *Hydrochus*

- 20.
- Hydrochus binodosus*
- Motschulsky

Order DIPTERA

Family CHIRONOMIDAE

Subfamily CHIRONOMINAE

Genus *Polypedilum*

- 21.
- Polypedilum fasciatipennis*
- Kieffer

Family CULICIDAE

Genus *Anopheles*

- 22.
- Anopheles funestus*
- var.
- listoni*
- Liston

- 23.
- Anopheles fuliginasus*
- Giles

- 24.
- Anopheles subpictus*
- Grassi

Genus *Culex*

- 25.
- Culex barbirostris*
- v. d. Wulp.

- 26.
- Culex fatigans*
- Wied

- 27.
- Culex tritaeniorhynchus*
- Giles

- 28.
- Culex vagus*
- Don

Order COLLEMBOLA

Genus *Pseudosira*

- 29.
- Pseudosira indra*
- Imms

Genus *Sisyra*

- 30.
- Sisyra indica*
- Ndm.

Order ODONATA

Genus *Ischnura*

- 31.
- Ischnura senegalensis*
- (Ramb.)

Order EPHEMEROPTERA

Genus *Cloeon*

- 32.
- Cloeon*
- sp.

Note : 1. Earlier *Gerris fossarum* Distant; 2. Earlier *Plea pallescens* Distant; 3. Earlier *Plea metiadusa* Distant

BRYOZOA

INTRODUCTION

Bryozoa or Ectoprocta are small, benthic, sessile, aquatic invertebrates growing as colonies of connected zooids on submerged substrates. They feed on suspended organic particles captured by the whorls of ciliated tentacles (lophophore). Of the estimated 8000 extant species of bryozoans in world (Ryland, 2005), only 94 species consisting of 24 genera and 10 families (Massard & Geimer, 2008) occur in freshwater habitats which is unique to class Phylactolaemata. These freshwater species reproduce asexually by means of statoblasts (buoyant floatoblasts and fixed sessoblasts), providing significant character for the identification of species. Freshwater bryozoan colony adhere to the surface of submerged substratum *i.e.*, aquatic weeds, logs, stones, bricks or any other object in the ponds, lakes, streams, rivers, etc.

Literature of the freshwater bryozoa of India reveals that very little attention has been paid to this group. Annandale (1911) dealt with this group from the Indian subcontinent. Rao & Kulsreshtha (1962) and Rao (1972, 1976) have worked on freshwater bryozoa of western and middle part of India. So far, only 17 species of freshwater bryozoa are recorded from India of which 9 species are reported from West Bengal (Samanta, 1998). Interestingly, all the 9 species reported from West Bengal (*op. cit.*) were inhabiting different fresh water bodies of Calcutta (Annandale, 1911).

A total 3 species, *Plumatella* (= *Hyalinella*) *punctata* (Hancock, 1850), *Plumatella fruticosa* Allman, 1844 and *Plumatella emarginata* Allman, 1844 were described by Annandale (1911) from the Indian museum tank. Later, Sewell (1935) also recorded these species and observed their statoblasts in different seasons. During present investigation three species, namely, *Hyalinella punctata* (Hancock, 1850), *Plumatella fruticosa* Allman, 1844 and *Stolella indica* Annandale, 1909 were sampled. However, earlier recorded species *Plumatella emarginata* was not collected during recent studies. *Stolella indica* Annandale, is reported here for the first time from this tank. The present paper deals with the taxonomic account, habitat and distribution of four species, so far recorded from the Indian museum tank.

SYSTEMATIC ACCOUNT

Class PHYLACTOLAEMATA

Order PLUMATELLIDA

Family PLUMATELLIDAE

1. *Hyalinella punctata* Hancock, 1850

1850. *Hyalinella punctata* Hancock, *Ann. Mag. nat. Hist. Ser. II*, 5 : 153.

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Diagnosis : Zoarium entirely recumbent and often appearing to form an almost uniform flat layer instead of a dendritic body, zoecia greatly swollen with faintly brown gelatinous ectosysts; sessoblasts absent, floatoblasts variable and often asymmetrical in outline but free portion of the swim-ring nearly equal in diameter all around the periphery and the capsule relatively large; polypide comparatively short and stout with 20-30 tentacles.

Habitat : Submerged bricks, woods, stones, leaves and stems of water plants, and also on the tips of creepers immersed in water.

Distribution : India : Madhya Pradesh, Rajasthan, West Bengal.

Elsewhere : Europe, North America.

Remarks : This species flourishes during monsoon and winter in West Bengal (Samanta, 1998). According to Annandale (1911) this species commonly occurred in the Salt Lake area where the water was slightly brackish. Sewell (1935) observed the statoblasts of this species during winter from this tank; Annandale (*op. cit*) also observed the occurrence of this species during cold weather and rains.

2. *Plumatella fruticosa* Allman, 1844

1844. *Plumatella fruticosa* Allman, *Ann. Mag. nat. Hist. Ser. 1.* 13 : 328.

Diagnosis : Zoarium in typical form loose in appearance, and ectosysts by no means rigid; lateral branching as a rule occurred chiefly on one side of the main branch or trunk; zoecia cylindrical with a simple keel on dorsal surface; never emarginate or furrowed; ectosysts thin, colour usually pale brown but fading gradually towards tip of the zoecium; both sessoblasts and floatoblasts often formed, but sessoblasts rare and floatoblasts very common in occurrence; statoblasts very elongate; capsule relatively large, resembling swim-ring in outline, sides distinctly convex, ends rounded; polypide about 40-50 tentacles.

Habitat : Stems and leaves of aquatic plants, floating seeds, logs, stones, bricks, and other objects (Glass, plastics etc.).

Distribution : India : Kerala, Maharashtra, Orissa, Rajasthan, Himalayan region, West Bengal.

Elsewhere : Africa, Europe, North America, Pakistan, and Bangladesh.

Remarks : Annandale (1911) reported it as a cold weather species. Sewell (1935) found statoblasts of this species from October to February, and coralloid in October. Sewell opined that this species does not make its appearance before October in this tank. However, plenty of colonies of this species were observed in July and August also.

3. *Plumatella emarginata* Allman, 1844

1844. *Plumatella emarginata* Allman, *Ann. Mag. Nat. Hist. Ser. 1.* 13 : 320.

Diagnosis : Zooarium dichotomously branched and sometimes entirely recumbent; zooecia almost equal in width throughout, slender and moderately elongated; ectosysts stiff; emarginate at tip and more or less distinctly furrowed on the dorsal surface; floatoblasts elongate and truncate at the extremities, sides straight and parallel; capsule relatively much broader than the swim-ring; sessoblasts oval, usually found in old colonies; polypide with about 40 tentacles.

Habitat : Stones, bricks and stems of the water plants.

Remarks : Annandale (1911) expressed that this is exclusively a cold weather species, but Sewell (1935) found the statoblasts of this species in summer and late monsoon. It was not observed during present study.

4. *Stolella indica* Annandale, 1909

1909. *Stolella indica* Annandale, *Rec. Ind. Mus.*, 3 : 279.

Diagnosis : Zoarium adherent and linear, zooecia short and slender, erect, distinctly emarginate and furrowed; ectosysts soft, transparent with slightly rough surface; sessoblasts varying in outline, from circular to broadly oval; floatoblasts also variable in form; tentacles 30 to 35, rather short and stout.

Habitat : Roots of duckweed, stems of water plants, submerged rocks, dead leaves, sticks, etc.

Distribution : India : Madhya Pradesh, West Bengal.

Elsewhere : North America.

Remarks : It flourishes during the rainy season. Though Annandale (1911) reported this species from other water bodies of Kolkata, this is the first report of the species from this tank.

SUMMARY

The present paper deals with a systematic account of 4 species under 3 genera and one family belonging to a single class Phylactolaemata of freshwater bryozoa hitherto known from the tank of the Indian museum compound. *Plumatella emarginata* reported earlier by Annandale (1911) and Sewell (1935) was not collected during the present study. Occurrence of *Stolella indica* is the first record from this tank.

WETLAND VERTEBRATES

INTRODUCTION

The tank inside the Indian Museum campus, earlier known as *Jhinjherrie Talao*, has been a favourite study site for many zoologists in Kolkata including the scientists of the Zoological Survey of India. But their published works were mostly concerned with invertebrates rather than vertebrates. In fact, there is hardly any report of vertebrate fauna from the Indian Museum tank and hence the present study.

RESULTS

On the basis of the present study both aquatic and water dependent species were tabulated in Table I. It includes 27 species of fish, 5 species of amphibia, 3 species of reptile and 9 species of bird.

Table I : Classified list of vertebrate species in and around the Indian Museum Tank
(A = Aquatic; WD = Water Dependent)

Sl. No.	Scientific name	Common Name	Remarks
	Pisces		
	Class OSTEICHTHYES		
	Order CYPRINIFORMES		
	Family CYPRINIDAE		
1.	<i>Amblypharyngodon mola</i> (Hamilton)	Mola Carpet	A
2.	<i>Salmostoma phulo</i> (Hamilton)	Finescale razor-belly Minnow	A
3.	<i>Rasbora daniconius</i> (Hamilton)	Slender Rasbora	A
4.	<i>Catla catla</i> (Hamilton)	Catla	A
5.	<i>Cirrhinus mrigala</i> (Hamilton)	Mrigal	A
6.	<i>Labeo bata</i> (Hamilton)	Bata	A
7.	<i>Labeo calbasu</i> (Hamilton)	Orange Fin Labeo	A
8.	<i>Labeo rohita</i> (Hamilton)	Rohu	A
9.	<i>Puntius sophore</i> (Hamilton)	Punti	A
10.	<i>Puntius ticto</i> (Hamilton)	Tita Punti	A
	Order PERCIFORMES		
	Family GOBIIDAE		
11.	<i>Glossogobius guiris</i> (Hamilton)	Tank Goby	A
	Family CHANNIDAE		
12.	<i>Channa striata</i> (Bloch)	Snake-headed Murrel	A
13.	<i>Channa punctata</i> (Bloch)	Spotted Snakehead	A

Sl. No.	Scientific name	Common Name	Remarks
	Family AMBASSIDAE		
14.	<i>Chanda nama</i> Hamilton	Elongate Glass Perchlet	
	Family CICHLIDAE		
15.	<i>Oreochromis mossambicus</i> (Peters)	Mozambique Tilapia	A
16.	<i>Oreochromis niloticus</i> (Linnaeus)	Nile Tilapia	A
	Family ANABANTIDAE		
17.	<i>Anabas testudineus</i> (Bloch)	Climbing Perch	
	Family OSPHRONEMIDAE		
18.	<i>Colisa fasciata</i> (Schneider)	Giant Gourami	A
	Order SILURIFORMES		
	Family BAGRIDAE		
19.	<i>Mystus vittatus</i> (Bloch)	Striped Dwarf Catfish	A
	Family HETEROPNEUSTIDAE		
20.	<i>Heteropneustes fossilis</i> (Bloch)	Stinging Catfish	A
	Family CLARIIDAE		
21.	<i>Clarias magur</i> (Hamilton)	Walking Catfish	A
	Order CYPRINODONTIFORMES		
	Family APLOCHEILIDAE		
22.	<i>Aplocheilus panchax</i> (Hamilton)	Blue Panchax	A
	Order SYNBRANCHIFORMES		
	Family MASTACEMBELIDAE		
23.	<i>Macrogathus aral</i> (Bloch & Schneider)	One stripe Spiny Eel	A
24.	<i>Macrogathus pancalus</i> (Hamilton)	Barred Spiny Eel	A
25.	<i>Mastacembelus armatus</i> (Lacepede)	Zig-zag Eel	A
	Order OSTEOGLOSSIFORMES		
	Family NOTOPTERIDAE		
26.	<i>Notopterus notopterus</i> (Pallas)	Bronze Featherback	A
	Order CLUPEIFORMES		
	Family CLUPEIDAE		
27.	<i>Gudusia chapra</i> (Hamilton)	Indian River Shad	A
	Class AMPHIBIA		
	Order ANURA		
	Family BUFONIDAE		
28.	<i>Duttaphrynus melanostictus</i> (Schneider)	Common Indian toad	WD

Sl. No.	Scientific name	Common Name	Remarks
	Family RANIDAE		
29.	<i>Euphlyctis cyanophlyctis</i> (Schneider)	Skipping Frog	A
30.	<i>Euphlyctis hexadactyla</i> (Lesson)	Pond Frog	A
31.	<i>Hoplobatrachus tigerinus</i> (Daudin)	Indian Bull frog	WD
32.	<i>Fejervarya limnocharis</i> (Boie)	Paddy Field Frog	WD
	Class REPTILIA		
	Order SQUAMATA		
	Suborder SERPENTES		
	Family TYPHLOPIDAE		
33.	<i>Ramphotyphlops braminus</i> (Daudin)	Common Blind Snake	WD
	Family COLUBRIDAE		
34.	<i>Enhydryis enhydryis</i> (Schneider)	Fresh Water Snake	A
35.	<i>Xenochrophis piscator</i> (Schneider)	Checkered Keelback	WD
	Class AVES		
	Order PODICIPEDIFORMES		
	Family PODICIPEDIDAE		
36.	<i>Tachybaptus ruficollis</i> (Pallas)	Little Grebe	A
	Order PELICANIFORMES		
	Family PHALACROCORACIDAE		
37.	<i>Phalacrocorax niger</i> (Vieillot)	Little Cormorant	A
	Order CICONIFORMES		
	Family ARDEIDAE		
38.	<i>Ardeola grayii</i> (Sykes)	Indian Pond Heron	WD
39.	<i>Bubulcus ibis</i> (Linnaeus)	Cattle Egret	WD
40.	<i>Egretta garzetta</i> (Linnaeus)	Little Egret	WD
41.	<i>Nycticorax nycticorax</i> (Linnaeus)	Black-crowned Night Heron	WD, seen upto 1980's
	Order CORACIFORMES		
	Family ALCEDINIDAE		
42.	<i>Ceryle rudis</i> (Linnaeus)	Lesser Pied Kingfisher	WD
43.	<i>Alcedo atthis</i> (Linnaeus)	Small Blue Kingfisher	WD
44.	<i>Halcyon smyrnensis</i> (Linnaeus)	White-breasted Kingfisher	WD

FISHES

A total of 27 species of fishes belonging to 21 genera, 14 families are briefly described here under.

Phylum CHORDATA

Subphylum VERTEBRATA

Superclass PISCES

Class OSTEICHTHYES

Order CYPRINIFORMES

Family CYPRINIDAE

1. *Amblypharyngodon mola* (Hamilton)

1822. *Cyprinus mola* Hamilton, *Fish. Ganges* : 334.

Common Names : Mola carplet, Pale carplet (E); Dhawi (H); Maurala (B).

Diagnosis : D ii-iii 7; A ii-iii 5-6; P i 13-15; V i 8. Body elongate, depth 3.5 to 3.8 times in standard length; eyes large, diameter 3.5 to 4.00 in head length; dorsal fin origin behind the pelvic fin origin, nearer to base of caudal fin than to tip of snout; scales small; lateral line incomplete, ceases after 9 to 18 scales; 65 to 91 scales in lateral series; caudal fin forked.

Colour : In life, golden yellow with a broad silvery lateral band on body; usually dark markings on the dorsal, caudal and anal fins.

Distribution : Throughout India except Kerala. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan.

Remarks : Economically this species is less important due to smallness in size attaining maximum length upto 20 cm.

2. *Salmostoma phulo* (Hamilton)

1822. *Cyprinus phulo* Hamilton, *Fish. Ganges* : 262.

Common Names : Fine-scale razor belly minnow (E); Dunnahree (H); Phul-chela.

Diagnosis : D iii 7; A iii 17-19; P i 12; V i 7. Body elongate and compressed; mouth oblique, lower jaw length about 2 times in head length, with a prominent symphyisial process; gillrakers 13-16 on first arch; scales small, 99-112 scales along the lateral line; lateral transverse scale rows 12-15 between the lateral line and base of dorsal fin.

Colour : In life, silvery with a bright silvery lateral band.

Distribution : India : Brahmaputra and Ganga river systems. *Elsewhere* : Bangladesh.

Remarks : This species inhabits streams, ponds, large water reservoir and inundated fields and attains a length of 12 cm approximately.

3. *Rasbora daniconius* (Hamilton)

1822. *Cyprinus daniconius* Hamilton, *Fish. Ganges* : 327.

Common Names : Blackline Rasbora (E); Danikoni (B).

Diagnosis : D ii 7; A ii 5; P i 14; V i 8. Body oblong and compressed; abdomen rounded; mouth small; lips simple; pectoral fins shorter than head; lateral line nearly complete, with 31 to 34 scales.

Colour : In life, back olive, flanks and belly silvery, a distinct blue black lateral stripe from eye to base of caudal fin along the centre of body, a narrow dark stripe above the anal fin; fins hyaline tinged with yellow.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Malay Archipelago, Myanmar, Nepal, Pakistan, Sri Lanka, Zanzibar.

Remarks : This species is not favourite to aquarists owing to its less outstanding colour. This fish is very active and hardy.

4. *Catla catla* (Hamilton)

1822. *Cyprinus catla* Hamilton, *Fish. Ganges* : 287, 318, 387.

Common Names : Catla (E); Catla (H); Catla (B).

Diagnosis : D iii-iv 14-16; A iii 5; P i 20; V i 8. Body deep, depth 2.5 to 3 times in standard length; head enormously large; mouth wide and upturned; prominent protruding lower jaw; barbels absent; upper lip absent; lower lip very thick; dorsal fin inserted slightly in advance of pelvic fins; pectoral fins long, extend to pelvic fins; anal fin short; caudal fin forked; scale large; lateral line complete with 40 to 43 scales.

Colour : In life, greyish on back and flanks silvery white below; fins dusky.

Distribution : India : northern India. *Elsewhere* : Bangladesh, Myanmar, Nepal and Pakistan : Indus plain and adjoining hills.

Remarks : This species has been successfully transplanted into the rivers of peninsular India. It is an excellent edible fish and one of the major Indian carp.

5. *Cirrhinus mrigala* (Hamilton)

1822. *Cyprinus mrigala* Hamilton, *Fish. Ganges* : 297, 389.

Common Names : Mrigal (E); Mrigal (H); Mrigal (B).

Diagnosis : D iii-iv 12-13; A iii 5; P i 17; V i 8. Body streamlined, depth about equal to head length; mouth broad; upper lip entire, lower lip most indistinct; barbel one pair(rostral), short; gill-rakers 40-49 on first arch; dorsal fin as high as body; pectoral fins shorter than head; caudal fin deeply forked; scales cycloid; lateral line complete with 40-50 scales; lateral transverse scale rows 6-7/5.5-6.

Colour : In life, dark grey along back often with a coppery tinge, flanks silvery with a yellowish tinge and belly silver-white; eyes golden; pectoral, pelvic and anal fins orange tipped generally during breeding season; dorsal and caudal fins dusky.

Distribution : India : Northern India from Punjab to West Bengal, Assam. *Elsewhere* : Bangladesh, Pakistan.

Remarks : This species has been successfully transplanted into waters of peninsular India. As a result this species has now spreaded over whole of peninsular India.

6. *Labeo bata* (Hamilton)

1822. *Cyprinus bata* Hamilton, *Fish. Ganges* : 283.

Common Names : Bata labeo (E); Bhagan, Bata (H); Bata (B).

Diagnosis : D ii-iv 9-10; A ii-iii 5; P i 15-17; V i 8. Body elongate; dorsal profile more convex than ventral profile; eyes large, diameter 4.0 to 4.3 times in head; mouth inferior, lips thin, continuous; a small tubercle above mandibular symphysis and no horny covering inside jaws; barbels one pair of very short maxillary only, not easily perceptible; dorsal fin originates slightly nearer to tip of snout than to caudal base; pectoral fin reaching pelvic fin; scales moderate; lateral line with 37-40 scales; predorsal scales 10-13.

Colour : In life, golden-yellow above and on dorsal half of flanks, silvery on lower half of flanks and belly; young specimens often with 3-4 small, lateral black spots.

Distribution : Throughout India except Kerala. *Elsewhere* : Bangladesh, Nepal and Pakistan.

Remarks : This species breeds in rivers during monsoon and cultivated along with the Indian major carp.

7. *Labeo calbasu* (Hamilton)

1822. *Cyprinus calbasu* Hamilton, *Fish. Ganges*: 297, 289.

Common Names : Orange-fin labeo, Black rohu (E); Kalabenise (H); Kalbose (B).

Diagnosis : D iii-iv 13-16; A ii-iii 5; P i 16-18; V i 8. Body stout, rather deep; head conical, its length less than body depth; snout depressed, devoid of lateral lobe, studded with pores; mouth inferior; lips thick and prominently fringed, both lips with distinct inner fold; barbels two pairs; dorsal fin inserted midway between snout tip and base of caudal fin; caudal fin deeply forked; lateral line complete with 40-44 scales; predorsal scales 15-18.

Colour : In life, blackish-green, lighter below; flanks buff pink or with scarlet spots with dark edges which may form stripes; fins black; upper lobe of caudal fin usually tipped with white.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Thailand and also SW China.

Remarks : Bottom-feeder; it thrives better in tanks and lakes rather than running water and can tolerate slight brackish water.

8. *Labeo rohita* (Hamilton)

1822. *Cyprinus rohita* Hamilton, *Fish. Ganges* : 301.

Common Names : Rohu (E); Rohu (H); Rui (B).

Diagnosis : D iii-iv 12-14; A ii-iii 5; P i 16-18; V i 8. Body moderately elongate, its dorsal profile more arched than the ventral; snout fairly depressed, devoid of lateral lobe; eyes large, diameter 4 to 6 times in head; mouth inferior, lips thick and fringed, distinct inner fold to each lip; barbels one pair, small, concealed in lateral groove; dorsal fin originates middle in between snout tip and base of caudal fin; pectoral fin shorter than head; caudal fin deeply forked; lateral line complete with 40-44 scales; predorsal scales 12-16.

Colour : In life, bluish along back, becoming silvery on the flanks and beneath with a reddish mark on each scale during breeding season; fins greyish or dark; pectoral fin dusky.

Distribution : India : Northern India. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan; introduced into peninsular India and Sri Lanka.

Remarks : Rohu fish attains a length of about a meter and more active in the river system. It prefers to feed on plant matter including decaying vegetation.

9. *Puntius sophore* (Hamilton)

1822. *Cyprinus sophore* Hamilton, *Fish. Ganges* : 310, 389.

Common Names : Spot-fin Swamp Barb (E); Katcha-karawa, Pottiah, Pothi (H); Punt (B).

Diagnosis : D iii-iv 8-9; A iii 5; P i 14-16; V i 8. Body deep, dorsal profile more convex than ventral, its depth 2.7 to 3 times in standard length; mouth terminal; barbels absent; dorsal fin origin midway between tip of snout and the base of caudal fin; caudal fin forked; lateral line complete, with 22 to 27 scales; predorsal scales 8-10.

Colour : In life, beautiful silvery, back grey-green to brownish; flanks underside white; a deep black round blotch at base of caudal fin; a similar black blotch on central part of dorsal fin or also on anterior part of the body adjacent to dorsal fin.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Sri Lanka.

Remarks : This species attains a length of about 13 cm. and is considered of medicinal value.

10. *Puntius ticto* (Hamilton)

1822. *Cyprinus ticto* Hamilton, *Fish. Ganges* : 314, 398.

Common Name : Two spot barb, Firefin barb (E); Kaoli, Pothia (H), Punt (B).

Diagnosis : D iii-iv 8; A ii-iii 5; P i 12-14; V i 8. Body elongate, its depth 2.4 to 2.9 times in standard length; mouth terminal, upper jaw slightly longer; no barbels; dorsal fin inserted slightly posterior to pelvic origin; its last unbranched ray osseous, strong and serrated; lateral line incomplete, ceases after 6-8 scales in longitudinal series. Predorsal scales 9-11; caudal fin forked.

Colour : In life, back grey to grassy green; flanks silvery; a long, transverse black blotch (often faint) above the pectoral fin and another similar on caudal peduncle over the end of anal fin.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand.

Remarks : The arching reddish area in the dorsal fin of the male easily distinguishes the species; the dorsal fin of the female is pale.

Order PERCIFORMES

Family GOBIIDAE

11. *Glossogobius giuris* (Hamilton)

1822. *Gobius giuris* Hamilton, *Fish. Ganges* : 366.

Common Names : Tank Goby (E); Bele (B).

Diagnosis : D VI+I 8-9; A I 7-8; P i 16-21. Body elongate and somewhat compressed; eyes small; iris without process in pupil; branchiostegal membranes attached to sides of isthmus; pelvic fins united; caudal fin rounded.

Colour : In life, yellowish-brown with five dark blotches on flank; sides of head with irregular violet spots; dorsal, pectoral and caudal fins mottled with dark spots, spots darkest along the spine of second dorsal fin.

Distribution : India : Throughout the plains, Andaman Is. *Elsewhere* : East coast of Africa, Australia, Bangladesh, China, Japan, Malay Peninsula, Pakistan, Philippines, Thailand, the Indo-Australian archipelago and south Pacific Islands.

Remarks : Common in the estuaries and also all types of freshwater. This fish needs salt or brackish water to breed, but land lock populations breed in freshwater.

Family CHANNIDAE

12. *Channa striata* (Bloch)

1791. *Ophiocephalus striatus* Bloch, *Natur. Aus. Fische*, 2 : 141.

Common Names : Striped or Banded Snakehead (E); Soura (H).; Shol (B).

Diagnosis : D 37-46; A 23-29; P 15-17; V 6. Body elongate and fairly rounded in cross-section; eyes moderate; mouth large; lower jaw longer with 4-7 canines behind a single row of villiform teeth; villiform teeth on vomer and palatines; caudal fin rounded; 9 scale rows

between preopercular angle and posterior border of orbit; predorsal scales 18-20; scales 50-57 in lateral series; cephalic pits multiple.

Colour : In life, adults grey-green to black-green on upperside; belly usually pure white; a dark band runs obliquely upwards from snout to edge of gill cover; caudal fin dark, with two distinct pale vertical bands on its base.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Borneo, South China, Malay Archipelago, Pakistan, Philippines, Sri Lanka, Thailand.

Remarks : Economically important food fish.

13. *Channa punctatus* (Bloch)

1793. *Ophiocephalus punctatus* Bloch, *Natur.Aus. Fische*, 7 : 139.

Common Names : Spotted snakehead (E); Phool-dhok (H); Lata (B).

Diagnosis : D 28-33; A 20-23; P 15-18; V 6. Body elongate and fairly rounded in cross-section; eyes moderate; mouth large; lower jaw with 3-6 canines behind a single row of villiform teeth, villiform teeth on vomer and palatines; pectoral fins extend to anal fin; pelvic fin about 75% of pectoral fin length; caudal fin rounded; 5 scale rows between preopercular angle and posterior border of orbit; predorsal scales 12; scales 37-40 in lateral series.

Colour : In life, varies from black to light green on dorsal side and flanks; ventral side white to pale yellow; a dark stripe or band along the side of head and several short cross bands descending from back.

Distribution : Throughout India. *Elsewhere* : Afghanistan, Bangladesh, China, Malay, Myanmar, Nepal, Pakistan, Polynesia, Sri Lanka.

Remarks : Prolific breeder, breeds almost throughout the year by building circular nest between marginal weeds. This species is very much common throughout the plains of India.

Family AMBASSIDAE

14. *Chanda nama* Hamilton

1822. *Chanda nana* Hamilton, *Fish. Ganges. Fische* : 109.

Common Names : Elongate glass-perchlet (E); Channe (H); Chanda (B).

Diagnosis : D VIII + I 15-17; A III 15-17; P ii 11-12; V I 5. Body ovate and strongly compressed; mouth large with prominent lower jaw, with three canine teeth on either side of lower jaw and rest of the teeth villiform; scales minute, generally irregularly arranged; lateral line complete with 100 to 107 scales; caudal fin deeply forked.

Colour : In life, transparent, silver-yellow with a silvery longitudinal band along with flank; body with sparsely scattered minute black dots; eyes black; fins bright orange; upper half of spinous dorsal fin deep black; caudal fin dusky and orange, with a pale outer border.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan.

Remarks : Habitat, both stagnant and running fresh and brackish waters. This species could effectively be used in the control of small worms and malaria.

Family CICHLIDAE

15. *Oreochromis mossambicus* (Peters)

Common Names : Mozambique Tilapia (E); Tilapia (B).

Diagnosis : D XV-XVI 10-12; A III 10-11; P 14-15; VI 5. Body elongate, fairly deep and compressed; upper profile of body more convex than the lower; snout long; forehead with relatively large scale, starting with 2 scales between the eyes followed by 9 scales upto dorsal fin; mouth large, lower jaw prominent, lips thick, maxilla extends between nostril and eye in females and immature male; in breeding male maxilla extends to below anterior border of eye or a little beyond; teeth in 3-5 series on jaws; pectoral fin as long as head, pointed reaching to vent; outer rays of pelvic fin slightly produced; caudal fin truncate, often with rounded corners; caudal fin scaly in the basal half; scales cycloid.

Colour : In life, females and non-breeding males watery grey to yellowish with 3 or 4 dark blotches along flanks; body of breeding males deep black; dorsal fin black with a red margin; pectoral fin translucent red; caudal fin with a broad red margin.

Distribution : Introduced in India. *Elsewhere* : East Africa, Pakistan and Sri Lanka.

Remarks : This species is an exotic fish and introduced in India in August 1952. It inhabits primarily brackish waters but fresh waters also; mouth brooding by females.

16. *Oreochromis niloticus* Linnaeus

Common Names : Nile Tilapia (E); Nilotica (B).

Diagnosis : D XVI-XVIII 12-13; A III 9-11; P 14-15; V I 5. Body elongate, fairly deep and compressed; upper profile of body more convex than the lower; genital papilla of breeding male not tassellated; jaws of breeding male not greatly enlarged; presence of regular vertical stripes throughout the depth of caudal fin; caudal fin truncate with often rounded corners; scales cycloid.

Colour : Margin of dorsal fin grey or black; vertical bars in caudal fin 7-12; other colours are same with that of *O. mossambicus*.

Distribution : Introduced in India. *Elsewhere* : East Africa, Nepal, Pakistan, Sri Lanka.

Remarks : Mouth brooding by females. It is an exotic species.

Family ANABANTIDAE

17. *Anabas testudineus* (Bloch)

1795. *Anabas testudineus* Bloch, *Nat. Aus. Fish.*, 7 : 121.

Common Names : Climbing Perch (E); Kobai (H); Koi (B).

Diagnosis : D XVI-XVIII 8-10; A VIII-XI 9-11; P i 13-14; VI 5. Body somewhat elongate and moderately deep, depth 3-3.5 times in standard length; mouth fairly large; teeth villiform on jaws; scales large, 21 to 29 in lateral series; lateral line interrupted.

Colour : In life, adult greenish to dark grey on dorsal side and flanks, fading to pale yellow on belly; generally four vertical bands on flanks in juveniles; a conspicuous dark spot at the base of caudal fin, fades generally on maturity; usually a black spot at the base of pectoral fin; dorsal and caudal fins dark grey; pectoral and anal fins pale yellow and pelvic fins pale orange.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Cambodia, Indo-China, Malay and Malay Archipelago, Myanmar, Nepal, Pakistan, South-China, Sri Lanka, Thailand.

Remarks : A very hardy fish which can crawl over dry land for long distances at a stretch with the help of operculum spines.

Order PERCIFORMES

Family OSPHRONEMIDAE

18. *Colisa fasciata* (Bloch & Schneider)

1801. *Trichogaster fasciatus* Bloch & Schneider, *Syst. Ichth.* : 164.

Common Names : Giant Gourami (E); Khosti (H); Khalisha (B).

Diagnosis : DXV-XVII 9-14; A XV-XVIII 14-19; P 9-10. Body deep, oval, the dorsal profile much convex, compressed; mouth small, slightly protrusible, upper lip thick and papillose, especially in old males; dorsal and anal fins long-based; pelvic fins thread like; caudal fin truncate; scales large, 29-31 in longitudinal series; anal fins scaly at base only.

Colour : In life, greenish with orange or bluish bars descending obliquely downwards and backwards from back to anal fin; vertical fins with alternate dark and pale spots or bars; anal fin often with a red margin.

Distribution : India : Northern part. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Punjab.

Remarks : This species inhabits large rivers, estuaries, also tanks, ditches and ponds. It attains a length up to 12 cm; fairly common in Hooghly estuary (West Bengal) and fairly abundant in rainy season. It breeds easily and adapts well in aquarium.

Order SILURIFORMES

Family BAGRIDAE

19. *Mystus vittatus* (Bloch)

1797. *Silurus vittatus* Bloch, *Ichth. Hist. Nat.*, 11 : 40.

Common Names : Striped dwarf Catfish (E), Palwa, Tengra (H); Tengra (B).

Diagnosis : D I 7; A ii-iii 7-9; P I 9; V i 5. Body elongate and somewhat compressed, depth 3.8 to 4.2 times in standard length; head depressed; occipital process about 3 times as long as broad at its base, reaching basal bone of dorsal fin; mouth terminal, transverse and the upper jaw longer; median longitudinal groove on short head, not reaching to base of occipital process; barbels 4 pairs, maxillary pair extends posteriorly beyond pelvic fins, often to end of anal fin; dorsal spine weak; adipose fin small, inserted much behind rayed dorsal fin, but in advance of anal fin; caudal fin forked.

Colour : In life, very variable according to age; generally grey-silvery with several pale blue or dark brown to deep black longitudinal bands (total about five) on flank; fins often with dark tips.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Sri Lanka and Thailand.

Remarks : This is one of the most common small sized catfish in the Indian region which inhabits ponds, lakes, rivers *etc.*

Family HETEROPNEUSTIDAE

20. *Heteropneustes fossilis* (Bloch)

1798. *Silurus fossilis* Bloch, *Ichth. Hist. Nat. Poiss.*, 11 : 36.

Common Names : Stinging Catfish (E); Singee, Bitchu (H); Singhi (B).

Diagnosis : D 6-7; A 60-70; P I 7; V i 5. Body elongate, sub-cylindrical to pelvic fin base, compressed behind; head depressed; occipital process not exceeding to base of dorsal fin; mouth small and terminal; barbels 4 pairs, well developed; dorsal fin short, inserted usually above tip of pectoral fin; pectoral fin with a strong spine, serrated along its inner edge and externally with few serrations anteriorly, about 2/3rd as long as head; anal fin base long and separated by a distinct notch from caudal fin.

Colour : In life, yellow or leaden or dark purplish brown above, lighter below, usually with two longitudinal yellowish bands; young, reddish in colour.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand.

Remarks : As food, the flesh is esteemed for its invigorating qualities. The strong and sharp pectoral spine may cause painful wounds and bleeding if not held properly.

Family CLARIDAE

21. *Clarias magur* (Hamilton)

1822. *Macropteronotus magur* Hamilton, *Fish Ganges* : 146, 374.

Common Names : Magur (E); Mangur, Manguri (H); Magur (B).

Diagnosis : D 70-76; A 45-58; P I 8-11; V i 5. Elongated body with moderately depressed head; occipital process angular and narrow and distance from dorsal fin base 4.5 to 6 times in head length; mouth terminal, teeth in villiform bands on jaws; barbels 4 pairs, the maxillary pairs considerably extend beyond base of pectoral fin while the nasal pair extends to gill-opening; dorsal fin inserted slightly anterior to tip of pectoral fins; pectoral spine strong, often rough externally.

Colour : In life, brownish to greenish blue, the back dark with a greenish lustre; flanks and belly pale brown to delicate reddish, often with numerous pale to white spots on flanks.

Distribution : India : Northeastern India. *Elsewhere* : Bangladesh.

Remarks : Highly priced for its esteemed rejuvenating vigour and taste; found in all types of waters specially in swampy waters.

Order CYPRINODONTIFORMES

Family APLOCHEILIDAE

22. *Aplocheilus panchax* (Hamilton)

1822. *Esox panchax* Hamilton, *Fish Ganges* : 211, 380.

Common Names : Blue Panchax (E); Dendula (H); Trichoke (B).

Diagnosis : D ii 6; A iii 12-13; P i 4; V 6. Body elongate and compressed posteriorly; eyes large, diameter equal to inter-orbital width; mouth terminal; teeth villiform, arranged in several rows on jaws; pelvic fin small devoid of elongated rays; anal fin more or less square in shape; caudal fin rounded; scales large, 30-34 in longitudinal series.

Colour : In life, upper side of body greenish, gradually dull white with a bluish iridescence on flanks and belly; a prominent white occipital spot; fins yellowish; lower third of dorsal fin with a large black blotch at its base; anal fin orange at base; reddish with dark spot on outer parts; females generally colourless.

Distribution : India : Northern India. *Elsewhere* : Bangladesh, Indo Malay Archipelago, Myanmar and Pakistan : Lower Indus plain and adjoining hilly areas, Thailand.

Remarks : It lives in clear, shallow fresh and brackish waters. A medium sized fish easily recognized by the double bordered and oval tail fin. It is a larvivorous fish, helps in mosquito control.

Order SYNBRANCHIFORMES

Family MASTACEMBELIDAE

23. *Macrogathus aral* (Bloch & Schneider)

1801. *Rhynchobdella aral* Bloch & Schneider, *Syst. Ichth.* : 478.

Common Names : One Stripe Spiny Eel (E); Gainchi (H); Golchi (B).

Diagnosis : D XVI-XXIII 44-45; A III 44-52; P 19-24; C 15. Body elongate; rostrum large with concave ventral surface lined with 14 to 28 paired tooth plates; no spine on pre-orbital or pre-operculum bones; mouth very small, its gape not exceeding to below posterior nostrils; dorsal fin originated far behind the tip of pectoral fin; caudal fin distinctly separated from dorsal and anal fins.

Colour : In life, brownish or greenish, marbled superiorly becoming yellowish along abdomen; body with two, one dorsal and one ventral, broad pale longitudinal bands extending entire length; dorsal fin pale or orange, 3 to 11 ocelli at its base often present; dorsal and caudal fin with numerous fine streaks.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan and Sri Lanka.

Remarks : Habitat of the fish is both fresh and brackish waters, both running and stagnant. It attains a length of 38 cm.

24. *Macrogathus pancalus* Hamilton

1822. *Macrogathus pancalus* Hamilton, *Fish Ganges*. : 30, 364.

Common Names : Barred Spiny Eel (E); Patya (H); Pankal (B).

Diagnosis : D XXIV-XXVI 30-42; A III 31-46; P 17-19; C 12. Body eel shaped and slightly compressed; rostrum devoid of tooth plates; preopercle with 2 to 5 spines; preorbital spine strong; mouth small; dorsal fin originated above middle of pectoral fin; dorsal and anal fins separate from caudal fin.

Colour : In life, greenish-olive along back, yellowish on belly with many yellowish white spots on flanks; stripes with dark brown vertically present on flanks, sometimes may be confined to posterior half of body and also stripes join together forming a net work; soft dorsal, anal, pectoral and caudal fins yellow with many minute black spots.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Pakistan.

Remarks : This species are available in plains but never available above an altitude of 366 m.

25. *Mastacembelus armatus* (Lacepede)

1800. *Macrogathus armatus* Lacepede, *Hist. Nat. Poiss.*, 2 : 286.

Common Names : Zigzag Eel (E); Bam (H); Bam (B).

Diagnosis : D XXXII-XL 64-92; A III 64-90; P 21-27; C 14-17. Body slender; preopercle with 2 or 3 spines usually prominent; but often one or more may be concealed under the skin; preorbital spine strong; mouth small, its gape extending to below posterior nostril or at least to its anterior margin; teeth sharp, arranged in bands on jaws; spinous dorsal fin

originated from above middle or posterior third of pectoral fins, usually last dorsal spine hidden beneath skin; dorsal and anal fins broadly joined to caudal fin.

Colour : In life, brown or usually with zigzag lines, sometimes to form a net work but never extend on to abdomen; a black band generally through eye continued in an undulating course along upper half of side; often a row of black spots along base of soft dorsal fin, and short black bands over back under dorsal spines; pectoral fin usually spotted; dorsal and anal fins usually banded or spotted.

Distribution : India : Throughout. *Elsewhere* : Myanmar, Malay to South China, Nepal, Pakistan, Sri Lanka, Thailand.

Remarks : This fish inhabits fresh and brackish waters and is the largest spiny eel which attains a length of 61 cm.

Order OSTEOGLOSSIFORMES

Family NOTOPTERIDAE

26. *Notopterus notopterus* (Pallas)

1769. *Gymnotus notopterus* Pallas, *Specil Zool.*, Petersburg, 7 : 40.

Common Names : Bronze feather-back (E); Pholi (H); Pholui (B).

Diagnosis : D 7-9; A + C 100-110; V 5-6. Body oblong and strongly compressed; head compressed; preorbital serrated; mouth moderate; maxilla extends to middle of the orbit; dorsal fin short and tuft like, inserted nearer snout tip than to base of caudal fin; pectoral fin extends beyond anal fin origin; pelvic fin rudimentary; anal fin very long and ribbon like, confluent with small caudal fin; vent placed far forward; scales minute, considerably larger on the opercles than the body.

Colour : In life, silvery white with numerous fine grey spots on body and head.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Indonesia, Malaya, Myanmar, Nepal, Thailand.

Remarks : It lives fresh and brackish waters and breeds both stagnant and running water in the rainy season; owing to its carnivorous nature, this fish can be cultivated in wild water.

Order CLUPEIFORMES

Family CLUPEIDAE

27. *Gudusia chapra* (Hamilton)

1822. *Clupanodon chapra* Hamilton, *Fish Ganges* : 83, 248.

Common Names : Indian River Shad (E); Suiya (H); Khoira (B).

Diagnosis : D iv 11-13; A(ii) iii 19-22; Pi 12-13; v i7. Body fairly deep, compressed, its depth 2.6 to 3.2 times in standard length; 26-29 scutes along belly; gill rakers fine and 200

or more; cleft of mouth oblique, maxilla extending to mid orbit; dorsal fin inserted more or less equidistance between tip to snout and caudal fin base; Anal fin base longer than dorsal fin base; anal fin origin nearer to pelvic fin origin than to caudal fin origin; a single triangular pectoral axillary scale; scale in lateral series 77-91; exposed edge of scale smooth.

Colour : In life, back brown, flanks silvery or golden; dark blotch behind gill opening, often followed by a series of spots along flank.

Distribution : India affluent to the Bay of Bengal (chiefly the Ganga and Brahmaputra river systems and the Mahanadi River). *Elsewhere* : Bangladesh.

Remarks : This species attains a length of 15 cm and contributes artisanal fisheries.

AMPHIBIANS

A total of 5 species of amphibia under a single order Anura and families Bufonidae and Ranidae are described here under.

Class AMPHIBIA

Order ANURA

Family BUFONIDAE

28. *Duttaphrynus melanostictus* (Schneider)

1799. *Bufo melanostictus* Schneider, *Hist. Amph.*, 1 : 216.

Common Name : Common Asian toad (E); Mendhak (H); Kuno bang, Kat-kate bang (B).

Diagnosis : Snout to vent 55-130 mm; large-sized toads; head broader than long with cornified bony ridges; snout rounded; nostril nearer to tip of snout than eye; tympanum circular or oval nearly two-third diameter of eye. parotid glands large, bean-shaped; fingers without webs, first finger equal to second; tips of fingers and toes swollen; toes partly webbed with more than three phalanges, fourth toe free; two oval metatarsal tubercles present; skin rough with several black-tipped spiny warts on dorsum; ventrum also rough.

Colour : In life, uniform greyish or dark brownish with a few yellow or pink spots on dorsum; ventrum dull white with a yellowish tinge.

Distribution : Throughout the plains of India. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, Sri Lanka and south-east Asia upto Indonesia.

Habitat : Uses any available habitat from sea level to over 2000 m ASL in the hills. Found in roadsides and gardens of towns, under logs, stones, piles of bricks, in moist holes and crevices of tree-trunks or even in the dark corners of village huts and bathrooms. Despite their preference for human-modified habitats and homesteads, they may be seen along the edges of forests.

Remarks : The commonest toad of India; breeds in all types of water bodies, throughout the year; resident.

Family RANIDAE

29. *Euphlyctis cyanophlyctis* (Schneider)

1799. *Rana cyanophlyctis* Schneider, *Hist. Amph.*, 1 : 137.

Common Name : Skipping frog, (E); Pani Mendhak (H); Kat-kati bang, Jal bang (B).

Diagnosis : Snout to vent 30-69 mm; medium-sized pond frog; head broader than long; snout rounded; nostril equidistant between tip of snout and eye; tympanum, nearly equal to diameter of eye; fingers without webbing, first finger equal to second; tips of fingers pointed; sub-articular tubercles prominent; toes fully webbed; Tips of toes swollen, rounded; a pointed toe-like inner metatarsal tubercle present but outer absent; Tibiotarsal articulation reaches between eye and nostril when hind limb held parallel to body; small warts present on dorsum; belly smooth with a single row of porous warts on each flank; A prominent skin-fold runs from behind eye to shoulder.

Colour : Grey, greyish-brown or greyish-black with darker rounded spots on back and stripes on limbs; belly white with black spots along flanks.

Distribution : Throughout the plains of India and also in the hills upto 2000 m ASL.

Elsewhere : Afghanistan, Bangladesh, Bhutan, western China, Iran, Iraq, northern part of Malay Peninsula, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, Saudi Arabia.

Habitat : All kinds of water bodies including polluted ones.

Remarks : The species is very common and most adaptive of Indian amphibians and live in all sorts of wetlands. It can tolerate brackish water and polluted water.

30. *Euphlyctis hexadactyla* (Lesson)

1834. *Rana hexadactyla* Lesson, In : Belang, *Voy. India Orient. Zool.* : 331.

Common Name : Pond frog (E). Pani Mendhak (H); Pukure Bang (B).

Diagnosis : Snout to vent length 65 mm; moderate size; smooth skin with minute porous warts; a strong glandular fold extends from eye to shoulder and meets the other side behind the eyes; snout obtusely pointed; tympanum distinct; forelimbs slender, finger free, sub-articular tubercles small but prominent; hind limbs moderately long, toes pointed, fully webbed, sub-articular tubercles small and indistinct.

Colour : Dorsum yellowish to olive green, sometimes with a yellowish vertebral stripe from snout to vent; ventral pale yellowish.

Distribution : India : Maharashtra, Tamil Nadu, Tripura and West Bengal. **Elsewhere** : Sri Lanka.

Habitat : Completely aquatic; camouflage with the aquatic vegetation of the water body.

Remarks : Resident; population declined due to export of its leg as food but at present export is banned by the Government of India; it is a predator of several pests of agriculture as well as insects, carrier of human disease.

31. *Hoplobatrachus tigerinus* (Daudin)

1802. *Rana tigerina* Daudin, *Hist. Nat.*, : 42.

Common Name : Indian Bull frog (E); Mendhak (H); Sona bang, Brahmini bang (B).

Diagnosis : Snout to vent length 45-160 mm; large frog with smooth skin and longitudinal glandular folds on back; head as long as broad; snout somewhat pointed, projects beyond mouth; nostril equidistant between tip of snout and eye; tympanum distinct, nearly equal to eye diameter; fingers without webs, first finger longer than second; toes fully webbed but web does not reach the tip of third toe; fifth toe with an outer fringe of web; sub-articular tubercles prominent; inner metatarsal tubercle short and blunt, outer absent; lower side smooth with no porous warts on flanks; a prominent skin-fold runs from behind eye to shoulder.

Colour : Dorsum yellowish or olive-green or brownish-green with darker leopard-like spots; a yellow median stripe runs from tip of snout to vent; ventrum whitish; limbs black barred or spotted.

Distribution : Throughout India from the base of the Himalaya to the south. *Elsewhere* : Bangladesh, south China, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand.

Habitat : Among grasses, bushes and hollows at the edge of ponds, ditches, canals and stream-sides.

Remarks : Killing for its hind-legs for frozen frog-leg export industry has largely decimated its population in the countryside. Since frog-leg export was banned by Government of India from 1st April, 1986 the natural populations are reviving. One of the most common large frog of the country.

32. *Fejervarya limnocharis* (Boie)

1835. *Rana limnocharis* Boie, *Nova. Acta. Acad. Caesar. Leop. Coral. Hall.*, 17 : 225.

Common Name : Cricket frog, Paddy-field frog (E); Jhi-jhi Mendhak (H); Jhi-jhi bang (B).

Diagnosis : Snout to vent 30-62 mm; small to medium sized frogs; head as long as broad; snout somewhat pointed and projects beyond mouth; nostril nearer to tip of snout than eye; tympanum two-third of eye diameter; fingers without web, first finger longer than second; tips of fingers and toes swollen but not disc-like; sub-articular tubercles prominent; toes half-webbed with three phalanges, fourth toe free; a distinct oval metatarsal tubercle; tibiotarsal articulation reaches between eye and nostril when hind limb held parallel to body; some short and interrupted glandular folds are present on dorsum; a prominent skin-fold runs from behind eye to shoulder; belly smooth.

Colour : Olive-brown above, usually with distinct darker markings which assume irregular patterns; a V-shaped band between eyes; lips and limbs barred; a yellowish or reddish median streak of varying width is often present; ventrum whitish.

Distribution : Throughout the plains of India except the desert areas; also up in the hills upto 3000 m ASL. *Elsewhere* : Bangladesh, Bhutan, Borneo, China, Japan, Malay Peninsula, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Sumatra, Taiwan and Thailand.

Habitat : Largely a land-dwelling species and inhabits all sorts of moist habitats including evergreen forests; common in villages, agricultural lands, along streams and irrigation canals, banks of ponds and ditches; bushes and hedges growing at the edge of paddy fields are favourite haunts.

Remarks : The commonest frog of the country.

REPTILES

A total of 3 reptilian species under 2 families are found.

Class REPTILIA

Order SQUAMATA

Suborder SERPENTES

Family TYPHLOPIDAE

33. *Ramphotyphlops braminus* (Daudin)

1803. *Eryx braminus* Daudin, *Hist. Nat. Rept.*, viii : 279. (Based on Russell).

Common Name : Common Blind Snake (E); Jhanka Muthi (B).

Diagnosis : Length 12.5-23 cm; width of head and body almost equal, snout rounded; tiny scale-covered eye visible as black dot; short, blunt tail ends in a tiny spine; glossy body, almost uniform reddish-brown or blackish-brown above; lighter below; tongue tiny; only toothed maxilla; scales in 20 rows around the body, smooth; 290-320 transverse rows of scales; belly scales not broader than adjacent body scales.

Habitat : Lives underground in damp earth; observed beneath leaf litters on tank shore.

Distribution : India : Throughout.

Elsewhere : Arabia, Bangladesh, East Indies, Iran, Malaysia, Mexico, Myanmar, Pakistan, South Africa, southern China, Vietnam, Islands of Indian and Pacific Ocean.

Remarks : Common.

Family COLUBRIDAE

34. *Enhydris enhydris* (Schneider)

1799. *Hydrus enhydris* Schneider, *Hist. Amph.*, 1 : 245. ("Indian Orientales")

Common Name : Smooth Water Snake (E); Metuli (B).

Diagnosis : Average length of female, 810 mm and that of male 645 mm; upper parts brown, grey or olive with a mid-dorsal and a pair of dorsolateral stripes; ventral white or yellow, bordered with brown or grey with a series of median spots; head brown or grey above, indistinctly variegated; scales in 21 (rarely 23) rows at mid body; ventrals 141-174.

Habitat : Inhabitants of ponds, irrigated fields, slow running water bodies; very timid and not provoked to bite even in rough handling; food comprises, mainly of fishes but also takes frogs *etc.*; viviparous and produce 6-18 young at a time.

Distribution : India : Andhra Pradesh, Assam, Bihar, Jharkhand, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. *Elsewhere* : Bangladesh, Cambodia, China, Cochin-China, Laos, Malay Peninsula, Myanmar and Vietnam.

Remarks : Common.

35. *Xenochrophis piscator* (Schneider)

1799. *Hydrus piscator* Schneider, *Hist. Amph.*, 1 : 247.

Common Name : Checkered Keelback (E); Jal Dhonra (B).

Diagnosis : Length 60-175 cm; scales keeled; head broader than neck; rounded pupil; two bold black streaks, one below and the other from eye to angle of mouth; glossy olive green, olive brown, yellow, brown, grey or black, usually with a checkered body pattern; underside glossy white or yellowish-white; scales in 19 rows at mid body, keeled; ventrals 122-158; anal usually divided; subcaudals 70-97, paired; internasals distinctly narrowed anteriorly; supralabials 9 (4th and 5th touching eye, 6th excluded by lowest postocular).

Habitat : In and around fresh water bodies and paddy fields.

Distribution : Almost throughout the mainland of India. *Elsewhere* : East upto Borneo and west to Indus and mainland Asia.

Remarks : Common.

BIRDS

Altogether 9 species of water dependent birds are described here under.

Class AVES

Order PODICIPEDIFORMES

Family PODICIPEDIDAE

36. *Tachybapys ruficollis capensis* (Salvadori)

1884. *Podiceps capensis* Salvadori, *Ann. Mus. Civ. Genova* (2), 1 : 252.

Common Name : Little Grebe (E); Pandubi, Pind (H); Duburi (B).

Diagnosis : Length \pm 23 cm; a small, squat and tailless bird with short pointed bill and backwardly placed legs; dark brown above with darker crown; sides of head, throat and neck chestnut; underparts smoky white and base of bill yellowish green; sexes alike.

Habitat : Aquatic, weedy ponds and jheels.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Bhutan, Nepal, North Africa, Madagascar, Middle East and Pakistan.

Remarks : Occasional visitor.

Order PELICANIFORMES

Family PHALACROCORACIDAE

37. *Phalacrocorax niger* (Vieillot)

1817. *Hydrococorax niger* Vieillot, *Nouv. Dict, Hist. Nat.*, 8 : 88.

Common Name : Little Cormorant (E); Pan Kowwa (H); Pan Kowri (B).

Diagnosis : Length \pm 51cm; colour dark glossy black; slender compressed bill hooked at tip and a small white patch on neck; sexes alike.

Habitat : Aquatic, inland waters and tidal creeks.

Distribution : Throughout India except Himalaya. *Elsewhere* : Bangladesh, Bhutan, Nepal, Sri Lanka, southern Pakistan and SE Asia.

Remarks : Regular visitor.

Order CICONIFORMES

Family ARDEIDAE

38. *Ardeola grayii* (Sykes)

1832. *Ardea grayii* Sykes, *Proc. zool. Soc. Lond.* : 158.

Common Name : Indian Pond Heron, Paddy Bird (E); Andha bagla, Broku (H); Bak (B).

Diagnosis : Length \pm 46 cm; colour earthy brown streaked with yellowish buff, underparts white except the upper breast, streaked with brown; bill yellow, black at tip and bluish at base; legs horny green; sexes alike.

Habitat : Aquatic: marshes, streams, paddy fields, ponds.

Distribution : Throughout India up to 1500 m in Himalayas. *Elsewhere* : Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka; from Persian Gulf to Malaysia.

Remarks : Regular visitor.

39. *Bubulcus ibis coromandus* (Boddaert)

1783. *Cancroma coromanda* Boddaert, *Table Pl. enlum* : 54.

Common Name : Cattle Egret (E); Gai bagla (H); Gaibak (B).

Diagnosis : Length 48-53 cm; a lanky white bird with yellow bill; in breeding season golden-buff plumes appears on head, neck and back; sexes alike.

Habitat : Aquatic, in inland waters and usually in abundance on grazing cattle.

Distribution : Throughout India up to 1500 m in Himalayas.

Elsewhere : Bangladesh, Maldives, Nepal, Pakistan, Sri Lanka; SE Asia.

Remarks : Regular visitor.

40. *Egretta garzetta* (Linnaeus)

1766. *Ardea garzetta* Linnaeus, *Syst. Nat.*, 10th ed., 1 : 142.

Common Name : Little Egret (E); Karchia bagla (H); Chhota Korcha Bak (B).

Diagnosis : Length 55-63 cm ; a white lanky bird; bill and legs black; feet yellow; in breeding season a drooping nuchal crest of two long narrow plumes develops; filamentous ornamental feathers on breast and scapulars; a thick bunch of decomposed dorsal plumes extends beyond the tail. Sexes alike.

Habitat : Aquatic : inland waters like marshes, jheels, lakes, rivers, cultivation etc.

Distribution : Throughout India up to approximately 900m altitude, excepting NW and NE region. **Elsewhere**: Bangladesh, Bhutan, Maldives, Nepal, Sri Lanka, SE Asia, southern and eastern Europe; Northern and eastern Africa.

Remarks : Regular visitor.

41. *Nycticorax nycticorax* (Linnaeus)

1758. *Ardea nycticorax* Linnaeus, *Syst. Nat.*, 10th ed , 1 : 142.

Common Name : Night Heron (E); Waak (H); Bachka (B).

Diagnosis : Length \pm 46 cm; bill stout; back and scapular ashy grey with greenish black; forehead and sides of head white; occipital crest, crown and nape black; legs and feet dull green.

Habitat : Inland waters, estuaries, coastal lagoons and backwaters.

Distribution : India : Throughout. **Elsewhere** : Bhutan, Central and southern Europe, south to Africa, Middle east, Malaysia, Myanmar, Nepal, Pakistan, Thailand, the Indo-Chinese countries to China and Japan.

Remarks : Occasional visitor.

Order CORACIFORMES

Family ALCEDINIDAE

42. *Ceryle rudis leucomelanura* Reichenback

1851. *Ceryle leucomelanura* Reichenback, *Hanbd. spec. Orn.*: 21, pl. coix b, f. 3488.

Common Name : Lesser Pied Kingfisher (E); Kilkila (H); Machhranga (B).

Diagnosis : Length \pm 31cm; a black and white barred and speckled kingfisher with dagger like black bill; **Male** : crown, forehead and nuchal crest black, finely streaked with white; supercilium and collar on hind neck white; a black streak from eye to ear coverts; under parts white, with a double black gorget across breast. **Female** : only difference with male in having a single gorget broken in the middle.

Habitat : Stagnant water, jheels, reservoirs, ditches and slow flowing streams.

Distribution : Throughout Indian Union except Kerala. *Elsewhere* : Afghanistan, Bangladesh, Bhutan, Myanmar, Nepal, Pakistan, Sri Lanka, Vietnam, Tenasserim and Thailand.

Remarks : Occasional visitor.

43. *Alcedo atthis bengalensis* Gmelin

1788. *Alcedo bengalensis* Gmelin, *Syst. Nat.*, 10th ed. 1(1) : 450.

Common Name : Small Blue Kingfisher (E); Chhota kilkila (H); Nil Machhranga (B).

Diagnosis : Length \pm 18cm; blue with white patch on the side of neck; throat white; chest and belly light rusty.

Habitat : Streams, canals, ponds, mangrove swamps and seashore.

Distribution : From Himalayan Terai east to Sikkim, Assam, Manipur and south to 20°N Lat. as well as Andaman and Nicobar Islands. *Elsewhere* : Bangladesh, Bhutan, Malay Peninsula and adjacent islands, Myanmar, Nepal, Pakistan, Philippines, Thailand and the Indochinese countries.

Remarks : Regular visitor.

44. *Halcyon smyrnensis fusca* (Boddaert)

1783. *Alcedo fusca* Boddaert, *Table Pl. enlum.* : 54.

Common Name : White breasted Kingfisher (E); Kilkila (H); Sada-buk Machhranga (B).

Diagnosis : Length \pm 28cm; brilliant purplish or turquoise-blue to blue-green in colour with chocolate-brown head, neck and under parts; chin, throat and centre of head white; long, pointed, heavy, coral-red bill and leg. Most remarkably the shades of blue may vary with the season.

Habitat : Canals, streams, reservoirs, cultivation, garden and sandy seashore.

Distribution : India : Throughout. *Elsewhere*: Asia Minor, Iran, Iraq south to Arabia, east through the Indochinese sub-region to southern China, Hainan Island, Nepal, Sri Lanka, Taiwan and the Philippines.

Remarks : Common, Resident.

DISCUSSION

At the time of inception of the Indian museum in 1814, the Calcutta city was full of water tanks and there is no doubt that within last 200 years the scenario has been changed greatly. Except one report of reptile by Sewell (1926), practically there is no consolidated report on the vertebrate fauna of the Indian Museum tank. Compilation of the present report is chiefly based on sight record either gathered by the old inhabitants of the campus or by the present authors. As the size of the tank was much bigger than at present, it is obvious that many aquatic birds used to visit tank from the east Calcutta (presently Kolkata) wetlands.

Earlier, the fish diversity in the pond was very rich but in recent times both diversity and population are on the lower side. Among the cyprinid fish *A. mola*, *S. phulo* and *E. danricus* was available even upto 1980s but these fishes are not seen during the last 25 years. Among the three mastacembelids, *M. armatus* at present is not available in the pond. Both the species of *Oreochromis* of the family Cichlidae are introduced species. These are prolific breeders, sharing food and space with other species of fish. Thus, both diversity and population of other fish species are declining due to incompetency in their fitness over the species of *Oreochromis*.

All the five amphibian species (Table-I) are still available in the campus of the Indian Museum but the population of *D. melanostictus* and *E. cyanophlyctis* are much higher than other three species.

The typical aquatic and water dependent reptilian species like *R. braminus*, *E. enhydris* and *X. piscator* were common upto 1960s but with the construction of the Fire Proof Spirit Building on the northern side of the tank, the sightings of reptilian species have become a rare occasion.

The aquatic birds like *P. niger*, *A. grayii*, *B. ibis*, *E. gargetta* (Table-I) are regular visitor to this pond. Among the three species of the family Alcedinidae only *H. smyrnensis* is very common.

At present the total vertebrate fauna in the Indian Museum tank is not very rich but from conservation point of view, these species need to be protected from depletion/extermination as these vertebrate species especially the birds add to the aesthetic value and beauty of the tank in near future. There are so many vertebrate species which are either rare or even not seen after 1980s. The reason may be due to habitat loss or increasing of pollution load. As both tank and premises have a high heritage value, so conservation of the faunal wealth of the tank as well as the campus is a must.

SUMMARY

Altogether 44 vertebrate species are reported as aquatic or water dependent fauna from the Indian Museum tank. Of the 44 species, the major part is represented by 27 species of fishes while the amphibians, reptiles and birds represent only 5, 3 and 9 species respectively. Unless some sort of immediate conservation measures are adopted, most of the vertebrate species are likely to disappear from this heritage site due to changes in habitats.

TERRESTRIAL VERTEBRATES

INTRODUCTION

The Indian Museum campus is an important landmark in Kolkata, which is now recognized as a heritage site. The place is visited by people all over the world as this museum is rich in collection of exhibits of different disciplines. Though it is one of the favourite study site in Kolkata yet there is no study of terrestrial components especially the vertebrates and hence the present study.

MATERIAL AND METHODS

Observations on land, aerial and arboreal fauna surrounding the Indian Museum Tank have been made particularly from 1980s onwards, but actual investigation to document reptilian, avian and mammalian fauna in particular has been made in the years 2007 and 2008 as soon as urge was induced in relation to the oncoming bicentenary of the Indian Museum to bring out a detailed faunal diversity of the Indian Museum. Our earlier observations and informal interview of local knowledgeable persons and experts also add inputs to this study.

RESULTS AND DISCUSSION

On the basis of the present study a list of terrestrial reptilian, avian and mammalian species is prepared and presented in Table I to indicate the status of occurrence of these species. It includes 9 species of reptiles, 37 species of birds, 15 species of mammals. Herein, mention is made that a total of 44 aquatic and water dependent species comprising of fishes (27 species), amphibians (5 species), reptiles (3 species) and birds (9 species) were contributed in this document (please vide supra).

Table-I : List of terrestrial vertebrate associates in the Indian Museum campus

Sl. No.	Scientific name	Common Name	Occurrence
	Class REPTILIA		
	Order SQUAMATA		
	Suborder SERPENTES		
	Family COLUBRIDAE		
1.	<i>Ptyas mucosus</i> (Linnaeus)	Rat Snake, Dhaman	Occasional, last observed in 1980s
2.	<i>Amphiesma stolata</i> (Linnaeus)	Striped Keelback	Occasional

Sl. No.	Scientific name	Common Name	Occurrence
	Suborder SAURIA		
	Family GEKKONIDAE		
3.	<i>Hemidactylus brooki</i> (Gray)	Spotted House Gecko	Rare
4.	<i>H. flaviviridis</i> Ruppell	Yellow-bellied House Gecko	Common
	Family AGAMIDAE		
5.	<i>Calotes versicolor</i> (Daudin)	Indian Garden Lizard	Common
	Family SCINCIDAE		
6.	<i>Eutropis carinata</i> (Schneider)	Common Indian Skink	Common
7.	<i>Eutropis macularia</i> (Blyth)	Bronzy Grass Skink	Common
8.	<i>Lygosoma albopunctata</i> (Gray)	Brown Dwarf Skink	Rare
9.	<i>Lygosoma punctata</i> (Gmelin)	Dotted Garden Skink	Occasional
	Class AVES		
	Order FALCONIFORMES		
	Family ACCIPITRIDAE		
10.	<i>Milvus migrans</i> (Boddaert)	Black Kite	Common
	Order COLUMBIFORMES		
	Family COLUMBIDAE		
11.	<i>Columba livia</i> Gmelin	Blue Rock Pigeon	Common
12.	<i>Streptopelia chinensis</i> (Scopoli)	Spotted Dove	Common
	Order PSITTACIFORMES		
	Family PSITTACIDAE		
13.	<i>Psittacula krameri</i> (Scopoli)	Rose-ringed Parakeet	Common
	Order CUCULIFORMES		
	Family CUCULIDAE		
14.	<i>Clamator coromandus</i> (Linnaeus)	Red-winged Crested Cuckoo	Rare
15.	<i>Clamator jacobinus</i> (Boddaert)	Pied Crested Cuckoo	Occasional
16.	<i>Eudynamis scolopacea</i> (Linnaeus)	Asian Koel	Common
17.	<i>Centropus sinensis</i> (Stephens)	Greater Coucal	Common
	Order STRIGIFORMES		
	Family STRIGIDAE		
18.	<i>Tyto alba</i> (Scopoli)	Barn Owl	Common
19.	<i>Athene brama</i> (Temminck)	Spotted Owlet	Common
	Order APODIFORMES		
	Family APODIDAE		
20.	<i>Apus affinis</i> (J.E. Gray)	House Swift	Common
21.	<i>Cypsiurus balasiensis</i> (J.E. Gray)	Asian Palm Swift	Occasional

Sl. No.	Scientific name	Common Name	Occurrence
	Order CORACIFORMES		
	Family MEROPIDAE		
22.	<i>Merops orientalis</i> Latham	Small Bee-eater	Common
	Family CORACIIDAE		
23.	<i>Coracias benghalensis</i> (Linnaeus)	Indian Roller	Rare
	Order PICIFORMES		
	Family CAPITONIDAE		
24.	<i>Meghalaima haemacephala</i> (P.L.S. Muller)	Coppersmith Barbet	Common
	Family PICIDAE		
25.	<i>Dinopium bengalense</i> (Linnaeus)	Lesser Golden-backed Woodpecker	Occasional
	Order PASSERIFORMES		
	Family LANIIDAE		
26.	<i>Lanius vittatus</i> Valenciennes	Bay-backed Shrike	Occasional
27.	<i>Lanius schach</i> Linnaeus	Rufous-backed Shrike	Occasional
28.	<i>Lanius cristatus</i> Linnaeus	Brown Shrike	Rare
	Family ORIOLIDAE		
29.	<i>Oriolus xanthornus</i> (Linnaeus)	Black-headed Oriole	Occasional
	Family DICRURIDAE		
30.	<i>Dicrurus adsimilis</i> Vieillot	Black Drongo	Common
	Family STURNIDAE		
31.	<i>Sturnus contra</i> Linnaeus	Asian Pied Starling	Common
32.	<i>Acridotheres tristis</i> (Linnaeus)	Common Myna	Common
33.	<i>A. ginginianus</i> (Latham)	Bank Myna	Common
	Family CORVIDAE		
34.	<i>Dendrocitta vagabunda</i> (Latham)	Indian Tree Pie	Occasional
35.	<i>Corvus splendens</i> Vieillot	House Crow	Common
36.	<i>Corvus macrorhynchos</i> Wagler	Jungle Crow	Occasional
	Family PYCNONOTIDAE		
37.	<i>Pycnonotus jocosus</i> (Linnaeus)	Red-whiskered Bulbul	Occasional
38.	<i>Pycnonotus cafer</i> (Linnaeus)	Red-vented Bulbul	Common
	Family MUSCICAPIDAE		
39.	<i>Orthotomus sutorius</i> (Pennant)	Common Tailor Bird	Common
40.	<i>Copsychus saularis</i> (Linnaeus)	Oriental Magpie Robin	Common
	Family MOTACILLIDAE		
41.	<i>Motacilla flava</i> Linnaeus	Yellow Wagtail	Occasional

Sl. No.	Scientific name	Common Name	Occurrence
42.	<i>Motacilla citreola</i> Pallas	Citrine Wagtail	Occasional
43.	<i>Motacilla alba</i> Linnaeus	White Wagtail	Occasional
	Family NECTARINIDAE		
44.	<i>Nectarinia asiatica</i> (Latham)	Purple Sunbird	Common
	Family PLOCEIDAE		
45.	<i>Passer domesticus</i> (Linnaeus)	House Sparrow	Common
	Class MAMMALIA		
	Order INSECTIVORA		
	Family SORICIDAE		
46.	<i>Suncus murinus</i> (Linnaeus)		Common
	Order CHIROPTERA		
	Suborder MEGACHIROPTERA		
	Family PTEROPODIDAE		
47.	<i>Pteropus giganteus</i> (Brünnich)	Indian Flying Fox	Rare
48.	<i>Cynopterus sphinx</i> (Vahl)	Short-nosed Fruit Bat	Common
	Suborder MICROCHIROPTERA		
	Family VESPERTILIONIDAE		
49.	<i>Pipistrellus coromandra</i> (Gray)	Indian Pipistrelle	Common
50.	<i>Pipistrellus mimus</i> Wroughton	Indian Pygmy Pipistrelle	Rare
	Order PRIMATES		
	Family CERCOPITHECIDAE		
51.	<i>Macaca mulatta</i> (Zimmermann)	Rhesus Macaque	Last seen upto 1994
52.	<i>Semnopithecus entellus</i> (Dufresne)	Langur, Entellus Monkey	Rare
	Order CARNIVORA		
	Family VIVERRIDAE		
53.	<i>Paradoxurus hermaphroditus</i> (Pallas)	Common Palm Civet	Common
	Family HERPESTIDAE		
54.	<i>Herpestes javanicus</i> (E. Geoffroy Saint-Hilaire)	Small Indian Mongoose	Common
	Order RODENTIA		
	Family SCUIRIDAE		
55.	<i>Funambulus pennantii</i> Wroughton	Northern Palm Squirrel	Common
	Family MURIDAE		
56.	<i>Rattus rattus</i> (Linnaeus)	Black Rat, House rat, Roof Rat, Ship Rat	Common
57.	<i>Rattus norvegicus</i> (Berkenhout)	Brown Rat, Common rat	Common
58.	<i>Mus musculus</i> Linnaeus	House Mouse	Common
59.	<i>Bandicota bengalensis</i> (Gray & Hardwicke)	Lesser Bandicoot Rat	Common
60.	<i>B. indica</i> (Bechstein)	Greater Bandicoot Rat, Large Bandicoot Rat	Common

REPTILIA

Class REPTILIA

Order SQUAMATA

Suborder SERPENTES

Family COLUBRIDAE

1. *Ptyas mucosus* (Linnaeus)1758. *Coluber mucosus* Linnaeus, *Syst. Nat.*, 10th ed. 1 : 226.*Common Name* : Indian Rat Snake (E); Dhamin (B).

Diagnosis : Length 200-350 cm; head broader than neck; large eye with rounded pupil; lip scales usually separated by vertical black lines; underside usually with prominent dark cross-bars; scales in 17,18 or 19 : 17 or 16 : 14 rows, smooth or upper rows more or less keeled; ventrals 190-213; anal scale divided; subcaudals 100-146, paired.

Colour : Colour variable, pale yellow, olive, brown, grey or black; body lightly or strongly marked with black; markings usually distinct on tail.

Distribution : Throughout South and SE Asia, from sea level to 4000 m.

2. *Amphiesma stolata* (Linnaeus)1758. *Coluber stolatus* Linnaeus, *Syst. Nat.*, 10th ed., 1 : 219.*Common Name* : Stripped Keelback (E); Hele (B).

Diagnosis : Length 40-80 cm; slender bodied with keeled scales; scales in 19 (17 or 20) : 19 : 17 rows, keeled with more or less bidentate tips; ventrals 118-161; anal usually divided; subcaudals 46-89, paired; internasal truncate, but distinctly narrowed anteriorly; supralabials 8 (3rd to 5th touching eye).

Colour : Dorsal brown with two distinct ribbon-like yellowish stripes from neck to tip of tail; fore body with additional black or dark-brown cross-bars or spots that fade towards the tail; head light-brown or olive above; under parts white.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka.

Suborder SAURIA

Family GEKKONIDAE

3. *Hemidactylus brookii* (Gray)1845. *Hemidactylus brookii* Gray, *Cat. Liz. Brit. Mus.*, 1845 : 153.*Common Name* : Brook's Gecko (E); Tiktiki (B).

Diagnosis : Size \pm 6cm; head large and ovate; eye large with vertical pupil; ear opening oval; upper labial 8-12 and lower 7-9; dorsum with small granular scales mixed with conical,

keeled tubercles, arranged in 16-20 longitudinal rows; scales on the ventrum smooth, rounded and imbricate; digits free, moderately dilated, with 5-6 oblique lamellae under the first and 6-10 under the fourth toes. Tail longer than head and body, much depressed, verticillate, swollen at the base; its dorsal aspect covered with small scales and with a series of 6-8 long, pointed, strongly keeled tubercles; male with 6-16 preanofemoral pores on each side, generally interrupted mesially.

Colour : Light and dark brown spotted dorsum; belly dirty white; dark streak along the side of head.

Distribution : Whole of India. *Elsewhere* : Pakistan, Sri Lanka, Myanmar, West Indies, Borneo, South China, Tropical Asia and northern half of Africa.

4. *Hemidactylus flaviviridis* Rüppell

1835. *Hemidactylus flaviviridis* Rüppell, *Neue wirb. Faun. Abyss.*, 1835 : 8.

Common Name : Yellow-bellied House Gecko (E); Tiktiki (B).

Diagnosis : Length \pm 7 cm; head large, snout broad, ear opening subcircular; head covered with minute granules; upper labials 12-15 and lower 10-12; dorsum with small granular scales, intermixed with very few large, round, feebly keeled tubercles; ventrum with smooth, rounded, imbricate scales; 7-10 lamellae under the first toe and 11-14 under the fourth; tail almost equal to the head and body, strongly depressed and swollen at the base in the adults, flat beneath; male with 5-7 femoral pores on each side.

Colour : Dorsum pale-grey or greenish-grey or brown or olive, dark wavy cross bands on the back; belly yellowish.

Distribution : Whole of India but abundant north of 20°N Lat. *Elsewhere* : Arabia, Pakistan, Iran, shores of Red sea.

Family AGAMIDAE

5. *Calotes versicolor* (Daudin)

1802. *Agama versicolor* Daudin, *Hist. Nat. Rept.*, 3 : 395.

Common Name : Indian Garden Lizard (E); Girgiti (B).

Diagnosis : Length \pm 45cm; head large, swollen at angle of jaws in males; no gular pouch; eyes large; two separate spines above the tympanum; males with gular sac, long limbs with long slender digits with strong claws; tail round and slender; head scales irregular, juxtaposed; body scales keeled, imbricate with pointed tips; scales in 35-52 rows at mid body pointing backwards and upwards; dorsal crest prominent in male.

Colour : colour light greyish-brown; transverse spots on back and sides; dark streak from eyes.

Distribution : Whole of India. *Elsewhere* : Sumatra to South China, Sri Lanka, Pakistan, Afghanistan.

Family SCINCIDAE

6. *Eutropis carinata* (Schneider)

1807. *Scincus carinata* Schneider, *Hist. Amphib.*, 2 : 183.

Common Name : Common Indian Skink (E); Anjuni (B).

Diagnosis : Length \pm 29cm; head with shield; supranasal just touching or separated from one another; frontonasal broader than long; prefrontals in contact with one another; a pair of nuchals always present; temporal scales keeled; dorsal and lateral scales almost equal, 3-5 prominent keels; 30-34 scales round the middle of the body; digits moderately long with 14-18 smooth or obtusely keeled lamellae beneath the fourth toe; hind limb reaches to the wrist or to the elbow; lower eye lids scaly.

Colour : Colour glossy bronze or olivaceous brown; lateral aspects dark-brown or slightly lighter in colour; usually with brown spots; two lighter dorsolateral lines present; under parts yellowish white.

Distribution : India excepting NW and NE region. *Elsewhere* : Nepal, Sri Lanka.

7. *Eutropis macularia* (Blyth)

1839. *Euprepes macularius* Blyth, J. Asiat. Soc. Bengal, 22 : 652.

Common Name : Bronzy Grass Skink (E); Anjuni (B).

Diagnosis : SL 6-7.5cm, TL 11-14cm, lower eyelid scaly; temporal scales keeled; dorsal and lateral scales almost equal, with 5-9 keels, 28-34 scales round the middle of the body; digits moderately long, with 12-17 obtusely keeled lamellae beneath the fourth toe.

Colour : Colour brown, olive or bronzy, with or without longitudinally arranged black spots; light dorsolateral stripe; sides of neck and flanks dark-brown, generally spotted with white; prefrontals rarely touch each other.

Distribution : India : Except Jammu and Kashmir and part of Himachal Pradesh. *Elsewhere* : Malayasia, Myanmar, Pakistan, Thailand, Vietnam.

8. *Lygosoma albopunctata* (Gray)

1846. *Riopa albopunctata* Gray, *Ann. Mag. Nat. Hist.*, 18 : 430.

Common Name : Brown Dwarf Skink (E); Chhota anjuni (B).

Diagnosis : SL \pm 6cm; 2-3 central scales of lower eyelid larger than others; nuchals indistinct; body scales smooth, almost equal; 26-28 scales round the middle of the body; 63-72 scales rows down the middle of the back; limbs moderately large; digits short; 12-15 lamellae under the fourth toe; tail swollen at the base.

Colour : Colour reddish brown; each dorsal scale with a prominent black or dark-brown spot, thus forming longitudinal lines; sides of neck and anterior portion of body dark-brown or black, densely spotted with white; belly yellowish white.

Distribution : India : Andhra Pradesh, Chhatishgarh, Assam, Madhya Pradesh, West Bengal, Bihar, Uttar Pradesh, Kerala.

9. *Lygosoma punctata* (Gmelin)

1799. *Scincus punctatus* Gmelin, *Hist. Amphib.*, : 197.

Common Name : Dotted Garden Skink (E); Anjuni (B).

Diagnosis : SL \pm 8.6cm, TL \pm 9.2cm; snout obtusely pointed; lower eyelid with an undivided semitransparent disc; supranasals in contact with one another behind the rostral; a pair of nuchal; upper labials 7, the fifth below the middle of the eye, longer than the other labials; body scales smooth, almost equal, 24-28 scales round the body; 62-76 down the middle of the back; 11-14 keeled lamellae under the fourth toe; tail swollen at the base, slightly longer than head and body.

Colour : Dorsum brown, each scale with a dark basal spot forming a longitudinal row; a yellow dorsolateral stripe from the snout; belly yellowish white, each scale dotted with black; tail red in young.

Distribution : India : Almost whole of India except NE and NW region. *Elsewhere* : Bangladesh, Pakistan, Sri Lanka, Man-son mountains, Tonking.

AVES

Class AVES

Order FALCONIFORMES

Family ACCIPITRIDAE

10. *Milvus migrans* (Boddaert)

1783. *Falco migrans* Boddaert, *Table PL. enlum* : 28.

Common Name : Black Kite (E); Chil (H); Chil (B).

Diagnosis : Head, back and tail dark fulvous-brown; bill black; legs and feet yellow; claws black; tail deeply forked.

Habitat : Chiefly urban localities.

Distribution : Throughout India except Nicobar Is. *Elsewhere* : Bangladesh, Myanmar, Malaysia (occasional), Nepal, Pakistan and Sri Lanka.

Remarks : Resident, breeds in the campus.

Order COLUMBIFORMES

Family COLUMBIDAE

11. *Columba livia intermedia* Strickland

1844. *Columba intermedia*, *Ann. and Mag. Nat. Hist.*, 13 : 39.

Common Name : Blue Rock Pigeon (E); Kabutar (H); Gola Payra (B).

Diagnosis : Colour bluish grey with glistening metallic green, purple and magenta sheen on upper breast and round the neck, and two dark bars on the wings; sexes alike.

Habitat : Cliffs and gorges, and around habitations and cultivation.

Distribution : Throughout India. *Elsewhere* : Bangladesh, Bhutan, Myanmar, Nepal, Sri Lanka and Thailand.

Remarks : Resident, breeds in the campus.

12. *Streptopelia chinensis suratensis* (Gmelin)

1789. *Columba suratensis* Gmelin, *Syst. nat.*, 1(2) : 778.

Common Name : Indian Spotted Dove (E); Panduk (H); Ghughu (B).

Diagnosis : Length \pm 30 cm; back pinkish brown; head grey; hind neck and upper back with a conspicuous black and white 'chess board'; chin vinous-grey, paler on throat; belly, vent and under tail coverts white; bill dark horny or plumbeous brown; legs and feet bright magenta; sexes alike.

Habitat : Dry and moist deciduous biotope.

Distribution : Throughout India usually up to c. 2400 m altitude in Himalaya. *Elsewhere* : Bangladesh, Bhutan, Nepal, Pakistan.

Remarks : Resident but moves locally and also breeds in the campus.

Order PSITTACIFORMES

Family PSITTACIDAE

13. *Psittacula krameri borealis* (Neumann)

1915. *Psittacula krameri borealis* Neumann, *Orn. Monatsb.*, 23 : 178.

Common Name : Northern Rose-ringed Parakeet (E); Tota (H); Tiya (B).

Diagnosis : Length \pm 42 cm; plumage grass green with a long pointed tail; bill, deeply hooked and red; male having a rose pink and black collar but female lacks it and instead of that collar there is an indistinct emerald green ring round the neck.

Habitat : Moist and dry deciduous biotope, thin jungle, orchards, cultivation and human habitation.

Distribution : Whole of northern India up to 20°N Lat. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, SE China and Vietnam.

Remarks : Resident, breeds in the campus.

Order CULIFORMES

Family CUCULIDAE

14. *Clamator coromandus* (Linnaeus)

1766. *Cuculus coromandus* Linnaeus, *Syst. Nat.*, ed. 12, 1 : 171.

Common Name : Red-winged Crested Cuckoo (E).

Diagnosis : Length + 47 cm; back, head and crest glossy black; a white half collar on hind neck; wings chestnut, chin, throat and breast rust colour, belly and vent white.

Habitat : Evergreen and moist deciduous biotope; foothill forests and scrub jungle.

Distribution : India : Himalayas from Garhwal east to NE States south to West Bengal, Maharashtra and rare in South India. *Elsewhere*: Bangladesh, Bhutan, Celebes, China, Indonesia, Indochinese Countries, Malay peninsula, Myanmar, Philippines, Thailand.

Remarks : It is a winter migrant and reported from Indian Museum Campus during its migratory journey.

15. *Clamator jacobinus serratus* (Sparrrman)

1786. *Cuculus serratus* Sparrrman, *Mus. Carls. fasc.* 1, No. 3 and pl.

Common Name : Pied Crested Cuckoo (E); Papiya (H); Papiya (B).

Diagnosis : Length ± 33cm; a slender long-tailed, crested black and white bird, black above and white below; a white patch on the black wings; white tips to the black graduated tail feathers.; sexes alike.

Habitat : Dry and moist deciduous lightly wooded biotope.

Distribution : With the on set of southwest monsoon it arrives over most of its Indian range except the drier parts and stays up to the end of monsoon period, from northern India south to peninsular India up to c 18°N Lat. and high up to c 2600m. *Elsewhere*: Africa south of the Sahara in winter and in Bangladesh and Pakistan in summer.

Remarks : Occasional visitor in monsoon months.

16. *Eudynamys scolopacea* (Linnaeus)

1758. *Cuculus scolopaceus* Linnaeus, *Syst. nat.*, ed. 10, 1 : 111.

Common Name : Asian Koel (E); Koel (H); Kokil (B).

Diagnosis : Length ± 43cm; *Male* : glistening metallic black; yellowish green bill; crimson eyes; legs and feet plumbeous; *Female* : Dark brown, profusely white-spotted and barred; tail feathers and wing quills barred with white; under parts spotted on chin, throat and foreneck, barred on rest of under parts with black.

Habitat : Lightly wooded forest, gardens, orchards, cultivation, towns and villages.

Distribution : Almost throughout India except northeastern region, rare in western Rajasthan, northern Gujarat. *Elsewhere* : Bhutan, Maldiv Islands, Nepal, Pakistan, and Sri Lanka.

Remarks : Regular visitor in spring.

17. *Centropus sinensis* (Stephens)

1815. *Polophilus sinensis* Stephens, in *Shaw's Gen. Zool.*, 9(1) : 51.

Common Name : Greater Coucal (E); Mahoka (H); Kuko (B).

Diagnosis : Length \pm 48 cm; a stout built glossy black bird with chestnut wings; long, broad, graduated black tail; bill, legs and feet black.

Habitat : Deciduous, scrub jungle, and garden.

Distribution : India : Throughout. *Elsewhere* : Bangladesh, Bhutan, China, Hainan, Indochinese countries, Myanmar, Pakistan, Thailand, the Indochinese countries, China.

Remarks : Resident.

Order STRIGIFORMES

Family STRIGIDAE

18. *Tyto alba stertens* Hartert

1929. *Tyto alba stertens* Hartert, *Nov. zool.*, **35** : 98.

Common Name : Indian Barn Owl (E); Kuraya (H); Lakshmi Pencha (B).

Diagnosis : Length \pm 36 cm; large round head with white facial disc, entirely surrounded by a ruff of stiff feathers; legs long, the upper part of the tarsus covered with feathers; back and wings golden buff and grey, finely stippled with black and white; under parts silky white tinged with buff and usually spotted with dark brown.

Habitat : Neighbourhood of cultivation and human habitation, ruined houses.

Distribution : Throughout Indian mainland. *Elsewhere* : Bangladesh, Bhutan, Myanmar, Nepal, Pakistan, Sri Lanka.

Remarks : Resident, breeds in the campus.

19. *Athene brama indica* (Franklin)

1831. *Noctua Indica*, *Proc. zool. Soc. London* : 115.

Common Name : Spotted Owlet (E); Ullu (H); Kuture Pencha (B).

Diagnosis : Length \pm 21 cm; head, back, wings and tail grayish brown with white spot; underparts white barred with brown.

Habitat : Ruins, old houses, groves of ancient trees.

Distribution : Throughout Indian mainland. *Elsewhere* : Pakistan and Indo-Chinese subregion.

Remarks : Resident.

Order APODIFORMES

Family APODIDAE

20. *Apus affinis* (J.E. Gray)

1830. *Cypselus affinis* J.E. Gray, in Gray and Handwicke's III. *Ind. zool.* : 1(2), pl. 35, f. 2.

Common Name : House Swift (E); Ababeel (H); Batasi (B).

Diagnosis : Length \pm 15 cm; crown brown, forehead more grey but no white and no trace of supercilium; bill horny black; legs and feet pinky brown.

Habitat : Around buildings and cliffs.

Distribution : Throughout mainland India. *Elsewhere* : Africa, Middle East, Indochinese and Malaysian subregions to Philippines, southern China and Taiwan.

Remarks : Resident.

21. *Cypsiurus balasiensis* (J.E. Gray)

1829. *Cyp. (selus) Balasiensis* (Sic) J.E. Gray, in Griffith's Anim. Kingdom, 7 : 60.

Common Name : Asian Palm Swift (E); Patta deuli (H); Batasi (B).

Diagnosis : Length \pm 13 cm; small swift with deeply forked tail; toes arranged in pairs, the 3rd and 4th toes outward, the 1st and 2nd inward.

Habitat : Associated with palms, especially *Borossus*.

Distribution : India : Throughout the mainland except NE states. *Elsewhere* : Sri Lanka.

Remarks : Occasional visitor.

Order CORACIFORMES

Family MEROPIDAE

22. *Merops orientalis* Latham

Merops Orientalis Latham, Index Orn. Suppl. : xxxiii (India : Pondichery *vide* Stresemann, 1952, Ibis 94 : 515).

Common Name : Small Green Bee-eater (E); Patringa (H); Banspati (B).

Diagnosis : Length \pm 21cm (from bill tip to tip of tail pin) ; back and under parts grass-green; head and neck tinged with reddish brown; central pairs of tail feathers project beyond tail as blunt pins; bill slender, long and slightly curved; chin, throat verditer blue bordered by a black gorget.

Habitat : Light forest and cultivation.

Distribution : Throughout Indian Union except northeastern region. *Elsewhere* : Bangladesh, Bhutan, Nepal.

Remarks : Occasional visitor.

Family CORACIIDAE

23. *Coracias benghalensis* (Linnaeus)

1758. *Corvus benghalensis* Linnaeus, Syst. Nat. ed., 10, 1 : 106.

Common Name : Indian Roller (E); Nilkant (H); Nilkantha (B).

Diagnosis : Length \pm 31 cm; striking blue in colour; head large and heavy; bill brownish black; breast rufous brown; abdomen and vent pale blue; a pale reddish brown collar on hind neck; legs and feet dirty brownish yellow.

Habitat : Deciduous forest, open cultivation, garden *etc.*

Distribution : From Himalayan submontane tract south to 20°N Lat. *Elsewhere* : Bangladesh, Bhutan, eastern Arabia, Iran, Iraq, Nepal, Pakistan.

Remarks : Rare visitor.

Order PICIFORMES

Family CAPITONIDAE

24. *Megalaima haemacephala indica* (Latham)

1788. *Bucco indicus* Latham, *Index Orn.*, 1(1) : 205.

Common Name : Coppersmith (E); Chhota basanth (H); Chhoto Basanta-bauri (B).

Diagnosis : Length \pm 17 cm; small, stout, green in colour; throat yellow, breast crimson, forehead crimson, under parts yellowish, streaked with green; short truncated tail; bill dark brown or black; legs and feet coral-red.

Habitat : Wooded country.

Distribution : Throughout India but rather scarce in arid and heavy rainfall area of Western Ghats. *Elsewhere* : Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka and SE Asia.

Remarks : Resident, breeds in the campus.

Family PICIDAE

25. *Dinopium benghalense* (Linnaeus)

1758. *Picus benghalensis* Linnaeus, *Syst. Nat. ed.*, 10, 1 : 113.

Common Name : Lesser Goldenbacked Woodpecker (E); Katphora (H); Khatthokra (B).

Diagnosis : Length \pm 29cm; crown and occipital crest crimson, upper parts chiefly golden-yellow with black; under parts white streaked with black; chin, throat and sides of head black, finely streaked and stippled with white. Female differs from male in having black forecrown stippled with white.

Habitat : Dry and moist-deciduous biotope.

Distribution : From Himalayan foothills south up to Godavari river, west to Gujarat, Rajasthan and east to Assam.

Remarks : Earlier very common but presently rare.

Order PASSERIFORMES

Family LANIIDAE

26. *Lanius vittatus* Valenciennes

1826. *Lanicus vittatus* Valenciennes, *Dict. Sci. Nat.* ed. Levrault, 40 : 227.

Common Name : Bay-backed Shrike (E); Pachanak (H).

Diagnosis : Length \pm 18 cm; head and neck white and grey; a broad black band across the forehead encircling eye and reaching back to end of ear-coverts; back chestnut; rump dirty white; under parts white, fulvous on breast, rusty on flanks.

Habitat : Mostly dry-deciduous biotope and open scrub thorn jungle.

Distribution : Throughout the Indian Union except NE region. *Elsewhere* : Nepal, Pakistan.

Remarks : Occasional visitor.

27. *Lanius schach* Linnaeus

Cf. Biswas, B., 1950, JBNHS 49 : 444-55; Vaurie, C., 1955, *Amer. Mus. Novit.*, No. 1752 : 13; Rand, A.L. & Flemming, R.L., 1957, *Fieldiana Zoology* 41 : 189-92.

Common Name : Rufous-backed Shrike (E); Kajala (H).

Diagnosis : Length \pm 25 cm; head large; laterally compressed, hook tipped black bill; a broad band from forehead through eye black; from crown to upper back grey; rest of under parts rufous or cinnamon; graduated tail black and rufous; chin, throat and upper breast white; rest of under parts pale rufous; wings blackish with a white wing spot.

Habitat : Open wooded country and cultivation.

Distribution : From NW India east to Kumaon, south to Maharashtra and east through Chhattisgarh, Andhra Pradesh up to West Bengal. *Elsewhere* : NE Iran, Afghanistan, Pakistan, southern Russian Turkestan, eastward to Ferghana, south ward to Transcaspia.

Remarks : Migratory, arrives early April and leaves by September; rare visitor.

28. *Lanius cristatus* Linnaeus

1758. *Lanius cristatus* Linnaeus, *Syst. Nat.*, ed. 10, 1 : 93.

Common Name : Brown Shrike (E); Kerkheta (H).

Diagnosis : Length \pm 19 cm; upper parts reddish brown; forehead and supercilium white; black line from bill through eye to ear coverts; tail rufous brown; wings blackish brown with rufous edge; chin, cheeks and throat white; rest of under parts fulvous.

Habitat : Dry-deciduous and semi-evergreen biotope.

Distribution : Throughout India except NW region. *Elsewhere* : Breeds in Siberia from Tomsk to the Kolyma R. and Kamchatka south to N. Mongolia and N. Amurland; wintering to Bangladesh, Myanmar, Malay Peninsula, Thailand, Indochinese countries, Sri Lanka.

Remarks : Migratory; rare visitor.

Family ORIOLIDAE

29. *Oriolus xanthornus* (Linnaeus)

1758. (*Coracias*) *xanthornus* Linnaeus, *Syst. Nat.*, ed. 10, 1 : 108.

Common Name : Black-headed Oriole (E); Peelak (H); Bene bou (B).

Diagnosis : Length \pm 25 cm; a golden yellow bird with full black head, throat and upper breast as well as some black on wings and tail; bill reddish; sexes alike but female is little paler.

Habitat : Light forest, moist-deciduous biotope, plantation, groves, gardens *etc.*

Distribution : Throughout Indian Union. *Elsewhere* : Bangladesh, Myanmar south to Tenasserim, Shan States, Thailand.

Remarks : Occasional visitor.

Family DICRURIDAE

30. *Dicrurus adsimilis albirictus* (Hodgson)

1836. (*Bhuchanga*) *Albirictus* Hodgson, *Ind. Rev.*, 1(8) : 326.

Common Name : Black Drongo (E); Bujanga (H); Finge (B).

Diagnosis : Length \pm 31cm, wing 130-145 mm, tail 135-165 mm; glossy jet black bird with long deeply forked tail; no tuft on forehead; outermost rectrices exceeding central ones by about length of tarsus and only faintly curved; sexes alike.

Habitat : Open deciduous forest and cultivation.

Distribution : Throughout peninsular India, south of a line roughly from Kutch, east to Chhattisgarh, Orissa and SW West Bengal.

Remarks : Resident.

Family STURNIDAE

31. *Sturnus contra* Linnaeus

1758. *Sturnus contra* Linnaeus, *Syst. Nat.*, ed. 10, 1 : 167.

Common Name : Asian Pied Starling (E); Ablaki myna (H); Guye Salik (B).

Diagnosis : Length \pm 23 cm; entire plumage black and white; orbital skin deep orange-red; basal portion of bill bright orange-red and terminal pale yellow; legs and feet yellowish brown.

Habitat : Open country, cultivation, human habitation.

Distribution : India : Andhra Pradesh, Assam, Bihar, Haryana, Madhya Pradesh, Meghalaya, Orissa, Punjab, Rajasthan and West Bengal. *Elsewhere* : Bangladesh, Nepal.

Remarks : Resident, breeds in the campus.

32. *Acridotheres tristis* (Linnaeus)

1766. *Paradisea tristis* Linnaeus, *Syst. Nat.*, ed. 12, 1 : 167.

Common Name : Common Myna (E); Desi Myna (H); Salik (B).

Diagnosis : Length \pm 23cm; colour dark brown; head glossy black; legs, bill and naked patch below and behind eye bright yellow; a large white patch on wing conspicuous in flight; sexes alike.

Habitat : Neighborhood of human habitation; outskirts of desert or forest.

Distribution : Almost throughout Indian Union. *Elsewhere* : Afghanistan, Bangladesh, Bhutan, Myanmar, Nepal, Pakistan, Russian Turkestan, SE Persian Baluchistan, Thailand and the Indochinese countries; introduced in Andaman Islands (India), Australia, Hawaii, New Zealand, South Africa and Islands of Indian Ocean, Atlantic and Pacific.

Remarks : Resident, breeds in the campus.

33. *Acridotheres ginginianus* (Latham)

1790. *Turdus ginginianus* Latham, *Index Orn.*, 1 : 362.

Common Name : Bank Myna (E); Ganga Myna (H); Gang Salik (B).

Diagnosis : Length \pm 21 cm; back and belly pale bluish grey; head black; naked orbital skin brick-red; wings patch and tips of tail feathers pinkish buff; forehead with black distinct tuft of feathers.

Habitat : Neighbourhood of human habitations.

Distribution : India : Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal. *Elsewhere*: Bangladesh and Pakistan.

Remarks : Resident.

Family CORVIDAE

34. *Dendrocitta vagabunda* (Latham)

1790. *Coracius vagabunda* Latham, *Index Orn.*, 1 : 171.

Common Name : Indian Tree Pie (E); Mahalat (H); Handichancha (B).

Diagnosis : Length \pm 30 cm; a slim, long tailed, bright rufous bird with dark sooty grey head, neck and breast; graduated grayish tail with broad black tips; wing designed with grey, white and black in typical; sexes alike.

Habitat : Lightly wooded, dry and moist-deciduous biotope.

Distribution : From sub-montane tract of Himalayas of Uttar Pradesh, Bihar east to NE India, Madhya Pradesh, Chhattisgarh, eastern Maharashtra, Orissa, northern Andhra Pradesh, south up to 17-18°N Lat.

Remarks : Resident.

35. *Corvus splendens* Vieillot

1817. *Corvus splendens* Vieillot, *Nouv. Dict. d'Hist. Nat.*, 8 : 44.

Common Name : House Crow (E); Deshi Kawwa (H); Pati Kak (B).

Diagnosis : Length \pm 43 cm; bill thick and black; glossy black forehead, crown and throat; nape, neck, upper breast and upper back glossy black with dusky grey.

Habitat : Human habitations, towns and cities.

Distribution : India : Throughout except Jammu and Kashmir, Punjab, Himachal Pradesh, Kerala. Andaman Islands (introduced). *Elsewhere*: Bangladesh, Myanmar.

Remarks : Resident, breeds in the campus.

36. *Corvus macrorhynchos* Wagler

1831. *Corvus levaillantii* Lesson, *Traité d'Orn.*, : 328.

Common Name : Jungle Crow (E); Jangli kowwa (H); Danrh Kak (B).

Diagnosis : Length \pm 48cm; a stout built glossy jet black bird with heavy black bill; sexes alike.

Habitat : Well wooded country, forest and outskirts of forest, village, towns and cities.

Distribution : From a line of Delhi west to Mt. Abu and Kutch and east to West Bengal and from the Nepal Terai south to Kanyakumari. *Elsewhere* : Sri Lanka.

Remarks : Occasional visitor.

Family PYCNONOTIDAE

37. *Pycnonotus jocosus emeria* (Linnaeus)

1758. *Motacilla emeria* Linnaeus, *Syst. Nat.*, 1 : 187.

Common Name : Red-whiskered Bulbul (E); Pahari Bulbul (H); Bulbul (B).

Diagnosis : Length \pm 20cm; forehead and crown black with pointed black crest; upper parts brown; crimson tufts behind the eyes; chin, throat and belly white with dark collar on breast; under tail coverts scarlet.

Habitat : Scrub jungle, forest edge and semi-cultivation.

Distribution : India : Andhra Pradesh, Chhattisgarh (Bastar), Orissa, Tamil Nadu, Tripura, West Bengal. *Elsewhere* : Bangladesh, Myanmar, Tenasserim, Thailand.

Remarks : Resident.

38. *Pycnonotus cafer* (Linnaeus)

1766. *Turdus cafer* Linnaeus, *Syst. Nat.*, ed. 12, 1 : 295.

Common Name : Red-vented Bulbul (E); Kala Bulbul (H); Bulbul (B).

Diagnosis : Length \pm 20cm; colour pale brown, tufted head and throat black; scale like markings on back and breast; white rump, scarlet vent and white-tipped blackish tail.

Habitat : Lightly wooded forest, cultivation, garden, scrub *etc.*

Distribution : India : From NW India to eastern Madhya Pradesh and south to a line running from Jagdalpur (SE Chhattisgarh) to Mumbai. *Elsewhere* : Pakistan, from Bangladesh east to Indochinese sub-region and Java.

Remarks : Resident, breeds in the campus.

Family MUSCICAPIDAE

39. *Orthotomus sutorius* (Pennant)

1845. *Orthotomus patia* Hodgson, *Proc. zool. Soc. London* : 29.

Common Name : Indian Tailor Bird (E); Darzee (H); Tuntuni (B).

Diagnosis : Length \pm 13cm; yellowish green upper parts with rusty crown; under parts buff; pointed tail usually placed erect in position while sitting; sexes alike.

Habitat : Deciduous Forest, gardens and even in the noisy city area.

Distribution : India, from Himalayan foothills to the extreme south. *Elsewhere* : Pakistan.

Remarks : Resident, breeds in the campus.

40. *Copsychus saularis* (Linnaeus)

1758. *Gracula saularis*, *Syst. Nat.*, 1 : 109.

Common Name : Indian Magpie-Robin (E); Dhaiyal (H); Doyel (B).

Diagnosis : Length \pm 20 cm; long tailed black and white bird; *Male* : upper parts glossy blue-black; blackish-brown wings with a prominent long white patch; graduated tail with white outer rectrices; under parts white except blue-black throat; *Female* : upper parts slate in colour and under parts white except on grey throat and breast.

Habitat : Garden, orchard, groves, deciduous and open secondary forest.

Distribution : Almost throughout the country except certain parts of NE and southern region. *Elsewhere* : Pakistan (In part).

Remarks : Resident but moves locally.

Family MOTACILLIDAE

41. *Motacilla flava* Linnaeus

1758. *Motacilla flava* Linnaeus, *Syst. Nat.*, 1.

Common Name : Yellow Wagtail (E); Pilkya (H); Khanjan (B).

Diagnosis : Length \pm 17 cm; back olive; two yellow bars on brown wing; head, nape and ear coverts dark slate-grey; tail dark brown with white outer edge; under parts yellow from chin to under tail-coverts; sexes alike.

Habitat : Along river side and jheel margins.

Distribution : Winters in India from the plains of Ganges south to Kanyakumari; passage migrant in the Himalayas west of Simla; Andaman and Nicobar Islands. *Elsewhere*: Bangladesh, Pakistan, Africa south of Sahara as winter visitor and breeds from Scandinavia to NW Siberia.

Remarks : Winter migrant.

42. *Motacilla citreola* Pallas

1776. *Motacilla citreola* Pallas, *Reise Russ. Reichs*, 3 : 696.

Common Name : Citrine Wagtail (E).

Diagnosis : Body length \pm 17 cm with long tail; *Male*: Rich lemon-yellow head; back and rump black; wings dark brown with white edge; under parts lemon-yellow and sides of breast black; back dark grey mixed with black in winter season. *Female* : Either similar to male or with paler head or with dark grayish crown and mantle, yellow forehead, supercilium and ear-coverts more or less streaked with grey.

Habitat : Marshes, irrigated fields.

Distribution : *Summer* : N. Baluchistan, NWFP, east through Baltistan, Gilgit, Kashmir, Ladakh, Lahul, Spiti. *Winter* : Pakistan, India, Bangladesh, the Indochinese sub-region and southern China.

Remarks : Rarely seen in winter.

43. *Motacilla alba* Linnaeus

1758. *Motacilla alba* Linnaeus, *Syst. nat.* 1.

Common Name : White Wagtail (E); Dhoban (H); Khanjan (B).

Diagnosis : Length \pm 18cm; black and white wagtail; forehead, sides of head and around the eyes white; a large black patch on hind crown and nape; back and rump ashy; wings brownish, coverts and tertials broadly margined with white; tail blackish brown with white outer rectrices; under parts white with a large crescent shaped black patch on breast; sides of breast and flanks ashy; sexes alike.

Habitat : Vicinity of rivers, streams, flooded area etc.

Distribution : Wintering from the Himalayan foothills south to Karnataka and Andhra Pradesh. *Elsewhere* : Bangladesh, Nepal, Pakistan, Sri Lanka; breeds from Yenisey to the Ural Mts. and ranges over the whole of Eurasia from the Chukchi Peninsula, Japan and China west to Morocco, British Isles and Iceland and winters from the southern parts of the breeding range south to the Arabia, Congo, Kenya, Indochinese countries and Philippines.

Remarks : Regular winter migrant.

Family NECTARINIDAE

44. *Nectarinia asiatica* (Latham)

1790. *Certhia asiatica* Latham, *Index Orn.*, 1 : 288.

Common Name : Indian Purple Sunbird (E); Phul soongni (H).

Diagnosis : Length \pm 10cm; *Male* : colour looks like glistening black but actually a mixture of glistening metallic purplish blue, green and black; in non breeding season males may appear with olive-brown plumage with black wing and tail; under parts yellow with a broad blue-black band through middle of throat and breast. *Female*: upper parts olive-brown; under parts dull yellow.

Habitat : Light deciduous forest, semi-cultivation, gardens *etc.*

Distribution : Almost throughout India. *Elsewhere* : Nepal, Sri Lanka.

Remarks : Resident, moves locally but breeds in the campus.

Family PLOCEIDAE

45. *Passer domesticus* (Linnaeus)

Common Name : House Sparrow (E); Churi (H); Charai (B).

Diagnosis : *Male* : Colour of crown grey; sides of crown behind eye, sides of neck and upper back chestnut; rufous-chestnut with black streaks on back; shoulder patch white, wing rufous; rump grey brown; tail dark brown; sides of throat white; centre of throat and breast black. *Female*: colour greyish brown streaked with fulvous and dark brown on back; throat, breast and abdomen white.

Habitat : Ubiquitous commensal of man in cities, suburbs, villages *etc.*

Distribution : Throughout India except Jammu and Kashmir and Sikkim. *Elsewhere* : Arabia, Bangladesh, Myanmar, Pakistan, Sri Lanka; introduced in South Africa, Comoro and Mascarene Is.

Remarks : Resident, breeds in the campus.

MAMMALS

Class MAMMALIA

Order INSECTIVORA

Family SORICIDAE

46. *Suncus murinus* (Linnaeus)

1766. *Sorex murinus* Linnaeus, *Syst. Nat.*, 12th ed., 1 : 74.

Common Name : Grey Musk Shrew (E); Chhuchhundar (H); Chuncho (B).

Diagnosis : Colour Brownish slaty or Slaty Grey; HB more than 93 mm.

Habitat : Nocturnal, fossorial and very common near human habitation.

Distribution : Throughout the country. *Elsewhere* : China, Japan, Myanmar, Nepal, Sri Lanka, Continental and peninsular Indo-Malayan region; introduced into Guam, Maldives Islands; coastal Africa, Madagascar, Mauritius and coastal Arabia.

Remarks : Resident; Common.

Order CHIROPTERA

Suborder MEGACHIROPTERA

Family PTEROPODIDAE

47. *Pteropus giganteus* (Brünnich)

1782. *Vespertilio giganteus* Brünnich, *Dyrenes Histoire*, 1 : 45.

Common Name : Indian flying fox (E); Bada Badur (H); Badur (B).

Diagnosis : Size large, forearm 200 mm; rufous brown around head and neck; a conspicuous orange or honey-coloured band across upper back; lower back blackish brown; ventral parts dark chestnut brown; naked skin of wings, uropatagium, ears and muzzle jet black; no external tail; a narrow flap of skin inside each leg.

Habitat : Spends the day time hanging itself with the claws and head down from the branches of tall trees in groups and starts flying at dusk.

Distribution : Throughout the country, including Andaman Is., where it is rare. *Elsewhere* : China, Maldives, Myanmar, Nepal, Sri Lanka and Thailand.

Remarks : Not uncommon upto 1980's.

48. *Cynopterus sphinx* (Vahl)

1797. *Vespertilio sphinx*, *Skr. Nat. Selsk., Copenhagen*, 4(1) : 123.

Common Name : Short-nose Fruit Bat (E); Chhota Badur (H); Kala Badur (B).

Diagnosis : A medium sized bat, forearm approximately 70 mm, ears with white margin, metacarpal and phalanges whitish, nostrils divergent with deep internarial groove, dorsal colour grey or greyish brown, paler ventrally, often with a broad rufescent or chestnut area around shoulder and throat, naked skin of wings, nozzle blackish brown, tail reduced and rod like.

Distribution : Widely distributed throughout the main land of Indian Union. *Elsewhere* : Bangladesh, Myanmar, Nepal, Pakistan, and Sri Lanka.

Remarks : Resident, common and observed to roost in houses in the Museum campus.

Suborder MICROCHIROPTERA

Family VESPERTILIONIDAE

49. *Pipistrellus coromandra* (Gray)

1838. *Scotophilus coromandra* Gray, *Mag. Zool. Bot.*, 2 : 498.

Common Name : Indian Pipistrelle (E); Chamgaur (H); Chamchika (B).

Diagnosis : A small sized pipistrelle, forearm \pm 31 mm, dorsal blackish brown with tips of hairs slightly rufescent, ventral fur slightly paler brown, tragus forward curving and bluntly rounded, calcarial lobe small.

Habitat : Lives in old houses.

Distribution : From peninsular India, north to Jammu and Kashmir east to NE states upto Tripura and Car Nicobar Is. **Elsewhere** : Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam.

50. *Pipistrellus mimus* Wroughton

1899. *Pipistrellus minimus* Wroughton, *J. Bombay nat. Hist. Soc.*, 12 : 722.

Common Name : Indian Pygmy Pipistrelle (E); Chhota Chamgaur (H); Chhoto Chamchika (B).

Diagnosis : A small pipistrelle, forearm \pm 28 mm, fur dense and short, dorsal colouration bistre brown, base of hairs almost black, ventral parts lighter; face, ears and wing-membranes almost black; ears small and scarcely triangular; tragus short and curved forward, post calcarial lobe present, wings from base of toes.

Habitat : Same as sl. no. 54.

Distribution : Throughout the country. **Elsewhere** : Afghanistan, Bhutan, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam.

Remarks : Resident; common.

Order PRIMATES

Family CERCOPITHECIDAE

51. *Macaca mulatta* (Zimmermann)

1780. *Cercopithecus mulata* Zimmermann, *Geogr. Gesch. Mensch. Vierf. Thiere*, 2 : 195.

Common Name : Rhesus Macaque (E); Lal-muh Bandar (H); Bandor (B).

Diagnosis : A medium-sized macaque, HB 47-63 cm, hind quarters of the body of orange-red hue, tail short and hairy, less than half the length of head and body.

Habitat : Arboreal, troops live near or in villages, towns and in groves around tanks and temples. In the forest, they usually keep to the outskirts, rarely penetrating into the depths.

Distribution : Whole of North and NE India, south upto 15° 46' N Latitude near Bay of Bengal. **Elsewhere** : Afghanistan, Bangladesh, Nepal, Pakistan, Bhutan to Thailand including China.

Remarks : Troops were common upto 1960's but a single male (*Masthan*) was in the Indian Museum campus upto 1991.

52. *Semnopithecus entellus* (Dufresne)

1797. *Simia entellus* Dufresne, *Bull. Sci. Soc. Philom. Paris*, (1), 7 : 49.

Common Name : Entellus Monkey or Langur (E); Hanuman, Langur (H); Hanuman (B).

Diagnosis : Slender body, long tail, long slender hands, black face, dark-grey on the back, ventrally paler; when seated 60-75 cm high; tail 90-100 cm.

Habitat : Arboreal but may live on rocks and cliffs; comes down to the ground as and when needed; comfortable from forest to human habitation.

Distribution : Throughout the country except NE India and western part of Gujarat.

Elsewhere : Bangladesh, China, Nepal, Pakistan, Sri Lanka.

Remarks : Troops were seen upto 1970's but individual visit was observed upto 1980's.

Order CARNIVORA

Family CANIDAE

53. *Canis aureus* Linnaeus

1758. *Canis aureus* Linnaeus, *Syst. Nat.*, 10th ed., 1 : 40.

Common Name : Asiatic Jackal (E); Siar (H); Sial (B).

Diagnosis : A well shaped head with long conical muzzle but lacks arching brows and elevated forehead; large erect ears, long slender legs, a bushy tail, and five toes on forefeet and four on the hind; HB 60-75 cm, males 38-43 cm high at shoulder, coat colour a mixture of black and white washed with buff.

Habitat : Lives in almost any environment from forest to near human habitation; prefers to live in lowlands, about town and villages and cultivation, sheltering in holes in the ground, among ruins or in dense grass and scrub.

Distribution : Almost throughout the country. **Elsewhere** : Afghanistan, North and East Africa, Central, Southwest and South Asia, SE Europe, Iran, Nigeria, Tangania, Sri Lanka, Thailand and Transcaucasus.

Remarks : It was reported from this campus upto the middle of 20th century.

Family VIVERRIDAE

54. *Paradoxurus hermaphroditus* (Pallas)

1777. *Viverra hermaphroditus* Pallas, In : Schreber, *Die Säugethiere*, 3(25) : 426.

Common Name : Common Palm Civet, Toddy Cat (E); Lakati (H); Khatas (B).

Diagnosis : HB 432-710 mm; TL 406-660 mm; fur coarse and long ; blackish brown in colour; coat bears longitudinal stripes on the back; a white spot present below each eyes; a large patch extending from above the eye to the base of the ears.

Habitat : Common in well wooded regions; prefers to live on large mango or palm trees near villages, towns and cities but many have forsaken an arboreal existence and have adapted themselves to a life in human settlements even in the heart of the crowded cities.

Distribution : Almost throughout the country except desert part of Rajasthan and Gujarat. **Elsewhere** : Bhutan, Bangladesh, Cambodia, China, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Singapore, Sri Lanka, Thailand, Vietnam, Sulawesi, Moluccas, Aru Islands.

Remarks : Resident; in Indian Museum campus, it lives inside the store house of waste materials or on the large trees and breeds there. One specimen collected by Dr. T.N. Annandale, first Director of Zoological Survey of India and deposited in the National Zoological collection.

Family HERPESTIDAE

55. *Herpestes javanicus* (E. Geoffroy Saint-Hilaire)

1818. *Ichneumon javanicus* E. Geoffroy Saint-Hilaire, *Descrip. de l'Egypte*, 2 : 138.

Common Name : Small Indian Mongoose (E); Newla (H); Benji (B).

Diagnosis : Total length 45-50 cm; dark olive brown in colour, minutely speckled with gold; tail shorter than head and body.

Habitat : Lives in holes, burrowed by itself in bushes, hedges and cultivated fields.

Distribution : From Jammu and Kashmir at north to Andhra Pradesh at south and west from Gujarat east upto NE states. **Elsewhere** : Afghanistan, Bangladesh, Bhutan, Cambodia, China, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Thailand, Vietnam, and introduced in Cuba, Fiji Isls., Hawaiian Isls., Jamaica, Japan, Puerto Rico, Surinam, Surinam, West Indies and many other tropical regions.

Remarks : Resident, but a few only.

Order RODENTIA

Family SCIURIDAE

56. *Funambulus pennantii* Wroughton

1905. *Funambulus pennantii* Wroughton, *J. Bombay nat. Hist. Soc.*, 16 : 411.

Common Name : Northern Palm Squirrel (E); Gilheri (H); Khatberali (B).

Diagnosis : HB 130-150 mm, tail little longer; colour of the back brownish or greyish; head and limb tending to be greyish; feet pale often whitish; back with five whitish or white stripes separated by four dark brown bands; colour of the tail apparently whitish or greyish white, then blackish and paler at tip; under parts whitish or dirty white.

Habitat : Arboreal, prefers to live near human habitation.

Distribution : In India, northern, northeastern, west and central part; Andaman Islands (introduced). *Elsewhere* : Afghanistan, Iran, Nepal, Pakistan.

Remarks : Resident; common; breeds in the campus.

Family MURIDAE

57. *Rattus rattus* (Linnaeus)

1758. *Rattus rattus* Linnaeus, *Syst. Nat.*, 10th ed., 1 : 161.

Common Name : Black Rat (E); Chuha (H); Indur (B).

Diagnosis : Grayish black above, dark ashy beneath, tail longer than head and body; long piles numerous, somewhat flattened; muzzle sharper, ears oval; HB \pm 190 mm; TL \pm 203 mm.

Habitat : Lives in varied type of habitat, very common near human habitation.

Distribution : Cosmopolitan, practically throughout the country. *Elsewhere* : Introduced worldwide in the tropics and temperate zones.

Remarks : Resident.

58. *Rattus norvegicus* (Berkenhout)

1769. *Rattus norvegicus* Berkenhout, *Outlines of the Natural History of Great Britain and Ireland*, 1 : 5.

Common Name : Brown Rat (E); Indur (B); Chuha (H).

Diagnosis : Dark brown above, grey below, tail shorter than head and body; ears small, obscurely bicoloured.

Habitat : Lives near human habitations.

Distribution : Cosmopolitan, almost throughout the country. *Elsewhere* : Palaearctic species, now distributed throughout greater part of the world due to accidental transportation by human agency.

Remark : Resident.

59. *Mus musculus* Linnaeus

1758. *Mus musculus* Linnaeus, *Syst. Nat.*, 10th ed., 1 : 62.

Common Name : House Mouse (E); Musi, Chuhi (H); Nengti Indur (B).

Diagnosis : Smallish mice; head and body rarely exceed 100 mm; tail exceeds head and body length usually; hallux clawed; dark grey to dark brown above and paler below.

Habitat : Lives chiefly in houses but sometimes in gardens and fields near villages and towns.

Distribution : Throughout India. *Elsewhere* : Spread throughout most of the world through human agency.

Remarks : Resident; common.

60. *Bandicota bengalensis* (Gray and Hardwicke)

1833. *Arvicola bengalensis* Gray and Hardwicke, *Illustr. Indian Zool.* : 21.

Common Name : Lesser Bandicoot Rat (E); Chuha (H); Metho Indur (B).

Diagnosis : HB 150-260 mm; tail shorter than head and body; body dark grey above; paler below; forefeet with four finger and hinder ones with five; hairs short and harsh.

Habitat : An inhabitant of field and forest but adapted much to live in human habitations.

Distribution : Throughout India. *Elsewhere* : Indo-China, Indonesia, Myanmar, Nepal, Pakistan, Sri Lanka.

Remark : Resident; common.

61. *Bandicota indica* (Bechstein)

1800. *Mus. Indicus* Bechstein, In : Pennant, *Allgemeine Ueber Vierfuss. Thiere*, 2 : 497.

Common Name : Greater Bandicoot Rat, Large Bandicoot Rat (E); Musha, Barah Chuha (H); Dhere Indur (B).

Diagnosis : A dark grey, large robust rat, sometimes body length reaches more than 300 mm and tail is little shorter than head and body.

Habitat : Living essentially in or about human dwellings.

Distribution : Almost throughout India. *Elsewhere*: Bangladesh, China, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam.

Remark : Resident; common.

DISCUSSION

At the time of inception of the Indian museum in 1814, the Calcutta (renamed as Kolkata) city was full of water tanks, groves, bushes *etc.* There is no doubt, at that time both diversity and population of birds and mammals were much higher than that of the present time. Practically there is no consolidated report on the avian and mammalian fauna of the Indian Museum campus. Compilation of the present report is chiefly based on sight record either gathered by the old inhabitants of the campus or by the present author. The avifauna of the campus is likely to be healthy as there are still a number of large trees which could be able to provide food and shelter to them.

There are some trees like Berry, Mango, Palm, *Radhachura*, *Krishnachura*, *Bandhar lathi etc.*, whose fruits are relished by many frugivorous birds. Moreover, fruiting time of individual plant species is different and thus, some birds are very comfortable in all the seasons inside the campus. The same is true in case of insectivorous species as there are various types of insects and worms in the bushes, under the barks, along the banks. Some migratory species

and local migrants are occasional visitor and only be seen during their migratory journey. There are huge refuge of food is available in the campus as a number of offices are running in the campus and the waste food materials are the prime attraction for kites and crows, thus they are the most comfortable bird species so far noticed in the campus. Among all the avian species the population of Mynas is much higher than any other species as well as the trees are also used as roosting place.

So far, only fifteen species of mammals have been recorded from the campus, of which, only twelve are being seen presently. No doubt the murid rodents are the most dominant among the mammalian species. The only squirid which is found in this campus is *F. pennanti*. It breeds in the campus and established a very good colony.

At present, the total avian and mammalian fauna is not very rich but from the conservation point, these species should be protected properly otherwise more and more declining of species are likely to occur in near future. There are some species which are either rare or not seen after 1980s. The reason may be due to habitat loss or increasing of pollution load. However, at any cost the conservation of the faunal wealth of the campus by planting of fruiting trees, releasing of fish fries in the tank and even planting of bush *etc.* is must to add to environment and aesthetic value as the premises have got a heritage value.

SUMMARY

Altogether 60 species of terrestrial vertebrates have been reported from the Indian Museum campus of which 9 reptilian, 37 avian and 15 are mammalian. For conservation of the present species diversity and population, planting of more trees and release of fish fry in the tank are much needed. If the conservation measure is not taken properly, most of the vertebrate species may likely to abolish from the premises very soon.

MACROZOOBENTHOS

INTRODUCTION

Macrozoobenthos are diverse groups of organisms comprising of various species with wide ecological tolerance that occur in almost every aquatic habitat on earth. In freshwater ecosystem, benthic invertebrates are not only diverse but also often occur in abundance. Functional importance of freshwater benthic invertebrates generally goes unnoticed until unexpected changes occur in ecosystems. On a global scale, the pressure of population growth, economic development and related anthropogenic activities are nowadays changing the environmental scenario and the consequences are noticed to a critical extent in tropical urban waterbodies in most cities in India. It may be mentioned that although some reports (Mandal and Moitra, 1975; Sarkar, 1989, 1992; Ghosh, 1990; Mukherjee and Nandi, 2004; Banerjee and Banerjee, 2005 and Nandi *et al.*, 1993, 1999, 2001a, b, 2005, 2007) are available regarding benthos from freshwater ecosystems of West Bengal, but detailed studies on most of the waterbodies of Kolkata metropolis are lacking. Hence, the present work was undertaken in the Indian Museum Tank with a view to study benthic faunal composition, population density, total benthos and biomass. The statistical analysis included in this communication can be considered as a model for the beginners to understand pond ecology with special reference to macrozoobenthos.

MATERIALS AND METHODS

Study area

The tank in the compound of Indian Museum of Kolkata was selected for the present study. This is a rectangular shaped pond measuring 324ft by 286ft, located in between 22°33.394'-22°33.412'N longitude and 88°21.115'-88°21.101'E in latitude. This perennial tank, with water depth varying from 10 – 16ft at different seasons in the centre, is devoid of any inlet and outlet and is mainly fed by rain and subsoil water. The present study was done on two study stations for one year from June 2007-May 2008 which are as follows :

Station 1 (IMT 1) : This study point is situated at the corner of eastern and southern side of the pond, over-shaded by tall trees and characterized by household wastes and decomposed tree leaves.

Station 2 (IMT 2) : It is situated at the northern side of the pond and almost near a small *ghat* which is rarely used by people. The site has some aquatic vegetation but there is no shade of trees. At this point water flows into the tank from its bank and roads in the compound during rain.

Methods :

The qualitative and quantitative benthic samplings were done with the aid of a box-type sampler (15cm × 15cm) (Mukherji and Nandi, 2004) and sieve (5 mm mesh size). Collected organisms were sieved, sorted and preserved in 4% formalin or 70% alcohol. Data were analyzed to understand the effect of abiotic factors on the macrozoobenthic group. Six biotic indices *viz.* (i) Index of dominance, (ii) Margalef's index, (iii) Shannon-Weiner index, (iv) Evenness index, (v) Berger-Parker index and (vi) Menhinick's index were calculated as follows :

Index of Dominance (Simpson's index)

The index of dominance (Simpson, 1949) is expressed as :

$$c = 1 - \sum (n_i/N)^2$$

where, c = index of dominance,

n_i = importance value for each species (number of individuals, biomass, production, etc.) and

N = total of importance values

The diversity values are directly correlated with the diversified resources in the habitat available for components of the community. Decreased values indicate increase by an average species resulting in the lowering of the number of coexisting species in the community. Value ranges from 0, indicating a low level of diversity, to a maximum of 1.

Margalef's Index

Species diversity comprises of a number of components that respond differently to geographical, developmental or physical factors (Odum, 1971). One of the major components of species diversity is called the 'species richness' or variety components or Margalef's diversity index (d) and is expressed by simple ratio between total species (s) and total number of importance value (N).

$$d = s - 1/\text{Log}N \text{ (Margalef, 1958)}$$

This index commonly varies between 1 and 5 and larger the index a more healthy body of water. When it tends towards 1 pollution is thought to increase and damage should be suspected.

Shannon-Weiner Index

In estimating species diversity probably the most widely used index is the Shannon-Weiner (1949) index given by the formula.

$$\bar{H} = \sum (n_i / N) \log (n_i / N)$$

Where,

\bar{H} = Shannon-Weiner index, n_i = importance value of each species;

N = total of importance values.

The value of this index can theoretically range from 0 to infinity. However, values normally range from 0 to 4. Wilhm and Dorris (1968), after examining diversity in a range of polluted and unpolluted streams, concluded that the value of H' greater than 3 indicated clean water, values in the range of 1 to 3 were characterized by moderately polluted conditions and values less than 1 characterized heavily polluted conditions.

Evenness Index

Another component of diversity is called 'evenness' or 'equitability' in the apportionment of individuals among the species. It is noted that both evenness and Shannon-Weiner index behave inversely to the index of dominance since high values indicate a low concentration of dominance. It is the apportionment of individuals among the species in the community and is expressed as :

$$e = \bar{H} / \text{Log}S \text{ (Pielou, 1966)}$$

where,

e = evenness index, H = Shannon-Weiner index and S = number of species

Berger-Parker (1970) index

$$BP = N_{\max} / N$$

Where,

N_{\max} = number of individuals in the most abundant taxon

N = the total number of individuals

Positive relationship relates between the number of numerically important species and the diversity value.

Menhinick (1964) index

$$M = S / \sqrt{N}$$

Where,

S = the total number of taxa; N = the total number of individuals

Low values of this index indicate less number of species.

For statistical analysis, Pearson's correlation coefficients were calculated through SPSS10 version to evaluate the parametric relationships between the limnological parameters, benthic groups and biotic indices. The two tailed t test was used to test the correlation coefficients at 5% and 1% level of significance.

RESULTS

Species composition

Qualitative samplings of macrozoobenthos in Indian Museum Tank revealed the presence of 26 species belonging to three phyla comprising 6 major groups viz., Polychaeta, Oligochaeta, Crustacea, Insecta, Gastropoda and Bivalvia. The composition (binary data) of collected macrozoobenthic species occurring in two study stations (IMT 1 and IMT 2) is shown in Table 1.

Table 1 : List of macrozoobenthic species collected from two study stations of Indian Museum Tank.

Sl. No.	Groups and Species	Abbreviation	IMT1	IMT2
	I. ANNELIDA			
	A. POLYCHAETA			
	Family NEREIDIDAE			
1.	<i>Namalycastis indica</i> (Southern)	N. sp.	+	+
	B. OLIGOCHAETA			
	Family TUBIFICIDAE			
2.	<i>Branchiodrilus hortensis</i> (Stephenson)	Bh	-	+
3.	<i>Limnodrilus hoffmeisteri</i> Claparede	Lh	+	+
4.	<i>Branchiura sowerbyi</i> Beddard	Bs	+	+
5.	<i>Dero cooperi</i> Stephenson	Dc	-	+
6.	<i>Nais simplex</i> Pignet	Ns	-	+
	II. ARTHROPODA			
	A. CRUSTACEA			
	Order DECAPODA			
	Family PARATHELPHUSIDAE			
7.	<i>Sartoriana spinigera</i> (Wood Mason)	Ss	+	+
	Family PALAEMONIDAE			
8.	<i>Macrobrachium lamarrei</i> (H. M. Edw.)	Ml	+	+
	B. INSECTA			
	Order DIPTERA			
	Family CHIRONOMIDAE			
9.	Chironomid larvae		+	+
	Order COLEOPTERA			
	Family DYTISCIDAE			
10.	<i>Canthydrus laetabilis</i> (Walker)	Cl	-	+
11.	<i>Hydrovatus</i> sp.	Hsp	+	+

Sl. No.	Groups and Species	Abbreviation	IMT1	IMT2
12.	Order HEMIPTERA			
	Family BELOSTOMATIDAE			
	<i>Diplonychus annulatus</i> (Fabricius)	Da	+	+
13.	Order ODONATA			
	Family COENAGRIONIDAE			
	Dragonfly larvae		-	+
14.	Insect larvae		-	+
15.	III. MOLLUSCA			
	A. GASTROPODA			
	Family VIVIPARIDAE			
	<i>Bellamyia bengalensis</i> (Lamarck)	Bb	+	+
16.	Family BITHYNIIDAE			
	<i>Bithynia (Digoniostoma) cerameopoma</i> (Benson)	Bc	+	+
17.	<i>Gabbia orcula</i> (Nevill)	Go	+	+
18.	Family THIARIDAE			
	<i>Thiara tuberculata</i> (Müller)	Tt	+	+
19.	<i>Tarebia lineata</i> (Gray)	Tl	+	+
20.	<i>Tarebia granifera</i> (Lamarck)	Tg	+	+
21.	Family LYMNAEIDAE			
	<i>Lymnaea acuminata</i> (Lamarck)	La	+	+
	<i>Lymnaea luteola</i> (Lamarck)	Ll	+	+
23.	Family PLANORBIDAE			
	<i>Gyraulus convexiusculus</i> (Hutton)	Gc	+	+
	<i>Gyraulus labiatus</i> (Benson)	Gl	+	+
25.	Family PLANORBIDAE			
	<i>Indoplanorbis exustus</i> (Deshayes)	Ie	+	+
26.	B. BIVALVIA			
	Family UNIONIDAE			
	<i>Lamellidens marginalis</i> (Lamarck)	Lm	+	+
	Total (26 species)		19	26

The station IMT2 with open light penetration represents highest diversity (26 species) of macrozoobenthos including oligochaetes (Table 1). Amongst the groups, Gastropoda represented highest diversity of 11 species. All the five oligochaete species of Tubificidae family were found at station IMT2 indicating eutrophic substratum of this point. Diversity of species including insects was quite high when the macrophytes were present in the ponds. Most of the aquatic insect species were absent in the pond after the removal of aquatic weeds.

Population density

Out of a total of 26 macrozoobenthic species, six species of Mollusca viz. *Bellamya bengalensis*, *Bithynia (Digoniostoma) cerameopoma*, *Gabbia orcula*, *Thiara tuberculata*, *Tarebia lineata* and *Lamellidens marginalis* and one species of oligochaete, *Branchiura sowerbyi*, were commonly occurring in the two study stations of the tank as they were available and represented by more than 50% of the sample in every month or season. The population density of these seven species are pooled and presented month-wise in Tables 2 and 3 along with some other species collected from the tank. It is evident that month-wise distribution of different groups of macrozoobenthic species varied from groups to groups and also species to species. Insect species were absent after the removal of weeds in June 2007.

The density of oligochaete species (*Branchiura sowerbyi*) showed distinct peak in November (267 no/m²) in station 2 and in February (133 no/m²) in station 1. This species was common in the months of post monsoon season. The population of large sized bivalve species (*Lamellidens marginalis*) fluctuated from nil in monsoon to early postmonsoon season and to 400 no/m² in early premonsoon season. Most of the gastropod species (*Bellamya bengalensis*, *Bithynia cerameopoma*, *Gabbia orcula* and *Thiara tuberculata*) were found abundant in premonsoon to early monsoon. This high density of molluscan species was related to the recruitment of juvenile forms. Gupta and Pant (1986), Singh and Roy (1991) and Mukherji and Nandi (2004) reported the premonsoon or monsoon peak of gastropod density like that of present finding. Muley (1977) suggested *Thiara* sp. as continuous breeder which may result in the variation of population as well as its peak period.

Total benthos and biomass

Densities of total benthos for both the study stations are given month-wise in Tables 2 and 3. It ranged from 978-4888 no/m² at IMT1 and 1244-4000 no/m² at IMT2. The variations in total macrobenthic densities in these two study stations were related to the numerical abundance of common and/or dominant macrobenthic species (*Branchiura sowerbyi*, *Limnodrilus hoffmeisteri*, *Bellamya bengalensis* and *Bithynia cerameopoma*). Highest density was observed in May (4888 no/m²) at IMT1 and in September (4000 no/m²) at IMT2. The minimum density was recorded in February (978 no/m²) at station IMT1 and in July (1244 no/m²) at station IMT2. Differences in numerical abundance of dominant macrozoobenthic species at the stations were responsible for the month-wise variations of total benthos density.

The monthwise macrobenthic biomass of total benthos (Tables 2 and 3) ranged from 52.79 gm/m² in December to 2540.77gm/m² in March at station IMT2. Lower abundance of various larger macrobenthic species in December month was responsible for the minimum values of biomass of the pond.

Table 2 : Monthwise population density of different macrozoobenthic species, total benthos density and biomass at IMT1.

Group/ Species	Month (2007-2008)											
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Oligochaeta												
Bs	44	0	0	0	44	0	44	89	133	89	0	0
Crustacea												
Ss	89	0	0	0	0	44	0	0	0	0	0	89
MI	44	0	0	0	0	0	0	0	0	0	0	0
Insecta												
H. sp.	89	0	0	0	0	0	0	0	0	0	0	0
Mayfly	44	0	0	0	0	0	0	0	0	0	0	0
Gastropoda												
Bb	178	178	711	800	933	1511	1999	1155	667	331	755	1822
Bc	755	1422	755	844	22	133	178	889	44	711	578	1555
Go	133	267	0	44	0	0	133	0	0	0	44	89
Tt	89	0	0	267	44	0	89	44	0	0	222	1022
Tl	0	44	0	178	0	44	0	133	44	89	222	178
Tg	0	0	0	0	0	0	0	1378	0	0	0	44
La	0	0	0	44	00	0	44	0	0	0	0	0
Li	89	0	44	0	0	0	89	0	0	0	44	44
Gc	44	0	0	44	44	0	0	0	0	44	0	44
Gl	0	0	0	44	0	0	0	0	0	0	0	0
Ie	44	0	44	0	0	44	178	0	0	0	0	0
Bivalvia												
Lm	89	0	0	0	0	0	0	222	0	44	89	0
Total Benthos (no/m²)	1733.16	1910.92	1555.4	2266.44	1288.76	1777.6	2754.3	3910.72	977.68	1288.76	1955.36	4888.4
Biomass (gm/m²)	1012.93	188.87	183.75	413.64	270.017	462.35	721.35	1714.01	407.115	1030.61	654.379	796.59

Table 3 : Monthwise population density, total benthos density and biomass of common macrozoobenthic species at IMT2.

Group/Species	Month (2007-2008)											
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Polychaeta												
Ns	0	0	0	0	44	0	0	0	44	0	0	0
Oligochaeta												
Bs	89	0	133	0	44	267	133	133	89	0	44	0
Bh	0	0	133	222	89	222	0	0	0	0	0	0
Dc	0	0	0	0	44	0	0	44	0	0	0	0
Crustacea												
Ss	133	0	0	0	0	44	0	44	0	44	0	44
MI	133	0	0	0	0	0	0	0	0	0	0	0
Insecta												
Cl	44	0	0	0	0	0	0	0	0	0	0	0
H. sp.	44	0	0	0	0	0	0	0	0	0	0	0
Isopod	44	0	0	0	0	0	0	0	0	0	0	0
Mayfly	44	0	44	0	0	0	0	0	0	0	0	0
Dragonfly	44	0	44	0	0	0	0	0	0	0	0	0
Gastropoda												
Bb	489	622	444	1289	356	489	667	978	1733	1111	578	667
Bc	311	489	667	1822	444	89	489	311	755	889	1555	533
Go	89	44	178	178	89	0	0	0	0	44	89	44
Tt	89	0	44	89	89	44	133	89	0	133	267	489
Tl	44	0	44	89	0	44	44	0	0	0	0	0
La	44	0	0	44	0	0	0	0	0	0	0	0
Ll	0	0	44	89	0	44	0	0	44	0	0	0
Gc	89	44	0	0	0	0	0	0	0	0	0	0
Ie	89	44	0	0	89	44	44	0	0	0	0	0
Bivalvia												
Lm	178	0	0	178	0	0	0	0	400	178	89	178
Total Benthos (no/m²)	2044.26	1244.3	1777.6	3999.6	1288.8	1333.2	1511	1599.84	3066.36	2399.76	2621.96	2177.6
Biomass (gm/m²)	1954.71	111.54	82.97	406.88	90.79	105.86	52.795	1521.14	2355.19	2540.77	623.182	1406.3

Note : Insect species (adult) were not encountered after removal of weeds in June 2007.

Community analysis

Benthic macroinvertebrates play an important role in determining the health of the aquatic ecosystem for their specialized mode of sessile and semi-sessile life. Community indices or biotic indices based on benthic community are extensively used to determine the status of the waterbodies (Harkantra and Parulekar, 1994; Ghosh and Banerjee, 1996; Ravera, 2001; Mukherjee and Nandi, 2004). In the present investigation, six different biotic indices for each of the two stations are presented in Table 4.

Table 4 : Biotic community indices at the stations of Indian Museum Tank.

Indices	IMT 1	IMT 2	Impression
Simpson's index (c)	0.58 (0.27-0.777)	0.70 (0.577-0.89)	Species diversity is higher at IMT 2 than IMT1 representing the increase of average species resulting in the lowering of the coexisting species at IMT1.
Margalef's index (d)	3.04 (2.708-3.341)	3.04 (2.773-3.227)	Moderately healthy water condition at two sites.
Shannon-Weiner index (H')	1.22 (0.609-2.024)	1.52 (1.71-2.545)	IMT 1 is more polluted than IMT 2; Number of individuals and distribution of macrobenthic species within the community is higher at IMT2.
Evenness index (e)	0.38 (0.192-0.637)	0.48 (0.337-0.801)	Higher concentration of species dominance at IMT1 than IMT2.
Berger-Parker index (BP)	0.32 (0.045-0.744)	0.31 (0.067-0.593)	Even distribution of dominant species at both the sites.
Menhinick index (M)	0.55 (0.343-0.768)	0.55 (0.379-0.680)	Moderate number of species; larger food chain and complex food web at both the sites.

Simpson's index of dominance values ranged in between 0.27-0.777 at IMT1 and 0.577-0.89 at IMT2. The Margalef's diversity index varied from 2.708-3.341 at IMT1 and 2.773-3.227 at IMT2. The analysis of H' never exceeded 2.545 in both the study stations. Evenness index showed values ranging from 0.192 to 0.801 in Indian Museum Tank. BP index was recorded highest (0.744) and lowest (0.045) at the same station (IMT1). Highest value of M index (0.768) was noticed at IMT1. The minimum values were recorded 0.343 in IMT1 and 0.379 in IMT2. From the analysis of the diversity and biotic indices used to assess the water quality of the tank, it can be suggested that the water quality is better at IMT2 than IMT1 though the whole waterbody reveals moderately polluted condition. Biotic indices also indicating that the species diversity is higher at IMT2 which might be due to better habitat condition.

Statistical analysis

The biotic and abiotic data obtained from the present investigation were subjected to different statistical analysis, namely i) Pearson's correlation coefficient through SPSS10 and ii) Canonical correspondence analysis through CANOCO 4.5 (ter Braak and Smilauer, 2002)

to find out the interdependence of biological components and water chemistry of Indian Museum Tank.

Pearson's correlation coefficient

Pearson's correlation coefficients were calculated to determine a relationship between every physico-chemical parameters of water and biotic variables, *i.e.*, the density of species, groups and biotic indices. Significant correlations are presented in Tables 5-8.

Population density of oligochaete (*Branchiura sowerbyi*) exhibited significant negative correlations with water temperature at IMT1 and atmospheric temperature at IMT2 and also showed significant positive correlation with NO_3 at IMT2 which indicates that the species prefers polluted water and remained in burrows in sunny weather. Another oligochaete species *Branchiodrilus hortensis* showed significant positive correlation with BOD ($r = 0.688$, $p < 0.01$) representing its tolerance to polluted condition and significant negative correlation with hardness of water at IMT2.

The freshwater crab species *Sartoriana spinigera* was positively related with BOD at IMT1 and with chloride at IMT2. The prawn species *Macrobrachium lamarrei* exhibited significant positive correlation with BOD ($r = 0.631$, $p < 0.05$ at IMT1), alkalinity ($r = 0.737$, $p < 0.01$ at IMT1 and $r = 0.674$, $p < 0.05$ at IMT2), chloride ($r = 0.69$, $p < 0.01$ at IMT1 and $r = 0.776$, $p < 0.01$ at IMT2). The coleopteran insect species *Canthydrus laetabilis*, *Hydrovatus* sp and insect larvae showed the same relationship with the above mentioned water parameters. Mayfly was significantly positively correlated with BOD and chloride at IMT1, alkalinity ($r = -0.737$, $p < 0.01$ at IMT1 and $r = 0.607$, $p < 0.05$ at IMT2) and showed significant negative correlation with water transparency at IMT2 which indicate its preference of clear water. Dragonfly larvae was positively correlated with alkalinity at IMT2 and significantly negatively correlated with transparency at IMT2. It is to be mentioned that most of the arthropod species were abundant before the removal of aquatic weeds in the pond.

Amongst the predominant gastropod species *Bellamya bengalensis* showed significant negative correlation with pH ($r = -0.805$, $p < 0.01$) and chloride ($r = -0.71$, $p < 0.01$) at IMT1 and significant positive correlation with transparency ($r = 0.609$, $p < 0.05$) at IMT2. Another gastropod *Gabbia orcula* was correlated positively with NO_2 at IMT1, atmospheric temperature and water temperature at IMT2 and negatively with NO_3 at IMT2. *Lymnea acuminata* at IMT1 exhibited positive significant correlation with PO_4 at IMT1 whereas *Lymnea luteola* showed significant positive correlation with alkalinity at IMT1 and BOD at IMT2. Density of *Gyraulus convexiusculus* was affected by four water parameters, *viz.*, alkalinity, hardness, transparency and chloride at IMT2. *Gyraulus labiatus* was also related with transparency at IMT1, alkalinity, hardness and chloride at IMT2. *Indoplanorbis exustus* exhibited positive significant correlation with PO_4 at IMT1.

Table 5 : Correlation coefficients between biotic components and abiotic factors at IMT1.

Biotic components	Significant correlations (r) with abiotic components								
	AT	WT	BOD	pH	Alkali	Transpa	Cl ₂	PO ₄	NO ₂
Bs		-0.631							
Ss			0.764						
Ml			0.631		0.737		0.69		
Hsp			0.631		0.737		0.69		
Mayfly			0.631		0.737		0.69		
Bb				-0.805			-0.71		
Bc	0.614								
Go									0.731
La								0.674	
Ll					0.197				
Gl						0.835			
Ie								0.924	

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Table 6 : Correlation coefficients between biotic components and abiotic factors at IMT2.

Biotic components	Significant correlations (r) with abiotic components							
	AT	WT	BOD	Alkalinity	Hardness	Transparency	Cl ₂	NO ₃
Bh			0.688		-0.6			
Bs	-0.639							0.581
Ss							0.586	
Ml				0.674	0.726		0.776	
Cl				0.674	0.726		0.776	
Hsp				0.674	0.726		0.776	
Isopod				0.674	0.726		0.776	
Mayfly				0.607		-0.756		
Dragonfly				0.607		-0.756		
Bb						0.609		
Go	0.815	0.811						-0.604
Ll			0.655					
Gc				0.694	0.741	-0.658	0.849	
Gl				0.674	0.726		0.776	

Correlation is significant at the 0.01 level (2-tailed)

Correlation is significant at the 0.05 level (2-tailed)

Groupwise analysis (Table 7) revealed that Annelida were significantly negatively correlated with water temperature ($r = -0.593, p < 0.05$) at IMT1 and hardness ($r = -0.611, p < 0.05$)

at IMT2. Five water parameters viz., BOD, alkalinity, hardness, transparency, and chloride exerted significant correlation on arthropod population density. Only biomass of macrozoobenthos showed significant positive correlation with hardness ($r = 0.577$, $p < 0.01$) at IMT2.

Biotic indices like c , H' , e and BP exhibited significant correlations with six water parameters viz. atmospheric temperature, water temperature, BOD, pH, alkalinity and chloride at IMT (Table 8). Index of dominance (c) was significantly negatively correlated with atmospheric temperature, BOD, alkalinity and chloride at IMT1. BOD, alkalinity and chloride exerted positive correlation with H and e . BP exhibited significant positive correlation with atmospheric temperature at IMT1 and IMT2, water temperature at IMT1.

Table 7 : Correlation coefficients between groups, biomass and abiotic factors in Indian Museum Tank.

Parameter	Biotic components at study sites				
	IMT 1		IMT 2		
	ANNELIDA	ARTHROPODA	Biomass	ANNELIDA	ARTHROPODA
Water Temp.	-0.593				
BOD		0.756			
pH					
Alkalinity		0.698			0.671
Hardness			0.577	-0.611	0.683
Transparency					-0.597
Cl ₂		0.591			0.747

Table 8 : Correlation coefficients between biotic indices and abiotic factors in Indian Museum Tank.

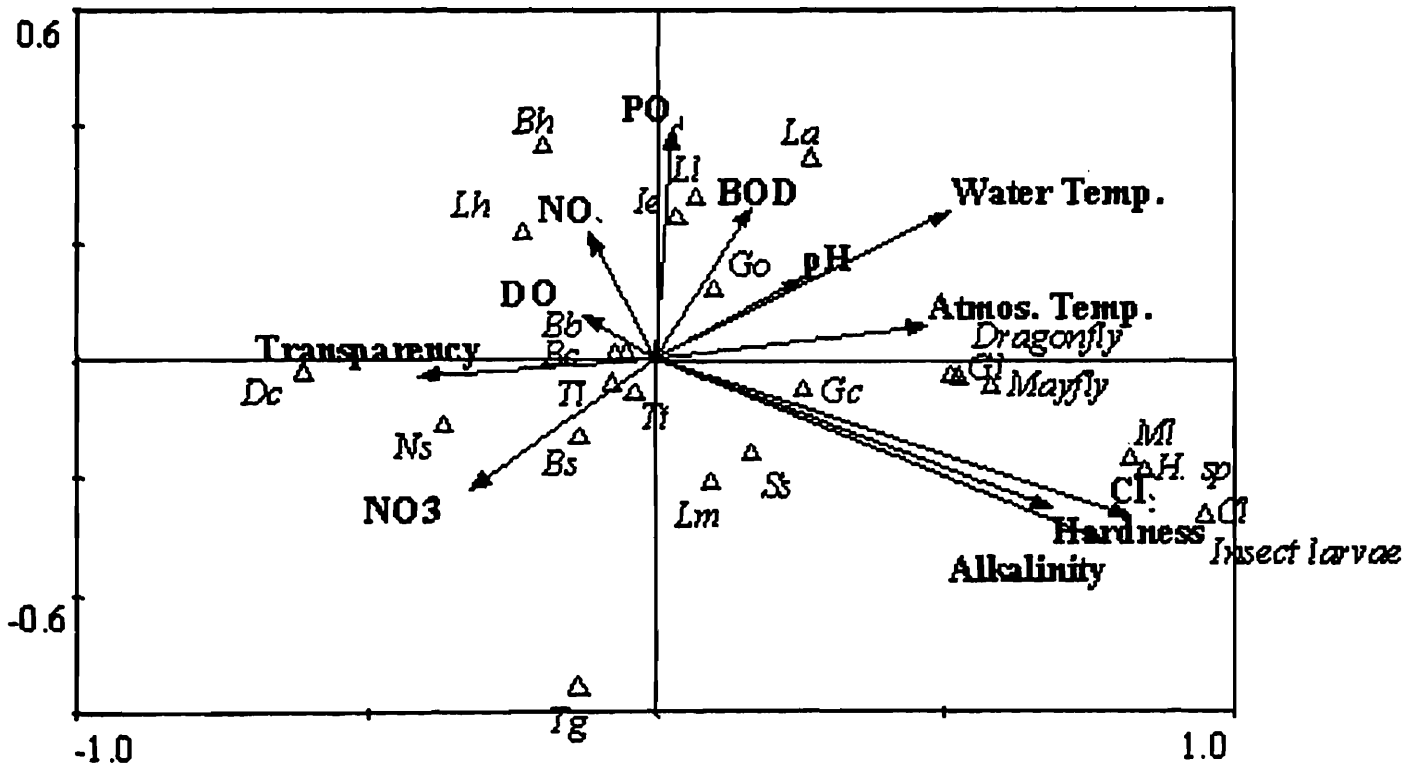
Parameter	Biotic indices at study sites				
	IMT 1				IMT2
	c	H	e	BP	BP
Atm. Temp.	-0.578			0.685	0.654
Water Temp.				0.679	
BOD	-0.595	0.649	0.649		
pH			0.811		
Alkalinity	-0.61	0.7	0.7		
Hardness					
Transparency					
Cl ₂	-0.619	0.697	0.697		

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Canonical Correspondence Analysis (CCA)

Canonical correlation analysis showed a significant relationship between species distribution and water parameters like chloride content and nitrate content. Forward selection of environmental variables for CCA of Indian Museum Tank showed that chloride ($F = 2.53$, $p = 0.002$) and nitrate ($F = 1.59$, $p = 0.04$) were statistically significant. The first two axes represented 42.5% of the species-environmental relationship. Ordination diagram (Fig. 1) shows that a number of macrozoobenthic species (*Macrobrachium lamarrei*, *Canthyrus laetabilis*, *Hydrovatus* sp and insect larvae) were associated positively with chloride content of water. *Branchiura sowerbyi*, *Nais simplex*, *Tarebia lineata* and *Thiara tuberculata* were associated with nitrate. The whole analysis revealed that other species viz. *Bellamyia bengalensis* and *Bithynia cerameopoma* were associated with DO, *Limnodrilus hoffmeisteri* and *Branchiodrilus hortensis* were related to nitrite, BOD exerted correlation on *Lymnea acuminata*, *Gabbia orcula* and *Lymnea luteola*. *Indoplanorbis exustus* was associated with phosphate, dragonfly and mayfly larvae were related with the temperature. Hardness and alkalinity exerted relationship on *Gyraulus convexiusculus*, *Satoriana spinigera* and *Lamellidens marginalis*, while *Dero cooperi* was closely related with transparency.



DISCUSSION

Among the 26 macrozoobenthic species collected from IMT, five species of oligochaetes, two species of decapods crustaceans, one insect larva, four species of insects, 11 species of gastropod and one bivalve species have been recorded. Mukherji and Nandi (2004) reported 32 benthic species comprising of two species of oligochaetes, three species of hirudineans, four species of crustaceans, four species of insects, 14 species of gastropods

and five bivalve species from two large lakes of Kolkata metropolitan city, while each lake harboured 29 macrobenthic species. Mandal and Moitra (1975) observed 21 macrozoobenthic species from the wetlands of Burdwan district of West Bengal. Sarkar (1992) recorded 13 species from a lentic pond of Kolkata. Ghosh and Banerjee (1996) reported 12 species from a managed freshwater pisciculture pond. In general, the composition and density of macrobenthic species depends on lake area, climatic and geographical conditions, number of samples taken, analytical procedures and time and technique of sampling (Ali *et al.*, 1978; Victor *et al.*, 1981 and Sarkar, 1989). Thus it appears that the Indian Museum Tank harbor higher diversities than other pond ecosystem in Kolkata.

In the present study, diversity of macrozoobenthic species, mainly the arthropods, was high in presence of vegetation. Learner *et al.* (1971) noticed that aquatic macrophyte supported the presence of aquatic insect. Rao (1981), Nirmalakumari and Nair (1984) and Pandit *et al.* (1985) reported the association of hemipteran insect with macrophytes. Detailed report is available on the relationship between macroinvertebrates and macrophytes from two lake ecosystems studied by Pal and Nandi (2006). They have recorded high number of insects in weed infested water area. Presence of oligochaete species of Tubificidae family at both the sites reflected pollution in the water body. It was more evident when water level was low. The importance oligochaete species as indicator of increased eutrophication is well documented by Brinkhurst (1965) and Brinkhurst and Cook (1974).

Gastropod species among Mollusca dominated over other macrozoobenthic groups recorded from Indian Museum Tank. Among the gastropods *Bellamyia bengalensis*, *Bithynia cerameopoma*, *Gabbia orcula*, *Thiara tuberculata* and *Tarebia lineata* were the most abundant species. Most of these species were high in premonsoon to early monsoonal months at both the sites. Okland (1990) reported that the presence of macrophytes and substratum explains most of the differences in gastropod distribution in the littoral zone of lakes, while Mouthon (1992) and Martin *et al.* (2000) claimed organic enrichment of the waterbody for the high density of gastropods.

Maximum macrozoobenthic density in premonsoon was probably related to the abundance of predominant benthic group (Cowell and Vodopich, 1981), food availability (Peeters *et al.*, 2004) with growth of plankton, environmental variables (Elexova and Nemethova, 2003), pond fertilization (Chakrabarti, 1987) and water temperature (Mukherji and Nandi, 2004). Lower population density during monsoon or postmonsoon season was due to habitat disturbance, rise of water level and heavy rainfall (Singh and Roy, 1991; Mukherji and Nandi, 2004). In the present investigation habitat disturbance through the removal of aquatic weeds of the pond also influenced the variation of population density of macrobenthic species and total benthos density. The higher values of biomass at both the sites were related mainly with the presence of bivalve *Lamellidens marginalis*. Sarkar (1989), Gupta and Pant (1990) and

Mukherji and Nandi (2004) reported that the fluctuation in estimated biomass of total benthos is related with the composition and benthic population density.

In the present study, higher values of Simpson's index (c) indicated higher species diversity in macrozoobenthic community at IMT2. Margalef's index values of the pond indicated moderately healthy waterbody. Margalef's and Menhinick's index reflects the suitability of habitat for the organism in one hand while, on the other hand, it is correlated with larger food chain and complex food web of the ecosystem. In contrast, water condition at IMT1 showed more polluted condition through H' diversity indices values (Wilhm and Dorris, 1968). Evenness index values showed significance of greater equitability in the distribution of individuals among the species in both the study points as well as moderate concentration of species dominance. A slightly higher value of BP index is attributed to IMT2 than IMT1 which indicates higher diversity of species at IMT2 than that of IMT1 as also revealed from faunal composition in these two sites (25 species in IMT2 vs. 18 species in IMT1).

On the basis of statistical analysis of the present investigation it appears that the environmental parameters monitored had a strong significant effect on the macrobenthic faunal composition and distribution in Indian Museum Tank. Among the recorded 26 macrozoobenthic species, 17 species exhibited relationship with at least one of the 11 environmental variables. The population of oligochaete species *Branchiura sowerbyi* decreased with the higher temperature indicating its preference towards burrowing nature and *Branchiodrilus hortensis* population increased with the elevated level of BOD and decreased with the increased hardness values of the waterbody. Among the arthropods, most of the species flourished with the higher level of BOD and organic enrichment. Higher transparency level i.e. higher amount of light penetration was not preferred by dragonfly larvae as they mostly inhabit weed infested water area where sunlight does not penetrate much to the bottom in the littoral zone.

Population of two gastropod species viz. *Bithynia cerameopoma* and *Gabbia orcula* were associated with increased temperature as their juveniles were recorded more in premonsoon or early monsoon season. *Bellamya bengalensis* population decreased with the higher pH and chloride content and flourished with the intensity of sunlight penetration. Pollution tolerant lymnaeid species like *Lymnea acuminata* and *Lymnea luteola* persisted in polluted condition with increased level of phosphate, alkalinity and BOD whereas the bithynid gastropod species *Gabbia orcula* was not tolerant to nitrate. The planorbid species *Gyraulus convexiusculus* preferred the shaded area as it was negatively related with transparency but showed affinities with organic enrichment of water. Another planorbid species *Gyraulus labiatus* also showed same trend except transparency. This species preferred well lighted area. The other species of the same family, *Indoplanorbis exustus*, another pollution tolerant species, exhibited its ability to withstand higher phosphate concentration.

Group-level study undertaken in this investigation revealed that annelids preferred lower water temperature and soft water whereas arthropods could withstand polluted condition of water to some extent but they preferred shaded area where sunlight did not penetrate so much. The investigation of Martin *et al.* (2000) in Tamiraparani river of India documented direct relationship of crustacean population with BOD of water. According to Pal and Nandi (2006) macrophyte is the most important determining factor for insect population which is in accordance with the present findings. Molluscs can flourish in the presence of different salt concentration of the waterbody. It was also evidenced in the present study as the biomass of total macrozoobenthos comprising mainly of mollusk species became higher with the increased level of hardness.

Diversity of species in Indian Museum Tank decreased with the rise of atmospheric temperature, BOD, alkalinity and chloride content of the waterbody as the ecological relationship with Simpson's index (Index of dominance) and environmental parameters shown in the present investigation leading to an increase of an average number of species in macrozoobenthic population. Dominance of lower variety (in size) of species increased with temperature rise and pH as BP index was related with those factors. Evenness of species diversity in the population of Indian Museum Tank preferred higher BOD, alkalinity and chloride content of water.

On the basis of CCA and its graphic interpretation it can be inferred that there is significant influence of organic enrichment on the population of macrozoobenthos and mainly on decapod crustacean and oligochaeta species in the tank. It is further inferred that the macrozoobenthic species composition, their abundance and community structure in Indian Museum Tank were the result of complex interactions of various environmental factors. However, in the present investigation, the most important factors affecting the macrozoobenthic population distribution and abundance were temperature and organic enrichment of the water body.

SUMMARY

The present paper deals with the benthic faunal composition, population density, total benthos and biomass along with statistical analysis to find out the interrelationship between benthic invertebrates and abiotic factors in Indian Museum Tank, Kolkata. This tank harbor higher macrozoobenthic diversities (26 species) than other pond ecosystem in Kolkata. Gastropod species among Mollusca dominated over other macrozoobenthic groups in the study sites. Maximum total benthic density (4888 no/m²) was recorded in premonsoon season. Biotic indices values indicated moderately healthy waterbody. According to statistical analysis, the most important factors affecting the macrozoobenthic population distribution and abundance were temperature and organic enrichment of the water body.

SPONGE (*EUNAPIUS CARTERI*) ASSOCIATES

INTRODUCTION

During the course of faunistic survey in the Indian Museum Tank numerous small invertebrates are found associated with freshwater sponges, *Eunapius carteri* (Bowerbank, 1863). The sponges serves as a favourable substratum for a number of metazoans, such as insects, crustaceans, annelids, nematodes and mollusks (Roback, 1968; Pennak, 1978).

Annandale (1906, 1911) investigated on few freshwater fauna associated with *Spongilla carteri* in Calcutta. The aim of this present investigation is to examine the existence of faunal associations with sponges and their composition in the Indian Museum Tank.

The sponges were collected on March, 5, 2009 from five different locations and were transported to the laboratory. They were rinsed thoroughly in freshwater and the water sieved through 50 mm plankton net and the faunal collections were preserved in 5% formaldehyde and studies.

A total of 15 species represented by various groups mollusca (04), decapoda (02), copepoda (01), cladocera (01), ostracoda (01), diptera (01), odonata (02) and among phytoplankton, chlorophyceae (01) and bacillariophyceae (02) were recorded (Table 1).

Association of crustaceans, molluscs and chironomous larvae with sponges were already reported from earlier works and it has often been suggested that sponge associates utilize plankton and organic particles concentrated in the water flowing through the incurrent and excurrent canals of the sponges (Anger, 1972; West, 1976; Zavodnik, 1976; Westinga & Hoetjes, 1981; Bongers, 1983; Costello & Myers, 1987). Klitgaard, (1995) explicate the morphology of the sponges as well as the possible influence of secondary metabolites from sponges can be expected to be determining factors in the composition of an associated fauna in waters.

Table 1 : List of Organisms Associated with Sponge (*Eunapius carteri*)

Sl. No.	Name of Species	Loc 1	Loc 2	Loc 3	Lo 4	Loc 5
1.	MACROFAUNA–Mollusca-Gastropoda					
2.	Planorbidae– <i>Gyraulus convexiusculus</i> (Hutton, 1849)	+	+	+		+
3.	Lymnaeidae– <i>Lymnaea luteola</i> Lamarck, 1822		+		+	
4.	Thiaridae– <i>Thiara lineata</i> (gray, 1828)	+		+	+	+
	<i>Brotia costula</i> (Rafinesque, 1833)	+	+			
5.	Crustacea–Decapoda					
6.	Palaemonidae– <i>Macrobrachium lammrrei</i>					
	(H. Milne Edwards, 1837)			+		
7.	Potamonidae– <i>Sartoriana spinigera</i>					
	(Word-Mason, 1971)		+			
	Juvenile crabs			+		
8.	Odonata					
9.	Dragonfly nymph	+	+	+	+	+
	Damselfly nymph		+	+	+	
10.	MICROFAUNA–Copepoda					
11.	Harpacticoid nauplii	+			+	+
12.	Harpacticoid copepodite	+	+			
13.	Cyclopoid copepodite		+	+	+	+
	<i>Microcyclops varicans</i> (Sars, 1918) brood female	+		+		
14.	Cladocera					
15.	<i>Kurzia longirostris</i> (Daday 1898)	+	+	+		+
	Resting eggs	+		+		+
16.	Ostracoda					
17.	<i>Paracyprretta subglobosa</i> (Sowerby 1840)				+	
18.	<i>Strandesia indica</i> Hartmann, 1964		+			+
	Larvae	+	+	+	+	+
19.	Diptera					
	Chironomid larvae	+	+	+	+	+
20.	Phytoplankton					
	Chlorophyceae– <i>Spirogyra</i> sp.	+	+	+	+	+
21.						
22.	Bacillariophyceae– <i>Navicula rhynchocephala</i>	+	+	+		+
23.	<i>Gomphonema</i> Colonies	+	+	+	+	
	<i>Tabellaria</i> sp.	+	+	+	+	+
	Total number of taxa	15	15	16	12	14

WEED ASSOCIATED INSECTS

The weed associated organisms especially insects inhabiting lakes and ponds constitute an extremely diverse assemblage, both taxonomically and ecologically. In striking contrast to the marine environment, insects are extremely important and are proportionately more abundant in dilute oligotrophic waterbodies than in less dilute eutrophic waters. They are integral part of freshwater ecosystem and play a vital role in the trophic dynamics of freshwater wetlands. Macrophytes or aquatic weeds are known as the most important determining factor for diversity, composition and distribution of insect species as well as population in water body (Bhattacharya and Gupta, 1991; Nandi *et al.*, 2001; Pal and Nandi, 2006). In the present paper, a preliminary study on the species composition of aquatic weed associated insects have been investigated in June 2008, from the stacked aquatic weeds on land collected about 36 hours after the removal and deweeding from the Indian Museum Tank.

The sampled specimens were identified using the literature (Tonapi, 1980; De and Sengupta, 1993) as well as consulting experts of this department. The aquatic macrophyte species (Table-1) and insect species (Table-2) obtained in this study are listed as follows :

Table 1 : List of aquatic macrophyte species from which insects were collected

Family	Species
Family CONVOLULACEAE	<i>Ipomea aquatica</i>
Family SALVINIACEAE	<i>Azolla filiculoides</i>
Family HYDROCHARITACEAE	<i>Hydrilla verticillata, Vallisneria spiralis</i>
Family CERATOPHYLLACEAE	<i>Ceratophyllum demersum</i>
Family ALISMATACEAE	<i>Sagittaria sagittifolia</i>
Family AMARANTHACEAE	<i>Alternanthera</i> spp
Family MARSILEACEAE	<i>Marsilea minuta</i>

The collected insect species are listed in order of abundance as follows :

Table 2 : List of insect species collected from the aquatic macrophyte stacked on land

HEMIPTERA : BELOSTOMIDAE	<i>Diplonychus annulatus</i> (Fabricius)
COLEOPTERA : DYTISCIDAE	<i>Canthydrus morsbachi</i> (Wehncke), <i>Hydrovatus</i> sp.
EPHEMEROPTERA	Mayfly larvae
ODONATA : COENAGRIONIDAE	Dragonfly larvae
ODONATA : LIBELLULIDAE	<i>Brachythemis</i> sp.
DIPTERA : CHIRONOMIDAE	Chironomid larvae

Pal and Nandi (2006) noticed that aquatic insects are widely associated with aquatic macrophytes which support higher abundance of insects and reported that submerged vegetation of macrophytes is mostly preferred by phytofaunal community. Rai and Dutta Munshi (1978) have observed the abundance of chironomid larvae in weed infested areas of shallow pond. Tonapi (1980) recorded that some species of coleopteran insect deposit their eggs on the roots of aquatic plants and some lay eggs on floating vegetation. However, further investigation is needed to reveal the aquatic insect diversity of this tank.

MACROPHYTE ASSOCIATES

INTRODUCTION

The aquatic vegetation mainly macrophyte belonging to submerged floating and emergent categories form an important element of the aquatic environment, universal in its significance for manufacturing food for aquatic heterotrophic communities. They also provide suitable surface area for shelter, site for oviposition, development, resting and nesting ground in addition to ambient weather and hiding places for macroinvertebrates, fishes and other organisms. Several aquatic communities like to live in weed environment for their feeding and breeding purposes (Jones and Sujansingani, 1954; Ramamohana Rao and Kaliyamurthy, 1974). In the present study, the macrophyte (*Ipomoea aquatica*) associated fauna were well focused through the assessment on their abundance and composition.

Ipomoea aquatica (Forssk) is a common emergent aquatic plant known as water spinach, swamp morning-glory, that can grow freely up to 20 meters with profuse branching over the water surface or over marshy ground and bears beautiful flowers. They may form dense masses of tangled vegetation, thus developing impenetrable canopies over the water surface, restricting light penetration into the depths.

The present investigation reveals three major components, namely, phytoplankton, zooplankton (rotifera, cladocera, copepoda and ostracoda). and macrofauna. Macrofauna comprised of Annelida (Oligochaeta), Mollusca (Gastropoda) and Arthropoda (Crustacea and Insecta). A total of 20 species, Annelida (Oligochaeta-1 genera, 1 species); Mollusca (Planorbidae-2 genera, 3 speices; Lymnaeidae-1 genera, 2 speices; Thiaridae-2 genera, 4 speices; Bithynidae-1 genera, 1 speices; Viviparidae-1 genera, 1 speices) and Palaemonidae belongs to crustacea bears 1 genera, 1 speices and 7 species were identified upto genera level from insect group among the macrofauna from five different samples of *Ipomoea aquatica* (Table 1).

Oligochaetes were the dominant constituent of macrofauna. The faunal composition varies in the following order Annelida < Mollusca < Arthropoda (Diptera).

However the results of the survey clearly indicate the *Ipomoea aquatica* associated fauna and few flora confirms the suitability for conservation of diverse elements.

Microfauna mainly comprises on rotifera, cladocera, copepoda, ostracoda, phytoplankton (algae) and other miscellaneous organisms from the collection. A total of 12 species, phytoplankton (8 genera, 8 species); copepoda (cyclopoida-2 genera, 2 speices), cladocera (1 genera, 1 species); Rotifera (1 genera, 1 speices) and Among phytoplankton *Gomphonema*

colonies, *Spirogyra* sp. and *Phormidium* sp. were higher in contribution and occurred in all the samples. The percentage composition of zooplankton as follows., ostracoda < miscellaneous < cyclopoida < cladocera < harpacticoida < rotifera.

Table 1 : List of faunal assemblage with *Ipomoea aquatica*

Major groups	Species occurring in <i>Ipomoea aquatica</i>
Macrofauna	Oligochaeta - <i>Allonais inaequalis</i> (Stephenson, 1911)
	Gastropoda - <i>Gyraulus convexiusculus</i> (Hutton, 1849), <i>G. labiatus</i> (Benson, 1850), <i>Indoplanorbis exustus</i> (Deshayes, 1834), <i>Lymnaea luteola</i> Lamarck, 1822, <i>L. acuminata</i> , <i>Thiara lineata</i> (Gray, 1828), <i>Brotia costula</i> (Rafinesque, 1833), <i>Thiara granifera</i> (Lamarck, 1822), <i>Thiara tuberculata</i> (Mueller, 1774), <i>Gabbia orcula</i> Frauenfeld, 1862, and <i>Bellamyia bengalensis</i> (Lamarck, 1822)
	Crustacea - <i>Macrobrachium lammrrei</i> (H.Milne Edwards,1837)
	Insecta -Nymph of <i>Cloeon</i> sp, <i>Canthydrus</i> sp., <i>Ranatra</i> sp., Chironomid larva, Nymphs of Dragon flies, Nymphs of Damsel flies
	Arachnida - <i>Lycosa</i> sp.
Phytoplankton	<i>Gomphonema</i> sp. colonies, <i>Spirogyra</i> sp, <i>Ulothrix</i> sp., <i>Synedra</i> sp., <i>Closterium</i> sp., <i>Tabellaria</i> sp., <i>Navicula rhynchocephala</i> , <i>Phormidium</i> sp.
Zooplankton	Crustacea
	Copepoda - <i>Paracyclops fimbriatus</i> , <i>Eucyclops prascinus</i> , cyclopoid nauplii, cyclopoid copepodite, harpacticoid nauplii
	Cladocera -Neonates, <i>Simocephalus vetulus</i>
	Ostracoda -Cypris larvae
	Rotifera - <i>Hexarthra intermedia</i>
	Others -Sponge gemmules, Spicules of sponge, Nematodes

EFFECT OF SUNLIGHT AND SHADE ON BENTHOS

INTRODUCTION

Benthic community is controlled by abiotic factors (Wetzel and Likens, 1991; Bechara, 1996) including sunlight availability. Keeping this in mind the present study was taken up to understand the effect of sunlight on the distribution and abundance of macrozoobenthic species in the Indian Museum Tank (IMT) through monthly sampling of benthic macroinvertebrates from an open and a shaded site of the tank. It is expected that this study may excite the attention of future researchers to undertake further specific habitat related research on freshwater ecosystem to affirm the impact of sunlight.

MATERIALS AND METHODS

Study area

The tank in the compound of Indian Museum of Kolkata (latitude 22°33.394' -22°33.412'N and longitude 88°21.115' -88°21.101' E) is a rectangular shaped fish-pond mainly fed by rain water. Eastern side of this waterbody is guarded by a wall; near the southern side there are rows of quarters whose members use this pond for bathing, washing and disposal of their household refuses. Other two sides have sloping banks with trees. Observations for the present study were made from two study stations for one year from June 2007-May 2008. Characteristic features of two study stations are tabulated in Table-1.

Methods

Physico-chemical parameters of the water were measured following standard methods of APHA (1998) and Mukherji and Nandi (2004). The qualitative benthic samplings were done with the aid of a box-type (15cm x 15cm) sampler (Mukherji and Nandi, 2004) and sieve (0.5mm mesh size). Collected organisms were sieved, sorted and preserved in 4% formalin or 70% alcohol.

One year monthly data from two sites of Indian Museum Tank (IMT1 and IMT2), Kolkata were analyzed to understand the effect of sunlight and shades on the limnology and distribution of macrozoobenthic species and their abundance. Pearson's correlation coefficients were calculated to evaluate the parametric relationships between the atmospheric temperature, water temperature, transparency and benthic macroinvertebrate species supposedly in interaction. The two tailed t test was used to test the correlation coefficients at 5% and 1% level of significance.

Table 1 : Characteristic features of the studied sites of Indian Museum Tank.

Characteristics	IMT 1	IMT 2
Tree shade	Fully Shaded (95%)	Fully Open (5% shade)
Sunlight availability	Very less (5%)	Very high (95%)
Macrophyte cover	Very Low 5(%)	Low (15%)
Presence of leaf litter	High	Low
Soil condition	Silty	Coarse sandy
Anthropogenic activity	Medium	Negligible

RESULTS AND DISCUSSION

Hydrology

The water chemistry of two study stations in Indian Museum Tank for a period of one year indicate slight variations (Table-2) within these two stations for being small water body.

Water temperature which depends on the sunlight varied from 22°C to 34°C at shaded site i.e. station IMT1 whereas this showed slightly higher value (23°C-35°C) at station IMT2 of the tank which is an open site. Atmospheric temperature was also comparatively lower at station IMT1 (24°C-36.2°C) than station IMT2 due to the presence of tree shades. Transparency of water was lower (83.25 cm) at site IMT1. Other water parameters (pH and DO) show slightly higher values at shaded site (IMT1).

Table 2 : Mean, standard deviation and ranges of physico-chemical parameters of air and water at two study sites of Indian Museum Tank.

Parameter	IMT 1 (Shaded site)	IMT 2 (Open site)
Atmospheric Temp. (°C)	31.08 ± 4.37 (24.00-36.20)	31.51 ± 4.39 (24.20-36.80)
Water Temp. (°C)	29.85 ± 4.32 (22.00-34.00)	30.15 ± 4.13 (23.00-35.00)
Transparency (cm)	85.92 ± 37.00 (45.00-184.00)	83.25 ± 24.86 (41.00-120.00)
DO (mg/l)	4.30 ± 1.48 (2.3-7.15)	4.22 ± 1.097 (2-6.3)
pH	8.00 ± 0.5 (7.2-8.8)	7.97 ± 0.32 (7.5-8.5)

Diversity, total benthos and biomass of macrozoobenthos

Qualitative samplings of macrozoobenthos in Indian Museum Tank revealed the presence of 26 species belonging to three phyla comprising six major groups viz. Polychaeta, Oligochaeta, Crustacea, Insecta, Gastropoda and Bivalvia. The collected macrozoobenthic species are listed in Table 3.

Table 3. List of macrozoobenthic species collected from IMT1 and IMT2 of Indian Museum Tank.

Phylum ANNELIDA	Phylum ARTHROPODA	Phylum MOLLUSCA
Class POLYCHAETA	Class CRUSTACEA	Class GASTROPODA
<i>Namalycastis</i> sp.	<i>Sartoriana spinigera</i> (Wood Mason)	<i>Bellamyia bengalensis</i> (Lamarck)
Class OLIGOCHAETA	<i>Macrobrachium lamarrei</i> (H. M. Edw.)	<i>Bithynia (Digoniostoma)</i> <i>cerameopoma</i> (Benson)
<i>Bothrioneurum hortensis</i> *	Class INSECTA	<i>Gabbia orcula</i> (Nevill)
<i>Limnodrilus hoffmeisteri</i> Claparede*	Chironomid larvae	<i>Thiara tuberculata</i> (Müller)
<i>Dero cooperi</i> *	<i>Canthydrus morsbachi</i> * (Wehncke)	<i>Tarebia lineata</i> (Gray)
<i>Branchiura sowerbyi</i> Beddard	<i>Hydrovatus</i> sp.*	<i>Tarebia granifera</i> (Lamarck)
<i>Nais simplex</i> Pignet	Insect larvae	<i>Lymnaea acuminata</i> (Lamarck)
	<i>Diplonychus annulatus</i> * (Fabricius)	<i>Lymnaea luteola</i> (Lamarck)
	Dragonfly larvae*	<i>Gyraulus convexiusculus</i> (Hutton) <i>Gyraulus labiatus</i> (Benson) <i>Indoplanorbis exustus</i> (Deshayes)
		Class BIVALVIA
		<i>Lamellidens marginalis</i> (Lamarck)

Note : All the species except *Nais simplex* occur in IMT2, while asterisk (*) indicates species present only at open site (IMT2).

Out of the six major groups Gastropoda represented highest diversity of 11 species. The presence of pollution indicator oligochaete species, viz., *Branchiura sowerbyi* of Tubificidae family in both the stations indicates eutrophic status of the pond. However, station IMT2, an open site for light penetration represented highest diversity of 25 species of macrozoobenthos (Table-3) including oligochaetes (*Bothrioneurum hortensis*, *Limnodrilus hoffmeisteri* and *Dero cooperi*), while the station IMT1, a shaded site, revealed 18 species including *Nais simplex* exclusively at this site.

Total benthos density and biomass (Table 4) ranged from 978-4888 no/m² and 184-1714 gm/m² respectively at shaded site (IMT1), while the same varied from 1244-4000 no/m² and 53-2541 gm/m² respectively at the open lighted site (IMT2). It is evident that the mean density (2192 no/m²) of the shaded site is higher than the open site (2088 no/m²). But in spite of higher total benthos density, the mean biomass value of shaded site is much lower (655 gm/m²) than the open site (938 gm/m²).

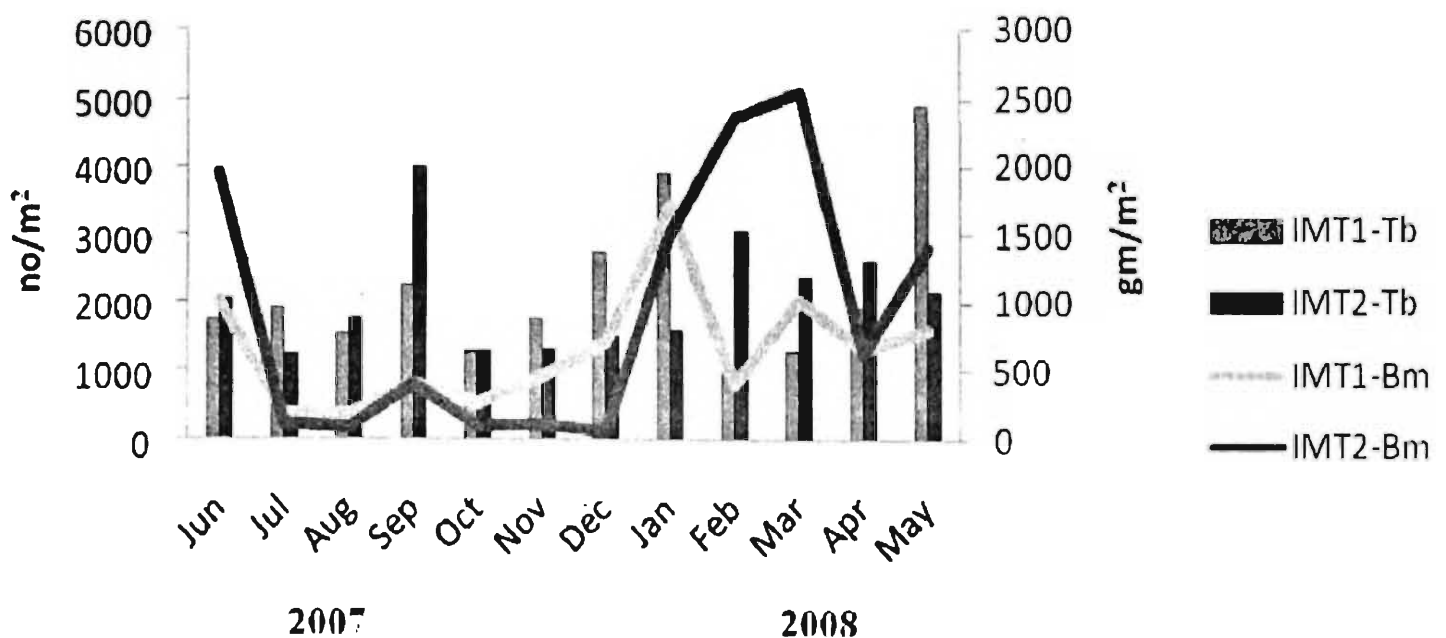
Table 4 : Biotic components recorded from Indian Museum Tank.

Parameters	IMT1 (shaded)	IMT2 (open)
Species Diversity (no.)	18	25
Total Benthos (nos/m ²)	2192.29 ± 1151.09 (977.68-4888.40)	2088.69 ± 830.74 (1244.32-3999.60)
Biomass (gm/m ²)	654.63 ± 443.08 (183.75-1714.01)	937.67 ± 961.03 (52.79-2540.77)

The month-wise total benthos density (Fig. 1) varies from 978 no/m² in February to 4888 no/m² in May at IMT1, while it ranges from 1244 in July to 4000 no/m² in September at IMT2. The variations in month-wise numerical abundance at these two stations are related with mobile epibenthic molluscs, the dominant group of this waterbody and their continuous breeding habit (Muley, 1977) and also appears to be related with the differential illumination or the light penetration at these sites. The month-wise total benthos and biomass value (Fig. 1) indicate highest biomass in late post-monsoon/winter months (January to March). The month-wise variations are mostly related with the numerical abundance of dominant gastropod species (*Bellamya bengalensis*, *Bithynia cerameopoma*, *Gabbia orcula* and thiarid species) along with one bivalve species (*Lamellidens marginalis*). In general, lower abundance of larger sized molluscan species was responsible for lower biomass value at the shaded site.

Statistical analysis

The biotic and abiotic data obtained from the present investigations were subjected to statistical analysis, namely, Pearson's correlation coefficient to find out the interdependence of biological components with some abiotic factors of water of Indian Museum Tank.

**Fig. 1** : Month-wise total benthos density (Tb) and biomass (Bm) at IMT1 and IMT2.

Pearson's correlation coefficient :

Pearson's correlation coefficients were calculated to determine a relationship between every physico-chemical parameters of water and biotic variables i.e. the density of species, groups and biotic indices. Only significant correlations are presented in Tables-5 and 6.

Population density of *Branchiura sowerbyi* exhibited significant negative correlations with water temperature at IMT1 and atmospheric temperature at IMT2. Insect larvae which prefers shade and macrophyte vegetation i.e. Mayfly and Dragonfly larvae were significantly negatively correlated with water transparency at IMT2. The predominant gastropod species *Bellamya bengalensis* showed significant negative correlation with pH ($r = 0.805, p < 0.01$) at IMT1 and positive correlation with transparency ($r = 0.609, p < 0.05$) at IMT2. *Gabbia orcula* was positively related with atmospheric temperature and water temperature at IMT2. Densities of *Gyraulus labiatus* and *Gyraulus convexiusculus* were affected by transparency at IMT1 and IMT2 respectively.

Table-5 : Significant correlation coefficient (r value) between different benthic species/groups and abiotic factors in IMT1 (AT = Air temperature; WT = Water temperature).

Group and Species	AT	WT	pH	Transparency
<i>Branchiura sowerbyi</i>		-0.631		
<i>Bellamya bengalensis</i>			-0.805	
<i>Bithynia cerameopoma</i>	0.614			
<i>Gyraulus labiatus</i>				0.835
Annelida		-0.593		

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Table-6 : Significant correlation coefficient (r value) between different benthic species and abiotic factors in IMT 2 (AT = Air temperature; WT = Water temperature).

Species	AT	WT	Transparency
<i>Branchiura sowerbyi</i>	-0.639		
Mayfly larvae			-0.756
Dragonfly larvae			-0.756
<i>Bellamya bengalensis</i>			0.609
<i>Gabbia orcula</i>	0.815	0.811	
<i>Gyraulus convexiusculus</i>			-0.658

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

In the present study, diversity of macrozoobenthic species was found to be high in open insolated site. A perusal of literature suggests that the variations of total benthos density are related with several factors like environmental variables (Elexova and Nemethova, 2003), food availability (Peeters *et al.*, 2004), trophic state of the wetland (Cowell and Vodopich, 1981), pond fertilization (Chakrabarti, 1987), *etc.* Sarkar (1989), Gupta and Pant (1990) and Mukherji and Nandi (2004) reported that the fluctuation in estimated biomass of total benthos is related with the composition and benthic population density of the wetland which is in accordance with the present study.

It is also evident that the environmental parameters especially sunlight availability had a strong significant effect on the macrobenthic faunal composition and distribution in Indian Museum Tank as the open site supports higher diversity of species and also biomass than the shaded site. It can be stated that the sunlight helps plants, algae and algal detritus to grow and thereby make the water productive for macrozoobenthic invertebrates.

SUMMARY

The diversity of macrozoobenthic species and their abundance were investigated in an open and a shaded site of Indian Museum tank, Kolkata. Diversity of species was recorded highest (25 species) at open site (IMT1) than the shaded site. Mean biomass was also highest at the open site. Total benthos density of macrozoobenthos was, however, higher at the shaded IMT1. The greater numerical abundance of molluscan macrozoobenthic species was responsible for higher biomass at the open site which appears to be associated with habitat suitability supported by sunlight and food availability.

BIBLIOGRAPHY

- Agarkar, S.V., Bhosale, A.B. and Patil, P.M. 1998. Physico-chemical analysis of drinking water from Buldhana district (M.S.). *J. Aqua. Biol.*, **13** (1 & 2) : 62-63.
- Agrawal, V.C., Das, P.K., Chakraborty, S., Ghose, R.K., Mondal, A.K., Chakraborty, T.K., Poddar, A.K., Lal, J.P., Bhattacharya, T.P. and Ghosh, M.K. 1992. Mammalia. *State Fauna Series 3: Fauna of West Bengal, Part 1* : 27-169, Zoological Survey of India.
- Alfred, J.R.B., Sinha, N.K. and Chakraborty, S. 2002. Checklist of Mammals of India. *Rec. Zool. Surv. India. Occ. Paper No. 199* : 1-289.
- Ali, S., Haque, A.S.M., Oppenheimer, J.R. and Aziz, K.M.S. 1978. Studies on the bottom fauna of three fish ponds in Dacca (Bangladesh). *Bangladesh J. Zool.*, **6** : 43-55.
- Alikunhi, A. 1957. Fish culture in India. *FM. Bull. Indian Coun. agric. Res.*, **20** : 144.
- Allman, G.J. 1856. *A Monograph of the Freshwater Polyzoa*. Ray Society, London. **1** : 119 pp.
- Anand, N. 1989. *Indian Freshwater microalgae*. Bishen Singh Mahendra Pal Singh. Dehradun. Delhi.
- Anand, N. 1998. *Handbook of Blue Green Algae*. Bishen Singh Mahendra Pal Singh. Dehradun, Delhi.
- Anderson, H.H. 1889. Notes on Indian Rotifers. *J. Asiat. Soc. Bengal*, Calcutta, **58**(2) : 345-358.
- Anderson, J. 1881. *Catalogue of Mammalia in the Indian Museum, Calcutta, Part I*.
- Anger, K. 1972. *Dipurena spongicola* sp.n. (Hydrozoa, Corynidae), ein in Schwammen lebender Hydroid polyp aus dem Kattegat und der nordlichen Kieler Bucht.–*Kieler Meeresforsch.*, **28** : 80-83.
- Anitha, G., Kodarkar, M.S., Chandrasekhar, S.V.A. and Nalini, G.G. 2004. Studies on macrozoobenthos in Mir Alam Lake, Hyderabad, Andhra Pradesh. *J. Aqua. Biol.*, **19**(1) : 61-68.
- Annandale, N. 1907a. Notes on freshwater sponges VI-VII. *Rec. Indian Mus.*, **1**, 387-392.
- Annandale, N. 1905. Notes on the Indian worm of the genus *Chaetogaster*. *J. Asiat. Soc. Beng.*, **1** : 117-120.
- Annandale, N. 1905. The Hydra of the Calcutta Tanks. *J. Asiat. Soc. Bengal (N.S.)*, **1** : 72-73.
- Annandale, N. 1906. Notes on freshwater fauna of India. V. Some animals found with *Spongilla carteri* in Calcutta. *J. Asiat. Soc. Bengal (N. S.)*, **2** : 187-196.
- Annandale, N. 1907b. Notes on freshwater fauna of India. IX. Description of new freshwater sponges from Calcutta, with a record of two known species from the Himalayas and a list of Indian forms. *J. Asiat. Soc. Bengal (N.S.)*, **3** : 15-26.

- Annandale, N. 1909. Preliminary note on a new genus of Phylactolaematous Polyzoa, *Rec. Ind. Mus.*, **3** : 279.
- Annandale, N. 1911. Freshwater sponges, Hydroids and Polyzoa. *The Fauna of British India*. 1-261. Taylor & Francis, London.
- Annandale, N. and Paiva, C.A. 1906. Notes on freshwater fauna of India. VI. The life history of an aquatic Weevil. *J. Asiat. Soc. Bengal (N.S.)*, **2** : 197-200.
- Anonymous. 1994-1998. State Fauna Series 3, Fauna of West Bengal. Published by Zoological Survey of India, Kolkata.
- Anonymous. 1997. *Flora of West Bengal*. Vol. 1, Botanical Survey of India, Kolkata.
- Anonymous, 2004. The Indian Museum 1814-1914, Calcutta. Trustees of the Indian Museum.
- APHA, 1998. *Standard Methods for the Examination of Water and Wastewater*. 20th edition. American Public Health Association, Washington, D.C.
- Banerjee, P. and Banerjee, S. 2005. Macrobenthic fauna in relation to soil and water quality of a portion of Hooghly estuary from Konnagar to Bally, West Bengal. *Environ. & Ecol.*, **23**(3) : 687-690.
- Battish, S.K. 1992. *Freshwater zooplankton of India*. Oxford and IBH Publ. Co. Pvt. Ltd. 1-114 pp.
- Beach, M.J. and Pascoe, D. 1998. The role of *Hydra vulgaris* (Pallas) in assessing the toxicity of freshwater pollutants. *Wat. Res.*, **32** : 101-106.
- Bechara, J.A. 1996. The relative importance of water quality, sediment composition and floating vegetation in explaining the macrobenthic community structure of floodplain lakes (Paraná River, Argentina). *Hydrobiol.*, **333** : 95-109.
- Behmer, D.J. and Hawkins, C.P. 2006. Effects of overhead canopy on macroinvertebrate production in a Utah stream. *Freshwater Biology*, **16**(3) : 287-300.
- Benson, B. and Boush, G.M. 1983. Effect of pesticides and PCBs on budding rates of green *Hydra*. *Bull. Environ. Contam. Toxicol.*, **30** : 344-350.
- Berger, W.H. and Parker, F.L. 1970. Diversity of planktonic foraminifera in deep sea sediments. *Science*, **168** : 1345-1347.
- Bhattacharya, D.K. and Gupta, B. 1991. Fresh water wetland inhabiting insects of West Bengal. *Environ. & Ecol.*, **9**(4) : 995-998.
- Bindu, L. 2010. Freshwater ciliates (Protozoa) from Kolkata wetlands. *Rec. zool. Surv. India*, **110**(2) : 81-88.
- Blanchard, 1897. *Glossiphonia weberi*, *Zool. Ergeb. Einer Reise in Niederlandische Ost.*
- Blyth, E. 1863. *Catalogue of Mammalia in the Museum Asiatic Society*. Calcutta (Asiatic Society in Bengal).

- Bongers, T. 1983. Bionomics and reproductive cycle of the nematode *Leptosomatum bacillatum* living in the sponge *Halichondria panicea*. *Neth. J. Sea Res.*, **17** : 39-46.
- Bosch, T.C.M. and Khalturin, K. 2002. Patterning and cell differentiation in *Hydra*: novel genes and the limits to conservation. *Can. J. Zool.*, **80** : 1670-1677.
- Bowerbank, 1863. A Monograph of the Spongillidae. *Proc. zool. Soc. Lond.*, 1863 : 440-472.
- Brinkhurst, R.O. 1965. The biology of the Tubificidae with special reference to pollution. *Proc. 3rd Sem. Env. Health Ser. Wat. Sup. Poll. Cont. Cincinnatti, Ohio*, pp. 57-66.
- Brinkhurst, R.O. and Cook, D.C. 1974. Aquatic earthworms (Annelida : Oligochaeta). In : Hart, Jr. C.W. and Fuller, S.L.H. (eds.). *Pollution Ecology of Freshwater Invertebrates*, pp. 143-156. Academic Press, New York.
- Brinkhurst, R.O. and Jamieson, B.G.M. 1971. *Aquatic oligochaeta of the world*. Oliver and Boyd. Edinburgh, 860 pp. Fig. 1.1-15.14.
- Campbell, R.D. and Bode, H.R. 1983. Terminology for Morphology and cell types In : Lenhoff HM (Ed.), *Hydra Research Methods*, pp. 5-14. Plenum Press, New York.
- Cantor, T. 1842. General features of Chusan, with remarks on the flora and fauna of that island. *Ann. Mag. nat. Hist., London*, **9** : 361-370.
- Carter, 1849. A descriptive account of the freshwater sponges (Genus *Spongilla*) in the Island of Bombay, with observation on their structure and development. *Ann. Mag. nat. Hist.*, **4** : 81-100.
- Cash, J. and Hopkinson, J. 1905. *The British Freshwater Rhizopoda and Heliozoa*. Vol. 1, Rhizopoda, Part-1. J. Ray Society, London.
- Cash, J. and Wailes, G.H. 1915. *The British Freshwater Rhizopoda and Heliozoa*. Vol. 3. Rhizopoda, Part-3. J. Ray Society, London.
- Cash, J. and Wailes, G.H. and Hopkinson, J. 1919. *The British Freshwater Rhizopoda and Heliozoa*, Vol. 4. J. Ray Society, London.
- Chakrabarti, N.M. 1987. Macrobenthic fauna of a sewage fed fish pond. *Environ. & Ecol.*, **5**(1) : 149-153.
- Chakrabarti, S. Ghosh, G. and Hore, T.B. 1985. 'Final report on the environmental geoscientific studies in Calcutta Metropolitan Area' (Field Session 1982-1985). Environmental Geology Division, Geological Survey of India, pp. 1-70.
- Chakraborty, K.R. 1991. The urbanization trend in the Calcutta Metropolitan District : A projective analysis. In : B. Dasgupta *et al.* (eds.). *Calcutta's Urban Future*, Govt. of West Bengal, Calcutta, pp. 112-133.
- Chanda, S.K. 2002. *Handbook-Indian Amphibians* : i-viii, 1-335 Zoological Survey of India, Kolkata).

- Chandra, 1977. *Glossiphonia weberi*, *Rec. zool. Surv. India*, **73**(1-4) : 189-195.
- Chandra, M. 1983. A check-list of leeches of India. *Rec. zool. Surv. India*, **80** : 265-290.
- Cook, C.D.K. 1996. *Aquatic and Wetland Plants Of India*. Oxford University Press.
- Costello, M.J. & A.A. Myers 1987. Amphipod fauna of the sponges *Halichondria panicea* and *Hymeniacion perleve* in Lough Hyne, Ireland.-*Marine Ecology Progress Series*, **41** : 115-121.
- Cowell, B.C. and Vodopich, D.S. 1981. Distribution and seasonal abundance of benthic macroinvertebrates in a subtropical Florida Lake. *Hydrobiol.*, **78** : 97-105.
- Cummins, K.W. and Lauff, G.H. 1969. The influence of substrate particle size on the microdistribution of stream macrozoobenthos. *Hydrobiol.*, **34** : 145-181.
- De Mann, J.G. 1908. The fauna of brackish ponds at Port Canning, Lower Bengal. Part 10. Decapod Crustacea with an account of a small collection from brackish water near Calcutta and in the Dacca District, Eastern Bengal. *Rec. Indian Mus.*, **2**(3) : 211-231, pls. 18-19.
- Das, A.K., Mondal, A.K. and Sarkar, N.C. 1993. Freelifving Protozoa. *State Fauna Series 3 Fauna of West Bengal*, Part 12 : 1-133, Zoological Survey of India.
- Das, A.K. 1971. *Leptopharynx chlorophagus* sp.nov. (Ciliata : Protozoa) from freshwater of West Bengal, India. *Curr. Sci.*, **40** : 195-196.
- Das, A.K. and Chattopadhyay Piyali, 1997. Role of protozoa in environmental biomonitoring. *Proc. zool. Soc., Calcutta*, **50** : 19-22.
- De (Pal), M. and Sengupta, T. 1993. Beetles (Coleoptera : Insecta) of wetlands of Calcutta and its surroundings. *Rec. zool. Surv. India*, **93** (1-2) : 103-138.
- Deb, M. 1998. Crustacea : Decapoda: Crabs. *State Fauna Series 3 : Fauna of West Bengal, Part 10* : 345-403, Zoological Survey of India.
- Desikachary, T.V., 1988. *Atlas of Diatoms*. Madras Science foundation. Fascicles (i-v).
- Dhanapathi, M.V.S.S.S., 2000. Taxonomic notes on the Rotifers from India (from 1889-2000). *Indian Association of Aquatic Biologists* **10** : 169 pp.
- Dussart, B.H and D., Defaye, 1995. *Copepoda. Introduction to the Copepoda*. SPB. Academic Publ., Netherlands, **7** : 1-253.
- Edmondson, W.T. 1959. *Freshwater Biology*, II edition, John Wiley and Sons Inc. New York. 420-494.
- Edmonson, W.T. 1966. Changes in the oxygen deficit of Lake Washington. *Verh. Int. Verein. Limnol.*, **16** : 153-158.
- Elexová, Emilla and Nemethová, D. 2003. The effect of abiotic environmental variables on the Danube macrozoobenthic communities. *Limnologica*, **33** : 340-354.
- Finn, F. 1917. *The birds of Calcutta*. Thacker, Spink & Co., Calcutta, pp. 1-166.

- Frey, D.G. 1967. Phylogenetic relationships in the family Chydoridae (Cladocera). *Proc. Symp. Crustacea*, Part. I. 29-37. Marine Biological Association of India.
- Galliot, B. and Schmid, V. 2002. Cnidarians as a model system for understanding evolution and re-generation. *Int. J. Dev. Biol.*, **46** : 39-48.
- Gerking, S.D. A method of sampling the littoral macrofauna and its application. *Ecology*, **38** : 219-226.
- Ghosh, A.K. 1990. Biological resources of wetlands of East Calcutta. *Indian J. Landscape System and Ecol. Studies*, **13**(1) : 10-23.
- Ghosh, A.K. 1991. Ecology and environment of Calcutta. In : B. Dasgupta *et al.* (eds.). *Calcutta's Urban Future*, Govt. of West Bengal, Calcutta, pp. 60-83.
- Ghosh, E. 1918. Studies on Infusoria. *Rec. Indian Mus.*, Calcutta, **15** : 129-134.
- Ghosh, E. 1919. Studies on Infusoria. II. On two new species of *Holophrya* Ehrenberg. *Rec. Indian Mus.*, Calcutta, **16** : 41-43.
- Ghosh, E. 1920. Infusoria from Bengal. Report Sci. Convension Indian Ass. *Cult. Sci.*, for 1918, Calcutta : 144-149.
- Ghosh, E. 1921a. Infusoria from the environment of Calcutta. *Bull. Carmichael med. Coll.*, Calcutta, **2** : 6-17.
- Ghosh, E. 1921b. New hypotiichous Infusoria from Calcutta. *J. roy. Micr. Soc.*, London, 1921 : 248-250.
- Ghosh, E. 1922. New species of *Vorticella* from Calcutta. *Bull. Carmichael med. Coll.*, Calcutta, **3** : 8-18.
- Ghosh, E. 1928. Two new ciliates from sewer water. *J. roy. Micr. Soc.*, London, 1928 : 382-384.
- Ghosh, E. 1929. Two new suctoria from sewer water. *J. roy. Micr. Soc.*, London, 1929 : 222-223.
- Ghosh, G.C. 1998. Leech. *State Fauna Series 3. Fauna of West Bengal*. Part **10** : 227-249, Zoological Survey of India.
- Ghosh, M.K. and Banerjee, S. 1996. Macrobenthic faunal diversity of two freshwater pisciculture ponds of West Bengal. *Proc. zool. Soc.*, Calcutta, **49**(2) : 171-192.
- Govind, B.V. 1969. Bottom fauna and macrovegetation in the Tungabhadra Reservoir and their role in the food chain of fish communities. In : Seminar on "*Ecology and Fisheries of Freshwater Reservoirs*", ICAR, CIFRI Barrackpore, 27th-29th November, 1969, pp. 99-128.
- Gray, 1867. Notes on the arrangement of sponges, with the description of some new genera. *Proc. zool. Soc. Lond.*, 1867 : 492-558.

- Gray, J.S., Wu, R. S-s. and Or, Y.Y. 2002. Effects of hypoxia and organic enrichment on the coastal marine environment. *Marine Ecology Progress Series*, **238** : 249-279.
- Green, J. 1962. Fresh water ecology in the Mato Grosso, Central Brazil II. Associations of Cladocera in meander lakes of the Rio Suie' Missu. *J. Nat. Hist.*, **6** : 215-227.
- Gupta S.D. 1976. Macrobenthic fauna of Loni reservoir. *J. Inland Fish. Soc. India*, **8** : 49-59.
- Gupta, P.K. and Pant, M.C. 1990. Distribution and seasonal abundance of benthic macroinvertebrates in lake Nainital, Uttar Pradesh, India. *Int. Revue. ges. Hydrobiol.*, **75**(4) : 493-506.
- Gurney, R. 1906. On some freshwater entomostraca in the collection of the Indian Museum, Calcutta. *J. Asiat. Soc. Bengal., (N.S.)*. **2** : 273-281.
- Gurney, R. 1907. Further notes on Indian Indian freshwater Entomostraca. *Rec. Indian Mus.*, **1** : 21-33.
- Gurney, R. 1907. Further notes on Entomostraca of Lower Bengal and Chota Nagpur. *Rec. Indian Mus.*, **1** : 21-35.
- Harding, W.A. and Moore, J.P. 1927. *Fauna British India. Hirudinea*, London, pp. 1-302.
- Harding, 1924. *Helobdella nociva*, *Ann. Mag. Nat. Hist., Ser. 9*, **14** : 489.
- Harkanta, S.N. and Parulekar, A.H. 1994. Soft sediment dwelling macroinvertebrates of Rajapur bay, central west coast of India. *Indian J. Mar. Sci.*, **23** : 31-34.
- Hasler, A.D. 1947. Eutrophication of lake by domestic drainage. *Ecology*, **28** : 288-295.
- Hooper, J.N.A. & Van Soest, R.W.M. (Ed.) 2002. *Systema Porifera : Guide to classification of sponges*. Kluwer Academic/Plenum Publishers, New York. Vol. I & II : 1-1707.
- Horsfield, T. 1851. *A Catalogue of the Mammalia in the Museum of the Hon. East India Company*. London. (J. & H. Cox.).
- Hyne, R., Rippon, G.D. and Ellender, G. 1993. Investigation of uranium-induced toxicity in fresh-water *Hydra*. In : Dallinger R and Rainbow P (Eds.), *Ecotoxicology of Metals in Invertebrates*. CRC press, Florida.
- Jain, S.K. 1999. *Medicinal Plants* (Reprinted edition). National Book Trust, India.
- Jenkin, P.M. 1934. Report on the Percy Sladen Expedition to some Rift valley lakes in Kenya in 1929. Cladocera from the Rift valley lakes in Kenya. *Ann. Mag. Nat. Hist.*, **13** : 281-308.
- Jha, P. and Barat, S. 2003. Hydrobiological study of lake Mirik in Darjeeling Himalayas. *J. Environ. Biol.*, **24**(3) : 339-344.
- Jones, S and Suransinghani, K.H. 1954. Fish and fisheries of the Chilka lake with statistics of fish catches for the years 1948-1950. *Indian J. Fish.*, **1**, 256-344.

- Kaburaki, 1921. *Nematobdella indica*, *Rec. Indian Mus.*, **22** : 689-719.
- Kaller, M.D. and Hartman, K.J. 2004. Evidence of a threshold level of fine sediment accumulation for altering benthic macroinvertebrate communities. *Hydrobiol.*, **518** : 95-104.
- Karntanut, W. and Pascoe, D. 2005. Effects of removing symbiotic green algae on the response of *Hydra viridissima* (Pallas 1776) to metals. *Ecotox. Environ. Saf.*, **60** : 301-305.
- Kessler, E., Huss, V.A.R. and Rahat, M. 1988. Species-specific ability of *Chlorella* strains (Chlorophyceae) to form stable symbioses with *Hydra viridis*. *Plant. Syst. Evol.*, **160** : 241-246.
- Kirkagac, M. and Demir, N. 2004. The effects of Grass carp on aquatic plants, plankton and benthos in ponds. *J. Aquat. Plant Manage.*, **42** : 32-39.
- Klitgaard, A.B. 1995. The fauna associated with outer shelf and upper slope sponges (Porifera, Demospongiae) at the Faroe Islands, northeastern Atlantic. *Sarsia*, **80** : 1-22. *Bergen*. ISSN 0036-4827.
- Korovchinsky, N.M. & N.N. Smirnov. 1993. Introduction to the "Cladocera" International training course : Zooplankton as a tool in Lake Management. Univ. Ghent Belgium : 39 p.
- Krishnamurthy, K.N. 1966. Preliminary studies on the bottom macrofauna of the Tungabhadra reservoir. *Proc. Indian Acad. Sci.*, **63(B)** : 96-103.
- Krishnaswamy, S. 1957. Studies on the Copepoda of Madras. *J. Mad. Univ.*, **23(1)** : 61-75; **23(2)** : 101-144.
- Kumar, A. 1997. Impact of organic pollution on the ecology of river Mayurakshi with special reference to macrozoobenthos. *Poll. Res.*, **14(3)** : 189-201.
- Kumar, A. and Gupta, H.P. 2002. Ecobiodiversity of aquatic biota in certain freshwater ecosystems of Santal Pargana (Jharkhand), India. In : A.. Kumar (ed.), *Ecology and Ethology of Aquatic Biota. Vol. II*. Daya Publishing House, New Delhi. Pp. 1-70.
- Kumar, A. and Singh, R.N.R. 1998. Biodiversity and pollution status of Masanjore Reservoir (South Bihar) in relation to certain abiotic factors. *Ecology Environment and Conservation*, **4(3)** : 139-144.
- Learner, M.A.R., Wifflams, M.H. and Hughes, B.D. 1971. A survey of the macrofauna of the river Cynon, a polluted tributary of the river. Taff (South Wales). *Freshwater Biology*, **1** : 339-367.
- Mahajan, K.K. and Nair, K.N. 1965. On some freshwater ciliates (Protozoa) from Calcutta and its environs. *Rec. zool. Surv. India*, **63** : 2-22.
- Maitland, P.S. 1978. *Biology of freshwater*. Blackwell Book Co., London.

- Majumdar, N., Roy, C.S., Ghosal, D.K., Dasgupta, J.M., Basuroy, S., Datta, B.K. 1992. Aves. *State Fauna Series 3 : Fauna of West Bengal, Part 1* : 171-418.
- Manakadan, R. and Pitte, A. 2001. Standardised common and Scientific names of the Birds of the Indian Subcontinent. *Buceros*. **6**(1).
- Mandal, B.K. and Moitra, S.K. 1975. Studies on the bottom fauna of a freshwater fishpond at Burdwan. *J. Inland Fish. Soc. India*, **7** : 43-48.
- Mandal, C.K. 1996. On the occurrence of the two Leeches; *Hemiclepsis marginata asiatica* and *Placobdella fulva* in West Bengal. *Sci. Cult.*, **62** : (5-6) : 164.
- Mandal, C.K. 2002. Checklist of the Hirudinea (Leech) of India. *Rec. zool. Surv. India* : **102** (Part1-2) : 41-46.
- Margalef, R. 1958. *Perspective in Ecological Theory*. Univ. Chicago Press, Chicago. 120 pp.
- Martin, P., Haniffa, M.A. and Arunachalam, M. 2000. Abundance and diversity of macroinvertebrates and fish in the Tamirapani river, South India. *Hydrobiologia*, **430** : 59-75.
- Martin, V.J., Littlefield, C.L., Archer, W.E. and Bode, H.R. 1997. Embryogenesis in *Hydra*. *Biol. Bull.*, **192** : 345-363.
- Massard, Jos. A. and Geimer, Gaby. 2008. Global diversity of bryozoans (Bryozoa or Ectoprocta) in freshwater : an update. *Bull. Soc. Nat. luxemb.*, **109** : 139-148.
- Menhinick, E.P. 1964. A comparison of some species-individual diversity indices applies to samples of field insects. *Ecology*, **45** : 859-861.
- Michael, R.G. and Sharma, B.K. 1988. Indian Cladocera. *Fauna of India. Zoological Survey of India*. 1-262.
- Michaelsen, W. 1900. *Oligochaeta* Das Tierreich. 10. Berlin. 1 : XXIX + 575 p.
- Michaelsen, W. 1909. He Oligochaeta of India, Nepal, Ceylon, Burma and the Andaman Islands. *Mem. Indian Mus.*, **1** : 131.
- Mitra, S.C. and Dey, A. 1992. Land and freshwater mollusks (Part-1). *State Fauna Series 3 : Fauna of West Bengal, Part 9* : 1-51.
- Moore, J.P. 1927. Fauna of British India, Hirudinea, 185-89.
- Moss, B. 1973. The influence of environmental factors and the distribution of freshwater algae on experimental study. The role of pH, CO₂ and bicarbonate system. *J. Ecology*, **6**(1) : 157.
- Mouthon, J. 1992. Snail and bivalve population analysed in relation to physico-chemical quality of lakes in eastern France. *Hydrobiologia*, **245** : 147-156.
- Mukherji, M. and Nandi, N.C. 2004. Studies on macrozoobenthos of Rabindra Sarovar and Subhas Sarovar in Kolkata in relation to water and sediment characteristics. *Rec. zool. Surv. India, Occ. Paper No.* **225** : 1-119.

- Mukhopadhyay, G. and Dewanji, A.** 2005. Presence of tropical Hydrophytes in relation to limnological parameters—a study of two freshwater ponds in Kolkata, India. *Ann. Limnol.—Int. J. Lim.*, **41**(4) : 281-289.
- Mukhopadhyay, S.K.** 1998. Oligochaeta : *State Fauna Series 3 : Fauna of West Bengal*, Part 10, *Zool. Surv. India*, 95-123.
- Mukhopadhyay, S.K.** 2005. *State Fauna Series 5 : Fauna of Andhra Pradesh*, *Zool. Surv. India* : 307-318,
- Muley, E.V.** 1977. Studies on the breeding habits and development of brood pouch of a viviparous prosobranch, *Melania scabra*. *Hydrobiologia*, **54**(2) : 181-185.
- Munawar, M.,** 1970. Limnological studies on freshwater ponds of Hyderabad I. Biotope. *Hydrobiologia*, **35**(1) : 127-162.
- Murugavel, P. and Pandian, T.J.** 2000. Effect of altitude on hydrology, productivity and species richness in Kodayar—a tropical peninsular Indian aquatic system. *Hydrobiologia*, **430** : 33-57.
- Naidu and Naidu,**1981a. Some freshwater oligochaeta from Bombay city and environs. *J. Bombay Nat. Hist. soc.*, **78**(3) : 524-538, 58 figs.
- Naidu, K.V.** 1962a. Studies on freshwater oligochaeta of south India. I. Aeolosomatidae and Naididae. Part-III, *J. Bombay. Nat. Hist. Soc.*, **59**(2) : 520-546., fig. 9-14.
- Nair, K.N.** 1960. On the occurrence of a heterotrichous ciliate, *Metopus spiralis* Smith, 1897 (Protozoa) in India. *Cu. Sci.*, **29** : 435-436.
- Nair, K.N.** 1966. On new records of two loricate peritrichous ciliates from India. *J. zool. Soc. India*, **16** : 87-89.
- Nair, K.N.** 1971. On a new species of hymenostomatous ciliate (Protozoa : Frontoniidae) from India. *Proc. Indian. Acad. Sci.*, **73B** : 74-77.
- Nair, K.N. and Das, A.K.** 1974. On a new and two rare species of freshwater ciliates (Protozoa) from West Bengal, India. *Proc. Zool. Soc., Calcutta*, **27** : 35-39.
- Nair, K.N. and Mukherjee, R.N.** 1968a. On a new species of testacean rhizopod (Protozoa : Euglyphidae) from India. *J. zool. Soc. India*, **20** : 124-127.
- Nair, K.N. and Mukherjee, R.N.** 1968b. On some testacean rhizopods (Protozoa : Sarcodina) of the ground and tree mosses from Calcutta and its environs. *Proc. Nat. Acad. Sci. India*, **38**(B) : 185-192.
- Nair, K.N., Das, A.K. and Mukherjee, R.N.** 1971. On some freshwater rhizopoda and heliozoa (Protozoa) from Calcutta and its environs. Part-1. *Rec. zool. Surv. India*, **65** : 16.
- Nandi, N.C.** 2000. Wetlands of Calcutta metropolis, *ENVIS Newsletter, ZSI*, **6**(2) : 8-12.

- Nandi, N.C. 2004. Conceptual Issues and Approaches to Biodiversity Conservation and Sustainable Development of Wetland Ecosystem. In : *Challenges in Sustainable Development*. Anmol Publications Pvt. Ltd., New Delhi, pp. 46-63.
- Nandi, N.C. 2007. Kolkata Wetlands–Mission Integrated Conservation (*Kolkatar Jalashay-Mission Susanhata Sanraksharan*–in Bengali), 4(1) : 17-18.
- Nandi, N.C. and Mukherji, M. 1996. Prevalence of pearl bearing mussel, *Lamellidens marginalis* (Lamarck) in Calcutta wetlands *Sci. & Cult.*, 62(3-4) : 99-100.
- Nandi, N.C. and Roy, Mousumi. 2007. Ecology and ecosystem services of some selected wetlands of Puruliya district, West Bengal. *J. Environ. & Sociobiol.*, 4(1) : 83-91.
- Nandi, N.C., Bhuinya, S. and Das, S.R. 2004. Notes on mid-winter waterbird population of some selected wetlands of Bankura and Puruliya districts, West Bengal. *Rec. zool. Surv. India*, 102(1-2) : 47-51.
- Nandi, N.C., Das, S.R., Bhuinya, S. and Dasgupta, J.M. 1993. Wetland Faunal Resources of West Bengal. 1. North and South 24-Parganas Districts. *Rec. zool. Surv. India, Occ. Paper No. 150* : 1-50.
- Nandi, N.C., Venkataraman, K., Das, S.R. and Bhuinya, S. 2001. Faunal diversity of wetlands in the Botanical Garden, Haora, West Bengal. *Rec. zool. Surv. India*, 99(1-4) : 111-129.
- Nandi, N.C., Venkataraman, K., Das, S.R. Bhuinya, S. and Das, S.K. 2001. Wetland Faunal Resources of West Bengal. 3. Birbhum District. *Rec. zool. Surv. India*, 99(1-4) : 135-156.
- Nandi, N.C., Venkataraman, K., Das, S.R. Bhuinya, S. and Das, S.K. 2005. Wetland Faunal Resources of West Bengal. 5. Darjiling and Jalpaiguri Districts. *Rec. zool. Surv. India*, 104(1-2) : 1-25.
- Nandi, N.C., Venkataraman, K., Das, S.R., Bhuinya, S. and Das, S.K. 1999. Wetland Faunal Resources of West Bengal. 2. Some selected wetlands of Haora and Hugli Districts. *Rec. zool. Surv. India*, 97(4) : 103-143.
- Naskar, K.R., 1990. Aquatic & semi aquatic plants of lower Ganga delta, Daya publishing house, Delhi-6. p. 173 & 174.
- Netto, S.A. and Lana, P. deCunha. 1997. Benthic macrofauna of *Spartina alterniflora* marshes and nearby unvegetated tidal flats of Paranagua Bay (S E Brazil), *Neritica*, 10 (1-2) : 41-55.
- Nirmalakumari, K.R. and Nair, N.B. 1984. Relative abundance of predatory aquatic insects in the Chackai canal, Trivandrum, India. *Comp. Phyiol. Ecol.*, 9 : 105-113.
- Okland, J. 1990. *Lakes and snails. Environment and Gastropoda in 1500 Norwegian lakes, ponds and rivers*. Universal Book services (ed. W. Backhuys). Oegstgeest, The Netherlands. 516 pp.

- P. Martin, E. Martinez-Ansemil, A. Pinder, T. Tim, M.J. Wetzel, 2008.** Global diversity of oligochaetous clitellates ("Oligochaeta" : Clitellata) in freshwater animal diversity assessment. *Hydrobiologia* DOI 10.1007/s10750-007-9009-1, 595 : 117-127.
- Pakrashi, S.C. and S. Mukhopadhyay (eds.). 2001.** *Medicinal and Aromatic Plants Of*.
- Pal, S. and Nandi, N.C. 2006.** Phytofaunal community of two freshwater lakes of West Bengal, India. *Rec. zool. Surv. India, Occassional Paper No. 248*, pp. 1-146.
- Pandit, A.K., Pandit, S.N. and Kaul, V. 1985.** Ecological relations between invertebrates and submerged macrophytes in two Himalayan lakes. *Poll. Res.*, 4 : 53-55.
- Patnaik, S. 1971.** Seasonal abundance and distribution of bottom fauna of Chilka lake. *J. Mar. Biol. Ass. India*, 13(1) : 106-125.
- Peeters, E.T.H.M., Gylstra, R. and Vos, J.H. 2004.** Benthic macroinvertebrate community structure in relation to food and environmental variables. *Hydrobiol.*, 519 : 103-115.
- Pennak, R.W. 1978.** *Freshwater invertebrates of the United States*. Ronald Press, New York : 803 pp.
- Penney J.T. and Racek, A.A. 1968.** Comprehensive Revision of Worldwide collection of freshwater sponges (Porifera : Spongillidae). *Bull. U. S. natn. Mus.* No. 272 : 184 pp.
- Pielou, E.C. 1966.** The measurement of diversity in different types of biological collections. *J. Theor. Biol.*, 13 : 131-144.
- Pollino, C.A. and Holdway, D.A. 1999.** Potential of two *Hydra* species as standard toxicity test animals. *Ecotox. Environ. Saf.*, 43 : 309-316.
- Prain, D. 1903.** *Bengal Plants*. Vol. 1 and 2. Bishen Singh Mahendra Pal Singh, Dehradun.
- Prasad, B. 1931.** The Indian Museum, Calcutta. *Nat. Hist. Mag.*, London, 3(18).
- Pruthi, H.S. 1933.** Studies on the bionomics of freshwaters in India I. Seasonal changes in the physical and chemocal conditions of the water of the tank in the Indian Museum Compound. *Int. Rev. Ges. Hydrob. Hydrog.*, 28 : 46-67.
- Puri, H.S. 1964.** Ostracods as ecological and palaeoecological indicators. *Publicassioni della Stazione di Napoli*. 33 Supplemento (Symposia, 1963).
- Quade, H.W. 1969.** Cladoceran faunas associated with aquatic macrophytes in some lakes in north western Minnesota. *Ecology*, 50(2) : 70-79.
- Rai, D.N. and Datta Munshi, J.S. 1978.** Studies on the community structure of aquatic macroinvertebrates associated with different types of weed communities of three tropical swamps of North Bihar, Darbhanga. *Proc. Symp. On "Environment Adaptation and Distribution"* Nat. Acad. Sci. India, Shillong. Oct. 25-26, Abst. No. 12.
- Ramakrishna and A. Dey 2007.** *Indian Freshwater Molluscs*. Zoological Survey of India, Kolkata, 399 pp.

- Ramamohana Rao, G and Kaliyamurthy, M. 1974. The abundance and distribution of juveniles of two beloniform fishes in lake Pulicat. *Indian J. Anim. Sci.*, 44(5).
- Ramamohana Rao, G, 1974. Observations on the seasonal abundance and distribution of bottom fauna in lake Pulicat. Abstract. *Seminar on the development of Inland fisheries in Tamil Nadu*, Coimbatore.
- Rangitham, N.S., G. Thirumaran, P. Anantharaman, V.D.R. Nightingale and R. Balasubramanian. 2008. Associated fauna of Seaweeds and seagrasses in Vellar Estuary. *American-Eurasian Journal of Botany*, 1(1) : 9-16.
- Rao, K.S. 1972. Studies on the freshwater Bryozoa. III. The Bryozoa of the Narmada system. *Proc. Second. Inter. Conf. Bryozoa*. IBA. Durham, 1971.
- Rao, K.S. 1976. Studies on fresh water Bryozoa. IV. The Bryozoa of Rajasthan, India. *Rec. Zool. Surv. India*, 69 : 329-345.
- Rao, K.S. and Kulsreshtha, K.S. 1962. Studies on freshwater Bryozoa. I. The bryozoa of Vindhyan region. *J. Univ. Sougor.*, 2B : 50-64.
- Rao, R.R. and B.D. Sharma. 1990. *A manual for Herbarium Collections*. Botanical Survey Of India, Kolkata.
- Rao, T.K.R. 1981. Ecology of the population of some species of aquatic hemiptera. *Proc. Symp. Scol. Anim. Pop. Zool. Sur. India*, 2 : 91-94.
- Raut, S.K. and Biswas, A. 1989. Pearls in fresh water mussels *Lamellidens marginalis* in India (Bivalvia : Unionidae). *Basteria*, 53 : 105-109.
- Ravera, O. 2001. A comparison between diversity, similarity and biotic indices applied to the macroinvertebrate community of a small stream: the Ravella river (Como Province, Northern Italy). *Aquatic Ecology*, 35 : 97-107.
- Reice, S.R. 1980. The role of substratum in benthic macroinvertebrate microdistribution and litter decomposition in a Woodland stream. *Ecology*, 61(3) : 580-590.
- Rey, J.C. and Saint Jean, L. 1968 Les Cladoceres (Crustaces : Branchiopodes) du Tchad (Deuxieme note). *Cah. O.R.S.T. outre Mer. Ser. Hydrobiol.*, 3 : 21-42.
- Roback, S.S. 1968. Insects associated with the sponge *Spongila fragilis* in the Savannah River. *Notulae Naturae*, 412, p. 1-10.
- Roy, A. 2002. A Review On The Medicinal Potentialities Of Macrophytes In India.
- Roy, A. and L.K. Banerjee. 2001. Diversity Of Wetland Flora and Their Management In India. *J. Econ. Taxon. Bot.*, 25(3) : 709-715.
- Roy, M. and Nandi, N.C. 2009. Rise in water temperature of Indian Museum Tank—A hydro-historical study. *J. Environ. & Sociobiol.*
- Ryland, J. 2005. Bryozoa : an introductory overview. *Denisia*, 16 : 9-20.

- Samanta**, 1998. Fresh Water Bryozoa, *State Fauna Series 3 : Fauna of West Bengal*, part-10 : 445-461.
- Sarkar, S.K.** 1989. Seasonal abundance of benthic macrofauna in a freshwater pond. *Environ. & Ecol.*, 7(1) : 113-116.
- Sarkar, S.K.** 1992. Composition and changes of benthic macroinvertebrates of a lentic pond in Calcutta. *Geobios*, 19 : 10-14.
- Schramm, H. Jr., Jirka, K.J and Hoyer, M.V.** 1987. Epiphytic macroinvertebrates on dominant macrophytes in two central Florida lakes. *J. Freshwater. Ecol.*, 4 : 151-161.
- Sewell, R.B.S.** 1926. Investigations regarding an epidemic of fish mortality in the tank in the Indian museum Compound. *J. Asiat. Soc. Bengal (N.S.)*, 22(4) : 177-201.
- Sewell, R.B.S.** 1935. Studies on the bionomics of freshwater in India. II. On the fauna in the tank in the Indian Museum compound and seasonal changes observed. *Int. Revue ges. Hydrobiol.*, 31 : 203-238.
- Sewell, R.B.S.** 1927. Investigations regarding an epidemic of fish mortality in the tank in the Indian Museum. *J. Proc. Asiat. Soc. Beng.*, (N.S.) 22(4) [1926] : 177-201, 1 pl.
- Shannon, C.E. and Weiner, W.** 1949. *The Mathematical Theory of Communication*. University of Illinois Press. Urbana. 117 pp.
- Sharma, B.K.** 1978. Contribution to the rotifer fauna of West Bengal. Part-I. Family Lecanidae. *Hydrobiologia*, 57 : 143-153.
- Sharma, B.K.** 1978. Contribution to the rotifer fauna of West Bengal. Part-II. Genus Lepadella Bory de St. Vincent. *Hydrobiologia*, 58 : 83-86.
- Sharma, B.K.** 1979. Further contributions to the lecanid fauna (Rotifera : Lecanidae) of West Bengal. *Acta Hydrobiol. Krakow*, 21 : 53-59.
- Sharma, B.K.** 1979. Rotifers fauna of West Bengal. Part-III. Further studies on Eurotatoria. *Hydrobiologia*, 64 : 230-250.
- Sharma, B.K.** 1979. Rotifers fauna of West Bengal. Part VI. Further studies on Eurotatoria. *Hydrobiologia*, 65 : 39-47.
- Sharma, B.K.** 1980a. A new lecanid rotifer from West Bengal, India. *Bangladesh J. Zoology*, 8 : 131-132.
- Sharma, B.K.** 1980b. A note on some epizoic rotifers from West Bengal. *Bull. zool. Surv. India*, 2 : 109-110.
- Sharma, B.K.** 1999. Freshwater Rotifers. *State Fauna Series 3 : Fauna of West Bengal*. Part-11 : 341-461. Zool. Surv. India, Kolkata.
- Sharma, B.K. and R.G. Michael**, 1980. Synopsis of taxonomic study on Indian Rotatoria. *Hydrobiologia*, 73 : 229-239.

- Sharma, B.K. and Michael, R.G. 1983. Redescription of *Alona taraporevalae* Shirgur & Naik. 1977 (Cladocera : Chydoridae : Aloninae). *Rec. Zool. Surv. India*, **81** : 35-39.
- Sharma, R.C. 2007. *The Fauna of India and the adjacent countries—Reptilia (Serpentes)* Vol. II : 1-410 (Pub.—Director, *Zool. Surv. India*, Kolkata).
- Sikoki, F.D. and Zabbey, N. 2006. Environmental gradients and benthic community of the middle reaches of Imo River, South-Eastern Nigeria. *Environ. & Ecol.*, **24**(1) : 32-36.
- Simmons, W.J. 1889. Note on a species of *Podophrya* found in Calcutta. *Amer. Mon. micro J.*, **10** : 145.
- Simmons, W.J. 1891a. Some of the animal and vegetable micro-organisms procurable at the General's Tank, Calcutta. *Bull. Micr. Soc.*, Calcutta, **I** : 1-5.
- Simmons, W.J. 1891c. On the occurrence in the freshwaters of Calcutta of reticulated Amoeba. *Amer. Micr. J.*, London, **12** : 112.
- Simmons, W.J. 1891b. A reticulated Amoeba (*Biomyxa vegans*) from Calcutta. *Sci. Gross.*, London : 109-202.
- Simpson, E.H. 1949. Measurement of diversity. *Nature*, **163** : 688.
- Sinha, P. 1991. The genesis of a colonial city. In : B. Dasgupta *et al.* (eds.). *Calcutta's Urban Future*, Govt. of West Bengal, Calcutta, pp. 1-7.
- Smith, G.R., Vaala, D.A. and Dingfelder, H.A. 2003. Distribution and abundance of macroinvertebrates within two temporary ponds. *Hydrobiol.*, **497** : 161-167.
- Soota T.D. and Pattanayak, J.G. 1982. On some freshwater sponges from the unnamed collection of the Zoological Survey of India. *Rec. zool. Surv. India*, **80** : 215-229.
- Soota, T.D. 1991. Freshwater Sponges of India. *Rec. zool. Surv. India, Occ. Paper No. 138* : 116 pp, text figs. 5.
- Soota, T.D. 1977. Fauna of Kashmir-Leeches. *Rec. Indian Mus.*, **54** : 1-4.
- Soszka, G.J. 1975. The invertebrates on submerged macrophytes in three Masurian lakes, *Ekologia Polska*, **23**(3) : 371-391.
- Stephenson, J. 1911. On some aquatic Oligochaeta in the collection of Indian museum. *Rec. Indian Mus.*, **6** : 203-214.
- Stephenson, J. 1912. On a new species of *Branchiodrilus* and certain other aquatic oligochaeta with remark on cephalisation in the Naididae. *Rec. Indian. Mus.*, **7** : 214-241, pl. XI, XII.
- Stephenson, J. 1913. On a collection of oligochaeta mainly from Ceylon. *Spol., Zeylan*, Colombo, **8** : 251-276, pl. I, II.
- Stephenson, J. 1914. On a collection of oligochaeta mainly from northern India. *Rec. Indian Mus.*, **10** : 321-365, Figs, pl. XXXVI.

- Stephenson, J.** 1923. *Oligochaeta. The Fauna of British India.* (London). XXIV + 518 pp, 262 figs.
- Stephenson, J.** 1932. Report on oligochaeta Mr. Omar-cooperi investigations of Abyssinian freshwaters. *Proc. zool. soc. London.*, 1932 (1-2) : 227-256, 18 figs.
- Subba Rao, N.V.** 1989. *Handbook: Freshwater molluscs of India.* Zoological Survey of India, Kolkata, XXIII. 289 pp.
- Subba Rao, N.V.** 1993. Freshwater Molluscs of India. In : K.S. Rao (ed.), *Recent Advances in Freshwater Biology.* 182-202 pp.
- Sukumaran, P.K.** 2006. Benthic and littoral fauna of a perennial tank in Bangalore. *Environment and Ecology*, 24S(2) : 348-351.
- ter Braak C.J.F. and Smilauer, P.** 2002. CANOCO Reference manual and CanoDraw for Windows user's guide : software for canonical community ordination (version 4.5). Micro-computer Poer, Ithaca, NY.
- Thresh, J.C., Beale, J.F. and Suckling, E.V.** 1949. *The examination of water and water suppliers.* J. and A. Churchill Ltd., London.
- Tiwari, K.K. and Sharma, B.K.** 1977. Rotifers in the Indian Museum Tank, Calcutta. *Sci. & Cult.*, 43 : 280-282.
- Tonapi, G.T.** 1980. *Fresh Water Animals of India. An ecological approach.*, Oxford and IBH Publishing Co. New Delhi, Bombay, Calcutta, pp. 341.
- Varga, I.** 2003. Structure and changes of macroinvertebrate community colonizing decomposing rhizome litter of common reed at Lake Fertő/Neusiedler (Hungary). *Hydrobiol.*, 506-509 (1-3) : 413-420.
- Victor R. and Fernando, C.H.** 1979. On freshwater Ostracods (Crustacea : Ostracoda) of India. *Rec. Zool. Surv. India*, 74(2) : 147-242.
- Victor, R., Dance, K.W. and Hynes, H.B.N.** 1981. Drift of ostracod crustaceans in adjacent intermittent and permanent stream. *Hydrobiologia*, 80 : 216-223.
- Victor. R and C.H., Fernando,** 1979. The Fresh Water Ostracods (Crustacea : Ostracoda) of India. *Rec. zool. Sur. India*, 74(2) : 147-242.
- Volmer-Rebeiro, C. and Pauls, S.M.** 2000. Freshwater Sponges (Porifera, Demosporingiae from Venezuela *Acta. Biol. Venez.*, 20, 1-28.
- Weatherhead, M.A. and James, M.R.** 2001. Distribution and diversity of benthic macroinvertebrates in relation to physical and biological variables in the littoral zone of nine New Zealand lakes. *Hydrobiologia*, 462 : 115-129.
- West, D.A.** 1976. Aposematic coloration and mutualism in spongedwelling tropical zoanths.- Pp. 443-452 in : Mackie, G.O. (ed.). *Coelenterate ecology and behaviour.* Plenum.

- Westinga, E. & PC. Hoetjes 1981. The intrasponge fauna of *Sphaciospongia vesparia* (Porifera, Demospongiae) at Curacao and Bonaire. *Marine Biology*, **62** : 139-150.
- Wetzel, M.J., R.D. Kathman, S.V. Fend & K.A. Coates, 2007. Classification and checklist of freshwater oligochaeta occurring in North America of Mexico. World Wide Web URL : <http://www.inhs.uiuc.edu/mjwetze/FWOligoNachklist.html>.
- Wetzel, R.G. 1983. *Limnology* 2nd Edition. CBS College Publishing, Philadelphia. 767 pp.
- Wetzel, R.G. and Likens, G.E. 1991. *Limnological analyses*. 2. ed. Springer-Verlag, New York.
- Whiteside, M.C. and R.V., Harmsworth. 1967. Species diversity in Chydorid (Cladocera) communities. *Ecology*, **48**(4) : 664-667.
- Wilhm, J.L. and Dorris, T.C. 1968. Biological parameters of water quality criteria. *Bioscience*, **18** : 477-481.
- Wilson, C.B. 1932. *The Copepods of the woods hole region Massachusetts*. Smithsonian Institution United States National Museum. *Bulletin*, **158** : 623 pp.
- Wood-Mason, J. 1871. Contribution to Indian Carcinology. Part-I. On Indian and Malayan Telphusidae. *J. Asiat. Soc. Bengal*, **40**(2) : 189-200, pls. 11-12.
- Zavodnik, D. 1976. Adriatic echinoderms inhabiting benthic organisms. *Thalassia Jugoslavica*, **12** : 375-380.

PLATE-II



Fig. 2 : Indian Museum tank surrounding in 1926. Courtesy : Director, Indian Museum



Fig. 3 : Recent photograph of Indian Museum Tank.

PLATE-III

Fig. 4 : Indian Museum Tank showing wooden pillars planted for reclamation.



Fig. 5 : Indian Museum Tank showing deweeded stack on the bank.

PLATE-IV



Fig. 6 : Showing demolition of residential quarter beside Indian Museum Tank



Fig. 7 : Left side view of Indian Museum Tank.

PLATE-V

Fig. 8 : Total view of Indian Museum Tank along with surrounding office buildings.



Fig. 9 : Collection site (IMT 2) of Indian Museum Tank.

PLATE-VI



Fig. 10 : Freshwater Sponge (*Eunapius carteri*).

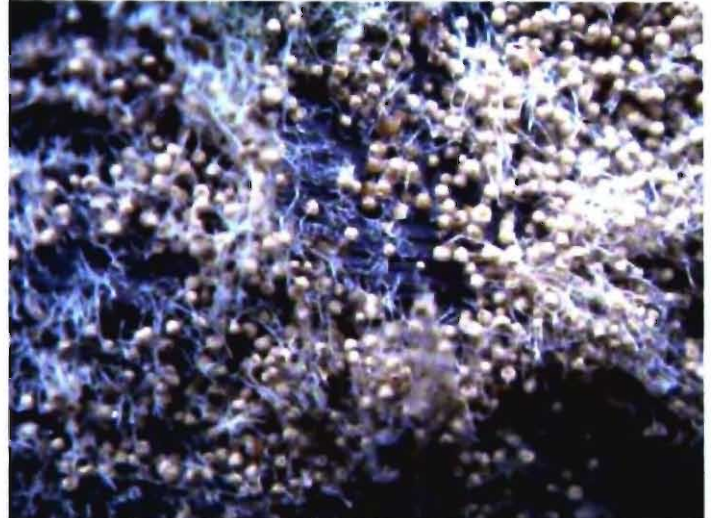


Fig. 11 : Gemmules of Freshwater Sponge (*Eunapius carteri*).



Fig. 12 : Freshwater Sponge (*Eunapius carteri*)
in habitat.



Fig. 13 : Freshwater Leech.

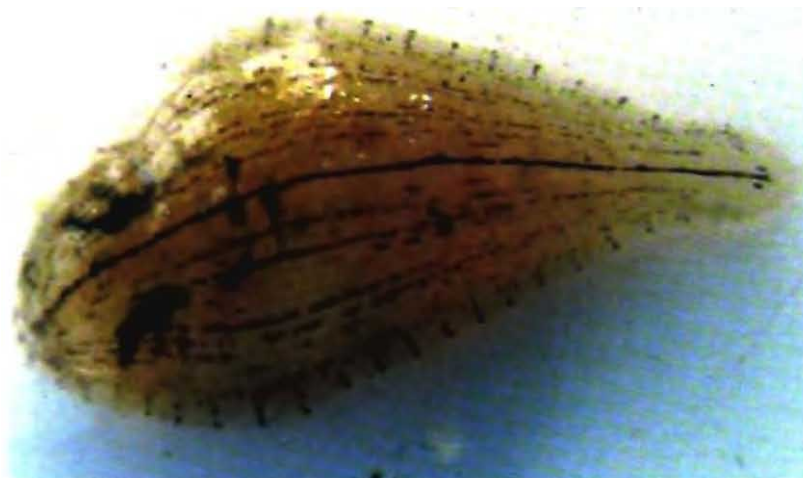


Fig. 14 : Freshwater Leech.

PLATE-VII



Figs. 15-20 : Insects inhabiting tanks surrounding.

PLATE-VIII



Figs. 21-24 : Spiders and Aquatic Hemiptera of IMT

PLATE-IX

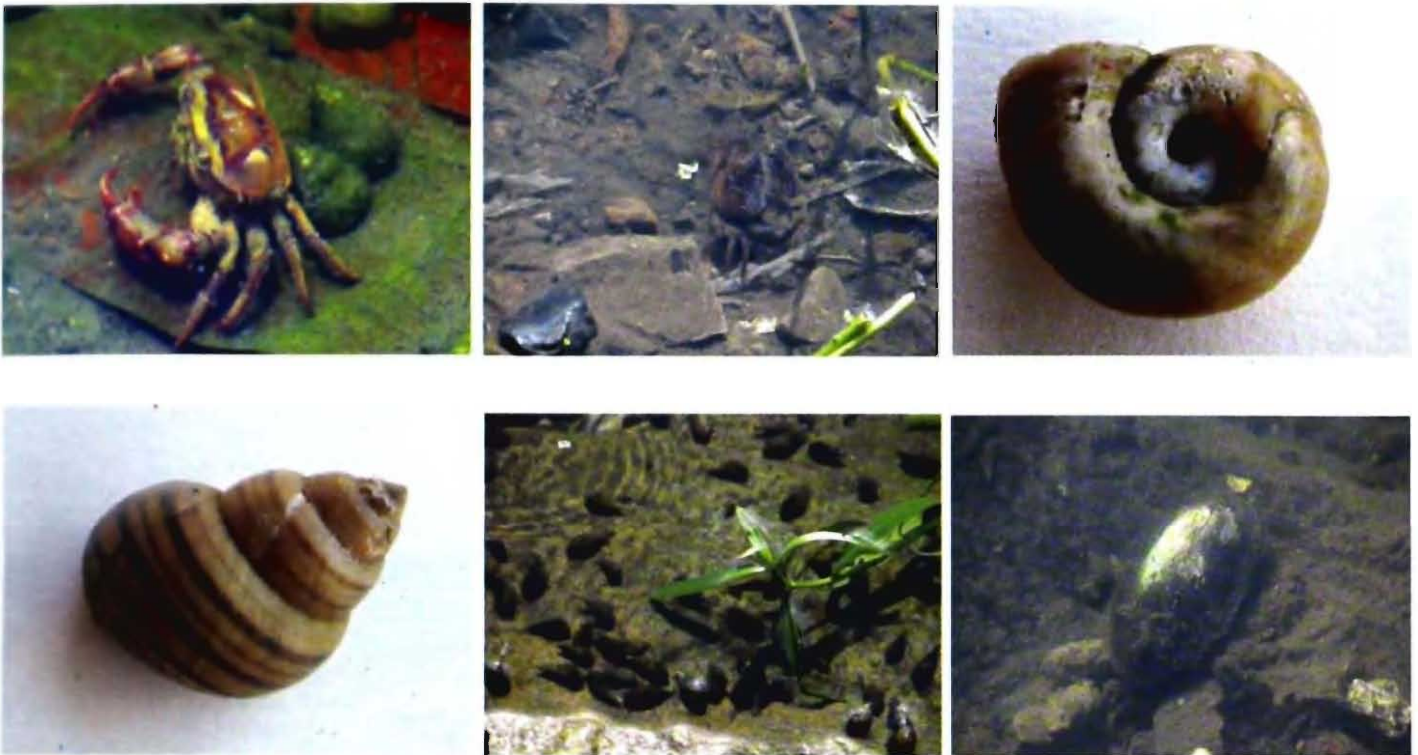


Fig. 25-30 : Freshwater Crabs and Molluscs of IMT

PLATE-X

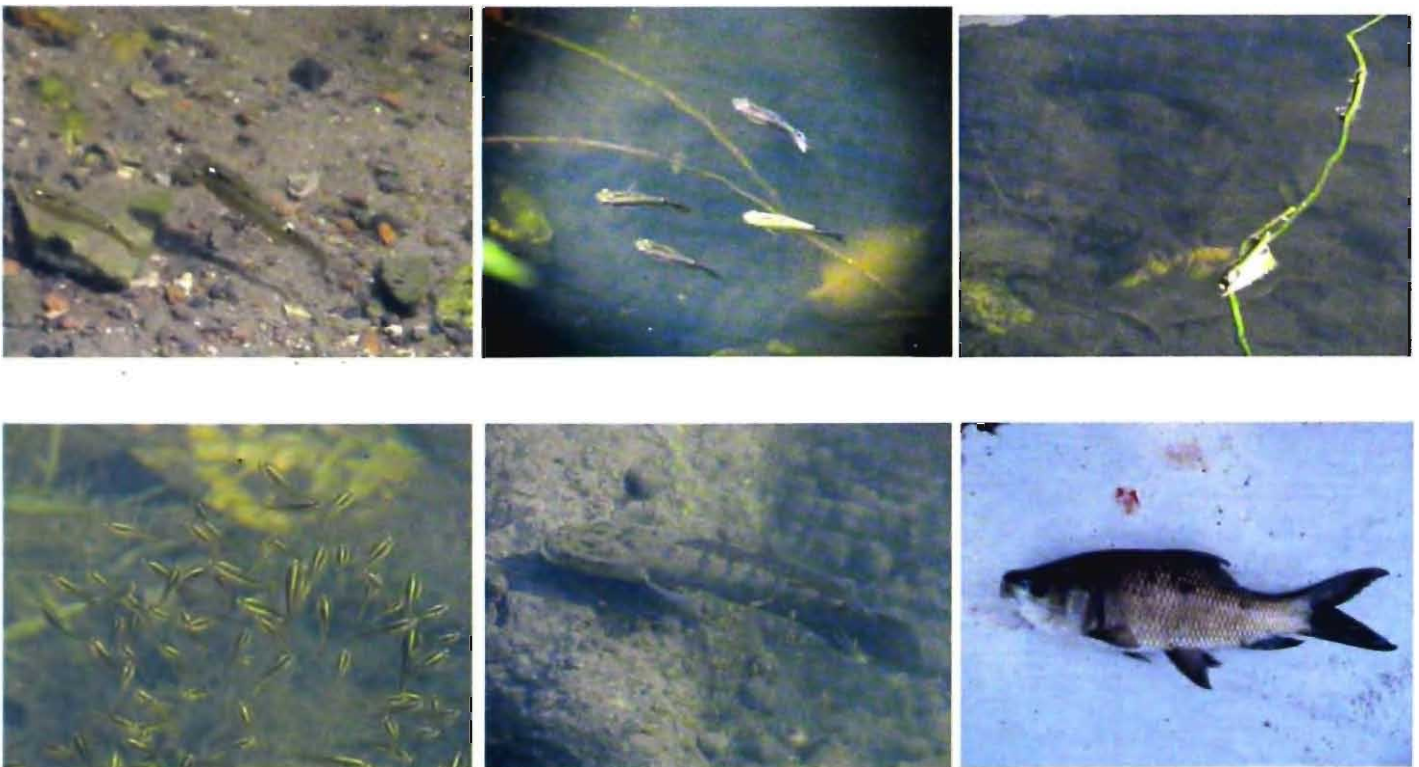


Fig. 31-36 : Fishes inhabiting in IMT.

PLATE-XI



Fig. 37-39 : Frog, Cormorants and Kingfisher associated with IMT.

PLATE-XII



Fig. 40-42 : Garden lizard, House crow and Purple rumped Sunbird. Associated with tank surrounding Garden.